ANALYSIS OF SUPPLY RESPONSE AND TREND OF GINGER PRODUCTION IN BENUE AND KADUNA STATES, NIGERIA

BY

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ABSTRACT

This study analysed supply response and trend of ginger production in Benue and Kaduna States Nigeria. A multistage sampling technique was employed. Cross sectional data from 359 respondents were collected through structured questionnaire and time series data from 1979 to 2018 were also used for the study. Simple descriptive statistics, Autoregressive Distribution Lag Model (ARDL) and the grafted polynomial model were employed for the study. Male (80.5%) dominated ginger farming. (83.3%) were married with an average household size of 8 persons. (62.4%) attained the level of secondary education at an average age of 31 years. Ginger farmers were well experienced in their farm practices with an average farm size of 1.0 ha. The result of the ARDL model revealed that ginger output responded positively to land area and price change at 1% significant level in the long run with a coefficient of 0.316 and 1.452. Ginger productivity dprod(-1) and dprod(-2) were significant at 1% and positively influenced the productivity of ginger in the short run. The coefficients of the current (0.381), first (0.2598) and second (1.0256) lag of land area positively affect ginger production at 1% significant level in the short run. The short run coefficients for the current price (1.8518) and first lag of price (1.2059) positively influenced ginger production at 1% significant level. However, ginger production was negatively influenced by price in the second previous years at 10% significant level. The estimate of the error correction term (ECT) has a coefficient of -0.884, -0.929 and -0.124 in Benue, Kaduna and the pooled sample respectively. This implies that nearly 88%, 92% and 12% of any disequilibrium level of ginger production during the previous years will be corrected in the subsequent years in Benue, Kaduna and the States combined respectively. The observed trend in ginger production indicated that ginger output stood between the ranges of 180,000 to 200,000 metric tonnes from 1980 to 1984 and maintains a slow rise from 1985 to 1990. However, between 1999 and 2000 there was a structurer break and a sharp drop in ginger production. Ginger production increases from 455,660.55 to 503,001.12 metric tonnes between 2009 and 2010 and reaches a peak of 594,502.52 metric tonnes in 2015. However ginger production fell sharply from 56,000 to 27,000 metric tonnes between 2017 and 2018. These changes occurred either as a result of price variation or government agricultural policies. The result of the ex-ante and ex-post forecast of the Quadratic-Quadratic-Linear function for the pooled sample predicted a fall in ginger output in the future with a root mean square error(RMSE), mean absolute error(MAE) and mean absolute percentage error(MAPE) of 65658.12, 49729.86 and 16.386 respectively. Inadequate rainfall, high, weed infestation, disease incidence, high cost of seedlings, inadequate improved seed variety, inadequate loan and credit, inadequate market extension service are serious constraint militating against ginger production in the study area. Since the Quadratic-quadratic-linear function predicted a possible fall in ginger production in the near future, it is recommended that credit facilities and farm inputs should be made available in the study area, ginger farmers should be sensitized through adequate extension services on modern production techniques and adaptation strategies to climate change constraints. Government should regulate the price of ginger as a potential export commodity. The land tenure act should be more flexible to give more access to land for ginger production.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Nigeria has in recent years, been involved in executing painful economic recovery programmes arising from recession in international oil market and changes in the macroeconomic direction of the world. This is the consequence of dependence on a monolitic (crude oil) economy at the expense of other untapped economic resources of the nation (Nigerian Association of Agricultural Economists, 2015).

A strong and efficient agriculture sector would enable a country to feed its growing population, generate employment and foreign exchange and provide raw materials for industries. The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of its multifunctional nature (Mbam, 2012). The crises in Nigeria economy lies in the neglect of the agriculture sector and the increase dependence on a mono-culture economy, mostly based on oil (National Directory of Employment, 2006). The neglect of the agriculture sector has post so many challenges in the development of agriculture in Nigeria. Aside this, most farmers are unaware of several factors to be considered during their farming practice. One among the major challenges is the fluctuation in price of agricultural commodities which is also common to ginger production (Titilayo *et al.,* 2016).

Ginger (*Zingiber officinale*) as a crop is an herbaceous perennial plant belonging to the order, *Scitamineae* and the family *Zingiberaceae*. It is referred to as root crop and a typical herb extensively grown across the world with its pungent aromatic under-ground stem or rhizome which makes it an important export commodity in world trade (Ajibade and Dauda, 2005). Ginger is a rhizomatous spice of culinary and medicinal importance (Amadi, 2012).

Nigeria was among the countries that the global production of ginger in 2008 was over 1.4 million metric tons (MT) and the major exporting country to US in 2007 (Folorunso and Adenuga, 2013). Out of over 1.4 million metric tons (MT) of ginger produced annually, Nigeria produces an average of 50,000 metric tonnes of fresh weight ginger per annum. About 10% of the produce is consumed locally as fresh ginger while the remaining 90% is dried for both local consumption and export. 20% of the dried ginger is consumed locally for various uses and 80% is exported (Ezeagu, 2006; Folorunso and Adenuga, 2013). The global demand for ginger was necessitated by the various uses of ginger crop. it is used domestically for spicing food and also for local medicinal purposes. It is also used by pharmaceutical, beverage and cosmetics companies, for the production of drugs, beverages and cosmetics respectively. According to Mallam (2015) ginger is not only an income earner for individual farmers, it is as well a foreign exchange earner for the country, and the dried products are the major forms of which ginger is traded internationally. It also has various uses, which ranges from been used as spices in soups, confectionaries, zingiberone (anti-helmintic) from Zingiberofficinale, oloresine are among the extracts used for medicinal purposes (Mallam, 2015). Fresh ginger is consumed as vegetable. Ginger powder is used in making ginger beer, wine, and baked foods. The essential oil obtained from ginger is used in the food and perfume industries. Oleoresin is the total extract, which contains both volatile oil and pungent extractions. It is used in many types of baked foods, sauces, and alcohol beverages. Ginger is widely used for flavouring a great variety of foods. In western countries, ginger is used for culinary purposes. In Saudi Arabia, ginger is used mainly in the preparation of ginger coffee. In United States of America (USA), United Kingdom (UK) and Canada, ginger is widely used in meat processing industries. Ginger is extensively used in winter for curing minor ailments like cough and cold. It is also prescribed as an adjunct of many tonic and stimulating remedies. Other uses include; culinary uses such as stews, pepper soups, etc; and Medicinal/Therapeutic uses such as ginger/lime/honey anti-malarial and anti-typhoid fever portion, ginger/garlic anti-hypertension tea (Mefoh, 2006). Ginger is used in the control of atherosclerosis in rabbits and nausea and vomiting and has confectionary and beverages uses as well used as ginger ale, ginger beer, meat flavouring and tendering, diary product and livestock feeds. Despite the increased demand and uses of ginger in both local and global market, its production is perceived to fall short of the demand for the crop, thus creating a wide gap between the demand and supply of ginger in the market place.

Despite the huge potentials of ginger in stimulating agricultural growth in Nigeria, it is surprising and unfortunate to note that the trend of ginger production and trading in Nigeria is not on a steady accent (Daniel, 2009). Over the years, in Nigeria, there have been occasional food supply shortfalls and high food prices in all or some parts of the country, it can be noted that changes in ginger production output was glaring over the years (2001 to 2016) from as low as 200,000.00 tons in 2001 to as high as 556,901.00 tons in 2016 (Kaduna State Agricultural Project, 2017). Though there may be fluctuation within the year interval, this report indicates the growing importance of ginger as an essential cash crop (Food Price Watch, 2017). Notwithstanding, ginger production has not been an exception to the declining performance of agricultural production in Nigeria, hence it has not been able to realize its full potential as an export crop and a major foreign exchange earner (Sunday *et al.,* 2014).

The price of nearly every agricultural commodity increased sharply by 55 percent between 2007 and 2008 (UN Department of Public Information, 2008). This fluctuation in the price of agricultural product (i.e tubers and cereals crop) produces a supply shock leading to a yearly seasonal change in agricultural output. A look at these seasonal changes in ginger production provides the required information on their causes and trend which further guides ginger farmers in their production pattern. Recently between 2015 and 2016 the price of agricultural commodities including ginger increased sharply with some commodities experiencing an increase of between 50% and 80% in Nigeria. However, despite frantic efforts by the Central Bank of Nigeria (CBN) to put stringent monetary policies in place, the prices of goods and services are steadily rising throughout the country (Food Price Watch, 2017).

Agricultural commercialization policies and price mechanism targeted towards increasing output in supply response play an important role in increasing farm production (Nerlove and Bachman, 1960). Measurement of supply trend and responsiveness of ginger farmers is a veritable means of assessing the impact of economic reforms. Policies which provide appropriate incentive such as price or non-price incentives are likely to bring about high supply responsiveness, while those that act as disincentives are less likely to do so. Interestingly, if agricultural supply is highly responsive to changes, it is likely farmers' behavior to produce more can effectively induced changes in ginger production.

For information to be meaningful and useful to ginger farmers there is the need for analysis to refine and summarise the information, hence, the estimations of output supply response and forecasting models to forecast the probable future values of an economic time series which is one of the econometric methods of information management (Nigerian Association of Agricultural Economists, 2015). The use of supply and trend models for estimation could improve ginger farmers level of productivity and the power of prediction provided by the use of time series data which subsequently guides against unforeseen circumstances in the near future (Commission for Sustainable Development, 2008).

1.2 Statement of the Research Problem

The population growth rate in Nigeria is higher compared to its food production (National Planning Commission, 2015). The population of Nigeria as at 2019 stood at 202,937,844 with a high dependency ratio of 78.8% (World Population Prospects 2019 Revision). The Nigeria Food Consumption and Nutrition Status Survey (NFCNS) showed that nationally, 42 percent of children were stunted with an estimated 2 million children in Nigeria suffering from severe acute malnutrition, 25 percent underweight and 9 percent wasted (USAID, 2017). This will convert sub-Saharan Africa to being the region with the highest number of inhabitants who are chronically malnourished.

Producers of ginger in Nigeria face the world market directly. They reap profits when prices are good but absorb shocks and suffer losses when prices fall. Consequently, the producer's price of ginger has become unstable creating dis-incentive for production thus making output and exports to suffer (Mesike *et al*., 2010). This could have negative implications for the agricultural industry and for the national income. Consequently, the prices at which ginger and other cash crops farmers in Nigeria are able to sell their produce to a large extent now depend on how they respond to both local and global demand.

Ginger production has not been an exception to the declining performance of agricultural production in Nigeria, given that it has not been able to realize its full potential as an export crop and a major foreign exchange earner. As observed by Sunday *et al*. (2014), the absence of scientific research on the supply system to back up the efforts of the farmers was among the factors limiting increased production. The trend and output supply response to price and other variables could have a negative effect on ginger production in Nigeria. According to Emmanuel (2008) in response to the dwindling fortune of ginger production in Nigeria, governments have over times initiated numerous policies, programmes and projects aimed at reviving ginger production. No study has been undertaken in Nigeria in recent years to analyse the supply response and trend in ginger production. It is assumed that if appropriate measures are not undertaken to address the problems and pattern of seasonal food production and price fluctuation, the future growth of agriculture in Nigeria would be jeopardized. It is in view of this that this study aims at answering the following research questions.

i What are the socio-economic characteristics of ginger farmers?

ii What is the output supply response of ginger farmers?

iii What is the observed trend of ginger production in the study area?

iv What is the ex-post forecast for ginger production in the study area?

v What are the constraints faced by ginger farmers in ginger production?

1.3 Aim and Objectives of the Study

The aim of this research work is to examine the supply response and trend of ginger production in Benue and Kaduna States, Nigeria. The specific objectives of the study are to:

i. describe the socio - economic characteristics of ginger farmers;

ii. determine the output supply response of ginger farmers;

iii examine the observed trend of ginger production in the study area;

v estimate and predict the trend of ginger output in the study area;

vi examine the constraints faced by ginger farmers in ginger production.

1.4 Research Hypotheses

$H0_1$ There is no significant relationship between supply and prices of ginger.

$H0_2$ The size of land area cultivated does not have significant effect on ginger output

$H0_3$ There is no fall in ginger production in the near future

1.5 Justification for the Study

Uncertainty in crop prices makes it difficult for farmers in Nigeria to be confident that they will obtain a sufficient return from the sale of the additional harvest in their production practices. This is alleviated by fluctuations in output and market information services that assist producers in organizing supply and enabling farmers to re-route goods to other markets which suffer from a shortage of supply or high-demand (Mani, 2018). There is therefore a need to understand the pattern of output variations and the causes of these variations in ginger production in other to establish policies that will help stabilize deviations in ginger production.

The focus on ginger supply apart from its importance is also derives from the fact that ginger is a valuable export commodity with the capacity of generating high foreign exchange as a means of government revenue and also a source of income to small scale rural farmers. In addition to this, ginger is a multipurpose crop; all parts of the plant have economic value. Emmanuel (2008) asserted that most of the previous researches focused on the profitability and efficiency of ginger production with little emphasis on the supply analysis and the supply trend.

Various factors affecting the supply of ginger in Nigeria could have a negative effect on the productivity level of ginger farmers and consequently, their level of incomes. It therefore becomes imperative to determine these factors and the trend of ginger output in order to provide credible information on redressing the situation. In addition, a supply output response analysis will enable this research to estimate the various trends associated with ginger production in the study area.

In developing countries like Nigeria, inadequate information on the determinants of an economic time series and the absence of capable statistical routines, have often limited the choice of predictive models. These conditions have necessitated the forecasting of key economic time series (supply, demand, prices, etc) on trend, using variants of the linear model which is not in good means as compared with the grafted model. It is therefore with the hope of using the right model in detecting relevant factors that could serve as incentive for agricultural households to increase the present level of ginger supply in an effort to bridge the gaps between food supply and consumption and to provide a better understanding of supply response in ginger production that this study will be carried out. Thus, the study is therefore another avenue towards increasing the production and supply of ginger by determining the structure of supply system.

Tight market conditions for essential agricultural commodities pose policy challenges for national governments, as well as for international organizations (Mani, 2018). In order to take the right policy decisions, there is the need to understand what causes the supply shock, what the implications may be for prices and price volatility in ginger production, and how ginger farmers may be affected. Prices vary almost throughout the year and understanding the trend of such variations will therefore be essential for good planning by ginger farmers, consumers and policy makers. This research aims to improve the knowledge of ginger farmers on how to predict and respond to price change in the future.

This study attempted using model which incorporates more general dynamic structure than the restrictive popular Nerlovian models often used in agricultural supply response function. Hence, unlike Nerlovian model, the co-integration approach is useful in overcoming the potential problem of spurious regression in supply response function. The research provide the basis for further research work most especially in respect to supply response and trend in ginger production. In addition to this, is to provide government with the understanding with the view to contributing to sound policy formulation for ginger production in Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Theory of Supply

The word "supply" is commonly used to mean two different things. One definition of "supply" is the total of new production and stocks. "Stocks" is the amount of product available at the beginning of a new production period. In other words, "supply" is the total quantity available. In this module, the term "total supply" will be used to indicate the total quantity available. The other common use of "supply" describes how producers react in the market place. "Market supply" or "aggregate supply" represents the amount of a product all producers are willing to sell over a range of prices at any given time period (Irena, 2012). At an individual level, a producer may be willing to sell a particular quantity as long as the market price is equal to or greater than the cost of producing that quantity.

Market or aggregate supply is the total of the quantities all individual farmers want to bring to market at various price levels. "Market supply" is represented graphically as an upward sloping curve or line with price on the vertical axis and quantity on the horizontal axis. An increase in price, in most instances, will result in farmers wanting to increase the quantities they bring to the market, so the relationship between price and supply is positive. Figure 1 shows a typical supply curve or line. It shows that as price increases, producers of the product are willing to produce more (Siyan, 2005).

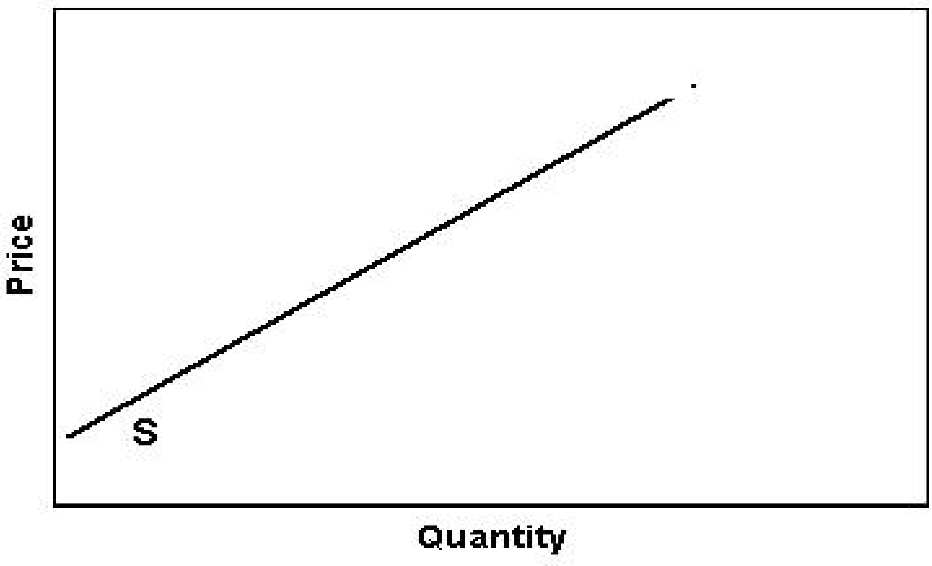

Figure 1: Supply Curve

There are other factors that influences supply actions of producers, this include: the size of the market, farm size, the number of firms producing the product, technological advancement, the price of inputs, the price of other or alternative products that could be produced, unpredictable events such as the weather and availability of storage facilities.

2.1.1.2 Supply response functions

The supply curve shows the relationship between the quantity supplied and it determinants. These other determinants include farm gate price, the price of inputs, land acreage, labour input, rainfall, fertilizer input, amount of capital and technological level.

When the ceteris paribus' assumption is not satisfied, the simple relationship is extended to a multivariate one as specified in equation (1) as:

$$QS_t = a + FP_t + PI_t + L_t + R_t + LA_t + F_t + C_t + TL_t + U_t \quad (1)$$

Where QS_t = quantity supplied in period t

FP_t = Farm gate price in period t

PI_t = Price of input in period t

Lt = Labour used in period t

R_t = Rainfall in period t

LA_t = Land Area used in period t

F_t = Quantity of fertilizer applied in period t

C_t = Capital expenditure in period t

TL_t = Technological level in period t

a = Constant parameters

U_t = Error in period t

The farm gate price(FP_t) and the price level of other input (PI_t) is influenced by macroeconomic policies such as foreign exchange rate policy, export taxes, import taxes and price subsidies. If the price level on the official markets is more or less fixed, the farm gate price and input price will depend on the transportation costs and the efficiency of the distribution system. If there are private buyers for the agricultural output or input, they can get a monopoly rent, thus lowering the farm gate and input price. If State agencies are working inefficiently, either the farm gate price is lowered, or the agencies are accumulating deficits to be paid by the government. Both, the transportation system and the market system, have an important impact on the output and input prices. The labour input (Lt) depends on the amount of available labour, the number of hours worked and the efficiency of the labour force. If the farm gate price level increases, the number of working hours might be reduced. The farm consumption of its own products could increase which will, in turn, reduce the marketable surplus. The availability of products to buy from outside, and the price level for these products can have an important impact on the consumption and production behaviour of the farms. When the farm gate prices rises, if there are no goods on which the extra money can be spent, there will be no incentive to work more. The intensity of rainfall (R_t) at different period in time could have a negative or positive influence on crop production depending on the nature of the crop. Climatic change could be responsible for the variation in rainfall over the years.

The size and quality of Land area (LA_t) cultivated at different period have an impact on the supply. In addition, the size structure influences productivity in the sense that the farming intensity is normally higher on smaller farms than on larger farms. Also, depending upon whether the farms are privately owned, or the farmers are tenants, the tenure conditions will vary, and they can be more or less conducive to new initiatives on the farms. The amount of capital at different period Ct on the farms is, of course, important. A well functioning credit system, so that new undertakings can be financed, is crucial. The technological level (TLt) depends on the human capital on the farms. The educational level and the nutritional standard influence the absorption capacity of new farming practices among the farmers.

The "supply" of technological know-how depends on the research activity in the area, and the dissemination of the know-how through extension services.

The supply response is not only a function of the output and input prices, but also a function of non-price factors. The crucial question is to find out the type of relation ship that exists between the price and major non-price factors. The choice of the other determinants of supply depends on the characteristics of the production schedule of each crop or product. It is to be further noted that these characteristics may even change in the same country or locality over time. What therefore is needed is a comprehensive supply model which can incorporate the various alternative opportunities open to the farmers (Mark, 2015).

2.1.1.3 Elasticity of supply

Supply elasticity is a measure of how much producers of a product change the quantities they are willing to sell in response to a change in price or other factors. If the change in sales is large compared to a unit change in price, supply is said to be elastic. On the other hand, if the change in the quantity supplied is small relative to a unit change in price, supply is said to be relatively inelastic.

Supply elasticity is usually written as a positive number, since a higher price can be expected to result in more products offered for sale and a smaller price will usually result in fewer products offered for sale. It is important to understand the difference between shifts in supply and changes in quantity supplied. Shifts in supply occur as a result of a change in one or more of the other factors influencing supply, but not a change in the product's price. A supply shift changes the amount producers are willing to supply at the same price levels. Changes in quantity supplied occur only as a result of a change in the price of the product (Siyan, 2005). A change in quantity supplied is represented as a change in position along a product's supply curve with all other factors remaining constant. Several factors have an influence on the quantity supplied in response to a product's price changes. The factors include time, the cost structure of producers, producer price expectations, ability to store a product, and the ease of changing from the production of one product to another (Mark, 2015).

The influence of time may be short, medium or long-term. In the short-term, responsiveness of quantity supplied to price change tends to be small as changes cannot be made quickly. Once a crop is seeded, for example, farmers have limited ability to alter the quantities they put on the market. Therefore, in the short-term, market supply is relatively inelastic or unresponsive. Where there is no opportunity to adjust production in response to price, the supply curve is vertical and the market supply is fixed. As the length of time represented in the supply curve, that is, the production time grows; market supply tends to become more elastic or more responsive to price changes.

The physical production process of any particular commodity influences how much time must pass for a term to be considered short or long. The short-term is that length of time over which only a few inputs can be changed. For example, once land is allocated to a crop and the crop is seeded, changes in planned output are limited. In the long-term, all factors such as land are variable. Somewhere in between these two extremes is the medium-term. Within the medium-term, uses of the existing land base may be altered, for example, before purchase or sale of additional land takes place (David, 2004).

The cost structure of firms can influence supply elasticity in two ways. First, if individual producers can expand easily, then their individual supply curves can be characterized as relatively elastic. Expansion could easily happen by quick or easy access to credit or subsidies/rebates on other inputs. If most individual producers' supply curves were elastic, then, the overall industry supply curve would also be elastic. Secondly, if possible new entrants into an industry had cost structures only slightly above those firms already producing it is possible that a small increase in price could be enough to permit many more firms to enter the industry. This would generate a large supply response in total. Market gardens (small-scale fruit producers) provide an example of an industry with this type of supply curve elasticity. Due to the small land base and low capital investment required, this business occurs very regularly. It only takes a small movement in local prices to encourage or discourage production (Dwivedi, 2002).

The effect of producer expectations on the supply curve can be seen in the market garden example. If an increase in market garden prices were considered by many potential producers to be short lived or too small, then the total supply response would be less. Conversely, if price increases were expected to remain in the medium, or long-term, the elasticity of the total supply curve may be greater. In other words, supply is generated by the behaviour of producers and the behaviour of producers is dependent upon what their managers expect to happen (David, 2004).

The ability of a product to be stored affects how much a producer can offer for sale in a given time period with respect to ginger, which is easily storable. For instance, In one crop year, a producer may offer for sale what is harvested this year's and also what is in storage from previous years. On the other hand, if a product is perishable, like lettuce, market supply will be limited to what is currently produced (Siyan, 2005).

The ease of switching inputs to different uses is related to the influence of cost structures on supply elasticity. Some inputs or set of inputs may not be used for anything other than one product. If that is the case, then, the supply of that product will be relatively inelastic compared to a product produced with inputs that can be used in a variety of ways. For example, a corn harvester has little use other than harvesting corn. Once the corn harvester has been purchased, the flexibility in switching output to wheat is more limited; the farmer is more locked into corn. In the market, corn supply has become less elastic, or less responsive to price changes.

2.2.1.4 Methods of measuring supply response analysis

According to Triphati (2008) there are two major approaches to estimation of agricultural supply response; the indirect structural form approach and the direct reduced form approach.

a. Indirect structural form approach

This approach involves derivation of the input demand function and supply function from the available data. It also includes derivation of the input demand function and supply function from the information relative to production function and individuals' behaviours. This method is more theoretically rigorous but fails to take into account the partial adjustment in production and the mechanism used by farmers in forming expectations. The approach requires detailed information on all the input prices (Triphati, 2008).

b. Direct reduced form approach

This approach involves the direct estimation of the single commodity supply functions from time series data. Production in agriculture is not instantaneous and is dependent on post investment decisions and expectations', meaning the production in any period or season is affected by past decisions. The supply level is a function of current economic conditions, at the time decisions were made as well as the expectation about future conditions (Thiele, 2002). The majority of supply response studies fall in this category. The most prominent directly estimated empirical models that have been used in previous studies to model supply response of agricultural crops include; partial adjustment model, co-integration and error correction model.

2.2 Conceptual Framework

This study is guided by the conceptual framework of farmers' response to price and non-price factors. From Figure 2, it can be seen that the formal trade, informal trade and inter-household trade form the ginger output market. The output market influences the output prices which are also largely affected by government, through policy intervention. Government policies also affect the agricultural input prices which in turn affects farmers' decision towards production and supply of ginger. Government policy also affects formal trade, through export and import bans, as well as land policy and this also affects the amount of land allocated to specific ginger production. Output therefore also responds to land allocation. Prices of the ginger output and other crops influences the farmer's decision of whether to invest in ginger or not, since the farmer is eager to invest in other crops which might be perceived as more profitable than ginger. In turn, the farmers' decision affects the amount of land and labour allocated for ginger production. Household characteristics affect the farmers' decision to invest in ginger and physical conditions also contribute to ginger productivity. This create a static effect, short run and long run shock in ginger supply which is capture in trend estimate and form the basis for this analysis.

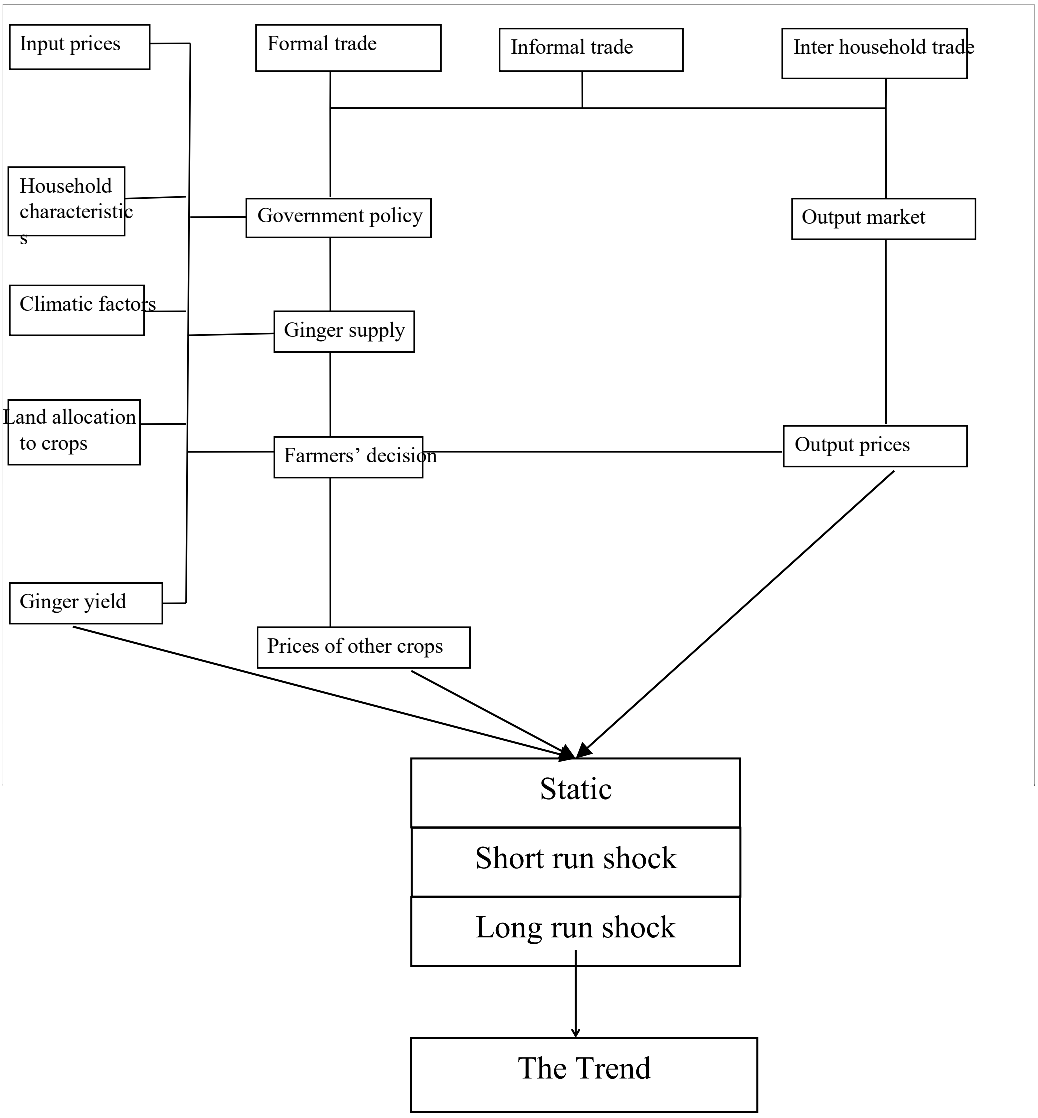

Figure 2: Farmer output supply response and trend in ginger production

Source: Adopted and modified from Rangariral (2014)

2.3 Supply Shifters

The total variation in the output is considered as a consequence of changes not only in the price factor but also in several non-price factors that have their bearing on production activity. It could be said that the price variation at best, explains only a part of the variation in the response variable (Gurikar, 2007). The bulk of studies on supply response highlighting the importance of non-price factors such as weather variations, technology, policies and market access for both inputs and output, have also drawn adequate attention as they have a significant effect on the supply side. Non-price factors seem to dominate price factors in farmers' decision-making (Rao, 2003; Mythili, 2008).

A major source of differences among studies has to do with accurately adjusting for non-price factors affecting production such as weather, infrastructure and technological changes which may be associated with prices. This is serious for studies of output response to prices. Studies differ in this regard depending on the availability of data on the authors judgment as to the relevance of a particular non- price factor (Rao, 2003). A measure of weather variation seems to be most commonly encountered in most studies, with a wide variety of methods used to capture this concept; indices of rainfall, humidity and frost etc. Concepts essentially related to infrastructure seem important and measurable to most researches, and thus are directly included in the statistical analysis model. In other instances, yardsticks that are difficult to quantify are presented by proxy variables.

According to Askari and Cummings (1977), the time or trend variable is mainly used as a proxy to detect time-related effects on overall output such as advances in agro-technology and secular growth in the demand of the industrial and/or consumption sectors for the output of the agricultural sector. The decision to use a trend variable rather than a more direct measure of postulated influence on supply is generally based on difficulties in obtaining reliable time series data for the factor in question. According to Thiele (2002) there are several other factors affecting agricultural production. These factors include; lack of infrastructure, human capital, technology and agro climatic conditions. Infrastructure includes accessibility of roads, market facilities, farmer access to credit; agro extension services, pesticides, communication and transport services have an effect on the agricultural output.

2.4 Specifications for the Analysis of Supply Response and Trend

2.4.1 Test for stationarity

A data series is said to be stationary if it has a constant mean and variance. That is the series fluctuates around its mean value within a finite range and does not show any distinct trend over time. In a stationary series displacement over time does not alter the characteristics of a series in the sense that the probability distribution remains constant over time. A stationary series is thus a series in which the mean, variance and covariance remain constant over time or in other words do not change or fluctuate over time. In a stationary series the mean always has the tendency to return to its mean value and to fluctuate around it in a more or less constant range, while a non-stationary series has a changing mean at different points in time and its variance change with the sample size (Mohammed, 2005). The conditions of stationarity can be illustrated in equation (2):

$$Y_t = \theta Y_{t-1} + \mu_t \qquad t=1 \quad \text{for all } t \qquad (2)$$

Where μ_t is a random walk with mean zero and constant variance, if $\theta < 1$, the series Y_t is stationary and if $\theta = 1$ then the series Y_t is non-stationary and is known as random walk. In other words the mean, variance and covariance of the series Y_t changes with time or have an infinite range. However Y_t can be made stationary by differencing.

Differencing can be done multiple times on a series depending on the number of unit roots a series has. If a series becomes stationary after differencing d times, then the series contains d unit roots and hence integrated of order d denoted as I (d). Thus, in equation (2) where $\theta = 1$, Y_t has a unit root. A stationary series could also exhibit other properties such as when there are different kinds of time trends in the variable. The DF (Dickey-Fuller)-statistic used in testing for unit root is based on the assumption that μ_t is white noise. If this assumption does not hold, it leads to autocorrelation in the residuals of the OLS regressions and this can make invalid the use of the DF-statistic for testing unit root. There are two approaches to solve this problem (Towsend, 2001). In the first instance the equations to be tested can be generalized. Secondly the DF-statistics can be adjusted. The most commonly used is the first approach which is the Augmented Dickey-Fuller (ADF) test. μ_t is made white noise by adding lagged values of the dependent variable to the equations being tested as indicated in equation (3-5):

$$\Delta Y_t = (\theta_1 - 1)\, Y_{t-1} + \sum_{i=1}^{k} \phi_1 Y_{t-1} + \mu_t \qquad (3)$$

$$\Delta Y_t = \alpha_2 + (\theta_2 - 1)\, Y_{t-1} + \sum_{i=1}^{k} \phi_1 \Delta Y_{t-1} + \mu_t. \qquad .(4)$$

$$\Delta Y_t = \alpha_3 + \beta_3 t(\theta_3 - 1)\, Y_{t-1} + \sum_{i=1}^{k} \phi_1 \Delta Y_{t-1} + \mu_t \qquad (5)$$

The ADF test uses the same critical values with DF. The results of the ADF test for unit roots for each of the data series used in this study are presented in the next section using equation (5) where Y_t is the series under investigation, t is the time trend, α_3 is the constant term and μ_t are white noise residuals.

2.4.2 Cointegration

Cointegration is founded on the principle of identifying equilibrium or long run relationships between variables. If two data series have a long run equilibrium relationship it implies their divergence from the equilibrium are bounded, that is they move together and are cointegrated. Generally for two or more series to be co-integrated two conditions have to be met. One is that the series must all be integrated to the same order and secondly a linear combination of the variables exist which is integrated to an order lower than that of the individual series. If in a regression equation the variables become stationary after first differencing, that is I(1), then the error term from the cointegration regression is stationary, I(0) (Hansen and Juselius, 2000). If the cointegration regression is presented in equation (6) as:

$$Yt = \alpha + \beta X_t + \mu_t \qquad (6)$$

where Y_t and X_t are both I (1) and the error term is I (0), then the series are co-integrated of order I (1,0) and β measures the equilibrium relationship between the series Y_t and X_t and μ_t is the deviation from the long-run equilibrium path. An equilibrium relationship between the variables implies that even though Y_t and X_t series may have trends, or cyclical seasonal variations, the movement in one are matched by movements in the other. The concept of cointegration has implications for economists. The economic interpretation that is accepted is that if in the long-run two or more series Y_t and X_t themselves are non-stationary, they will move together closely over time and the difference between them is constant (stationary) (Mohammed, 2005).

2.4.3 Testing for cointegration

There are two most commonly used methods for testing cointegration. The Augmented Dickey-Fuller residual based test by Engle and Granger (1987) and the Johansen Full Information Maximum Likelihood (FIML) test (Hansen and Juselius, 2000). For the purpose of this study the Johansen Full Information Maximum Likelihood test is used due to its advantages. The major disadvantage of the residual based test is that it assumes a single co-integrating vector. But if the regression has more than one co-integrating vector this method becomes inappropriate (Johansen and Juselius, 1990). The Johansen method allows for all possible co-integrating relationships and allows the number of co-integrating vectors to be determined empirically.

2.4.4 Johansen full information maximum likelihood approach

The Johansen approach is based on the following Vector Autoregression

$$Z_t = A_t Z_{t-1} + \dots + A_k Z_{t-k} + \mu_t \quad (7)$$

Where Z_t is an (n×1) vector of I(1) variables (containing both endogenous and exogenous variables), A_t is (n×n) matrix of parameters and μ_t is (n×1) vector of white noise errors. Z_t is assumed to be non stationary hence equation (7) can be rewritten in first difference or error correction form as;

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \dots + \Gamma_{k-1} \Delta Z_{t-k}+1 + \pi Z_{t-k} + \mu_t \quad (8)$$

where $\Gamma_1 = -(1 - A_1 - A_2 - \dots - A_i)$, $(i = 1, \dots, k-1)$ and $\pi = -(1 - A_1 - A_2 - \dots - Ak)$. Γ_1 gives the short run estimates while π gives the long run estimates. Information on the number of co-integrating relationships among variables in Z_t is given by the rank of the matrix π. If the rank of π matrix r, is $0 < r > n$, there are r linear combinations of the variables in Z_t that are stationary. Thus π can be decomposed into two matrices α and β where α is the error correction term and measures the speed of adjustment in ΔZ_t and β contains r co-integrating vectors, that is the cointegration relationship between non-stationary variables. If there are variables which are I(0) and are significant in the long run co-integrating space but affect the short run model then equation (9) can be rewritten as:

$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \pi Z_{t-k} + vD_t + \mu_t$ (9)

where D_t represents the I(0) variables. To test for co-integrating vector two likelihood ratio (LR) tests are used. The first is the trace test statistic;

$$\Delta_{trace} = -2 In Q + \sum_{ir+1}^{k} In(1-\lambda_i) + \mu_t \quad (10)$$

Which test the null hypothesis of r co-integrating vectors against the alternative that it is greater than r. The second test is known as the maximal-eigen value test:

Λ_{max} = -2 ln(Q: r 1 r + 1 = -T ln(1-λ_r+1) (11)

which test the null hypothesis of r co-integrating vectors against the alternative of r+1 co-integrating vectors. The trace test shows more robustness to both skewness and excess kurtosis in the residuals than the maximal eigen value test (Harris, 1995). The error correction formulation in (8) includes both the difference and level of the series hence there is no loss of long run relationship between variables which is a characteristic feature of error correction modeling. It should be noted that in using this method, the endogenous variables included in the Vector Autoregression (VAR) are all I(1), also the additional exogenous variables which explain the short run effect are I(0). The choice of lag length is also important and the Akaike Information Criterion (AIC), the Scharz Bayesian Criterion (SBC) and the Hannan-Quin Information Criterion (HQ) are used for the selection. According to Hall (1991) since the process might be sensitive to lag length, different lag orders should be used starting from an arbitrary high order. The correct order is where a restriction on the lag length is rejected and the results are consistent with theory.

2.4.5 Error correction model (ECM)

The idea behind the mechanism of error correction is that a proportion of disequilibrium from one period is corrected in the next period in an economic system (Engle and Granger, 1987). The process of making a data series stationary is either done by differencing or inclusion of a trend. A series that is made stationary by including a trend is trend stationary and a series that is made stationary by differencing is difference stationary. The process of transforming a data series into stationary series leads to loss of valuable long run information (Engle and Granger, 1987). Error correction models helps to solve this problem. The Granger representation theorem is the basis for the error correction model which indicates that if the variables are cointegrated, there is a long-run relationship between them and can be described by the error correction model. The following equation shows an ECM of agricultural supply response involving the variables Y and X in its simplest form shown in equation (12):

$$\Delta Yt = \alpha\Delta X_t - \theta(Y_{t-1} - \gamma X_{t-1}) + \mu_t \qquad (12)$$

Where μ_t is the disturbance term with zero mean, constant variance and zero covariance, parameter α takes into account the short run effect on Y of the changes in X, while γ measures the long-run equilibrium relationship between Y and X that is:

$$Y_t = \gamma X_t + \mu_t \qquad (13)$$

Where $Y_{t-1} - \gamma Y_{t-1} + \mu_{t-1}$ measures the divergence (errors) from long-run equilibrium, also θ measures the extent of error correction by adjustment in Y and its negative sign indicates that the adjustment is in the direction which restores the long-run relationship (Hallam and Zanoli, 1993). The Error Correction Model (ECM) has several advantages. It contains a well-behaved error term and avoids the problem of autocorrelation. It allows consistent estimation of the parameters by incorporating both short-run and long-run effects. Most importantly all terms in the ECM are stationary. It ensures that no information on the levels of the variables is lost or ignored by the inclusion of the disequilibrium terms (Mohammed, 2005). ECM solves the problems of spurious correlation because ECMs are formulated in terms of first difference which eliminates trends from the variables (Granger and Newbold, 1974). It avoids the unrealistic assumption of fixed supply based on stationary expectations in the partial adjustment model.

2.4.6 Nerlove's partial adjustment model

Empirical studies have largely concentrated on estimating the price elasticity of agricultural supply. In most cases, the so-called Nerlove-method (Nerlove 1979) has been employed. This method involves the estimation of a partial adjustment model of agricultural production in one country or state basis. The supply function of the partial adjustment model has the general form as detailed in equation (14).

$$\ln Q_t^* = a + b \ln P_{t-1} \qquad (14)$$

where Q_t^* denotes desired output at time t and P_{t-1}, the output price at time t–1. Furthermore, it is assumed that the dynamics of supply are captured by equation 15.

$$\ln Q_t - \ln Q_{t-1} = l(\ln Q_t^* - \ln Q_{t-1}) \qquad (15)$$

where Q_t is actual output and l is the partial adjustment coefficient. According to equation (15), adjustment costs imply that the actual change in output between two periods is only a fraction of the change required to achieve the optimal output level Q_t^* . Substituting equation (15) into equation (14) and rearranging gives equation (16).

$$\ln Q_t = la + lb \ln P_{t-1} + (1- l) \ln Q_{t-1} \qquad (16)$$

where la and lb are the short-run and long-run price elasticities of agricultural supply, respectively. Variants of equation (16) are estimated in the applications of the Nerlove method. Frequently, the regressions contain additional control variables, such as a time trend serving as a proxy for the impact of technological change on output. The overwhelming majority of the regression analyses based on the Nerlove-method obtained low or even zero long-run price elasticities of agricultural supply.

2.4.7 Grafted polynomial function

The quadratic-quadratic-linear (Q-Q-L) function is of a graphical form shown in figure 3 below:

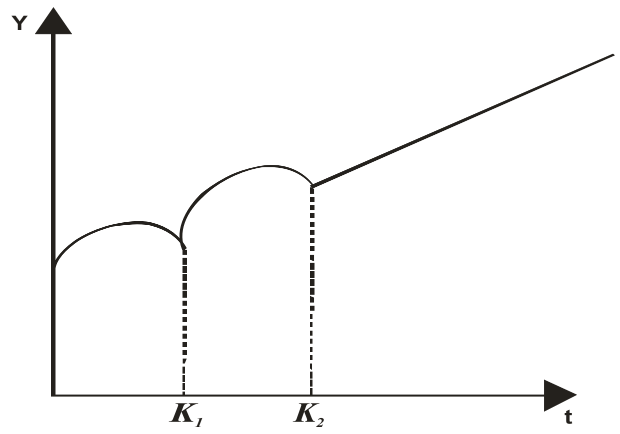

Figure 3: Quadratic-Quadratic-Linear Polynomial Function

The general equation of the linear trend model used in forecasting along with the mean function is of the general form;

$$Q_t = a + bt \quad (17)$$

This is an observed time series that do not relate linearly to trend as shown in figure 3. The three segments of the functional relationship can be expressed as functions of the form;

$$Q_t = a_0 + a_1t + a_2t^2, \text{ for } t \leq k_1 \quad (18)$$

$$Q_t = b_0 + b_1t + b_2t^2, \text{ for } k_1 < t \leq k_2 \quad (19)$$

$$Q_t = c_0 + c_1t, \text{ for } t > k_2 \quad (20)$$

There should be *a priori* expectation. In this model, we are assuming that the mean function is to be continuous, linear in parameters and differentiable at the joined points (k_1 and k_2) as contended by Fuller, (1969); and Philip, (1990). In other words, we need to derive a mean function which encompasses all the key local trends observed in the time series Q_t. Thus, it is imperative that the following restrictions must hold. There are four restrictions namely; two continuities and two differentiability's.

At continuity, the following expression holds.

$$a_0 + a_1k_1 + a_2k_2^2 = b_0 + b_1k_1 + b_2k_1^2 \quad (21)$$

$$b_0 + b_1k_2 + b_2k_2^2 = c_0 + c_1k_2 \quad (22)$$

At differentiability, we derive these expressions as shown in equations (23) and (24).

$$a_1 + 2a_2k_2 = b_1 + 2b_2k_1 \quad (23)$$

$$b_1 + 2b_2k_2 = c_1 \quad (24)$$

It is noticeable that, there are eight parameters namely a_0, a_1, a_2, b_0, b_1, b_2, c_0, and c_1. There are also four restrictions on the mean function. In other words, this implies that only four parameters can be estimated. The parameters to be estimated depend upon the motive of generating or formulating the mean function which is to forecast.

For forecasting, it is highly important to retain the coefficient in the terminal trend function and this is usually linear. Thus c_0, c_1, a_2 and b_2 are to be retained for subsequent estimation while a_0, a_1, b_0 and b_1 are to be dropped and eliminated. For ease and simplicity, it is better to start the derivations with equation (24) and making b_1 the subject of the formular. From equation (24).

$$b_1 = c_1 - 2b_2k_2 \quad (25)$$

from equation (23)

$$a_1 + 2a_2k_1 = b_1 + 2b_2k_1$$

$$a_1 = b_1 + 2b_2k_1 – 2a_2k_1$$

Substitute for b_1

$$a_1 = c_1 – 2b_2k_2 + 2b_2k_1 – 2a_2k_1$$

$$a_1 = c_1 – 2b_2 (k_2 – k_1) – 2a_2k_1 \quad (26)$$

From equation (22)

$$b_0 + b_1k_2 + b_2k_2^2 = c_0 + c_1k_2$$

Substituting for b_1

$$b_0 = c_0 + b_2k_2^2 \quad (27)$$

From equation (21),

$$a_0 + a_1k_1 + a_2k_1^2 = b_0 + b_1k_1 + b_2k_1^2$$

Substituting for a_1, b_0 and b_1

$$a_0 = c_0 + b_2 (k_2^2 – k_1^2) + a_2k_1^2 \quad (28)$$

From equation (18)

$$Q_t = a_0 + a_1t + a_2t^2$$

Substituting for a_0 and a_1

$$Q_t = c_0 + c_1t + a_2(t – k)^2 + b_2 [(k_2^2 – k_1^2) – 2(k_2 – k_1)t] \quad (29)$$

Equation Q_t can be transformed as

$$Q_t = c_0x_0 + c_1x_1 + a_2x_2 + b_2x_3 \quad (31)$$

For simplicity, equation (31) can be represented as;

$$Q_t = \propto_o x_o + \propto_1 x_1 + \propto_2 x_2 + \propto_3 x_3 \quad (32)$$

Where;

$x_0 = 1$; for all t, $x_1 = t$; for all t

$x_2 = (t - k_1)^2$; for k $\nleq$ t

= 0 otherwise

$x_3 = (k_2^2 - k_1^2) - 2(k_2 - k_1)$ t for $k_1 \nleq t$

$= (t - k_2)$; for $k_1 < t \leq k_2$

= 0

Equation (32) represents a grafted continuous (mean) function which encompasses all the key local trends indicated by the set of restrictions in equations (18), (19) and (20). Equation 31 is the empirical (grafted) model suitable for computing an ordinary least Squares (OLS) regression.

2.5 Ginger Production

The main ginger producing countries include India, China, Indonesia, Bangladesh, Thailand, Philippines and Jamaica. Ginger is also grown in Australia, Fiji, Brazil, Sierra Leone, Japan, Tanzania, Uganda, Ghana and Nigeria. United Kingdom, Japan and Saudi Arabia import large quantities of ginger. However, Nigeria ranks first with respect to the total global area under ginger coverage, followed by India, China, Indonesia, Bangladesh, while India ranks first with respect to ginger production, followed by China, Nigeria, Bangladesh and Indonesia. Asian countries, lead in the supply of ginger to the world market, while Japan and USA are the major importers. China has the major export share, India exports mainly in the form of whole and dry ginger. China, Nigeria and Thailand are competing with India in the recent past in the world market. Australia is the world leader in value added products. India has 50% share in oil and oleoresin trade (FAO, 2010). Table 2.1 shows total world and Nigeria production of ginger from 2000-2009. The percentage change in ginger production in Nigeria in respect to world output is fluctuating year in year out. This frequent rise and fall in ginger production is a serious problem affecting ginger supply in Nigeria. According to Micheal (2011), Nigeria produces an average of 50,000 metric tones' of fresh weight ginger per annum. About 10% of the produce is consumed locally as fresh ginger while the remaining 90% is dried for both local consumption and import. In the same vein, Ezeagu (2006) established that 20% of the dried ginger is consumed locally for various uses while 80% is exported.

Table 2.1: Global and Nigeria production of ginger (2000 – 2016).

Year	WORLD Outputs(Tonnes)	NIGERIA (Tonnes)	Percentage of World Output
2000	948,235	98,000	10.3
2001	986,267	104,000	10.5
2002	996,267	105,000	10.5
2003	1,150,820	110,000	9.6
2004	1,195,546	117,000	9.8
2005	1,321,790	125,000	9.5
2006	1,491,069	134,000	10.0
2007	1,581,392	162,390	10.3
2008	1,641,629	175,070	10.7
2009	1,615,974	152,106	9.4
2010	1,633,744	156,600	9.6
2011	1,697,223	161,710	9.8
2012	1,711,200	168,550	10.1
2013	1,813,419	171,255	10.5
2014	1,885,330	177,205	10.7
2015	1,923,240	187,851	10.9
2016	2,223,240	191,233	11.3

Source: FAOSTAT Database (FAO, 2014; FAO, 2016)

2.5.1 Problems in ginger production.

Nigeria ranked first in terms of the percentage of total hectares of ginger under cultivation but her contribution to total world output is too low compared to other countries. This can be attributed to the fact that most of production is undertaken by smallholder and traditional farmers with rudimentary production techniques and low yields (Amadi, 2012). According to Nze *et al.* (2018) there are indications that ginger traders are limited by a lot of factors which limits their scale of operation an invariably affecting the level of pro accruing from the ginger business. Rigorous and inconsistent methods of production in addition to price fluctuations have an adverse effect on the level of profitability to ginger traders. In addition, the smallholder farmers are constrained by many problems like the farmers do not see it as a business enterprise, therefore are not adequately focused on profit maximizing motive.

Adegboye (2010) few or no contacts by extension agents could have been caused by inadequate extension- farmer ratio in addition to difficult access to credit. There is no doubt that agricultural extension is a difficult and demanding profession, both physically and intellectually. Extension workers in most developing countries, Nigeria inclusive, suffer from low salaries, meagre benefits, and negligible opportunities for development of their professional career. The unsolved field problems of the farmers which include untimely supply of inputs, irregular extension visits and irrelevants market information have are not been adequately addressed. More so, high extension agent to farmer's ratio is grossly inadequate; 1:3000. Moreover, the farmers in the study area depend on the use of crude implements, old varieties of crops and personal saving as the only source of finance (Adegboye, 2010).

Mani (2018) stipulated that uncertainty in crop prices makes it difficult for farmers in Nigeria to be confident, that they will obtain a sufficient return from the sale of the additional harvest. This is because the storage process is technically difficult and expensive, agricultural prices are therefore subject to strong seasonal variations. This is alleviated by fluctuations of provision of information and market news services that assist producers in organizing supply and enabling farmers to re-rout goods to other markets which suffer from a shortage of supply or high-demand markets.

Anamayi (2018) identified major problems associated to ginger production, these include; unavailability of farm input, shortage of labour, lack of storage and transport facilities and disease infestation. The farmers complained that fertilizer and agrochemicals are made available when farmers are far into the production period, some time at the middle of the raining season and when the inputs are available; it becomes very expensive for small peasant farmers to purchase. Family labour was predominant in the study area and that is why there was acute shortage of hired labour in the labour market. Anamayi (2018) stipulated that during the active period of production every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, harvesting and processing.

Farmers also complained of lack of storage facilities, which forces them to sell their produce at the farm gate price. They agreed that lack of good road and high transportation cost prevent them from carrying their produce (Ginger) from the farm to their houses and market at the right time. Farmers had to face the uneatable task of renting a vehicle at the very exorbitant price to take their produce home and market because of the condition of the road. The farmers were faced with disease attack on their crops both in the field and while in the storage resulting in varying degrees of crop damages.

Ginger production in Nigeria is quite laborious; practically all the operations, including planting, mulching, fertilizing, weed control, harvesting, and processing are done manually. This of course has several adverse implications. First, it limits the hecterage that each individual farmer can cultivate, on the average, less than one hectare of land are often cultivated compared to Australia where planting and harvesting of the crop are completely mechanized. Secondly, production costs are relatively high, because of the relative high costs of labor and other inputs (Ayodele and Banake*,* 2016).

Adegboye (2010) who evaluated farmers' response to extension services on ginger production in Kagarko local government area of Kaduna State, stated that the production of ginger like other crops in the country is majorly through poor farmers. The business has not been profitable for them as it ought to be as a result of numerous socio-economic problems facing them. They depend on the use of crude implements, old varieties of crops and personal saving as the only source of finance. This assertion warrants and empirical probing to ascertain the impact of improved ginger technologies on the income the cooperative farmers.

2.6 Ginger Production and Supply Trends

Generally there are problems in improving ginger production and marketing in Nigeria with a multitude of production and post production challenges. There are basically two varieties of ginger which are being cultivated in the main ginger producing areas of the country as earlier stated. These are "*Tafin Giwa*" and *Yatsun Biri*" the Local Nigerian ginger varieties are generally low yielding. Yields of up to 8 to 15tons/ha have been recorded. Ginger is a high yielding crop in many places in the world, yield obtained from improved varieties in Australia and India is very high compared with the yield recorded in Nigeria (National Agricultural Extension and Research Liaison Services, 2004).

Emmanuel (2008) corroborated in a 3-day National Workshop on Massive Cassava and Ginger Production, the small scale farmers, who produce ginger are scattered, ill equipped and largely use traditional methods of production in Nigeria. This traditional practice, as well as non use of improved varieties, non mechanized land preparation, lack of inputs and production and post harvest handling of produce, absence of holding storage capacity result in low productivity, production of low volume and poor quality ginger in the country makes market access and pricing to match good quality and premium price difficult.

Nom (2014) opined that supply trend and price change are very significant factors affecting ginger production. When there is a flood, it affects ginger farming, but also make the price of ginger attractive in some places. Once the prices are attractive, farmers will produce plenty the next season and at the end of the cultivation, the price crashes again." The economic atmosphere in the country also hinders the stability of ginger market. Investigations in areas where ginger is produced, shows that the production has declined drastically. In addition, he further noted that in some ginger producing communities only few local business men and women, now have stores for the product because of devaluation in prices (Nom, 2014). Expectedly, Local farmers in communities where ginger was harvested in large quantities in the past are now begging the Government, especially Kaduna State Government, to embark on an agricultural revolution to boost the economy of the country instead of depending on crude oil.

According to Philip (2014) Nigeria will, in no distant future, recover from its economic malaise, if cash crops like ginger are not given due consideration by relevant institutions. There is a great demand for ginger and southern Kaduna produces the best ginger in the world, however, the activities of the middle men has become a serious problem in this area. The exploitation of ginger farmers by activities of middlemen, and subtle moves by some organizations to displace genuine ginger farmers, justifies the need for the government and various institutions to make concerted efforts to boost ginger farming to stabilize the economy.

The decline in ginger farming and export is not unconnected to the political crises that rocked parts of Northern Nigeria; such that countries that demand for ginger were forced to stay back. There is however hopes that if peace returns there will be serious expansion in ginger production (Philip, 2014).

Poor marketing price is a serious constraint faced by ginger farmers in the study area. The prices offered to farmers by the defunct commodity board were relatively lower, compared with other export crops; the situation remained the same even after abolishing the marketing Board. One common problem also associated with ginger production is the continuous fluctuation of ginger price, which is sometimes attributed to seasonality of agricultural production or the speculative activities of market middlemen.

According to Jonathan (2014), ginger had functioned like petroleum from 1980s-1990s, when a 40kg bag sold at ₦17,000 as against ₦3,000 today. The frequent fluctuation of demand and price of ginger in recent time is not unconnected to the insecurity problem in the northern parts of the country, which discourages shifting of the product across the borders to neighboring countries. Kaduna state government in previous years entered into contract agreement with technical partners in Europe, who have a ready market for ginger. It was gathered that as at 2000, the Kachia ginger factory produces 80 tonnes of oleoresin, four tonnes of oil and 100 tonnes of powder, annually. However in 2014, the company which was positioned to become a major foreign exchange earner for Kaduna State and Nigeria could not survive. Some blame successive governments for the collapse of the Kachia Ginger Company which rendered over 30,000 people jobless after shutting down its operation.

2.7 Review of Relevant Studies on Supply Response and Trend

The total supply response is the response of the total output to price and non-price factors (Rao, 2003). The concept of supply response in economic theory usually refers to output production in response to their supply determinants that are anticipated. Over the past years there has been a number of empirical studies on agricultural supply response and economic rationale of farmers in developed and developing economies, this include; Leaver (2003); Rao (2003); Mythili (2008); Muchapondwa (2009). However, the nature and extent to which farmers respond to changes in price and non-price factors still remains a debatable issue.

Liu *et al.* (2010) claimed that, there are many arguments to support the notion that farmers in developing countries are not responsive to economic incentives such as price. The various crop-level studies available for developing countries have for the most part arrived at the same outcome: that the supply response is less elastic than in developed countries. The reasons these studies cite for the poor response range from limitations on irrigation and infrastructure to the lack of complementary agricultural policies and subsidies. Furthermore, there are varying results on the degree of response. Two sets of explanations are offered as to why the results vary and what the analysis overlooks. The first set of reasons focus on conceptual problems in identifying correct prices and exogenous variables. The second set of reasons point to the formulation of empirical models; for instance, the specification of supply function, use of distributed lag, failure to recognise model identification problems and improper choice of non-economic factors (Gulati and Kelly, 1999). Generally farmers do respond to incentives, but the response might be restricted and subject to various constraints.

According to Bhagat (1989) studies on developing countries showed that if farmers did not respond much to changes in incentives, it was not so much due to their inability to adapt to changing circumstances but rather to the constraints they were facing, and that the potential for a significant supply response did exist if the constraints were relaxed. A badgering and recurring problem concerns the variability of estimated supply response from different studies. The different predictions of the output response to price incentives have also been explained by Rao (2003) who argued that different predictions of supply response to price incentives may be due to methodological diversity or a result of differing elasticities among crops and among countries in a systematic way.

Abiodun and Shehu (2010) estimated the response of aggregate agricultural output to exchange rate and price movements of food and export crops in Nigeria using available time series data that span about 37 years from the Central Bank of Nigeria (CBN) Annual Reports. The Augmented Dickey Fuller (ADF) and unit root test carried out for the study found that the variables used in the model are integrated of the same order. Using maximum likelihood estimation results also shows that the entire variables cointegrated. The results of the Vector Error Correction Model (VECM) for the estimation of short run adjustment of the variables toward their long run relationship showed a linear deterministic trend in the data and that food and export prices as well as the real exchange rate jointly explained 57% of the variation in the Nigeria aggregate agricultural output in the short run and 87% variation in the long run. Total agricultural output responds positively to increases in exchange rate and negatively to increases in food prices both in the short and long run. The significance of food crop prices and exchange rate at 5% and 1% respectively both in the short and long run suggest that changes in these variables are passed immediately to agricultural output.

To help bridge information gap in supply response studies for Nigeria and inform policy decision on how the demand-supply gap for rice in Nigeria could be bridged, David (2014) studied the yield response of rice in Nigeria through the use of Johansen's Full Information Maximum Likelihood test estimated a yield response model for Nigeria using national level data for the period 1966-2008. The results suggest that, increasing yield levels for paddy rice in Nigeria and ensuring stability requires interplay of biophysical, socio-economic and structural forces. Estimates from the study suggested that bridging of the demand-supply gap can be realized through initiation of measures to address inefficiencies in the supply chain to ensure appropriate transmission of price increment, promotion of local rice consumption to ensure ready market for farmers in times of increasing output, addressing soil fertility challenges through efficient use of fertilizer and regular management of fertility of rice fields, and increasing farmers access to credit to help them meet cost of relevant inputs of production. The latter suggestion could to a greater extent incite appropriate response of farmers to both price and non-price incentives in the country. Diagnostic tests conducted indicate that the residual series is normally distributed, non-serially correlated and homoscedastic.

In a study on Co-integration and Error-Correction Modeling of Agricultural Output, a Case Study of Groundnut in Nigeria by Ngbede and Akintola (2009). First and foremost, stationarity test was carried out and it reveals that at level form output was stationary while the various variables (producer price, rainfall, hectarage and fertilizer) became stationary only at first-differencing applying the unit root test. Furthermore estimates of factor affecting the output of groundnut were derived using Johansen co-integration and error-correction representation procedures. The result indicated the existence of the one co-integrating vector at 5 percent significance's level, thus rejecting the null hypothesis of no co-integrating vector. As a result a parsimonious error-correction model was set-up. The statistical significance of the error correction model for groundnut validates the existence of an equilibrium relationship among the variables. The result therefore shows that the combine effect of producers price, hectarages, rainfall and fertilizer jointly affect the output of groundnut.

Mesike *et al.* (2010) applied the vector Error Correction Model to measure the Supply Response of Rubber Farmers in Nigeria. Preliminary analysis suggested that estimations based on their levels might be spurious as the results indicated that all the variables in the model were not stationary at their levels. Further results indicated that producers' prices and the structural break significantly affected the supply of rubber. Response of rubber farmers to price were low with an estimated elasticity of 0.373 in the short-run and 0.204 in the long-run due to price sustainability and the emergence of other supply determinants indicating significant production adjustments based on expected prices. Policy efforts in promoting sustainable marketing outlets and promoting high value and high quality products for export were suggested in understanding farmer's responses to incentive changes.

Alemu *et al*. (2003) investigated grain-supply response in Nigeria using the error correction model. From the study It was found that planned supply of grain crops is positively affected by own price, negatively by prices of substitute crops and variously by structural breaks related to policy changes and the occurrence of natural calamities. The results found significant long-run price elasticities for all crop types and insignificant short-run price elasticities for all crops but maize. Higher and significant long-run price elasticities as compared to lower and insignificant short-run price elasticities were attributed to various factors, namely structural constraints, the theory of supply and the conviction that farmers respond when they are certain that price changes are permanent. The study concluded that farmers do respond to incentive changes. Thus attempts, which directly or indirectly tax agriculture with the belief that the sector is non-responsive to incentives, harm its growth and its contribution to growth in other sectors of the economy.

An empirical investigation on the responsiveness of rice and maize production in Ghana over the period 1970-2008 was presented by John (2011). Annual time series data of aggregate output, total land area cultivated, yield, real prices of rice, maize and rainfall were used for the analysis. The Augmented-Dickey Fuller test was used to test the stationarity of the individual series and Johansen maximum likelihood criterion was used to estimate the short-run and long-run elasticities. The land area cultivated of rice was significantly dependent on output, rainfall, real price of maize and real price of rice. The elasticity of lagged output (12.8) in the short run was significant at 1%, but the long run elasticity (4.6) was not significant. Rainfall had an elasticity of 0.004 and significant at 10%. Real price of maize had negative coefficient of -0.011 and significant at 10% significance level. This is consistent with theory since a rise in maize price will pull resources away from rice production into maize production. The real price of rice had an elasticity of 2.01 and significant at 5% in the short run and an elasticity of 3.11 in the long run. The error correction term had the expected negative coefficient of -0.434 which is significant at 1%. It was found that in the long run only real prices of maize and rice were significant with elasticities of -0.46 and 3.11 respectively. The empirical results also revealed that the aggregate output of rice in the short run was found to be dependent on the acreage cultivated, the real prices of rice, rainfall and previous output with elasticities of 0.018, 0.01, 0.003 and 0.52 respectively. Real price of rice and area cultivated are significant 10% level of significance while rainfall and lagged output are significant at 5%. In the long run aggregate output was found to be dependent on acreage cultivated, real price of rice and real price of maize with elasticities of 0.218, 0.242 and -0.01 respectively at the 1% significance level. The analysis showed that short-run responses in rice production are lower than long-run response as indicated by the higher long-run elasticities. These results have Agricultural policy implications for Ghana.

Oyewumi *et al*. (2011) studied the supply response of beef in South Africa using the error correction model. The results of the study confirmed that beef producers in South Africa respond to economic, climatic, trade and demographic factors in the long-run. In the short-run, however, the study showed that cattle marketed for slaughtering were responsive to climatic factors (i.e. rainfall) and imports of beef.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 The Study Area

The study was carried out in Benue and Kaduna States. Both States share boundary with Nassarawa State with a population of about 6.85 million and 10.63 million people in each state respectively (World Population Prospects, 2019).. There are twenty one and twenty three Local Government Areas (LGAs) in Benue and Kaduna State respectively and the numbers of ethnic groups in both States is high. The two major tribes in Benue are the Tiv and the Idoma's. The state occupies the central portion of Northern Nigeria and lies between Latitudes 60^0 25^1N and 80^0 8^1N of the equator and between Longitudes 70^0 47^1E and 100^0 00^1E of the Greenwich meridian while Kaduna State lies between Latitudes $09^0 02^1$ and $12^0 32^1$N of equator and between Longitudes $06^0 15^1$ and $08^0 50^1$E of the equator. Benue state has a total land area of 30,800 sq. km while Kaduna State has a landmass of 45,567 square kilometers.

Benue State falls within the tropical climate with two distinctive wet and dry seasons. The state generally has about 8-10 months of rainfall. Temperatures are constantly high throughout the year, with average temperatures ranging from 23°C-32°C. The climate of the state accommodates a wide range of agricultural production such as fruit crops, grain crops, and tuber crops. While the vegetation of Benue State is typically that of the southern Guinea Savannah biome, characterized by sparse grasses and numerous species of scattered trees. Ginger is predominantly produce in Benue North covering Konshisha, Vandeikya, Oshongo, Kwande, Katsena ala and Ukum Local Government

Area. Agriculture forms the thrust of the Benue State economy known to be the food basket of the nation (Benue State Agricultural Development Authority, 2018).

However, Kaduna State extends from tropical grassland (savannah) in the South to Sudan Savannah in the North. The Savannah region of the state covers the Southern part stretching to Gwantu, South of Kafanchan, with prevailing vegetation of tall trees. The Sudan or Sahel Savannah covers the northern part of the state, stretching from Zaria down to Ikara and its environs. The grasses (called *"veld"*) with short trees are sparsely distributed. The plants here are drought resistant.The State has two distinct seasons, the dry season and rainy season with temperature range of between 27.6^0C-30^0C. The southern part of the State enjoys heavier rainfall than the northern part; lasting between 5-6 months in the southern part and 4-5 months in the northern part. Generally, the rains start in April and ends in October. The major occupation of the people is farming (Zulai, 2013). The State has vast area of fertile lands growing both food and cash crops like rice, cassava, ginger, potatoes, millet, groundnut, shea-nut, benni-seed and soya beans, aside animal husbandry(Kaduna State Ministry of Information, 2014).

The two climatic conditions in Benue and Kaduna States has great influence on the activities of the people, thus the people are predominantly occupied in farming during the rainy season, while they engage in hunting and petty trading during the dry season. Ginger is predominantly produce in the southern path of Kaduna State mostly Kagarko, Jamaa' Sanga, Jaba, Kaura, Zango Kataf, Gwantu and Kachia Local Government Area. Ginger is produced and sold as fresh ginger in basins or slice, dried and package in a bag of 40kg. The ginger is sold to various marketing units within or outside the producing area.

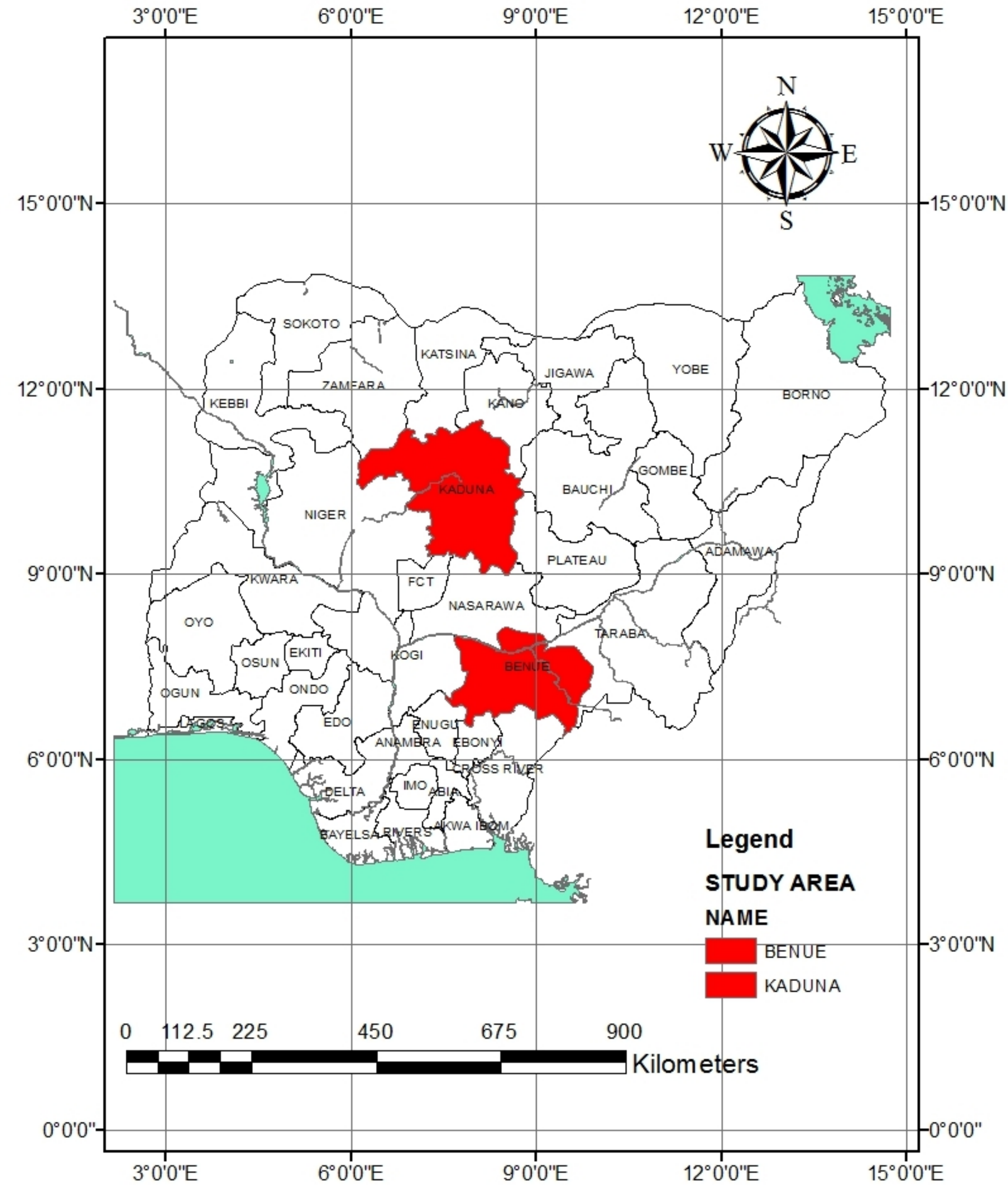

Figure 4: A Map showing the study areas.

Source: Encarta 2008

3.2 Sampling Techniques

The multistage sampling procedure was employed in the study. Firstly Benue and Kaduna States were purposively selected based on a *priori* knowledge that both are ginger producing state in Nigeria. The second stage involved purposive selections of three and four Local Governments Areas (LGAs) from Benue and Kaduna States respectively. This selection was base on sample size and the preponderance of ginger producing areas in each state. Konshisha, Vandeikya and Oshongo LGAs were selected from Benue State while in Kaduna state; Jabba Kachia, Kagarko and Kaura (LGAs) known to be predominantly involve in ginger production activities were selected. The third stage involved random selections of two town/villages from each of the selected LGA. In the fourth stage a total sample size of 359 was randomly selected using the list of ginger out growers obtained from the reconnaissance survey at 95% and 5% confident interval and precision level respectively. To determine the sample size, the Taro Yamenin formula as applied by Chukwuemeka (2002) was adopted. The formula is shown below:

$$n = \frac{N}{1+N(e)^2} \qquad (33)$$

Where n = Sample size

I = A Constant Value

N = Population size

E = Error limit

In this particular case, 5% or 0.05 will be an appropriate margin of error.

Table 3.1: The sample frame and sample size of the respondents

State	LGAS	Villages	Sample Frame	Sample Size
Kaduna	Jaba	Kwoi	550	56
		Nock	425	43
Kaduna	Kachia	Ganta	360	36
		Kwaturu	305	31
Kaduna	Kagarko	Aribi	520	53
		Katuga	400	41
Kaduna	Kaura	Manchok	225	23
		Kagoro	175	18
Benue	Konshisha	Tyoutsa	110	11
		Ndere	90	9
Benue	Vandeikya	Tsambe	105	10
		Mbaakase	70	7
Benue	Oshongo	Mngakaregh	120	12
		Igbeer	85	9
Total			3280	359

Source: Kaduna State Agricultural Development Project and Benue State Agriculture and Rural Development Authority

3.3 Method of Data Collection

Primary and secondary data were used for this study. The data were collected from sampled farmers using personal interview schedules and a structured questionnaire. The primary data collected from the respondents include the socio-economic characteristics of the respondents, such as age of farmers, farming experience, educational level, farm size, household size, gender, marital status, among others. Secondary data such as output, yield, price and areas of land cultivated from 1979-2018 were also collected from Benue and Kaduna States. The data were source from Agricultural Development Programme, National Bureau of Statistics, National Programme for Food Security, National Agricultural Extension Research and Liaison Services.

3.3.1 Test of secondary data and questionnaire

Test of autocorrelation, Breusch-Pagan-Godfrey, Breusch-Godfrey Serial Correlation LM Test, Jarque-Bera normality test, Specification tests and CUSUM tests of model stability were carried out on the secondary data used for this study. Also validity and reliability test were used to examine the questionnaire used for this study. Correctness and fitness to concept used in this study was ensured.

3.4 Methods of Data Analysis

Both descriptive and inferential statistics were employed in this study. Descriptive statistics such as means, frequency distribution, percentages, standard deviation and graph were employed to achieve objective (i), (iii) and (v). Inferential statistics such as the Autoregression Distribution Lag Model (ARDL) and different functional forms of the grafted polynomial models were used to achieve objective (ii) and (iv) respectively.

3.4.1 Descriptive statistics

Descriptive statistics are the statistical procedures used for organizing, describing and interpreting characteristics, parameters and variables in production in concise and meaningful quantifiable terms. Simple descriptive statistics was used to achieve objectives (i), (iii) and (v). Some of the simple descriptive statistical tools used include frequency, percentage, mean, standard deviation, skewness, kurtosis and graph.

Variables relating to socio-economic characteristics and trend such as household size, gender, marital status, farming experience, age of farmers, farm size, ginger output in different period and production constraints variables were measured.

3.4.2 Stationarity test

Engle and Granger (1987) provided appropriate tests for stationarity of individual series. Specifically the test procedure used includes the estimation of the Augmented Dickey-Fuller (ADF) statistics. The DF and ADF are tests for the null hypothesis that the variable of interest is non-stationary.

Thus, Ho: The variables are not stationary at their levels, i.e. I (1)

Ha: The variables are stationary at their levels, i.e. I (0).

The test procedure employed is indicated in the following equation:

$$\Delta X_t = a_0 + \delta X_{t-1} + \sum_{t-1}^{k} \Delta X_{t-1} + e_t \tag{34}$$

Ho is rejected if the t-statistic is negative and statistically significant when compared to appropriate critical values established for stationarity tests.

3.4.2.1 Bound test of cointegration.

The bound test of cointegration with the conditional ARDL (p, q1, q2, q3) model with four variables used for the study is specified as follows:

$$\Delta LnQ_t = a_{01} + b_{11}LnQ_{t-i} + b_{21}LnYLD_{t-i} + b_{31}LnHA_{t-i} + b_{41}LnP_{t-i} + \sum_{i=1}^{p} a_{1i}\Delta LnQ_{t-i} + \sum_{i=1}^{q} a_{2i}\Delta LnYLD_{t-i} + \sum_{i=1}^{q} a_{3i}\Delta LnHA_{t-i} + \sum_{i=1}^{q} a_{4i}\Delta LnP_{t-i} + e_{1t} \quad (35)$$

$$\Delta LnYLD_t = a_{02} + b_{12}LnQ_{t-i} + b_{22}LnYLD_{t-i} + b_{32}LnHA_{t-i} + b_{42}LnP_{t-i} + \sum_{i=1}^{p} a_{1i}\Delta LnYLD_{t-i} + \sum_{i=1}^{q} a_{2i}\Delta LnQ_{t-i} + \sum_{i=1}^{q} a_{3i}\Delta LnHA_{t-i} + \sum_{i=1}^{q} a_{4i}\Delta LnP_{t-i} + e_{2t} \quad (36)$$

$$\Delta LnQ_t = a_{03} + b_{13}LnQ_{t-i} + b_{23}LnYLD_{t-i} + b_{33}LnHA_{t-i} + b_{43}LnP_{t-i} + \sum_{i=1}^{p} a_{1i}\Delta LnHA_{t-i} + \sum_{i=1}^{q} a_{2i}\Delta LnQ_{t-i} + \sum_{i=1}^{q} a_{3i}\Delta LnYLD_{t-i} + \sum_{i=1}^{q} a_{4i}\Delta LnP_{t-i} + e_{3t} \quad (37)$$

$$\Delta LnQ_t = a_{04} + b_{14}LnQ_{t-i} + b_{24}LnYLD_{t-i} + b_{34}LnHA_{t-i} + b_{44}LnP_{t-i} + \sum_{i=1}^{p} a_{1i}\Delta LnP_{t-i} + \sum_{i=1}^{p} a_{2i}\Delta LnQ_{t-i} + \sum_{i=1}^{q} a_{3i}\Delta LnYLD_{t-i} + \sum_{i=1}^{q} a_{4i}\Delta LnHA_{t-i} + e_{4t} \quad (38)$$

Where

Q_t = Output of ginger in year t (tonnes)

YLD_{t-i}= Yield of ginger in year t-i (tones)

HA_{t-i} = Area harvested of ginger in year t-i (hectares)

P_t = Average price of ginger in year t (naira)

e = error correction factor.

3.4.3 The Autoregressive distribution lag model (ARDL) and the error correction model (ECM)

The Autoregressive Distribution Lag Model (ARDL) with the component of the Error Correction Term (ECT) was used to achieve objective (ii). The model is specify in equation (38) as:

$$\Delta LnQ_t = a_0 + \sum_{i=1}^{p} a_{1i}\Delta LnQ_{t-i} + \sum_{i=1}^{q} a_{2i}\Delta LnYLD_{t-i} + \sum_{i=1}^{q} a_{3i}\Delta LnHA_{t-i} + \sum_{i=1}^{q} a_{4i}\Delta LnP_{t-i} - \lambda ECT_{t-1} + e_{1t} \quad (39)$$

Where

Q_t = Output of ginger in year t (tonnes)

YLD_{t-i}= Yield of ginger in year t-i (tones)

HA_{t-i} = Area harvested to ginger in year t-i (hectares)

P_t = Average price of ginger in year t (naira)

e = error correction factor.

λ = speed of adjustment parameter with a negative sign

ECT = Error correction term.

a_{1i}, a_{2i}, a_{3i} and a_{4i} = The short-run dynamic coefficients of the model's adjusted in the long run equilibrium. The ARDL model capturing the ECT as specified in equation (39) was adopted since there was cointegration among the variables.

3.4.4 Grafted polynomial model

The linear functional form and different forms of the grafted polynomial model which include linear-quadratic-linear, quadratic-quadratic-linear, linear-quadratic-quadratic, linear-linear-quadratic and quadratic-linear-linear were used to achieve objective (iv) and the best functional form with good forecasting ability was selected.

3.4.4.1 Linear model

The general equation of the linear trend model used in forecasting along with the mean function is of the general form;

$$Y_t = \alpha + \beta t \tag{40}$$

Where

Y = Data series on the level of ginger production in year t

t = Trend

α and β = Structural coefficient to be estimated

3.4.4.2 Linear-quadratic-linear model

According to Nmadu (2009) the three segments of the functional relationships for the linear quadratic linear model can be expressed as functions of the form.

$$Y_t = \alpha_0 + \beta_0 t. \qquad t \leq JP_1 \qquad (41)$$

$$Y_t = \alpha_1 + \beta_1 t + \theta_1 t^2 \qquad JP_1 < t \leq JP_2 \qquad (42)$$

$$Y_t = \alpha_2 + \beta_2 t. \qquad t > JP_2 \qquad (43)$$

Where

Yt = Data series on the level of ginger production in year t

T = Trend variable

α_0, α_0, α_1, β_1, θ_1, α_2, β_2 = Parameters to be estimated and α_0, α_0, α_1, β_1 dropped from the restricted equation

JP_1 = Joint Point one

JP_2 = Joint Point Two

Equation 41-43 was reworked as shown below:

$$Y_t = \alpha_2 + \beta_2 t + \theta_1 (JP_2^2 - JP_1^2 + -2JP_2 t + 2JP_1 t). \qquad t \leq JP_1 \qquad (44)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_1 (JP_2^2 - 2JP_2 t + t^2). \qquad JP_1 < t \leq JP_2 \qquad (45)$$

$$Y_t = \alpha_2 + \beta_2 t \qquad .t > JP_2 \qquad (46)$$

Equation 43-45, was then formed into a single equation for estimation as follows:

$$Y_t = \mu_0 X_0 + \mu_1 X_1 + \mu_1 X_2 + U_t. \qquad (47)$$

Where

$X_0 = 1$ for all value of t

$X_1 = t$ for all t

$X_2 = (JP_2^2 - JP_1^2 + -2JP_2t + 2JP_1t)$ for $t \leq JP_1$

$X_2 = (JP_2^2 - 2JP_2t + t^2)$ for $JP_1 < t \leq JP_2$

$X_2 = 0$ for $t > JP_2$

3.4.4.3 Quadratic-quadratic-linear model

According to Nmadu (2009) a graphical examination of a data series may reveal that it can be divided into different segments as the trend equation below:

$$Y_t = \alpha_0 + \beta_0 t + \theta_0 t^2 \qquad t \leq JP_1 \qquad (48)$$

$$Y_t = \alpha_1 + \beta_1 t + \theta_1 t^2 \qquad JP_1 < t \leq JP_2 \qquad (49)$$

$$Y_t = \alpha_2 + \beta_2 t. \qquad t > JP_2 \qquad (50)$$

Where

Yt = Data series in year t

T = Trend

α_0, α_0, α_1, β_1, θ_1, α_2, β_2 = Parameters to be estimated and α_0, α_0, α_1, β_1 dropped from the restricted equation

JP_1 = Joint Point one

JP_2 = Joint Point Two

Equation 48-50 was then reworked as shown below:

$$Q_t = \alpha_2 + \beta_2 t + \theta_1 (JP_2 - t)^2 + (\theta_1 - \theta_0)(JP_1 - t)^2. \qquad t \le JP_1. \qquad (51)$$

$$Q_t = \alpha_2 + \beta_2 t + \theta_1 (JP^2 - t)^2. \qquad \vdots \qquad JP_1 < t \le JP_2. \qquad (52)$$

$$Y_t = \alpha_2 + \beta_2 t. \qquad t > JP_2 \qquad (53)$$

Equation 50-52, are then formed into a single equation for estimation as follows:

$$Q_t = \mu_0 X_0 + \mu_1 X_1 + \mu_2 X_2 + \mu_3 X_3 + U_t. \qquad (54)$$

Where

$X_0 = 1$ for all value of t

$X_1 = t$ for all t

$X_2 = (JP_2^2 - t)^2$ for $t \le JP_1$

$X_2 = (JP_2^2 - t^2)^2$ for $JP_1 < t \le JP_2$

$X_2 = 0$ for $t > JP_2$

$X_3 = (JP_1^2 - t^2)^2$ for $t \le JP_1$

$X_3 = 0$ for $JP_1 < t \le JP_2$

$X_3 = 0$ for $t > JP_2$

3.4.4.4 Linear-quadratic-quadratic model

A graphical examination of a data series may reveal that it can be divided into different segments as the trend equation below:

$$Y_t = \alpha_0 + \beta_0 t. \qquad t \leq JP_1 \qquad (55)$$

$$Y_t = \alpha_1 + \beta_1 t + \theta_1 t^2 \qquad JP_1 < t \leq JP_2 \qquad (56)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 t^2. \qquad t > JP_2 \qquad (57)$$

Where

zzYt = Data series in year t

T = Trend

α_0 , α_0 , α_1 , β_1 , θ_1 , α_2 , β_2 = Parameters to be estimated and α_0 , α_0 , α_1 , β_1 dropped from the restricted equation

JP_1 = Joint Point one

JP_2 = Joint Point Two

Equation 55-57, was then reworked as shown below:

$$Y_t = \alpha_2 + \beta_2 t + (\theta_2 - \theta_1)(2JP_2 t - JP_2^2) + \theta_1(2JP_1 t - JP_1^2) \qquad t \leq JP_1 \qquad (58)$$

$$Y_t = \alpha_2 + \beta_2 t + (\theta_2 - \theta_1)(2JP_2 t - JP_2^2) + \theta_1 t^2. \qquad JP_1 < t \leq JP_2 \qquad (59)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 t^2. \qquad t > JP_2 \qquad (60)$$

Equation 57-59 was then formed into a single equation for estimation as follows:

$$Y_t = \mu_0 X_0 + \mu_1 X_1 + \mu_2 X_2 + \mu_3 X_3 + \mu_4 X_4 + U_t \qquad (61)$$

Where

$X_0 = 1$ for all value of t

$X_1 = t$ for all t

$X_2 = (2JP_2 t - JP_2^2)$ for $t \leq JP_1$

$X_2 = (2JP_2 t - JP_2^2)$ for $JP_1 < t \leq JP$

$X_2 = 0$ for $t > JP_2$

$X_3 = (2JP_1 t - JP_1^2)$ for $t \le JP_1$

$X_3 = 0$ for $JP_1 < t \le JP_2$

$X_3 = 0$ for $t > JP_2$

$X_4 = 0$ for $t \le JP_1$

$X_4 = t^2$ for $JP_1 < t \le JP_2$

$X_4 = t^2$ for $t > JP_2$

3.4.4.5 Linear-linear-quadratic model

A graphical examination of a data series may reveal that it can be divided into different segments as the trend equation below:

$$Y_t = \alpha_0 + \beta_0 t. \qquad t \le JP_1 \qquad (62)$$

$$Y_t = \alpha_1 + \beta_1 t \qquad JP_1 < t \le JP_2 \qquad (63)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 t^2 \qquad t > JP_2 \qquad (64)$$

Where

Yt = Data series in ysear t

T = Trend

α_0, α_0, α_1, β_1, θ_1, α_2, β_2 = Parameters to be estimated and α_0, α_0, α_1, β_1 dropped from the restricted equation

JP_1 = Joint Point one

JP_2 = Joint Point Two

Equation 62-64, was then reworked as shown below:

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 (2JP_2 t - JP_2^2) \qquad t \le JP_1 \qquad (65)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 (2JP_2 t - JP_2^2) \qquad JP_1 < t \le JP_2 \qquad (66)$$

$$Y_t = \alpha_2 + \beta_2 t + \theta_2 t^2. \qquad t > JP_2 \qquad (67)$$

Equation 64-66 are then formed into a single equation for estimation as follows:

$$Y_t = \mu_0 X_0 + \mu_1 X_1 + \mu_2 X_2 + \mu_3 X_3 + U_t \qquad (68)$$

Where

$X_0 = 1$ for all value of t

$X_1 = t$ for all t

$X_2 = (2JP_2 t - JP_2^2)$ for $t \le JP_1$

$X_2 = (2JP_2 t - JP_2^2)$ for $JP_1 < t \le JP_2$

$X_2 = 0$ for $t > JP_2$

$X_3 = 0$ for $t \le JP_1$

$X_3 = 0$ for $JP_1 \le tt \le JP_2$

$X_3 = t^2$ for $t > JP_2$

3.4.4.6 Quadratic-linear-linear model

A graphical examination of a data series may reveal that it can be divided into different segments as the trend equation below:

$$Y_t = \alpha_0 + \beta_0 t + \theta_2 t^2. \qquad t \le JP_1. \qquad (69)$$

$$Y_t = \alpha_1 + \beta_1 t. \qquad JP_1 < t \le JP_2 \qquad (70)$$

$$Y_t = \alpha_2 + \beta_2 t. \qquad .t > JP_2 \qquad (71)$$

Where

Yt = Data series in ysear t

T = Trend

α_0 , α_0 , α_1 , β_1 , θ_1 , α_2 , β_2 = Parameters to be estimated and α_0 , α_0 , α_1 , β_1 dropped from the restricted equation

JP_1 = Joint Point one

JP_2 = Joint Point Two

Equation 69-71, are then reworked as shown below:

$$Y_t = \alpha_2 + \beta_2 t + \theta_0 (t^2 + JP_1^2 - 2JP_1 t). \qquad t \leq JP_1 \qquad (72)$$

$$Y_t = \alpha_2 + \beta_2 t \qquad JP_1 < t \leq JP_2 \qquad .(73)$$

$$Y_t = \alpha_2 + \beta_2 t. \qquad t > JP_2 \qquad (74)$$

Equation 71-73 are then formed into a single equation for estimation as follows:

$$Y_t = \mu_0 X_0 + \mu_1 X_1 + \mu_2 X_2 + U_t \qquad (75)$$

Where

$X_0 = 1$ for all value of t

$X_1 = t$ for all t

$X_2 = (t^2 + JP_1^2 - 2JP_1 t)$ for $t \leq JP$

$X_2 = 0$ for $JP_1 < t \leq JP_2$

$X_2 = 0$ for $t > JP_2$

3.4.4.7 Mean Square Error (MSE)

After the estimation of the models, the forecasting ability of each of them was assessed using Mean Square Error (MSE). MSE is given as:

$$MSE = \sqrt{\frac{1}{n}}\left[Y_t - y_t\right]^2 \qquad 76$$

Where:

MSE = Mean Square Error

Y_t = Observed value

y_t = Estimated value

N = Sample size

The model with the least MSE is adjudged better than the other.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-economics Characteristics of the Respondents

This section describes the socio economic characteristics of the various actors in the ginger production value chain.

4.1.1 Gender of the respondents

The socio-economic characteristics of respondents according to gender, marital status and age are represented in Table 4.1. The result revealed that large proportion of the respondents in both Kaduna (82.1%) and Benue States (72.4%) were male likewise when the two states combined (80.5%). This implies that ginger farming is dominated by males. Dauda (2017) attributed this to the fact that ginger farming requires high energy exertion and commitment of productive resources. These results conform to *a - priori* expectation that males tend to be far more than females in any agricultural production enterprise due to the tedious nature of farming activities. On the other hand, the low percentage of females involved in farming could be due to the nature of faming activities which makes it difficult for women to cope. Women are however, responsible for processing most of the farm produce, and in some cases, were involved in other farming activities like planting, harvesting and fertilizer application which is assumed to be less tedious. This agrees with the findings of Shehu *et al.* (2013) who asserted in their separate studies that the males dominated ginger production; the low participation of females is as a result of the tedious nature of ginger production. Policy formulation by the state should therefore take into account this gender – related peculiarity (Emmanuel, 2008).

Table 4.1: Gender, marital status and age of the respondents

	Kaduna		Benue		Pool	
Variable	**Freq**	**Percentage**	**Freq**	**Percentage**	**Freq**	**Percentage**
Gender						
Female	54	17.9	16	27.6	70	19.5
Male	247	82.1	42	72.4	289	80.5
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**
Marital status						
Divorced	2	.7	0	0.0	2	.6
Married	250	83.1	51	87.9	301	83.8
Never Married	43	14.3	7	12.1	50	13.9
Seperated	2	.7	0	0.0	2	.6
Widowed	4	1.3	0	0.0	4	1.1
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**
Age (year)						
20 and Below	17	5.6	9	15.5	26	7.2
21-30	68	22.6	16	27.6	84	23.4
31-40	107	35.5	16	27.6	123	34.3
41 – 50	64	21.3	6	10.3	70	19.5
51 – 60	25	8.3	8	13.8	33	9.2
61 and above	20	6.6	3	5.2	23	6.4
Mean	**32**		**30**		**31**	
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**
Years of farming						
1.0 - 10.0	49	16.3	11	19.0	26	7.2
10.1 - 20.0	91	30.2	23	39.7	84	23.4
20.1 - 30.0	96	31.9	13	22.4	123	34.3
30.1 - 40.0	43	14.3	6	10.3	70	19.5
40.1 - 50.0	19	6.3	5	8.6	33	9.2
50.1 and above	3	1.0	0	0	23	6.4
Mean	**24**		**18**		**21**	
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**
Years in school						
Primary education	27	9.0	15	25.9	42	11.7
Secondary education	186	61.8	38	65.5	224	62.4
Tertiary education	82	27.2	5	8.6	87	24.2
Religious studies	6	2.0	0	0	6	1.7
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**

Source: Field survey 2018

4.1.2 Marital status

Table 4.1 also shows the distribution of respondents according to their marital status. The results indicated that majority of the respondents sampled in both Kaduna (83.1%) and Benue States (87.9%) were married. Pooled results for the two states also showed that majority (83.3%) of the respondents are married. The preponderance of married farmers in the study area could translate into availability of family labour as opposed to other respondents who are never married, divorced or separated. In addition, marriage comes with responsibilities hence; the respondents that are married will be more willing to take risk that comes with adopting new technology and management strategies in other to increase their yield. According to Magaji (2005) the marital status of the rural people is a determinant factor for the supply of labour for farm practice.

4.1.3 Age

The distribution of the respondents according to age as represented in table 4.1 revealed that large proportion of the respondents in Kaduna (35.5%) and in Benue States (27.6%) were between the ages of 31 and 40years with a mean age of 32 and 31 years respectively. Similar trend was observed when the two states were combined (34.3%) with a mean age of 31 years. This implies that ginger farmers are within the active years. This also agree with the findings of Aba *et al.* (2015) who asserted that this categories of farmers are the economically active population as the age could affect the type of farming he or she could positively engage as reported by Food and Agricultural Organization (FAO, 2014). The ability to meet up with demand and procurement of ginger to meet consumers demand is energy demanding and therefore requires energetic and young farmers. The implication of this result is that there is likelihood of high productivity among farmers since majority of the farmers are less than 50 years of age which shows that they are strong, active and flexible to farming activities.

4.1.4 Farming experience

The farming experience of the respondent is represented in Table 4.1. The result indicated that an overwhelming majority of the respondents in Kaduna (83.7%), Benue

(81.0%) and pooled sample (92.8%) had more than 10years farming experience with mean years of farming experience of 24 years, 18 years and 21 years for Kaduna, Benue and the two states combined respectively. More experienced farmers are knowledgeable on the best production systems to adopt to maximize output and reduce cost. In addition, experienced farmers' are better able to adopt technologies extended to them to enhance their productivity and efficiency. It is in accordance with the findings of Makarau *et al.* (2013) who stated that farmers within this age bracket and years of experience are more willing to undertake new risk, therefore adopting new methods that will put them in a better economic position.

4.1.5 Educational attainment

Education is generally considered an important variable that could enhance farmer's acceptance of new technologies. *Shehu et al.* (2013) posited that education can influence the youth in the adoption of modern farming technologies and thereby sustaining a virile farming population. Results in Table 4.1 also shows the distribution of the respondent according to level of education. The result revealed that only few (9.0%) of the respondents in Kaduna State had attained primary education only, 25.9% and 11.7% had also attained the same level of education in Benue and the pooled data respectively. Majority of the respondents 61.8%, 65.5% and 62.4% had up to secondary education in Kaduna, Benue and the pooled sample respectively. The result further indicated that 27.2%, 8.6% and 24.2% had up to tertiary level of education in Kaduna, Benue and in the pooled data respectively and only 2.0% of respondents in the pooled sample attained religious studies. This implies that all the respondents in Kaduna and Benue had one form of formal education or the other which enables them to read and write. Hence, they are likely to understand extension guides or instructions and also to keep farm records. Educational enlightenment also implies that the ginger farmers were more receptive to information from extension agents and other means on the adoption of best practices for improved yield and harvesting techniques that would harness the quality of ginger. The implication of this result is that there is likelihood of high productivity among the ginger farmers.

4.1.6 Household size

The household size of the respondents is represented in Table 4.2. The respondents had varying household sizes. Majority (91.0%) of the respondents in Kaduna State had household sizes of 1-10 persons, 79.3% in Benue State had household sizes of 1-10 persons. In the same vein, 89.1% of the respondents in the pooled sample had household sizes of 1-10 persons.The average household sizes for Kaduna, Benue and pooled sample were at 8, 7 and 8 persons respectively. This implies that the farmers had large household size which could serve as a source of cheap labour in farming activities. The burden of hiring labour for all activities in ginger production, from land preparation to planting, mulching, weeding and harvesting contributes significantly to labour cost. Hence, extra family labour leads to a reduction in cost of production, as some labour activities can be shared among the family members. This is in line with the report of Oladele (2011) who stipulated that there is a positive and significant relationship between the household size and the efficiency of farmers in crop production.

Table 4.2 Household size and farm size of the respondents.

	Kaduna		Benue		Pool	
	Freq	**Percentage**	**Freq**	**Percentage**	**Freq**	**Percentage**
Household size (ha)						
1.0 - 10.0	274	91.0	46	79.3	320	89.1
11.0 - 20.0	21	7.0	12	20.7	33	9.2
21.0 - 30.0	5	1.7	0	0.0	5	1.4
Above 30	1	0.3	0	0.0	1	0.3
Mean	**8**		**7**		**8**	
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**
Farm size (ha)						
0.1 - 1.0	120	39.9	18	31.0	138	38.4
1.1 - 2.0	97	32.2	16	27.6	113	31.5
2.1 - 3.0	61	20.3	16	27.6	77	21.4
3.1 - 4.0	17	5.6	5	8.6	22	6.1
Above 4.0	6	2.0	3	5.2	9	2.5
Mean	**1**		**1**		**1**	
Total	**301**	**100.0**	**58**	**100.0**	**359**	**100.0**

Source : Field Survey 2018

4.1.7 Farm size

The size of farmland cultivated by ginger farmers is presented in table 4.2. The farmers had an average farm size of 1.0 ha in each of the state and the pooled result. Most of the farmers (39.9%), (31.0%) and (38.4%) in Kaduna, Benue and the combined State respectfully cultivated farm size of between 0.1 – 1.0ha, followed by 32.2%, 27.6% and 31.5% who cultivated between 1.1-2.0ha. According to Ojuekaiye (2001) farmers who have the same farm size of 0.1 to 5.9 hectares are classified as small scale farmers. The size of the farm holdings confirm that these ginger farmers are smallholder and produce on small scale. The farmers therefore could not engage in large scale production because the cost of ginger production and the labour involve is high, another reason for devoting only small portion of land for ginger production by many farmers was due to use of such farm lands mostly for staple crops such as maize, soybean and sorghum which are competing with ginger crop (Folorunso and Adenuga, 2013). Makarau *et al.* (2013) in his findings postulated that the larger the farm sizes of the household, the higher the expected level of food production.

4.2 The Output Supply Response of Ginger in the Study Area

The output supply response of ginger in Benue, Kaduna and the States combined was analysed and discussed in this study.

4.2.1 The summary statistics of time series variables

The summary statistics of the variables are presented in Table 4.3**.** The statistics include minimum, maximum, mean, standard deviation, skewness and kurtosis. On the average, ginger production, yield, land area and price stood at 27260.8900 metric tonnes, 4.1824 metric tonnes, 7807.8620 hectares and ₦44.4179 per kg in Benue State compared to that of Kaduna State which stood at 250245.0000 metric tonnes, 9.227256 metric tonnes, 27323.2300 hectares and ₦55.54310 per kg. A careful examination of the minimum, maximum and mean of the series in table 4.2 indicated that ginger production and yield in Kaduna state outweighed that of Benue State with Benue State contributing not more than 13% to the total production in the States combined. The price of ginger per kg is higher by ₦11.13 in Kaduna than Benue States. The result indicated a high variability in ginger production and land area used in Benue and Kaduna with standard deviation of 12096.5500 metric tonnes, 9392.1560 hectares and 103920.6000 metric tonnes, 8434.6570 hectares respectively.

Looking at the statistical summary of the pooled sample in Table 4.3, the highest level of production was recorded at 577026.7000 metric tonnes and a lowest production capacity of 178924.4000 metric tonnes. While the average production capacity stood at

283536.3000 metric tonnes with high level of variability and peakness indicating how ginger production can be highly deviated when affected by some factors.

Table 4.3: Summary statistics of the series

State/variables	Production (metric tonnes)	Yield (metric tonnes)	Land Area (hect.)	Prices (₦)
Benue State				
Maximum	79537.8000	7.7800	40550.0000	102.7400
Minimum	5290.0000	2.5200	1254.5400	30.1500
Mean	27260.8900	4.1824	7807.8620	44.4179
Std. Deviation	12096.5500	1.0110	9392.1560	13.9362
Skewness	2.0423	1.9709	2.9285	2.2436
Kurtosis	9.7488	7.9131	10.3858	9.2521
Kaduna State				
Maximum	524932.9000	16.5184	48000.4400	154.6000
Minimum	162254.7000	7.4122	16713.5700	30.0000
Mean	250245.0000	9.2272	27323.2300	55.54310
Std. Deviation	103920.6000	1.81550	8434.6570	23.74557
Skewness	1.5958	2.0741	1.0903	2.1245
Kurtosis	4.1574	7.9782	3.0945	8.9500
Pooled State				
Maximum	577026.7000	30.4700	81100.0000	106.0141
Minimum	178924.4000	10.9191	2509.0800	30.9677
Mean	283536.3000	9.7673	15674.8000	50.0080
Std. Deviation	117183.2000	3.7338	18799.5300	17.2902
Skewness	1.4282	2.8593	2.9125	1.5471
Kurtosis	3.6460	12.0405	10.3153	5.0838

Source: Analysed result of time series data from 1979- 2018

The yield at the time under study for the combined state stood at the highest point of 30.4700 metric tonnes and the lowest point of 10.9191 tons the average however is 13.7673 tons. The standard deviation, skewness and kurtosis indicated a moderate level of variability, moderately symmetric towards the centre point with a considerable level of peakness.

Ginger farmers within the time being cultivate an average of 15674.8000 hectares with a standard deviations of 18799.5300. The market price of ginger in the pooled sample stood at the ceiling of ₦106.0141 and sold as low as ₦30.9677 with an average market price of ₦50.0080 recorded in the States combined. Standard deviation, skewness and kurtosis stood at 17.2902, 1.5471 and 5.0838 respectively. According to Mani *et al.,* (2018) the high variation observed in ginger series may be attributed to the higher fluctuating nature of ginger price variations in the market between the harvest and the lean periods.

4.2.2 Unit root test at level 1(0)

Table 4 .4 present the result of the unit root test in the level 1(0) of the variables based on Augmented Dickey-Fuller test (ADF). The ADF test was carried out under an alternative hypothesis of no unit root 1(0) and the null hypothesis of a unit root (I (1)), at 5% significant level. The number of the lags is guided by the Akaike Information Criterion (AIC) to ensure absent of serial correlation in the series. When the deterministic was defined as constant in Benue State, the null hypothesis of unit root is rejected for three variables production, yield, and price while the result was not significant for land area since the t statistics of -2.946 was less than it critical value of -3.548. All variable in Benue state were not significant at noconstant term which indicated that the variables were not stationary at level 1(0). In Kaduna state, when the deterministic was defined as constant only price was stationary 1(0) in the level, for variables production, yield and land area, the null hypothesis for no unit root in their levels was rejected since their various t-statistic were less than their corresponding critical value. However when the deterministic was defined as noconstant, production, land area and price were not stationary at level 1(0) except for yield that was significant. The pooled result for both Benue and Kaduna state revealed that most variables production, yield and land area were not stationary at level 1(0) when a constant term was factored into the model except for price which was stationary in it level form. However when noconstant term was factor into the model, the null hypothesis of no unit root for all variables for all variables was rejected except production.

Table 4.4: Result of stationarity test at level 1(0)

Variables	Term	Benue State			Kaduna State			Pooled State		
		TS	CV(5 %)	DEC	TS	CV(5 %)	DEC	TS	CV(5%)	DEC
Prod.	Constant	-5.882	-3.548	S	-2.091	-3.548	NS	-2.098	-3.548	NS
	Noconstant	-0.094	-1.950	NS	-0.338	-1.950	NS	-0.245	-1.950	S
Yield	Constant	-4.791	-3.548	S	0.245	-3.548	NS	-3.041	-3.548	NS
	Noconstant	-0.167	-1.950	NS	-2.571	-1.950	S	0.913	-1.950	NS
Land	Constant	-2.946	-3.548	NS	-2.946	-3.548	NS	-2.946	-3.548	NS
	Noconstant	-1.855	-1.950	NS	-1.855	-1.950	NS	-1.855	-1.950	NS
Prices	Constant	-3.780	-3.548	S	-4.053	-3.548	S	-3.606	-3.548	S
	Noconstant	-0.162	-1.950	NS	-0.097	-1.950	NS	0.119	-1.950	NS

Source: Analysed result of time series data from 1979- 2018 (STATA 13)

TS = t-statistics; CV= Critical value; DEC = Decision; S = Stationary; NS = Not stationary; Prod= Production.

:

4.2.3 Unit root test at first difference 1(1)

Since all variables are not stationary in their level 1(0) we proceed to carry out a unit root test in their first difference at 5% significant level taking cognizance of both constant and noconstant deterministic terms. However, result of the unit root test as presented in table 4.5 revealed that all the non-stationary series became stationary after first differencing when the deterministic was define as both constant and noconstant.

This implies that all variables production, yield, land area and price were stationary in their first differencing in Benue, Kaduna and the pooled result. The hypothesis of unit root in all series was rejected at 5% level of significance after first difference. Since the ADF test statistics are greater than the respective critical values as shown in table 4.9. The result of the unit root test shows that the variables are a mixture of I(0) and I(1). This justifies the used of the ARDL model.

Table Table 4.5: Result of stationarity test at first diferences 1(1)

Variables	Term	Benue State			Kaduna State			Pooled State		
		TS	CV(5 %)	DEC	TV	CV(5 %)	DEC	TV	CV(5%)	DEC
Prod.	Constant	-8.743	-3.552	S	-4.127	-3.552	S	-4.216	-3.552	S
	Noconstant	-8.841	-1.950	S	-4.200	-1.950	S	-4.285	-1.950	S
Yield	Constant	-7.669	-3.552	S	-4.571	-3.552	S	-7.213	-3.552	S
	Noconstant	-7.339	-1.950	S	-3.429	-1.950	S	-6.443	-1.950	S
Land	Constant	-6.997	-3.552	S	-6.997	-3.552	S	-6.997	-3.552	S
	Noconstant	-7.179	-1.950	S	-7.179	-1.950	S	-7.179	-1.950	S
Prices	Constant	-6.856	-3.552	S	-6.986	-3.552	S	-6.886	-3.552	S
	Noconstant	-6.973	-1.950	S	-7.086	-1.950	S	-6.943	-1.950	S

Source: Analysed result of time series data from 1979- 2018 (STATA 13)
TV = t-value; CV= Critical value; DEC = Decision; S = Stationary; NS = Not stationary; Prod= Production.

4.2.4 The ARDL bound test of cointegration

Following the result of the unit root tests, we sought to determine the existence of co---integration relationship between the series. In the first stage of ARDL model that specifies the relationship between lnproduction (dependent variable) and other explanatory variables lnyield, lnland area and lnprice. The existence of long run cointegration relationship for the variables is investigated by computing the F test statistic. Different lag level were tried base on the Akaike Information Criterion (AIC) and the best lag level that fit the data from each state was selected. Given the few observations available for estimation, the maximum lag order for the various variables in the model for Benue, Kaduna and Pooled result is set at ARDL(1,0,0,0),

Table 4.6: Result of the ARDL bound test of cointegration

Critical Value	Benue		Kaduna		Pooled	
	Lower bound	Upper bound	Lower bound	Upper bound	Lower bound	Upper bound
10%	**2.72**	**3.77**	**2.72**	**3.77**	**2.72**	**3.77**
5%	**3.23**	**4.35**	**3.23**	**4.35**	**3.23**	**4.35**
1%	**4.29**	**5.61**	**4.29**	**5.61**	**4.29**	**5.61**

Source: Analysed result of time series data from 1979- 2018 (STATA 13)
Benue: ARDL(1,0,0,0) and (F= 5.463)
Kaduna : ARDL(1,3,2,1) and (F=9.455)
Pool : ARDL(3,3,3,1) and (F=5.59)

ARDL(1,3,2,1) and ARDL(3,3,3,1) respectively. Result of the ARDL bound test represented in Table 4.6 shows the F statistics, lower bound and upper bound test for testing the joint null hypothesis that there exists no long run relationship between the variables.

The computed F statistic was 5.463, 9.455 and 5.599 for Benue, Kaduna and the pooled sample respectively. The lower and upper bound test at 5% significant level are 3.23 and 4.35 . The estimated F statistics for both States and their resultant pooled statistics is higher than the upper bound critical value at 5% level of significance obtained from as computed by Pesaran, Shin, and Smith (2001) at the 5% probability level . Since the F satistic exceeds the upper bound of the critical value band, the null hypothesis of no long run relationship between the variables is rejected. This test result suggests that there exists a long-run relationship between Inproduction, lnyield, lnland area and lnprice in Benue, Kaduna and the pooled result.

Having rejected the null hypothesis of no long run cointegrating relationship between the variables in the ARDL model, specifications selected based on Akaike Information Criterion (AIC) was estimated capturing the error correction term (ECT)

4.2.5 Long run relationship

The test for the estimates of the long-run coefficients of ARDL modeling is represented in Table 4.7. The coefficients of yield is positive and statistically significant at 1% and in Benue with long-run coefficients 8.126 implying that, a 1% increase in the yield of ginger leads to 8.126% increase in ginger production in Benue. This is in line with the findings of Ojogho *et al.* (2013) who stipulated that positive relationship often exist between output and yield. However the result for Kaduna State and the combine pool result for Kaduna and Benue State indicated that yield is not a significant variable that affect the output of ginger in the long run. The coefficient of land area is not significant for Benue but significant in Kaduna State at 10% and at 1% significance level for their pool sample with a long run coefficient of 0.316. This implies that a unit increase in land area increased ginger production by approximately 0.316% in the long run. This is in line with the study of Tanko *et al.* (2016) which showed that increase in harvested area has positive impact on rice yield and concluded that, rice output in Northern Region of Ghana increase as a results of increase in planted area and not the adoption of new technology. This also agrees with the findings of Lekwot *et al.* (2016) which revealed that ginger production in Nigeria is dominated by small-holder producers and with land sizes ranging between 1-2 hectares, farmers are unable to exploit any benefit associated with economies of scale. The small sizes of farms in addition limit the capacity of farmers to mechanize or modernize their production and make efficient use of available labor (which is usually obtain at a high cost due to shortage of hired labour).

Increasing area cultivated of ginger, will therefore pave room for farmers to exploit economies of scale and make optimum use of labor available to them in the long run. These benefit would however be realized only

Table 4.7: Long run equilibrium of ginger output

Variables	Benue		Kaduna		Pooled	
	Coeff.	**t-value(Prob)**	**Coeff.**	**t-value(prob)**	**Coeff.**	**t-value (prob)**
Constant	-2625.36	-1.49 (0.142)	- 0.83347	- 0.48(0.634)	13.17317	4.19(0.000)***
Dprod						
Dyield	8.126.75	3.10(0.0038)***	**0.09059**	2.27 (0.032)	-0.16715	-0.57(0.571)
DlandArea	0.798	0.01 (0.988)	-.07618	-0.340(0.736)*	0.31608	3.05(0.006)***
Dprices	-0.0447	-0.38 (0.706)	2.2723	4.37(0.000)***	1.45240	6.99(0.000)***
R^2	**0.3851**		**0.7823**		**0.6649**	**0.4669**
Adj-R^2	**0.3148**		**0 . 6986**		**0.4669**	
Root MSE	**0.5300**		**0 . 12 14**		**0.1009**	
AIC	**21.594**		**54.9238**		**55.7358**	
ECT (-1)	**-0.884**	**-4.87 (0.000)**	**-0.929**	**-5.01(0.000)**	**-0.124**	**- 4.45(0.000)**

Source: Source: Analysed result of time series data from 1979- 2018 (STATA 13 & EVIEW 10)

***= implies statistically significant at (1%), **= implies statistically significant at (5%)
* = implies statistically significant at (10%), Values in parenthesis are t-values

through complementing area expansion with intensification measures to mitigate any adverse effect on production. Farm gate price for Kaduna and the pool sample was significant at 1% level of significant with coefficient of 2.2723 and 1.4524. A unit increase in the farm gate price of ginger in Kaduna State leads to a 2.272% increase in ginger output in the long-run and a unit increase in farm gate price in the pool sample will lead to an increase of ginger production by 1.452% in the long run. This finding is in consonance with the result obtained by Mani *et al.* (2018) where the price of ginger was significant at 1% respectively and positively influenced ginger productivity in the long run.

Obinatu (2003) made a similar observation in the study of ginger marketing in Kaduna State, Nigeria. Increasing the farm gate price of rough ginger (if increments are appropriately transmitted) increases the financial base of ginger producers and enable them to effectively meet the cost of vital inputs of production like labor, fertilizer, pesticides, and to ensure effective coverage of the cost of controlling diseases and weeds, the latter being a major problem with ginger production in Nigeria. The result also reflected that price factor was not a significant variable for ginger production in Benue State. This implies that ginger farmers are not sensitive to price change in Benue state and this may be attributed to the fact that farmers in the state produces ginger in a very small scale and mostly not for commercial purposes.

Estimates of the error correction term (ECT) that measures the speed of adjustment from both estimators has expected sign and significantly different from zero at 1% level of probability in Benue, Kaduna and the States combined. The error-correction term, ECT_{t-1}, was negative with coefficient of (-0.884), (-0.929) and (-0.124) respectively. This implies that nearly 88%, 92% and 12% of any disequilibrium level of ginger production during the previous period will be adjusted in the current period in Benue, Kaduna state and the States combined respectively.

The observed high in speed of adjustment perhaps can be attributed to the fact that ginger farmers can adjust quickly against the constrained they face in ginger production both in the short and long run. Furthermore, the fact that the estimated speed of adjustment is significant at 1% level of significance is also an indication that the feedback mechanism is effective in converging ginger supply towards long---run equilibrium aftershock in the ginger output supply and the price factors in the analysis.

4.2.6 Short-run dynamics

The short-run coefficients estimates revealed the dynamic adjustment of all variables and also the significant effects of the lags of some of the variables on ginger production. The result of the short run dynamics is shown in table 4.8. The result reveals that the first and second lag of dprod was statistically significant at 1% level of significant in the combined pooled sample of Benue and Kaduna State but was not captured by the model in the individual respective State during the short run production period. The coefficient of dprod(-1) and dprod(-2) is 1.034 and 1.081 meaning that a 1% change in the first and second lag of ginger production is associated with a 1.034% and 1.081% increase in ginger production in the next and second year at the 1% significant level in the short run. This is line with the findings of Ndubisi *et al.* (2017) who opined that ginger productivity of the previous seasons (-1) and two previous seasons (-2) was significant at 1% and positively influencing the productivity of ginger in the short run. This implies that ginger productivity level recorded previously affected current productivity positively i.e. the increase recorded in the previous years have a positive short-run impact on the productivity in the subsequent years.

Current yield of ginger was significant in Kaduna at 10% and in pooled sample at 5% with respective positive coefficient of 0.0462 and 1.06248, implying that a 1% increase in yield in the current period will be followed by an increase in the current ginger output by 0.0462% and 1.06248% in Kaduna State and the pooled sample respectively. The coefficient of current ginger yield was not significant in Benue State; however the significant level in the pooled result was as a result of the influence of ginger yield in Kaduna State. According to Emmanuel (2008) Kaduna State is known to be the major producers of ginger in Nigeria with other state such as Benue currently contributing just a little in the production frontier.

Table 4.8: Short run equilibrium of ginger output

Variables	Benue		Kaduna		Pooled	
	Coeff.	**t-value(Prob)**	**Coeff.**	**t-value(Prob)**	**Coeff.**	**t-value(Prob)**
Constant	-1.42912	-1.49 (0.146)	- 0.8334	- 0.48(0.634)	13.1731	4.19(0.000)***
dprod(-1)					1.0340	3.96(0.001)***
dprod(-2)					1.0810	4.14(0.000)***
Dyield	7.1875	0.000(3.775)	0.0462	1.82(0.077)*	1.0625	2.73(0.012)**
DlandA	-0.27889	-4.14 (0.000)***	-0.3808	- 1.95(0.062)*	0.3818	2.98(0.007)***
dlandA(-1)			0.4681	1.87 (0.074)*	0.2598	2.37(0.027)**
dland(-2)			1.0256	3.66 (0.001)***	0.1298	1.51(0.146)
Dprices			0.9392	2. 05(0.051)*	1.8518	4.86(0.000)***
dprice(-1)			- 1.4772	-1.80(0.085)*	1.2059	3.99(0.001)***
dprice(-2)					- 0.5572	- 2.63(0.015)**
R^2	**0.4765**		**0.7823**		**0.6649**	
Adj-R^2	**0.3971**		**0.6986**		**0.4669**	
Root MSE	**0.3971**		**0.1214**		**0.1009**	
AIC	**51.4738**		**54.9238**		**55.7358**	

Source: Analysed result of time series data from 1979- 2018 (STATA 10 & EVIEW 10)

***= implies statistically significant at (1%), **= implies statistically significant at (5%)
* = implies statistically significant at (10%), Values in parenthesis are t-values

The short run dynamics of dland in table 4.8 shows that the coefficients was significant at 1% significant level in Benue and Pooled sample but at 10% level of significant in Kaduna State. The coefficient in Benue and Kaduna state was negative -0.2788 and -0.3808 which implies that a percentage change in land area was associated with a 0.2788% and 0.3808% decline in the current ginger production in Benue and Kaduna during the short run period respectively. This result agrees with the findings of Ndubisi *et al.* (2017) who reported that land available for ginger production in previous years was statistically significant at 1% and the usage of land previously has a negative or positive effect on the productivity of ginger depending on how well land is managed.

With the depreciating soil fertility and availability of arable land for the cultivation of ginger the productivity of ginger is affected negatively (Soule, 2013).

According to Mohammed (2016) increase in land area in some cases may not lead to increase in production, for production to increase the land space must be complemented with other input such as effective fertilizer and agro chemicals application with good agronomy practice, this was the case with ginger production in the respective individual state were ginger farmers in the current year increases their land area without sufficient fund to complement the increament with effective farm management practice within the given period Lekwot (2016). The coefficient for dlandA in the pooled sample was significant and positive 0.3817 which indicated that a change in current land area will have a positive effect on ginger production by 0.3817%. The first and second lag of dlandA was significant at 10% and 1% in Kaduna but only the first lag is significant at 5% probability level in the combined result. All coefficients were positive in the first and second lag of Kaduna 0.4681 and 1.0256 and also in the first lag of the pooled sample 0.2598. This is an indication that increase in land area will increase the output of ginger in the short run. The lag variable for dlandA was dropped in the model for Benue State.

Further result from table 4.8 revealed that the coefficient for dprice (0.9392) and the first lag of dprice (-1.4772) was positive and negative in Kaduna State but significant at 10% probability level. A unit increase in price will increase current production of ginger by 0.9392% while a unit decreases in price in the last previous year's increases ginger output by 1.4772% in Kaduna State. For the pooled sample, the short run coefficients for the current price (1.8518) and first lag (1.2059) were positive and statistically significant at 1% while the coefficient of the second lag (- 0.5572) was negative and significant at 10% level. This implies that the current and first lag of dprice has a positive effect on ginger output while the second lag has a negative effect. The negative effect of some price variables in supply response as opined by Siyan (2005) was as a result of the cobweb behavior of farmers who may respond negatively or lately to price change in the process of achieving dynamic equilibrium. The farmers are both price and price risk responsive. The negative coefficient attributed to price in the first and second lag of Kaduna and the pooled sample may be attributed with farmer's behavior in cobweb analysis as opine by Siyan (2005). However dprice for all the price variables both current, first lag and second lag of Benue State were dropped by the model during the analysis considering the restriction placed on the data point available for estimation by the model in the short run.

4.2.7 The estimated diagnostic indicators

Before applying the model estimates for economic analysis, the results were subjected to several econometric tests. These include tests for heteroscedasticity, serial correlation, white test for heteroscedasticity, LM test for autoregressive conditional heteroskedasticity (ARCH), normality and stability test (Greene, 2008; Gujarati and Sangeetha, 2007). The econometric tools employed included Breusch-Godfrey Serial Correlation LM Test, Jarque-Bera and CUSUM tests respectively. The estimated diagnostic indicators are summarized in table 4:9. The result shows no evident of serial correlation for Benue, Kaduna and the pooled sample as indicated by Durbin-Watson d-statistic of 2.1659, 2.0659 and 2.1208 support by Breusch-Godfrey probability level of 0.4223, 0.6934 an d 0.5366 which are all greater than 5% probability level respectively. White's test of heteroskedasticity is also not significant with probability level of 0.1214, 0.4215 and 0.4215 for Benue, Kaduna and the States combined respectively. The result also indicate that there was no effect of autoregressive conditional heteroskedasticity (ARCH) since the F statistics was not significant for Benue (1.56), Kaduna (5.00) and the pooled result (3.62) supported by the Breusch-Godfrey Probability level of 0.4955, 0.6782 and 0.8979 which are all greater than 5% or 10% probability level. The normality test as revealed in table 4.9 and as illustrated in figure 5a-c indicated that the model is normal for Benue, Kaduna and the combined States evident from Jarque Bera diagnostics test of 0.1028, 0.2078 and 0.4433 with probability level of 0.9499, 0.9013 and 0.8012 respectively. Further result reveal that the CUSUM graph lies within the 5% boundary for Benue, Kaduna and Pooled sample concluding that the model is stable. The stability of the model was an evidenced from the results of the stability test using CUSUM test as indicated in the diagram in figure 6a-c.

Table 4.9: Diagnostics test of the time series data

Diagnostics Test	Benue	Kaduna	Pooled
Serial Correlation			
Durbin-Watson d-statistic	2.1659 (NS)	2.0659 (NS)	2.1208 (NS)
Breusch-Godfrey LM test probability	0.4223	0.6934	0.5366
Significant Level.	0.05	0.05	0.05
White's test of heteroskedasticity			
Probability level	0.1214 (NS)	0.4215 (NS)	0.4215 (NS)
Significant level	0.05	0.05	0.05
ARCH LM test			
Breusch-Godfrey F –Statistics	1.56 (NS)	5.00 (NS)	3.62 (NS)
Breusch-Godfrey Probability level	0.4955	0.6782	0.8979
Significant Level	0.05	0.05	0.05
Normality Test			
Jarque Bera	0.1028 (NS)	0.2078 (NS)	0.4433 (NS)
Probability level	0.9499	0.9013	0.8012
Significant level	0.05	0.05	0.05
Stability Test			
Cusum Test	Stable	Stable	Stable
Boundary	0.05	0.05	0.05

Source : Analysed result from time series data 1979-2018 (EVIEW 10)
NS = Not significant
(ARCH) = autoregressive conditional heteroskedasticity

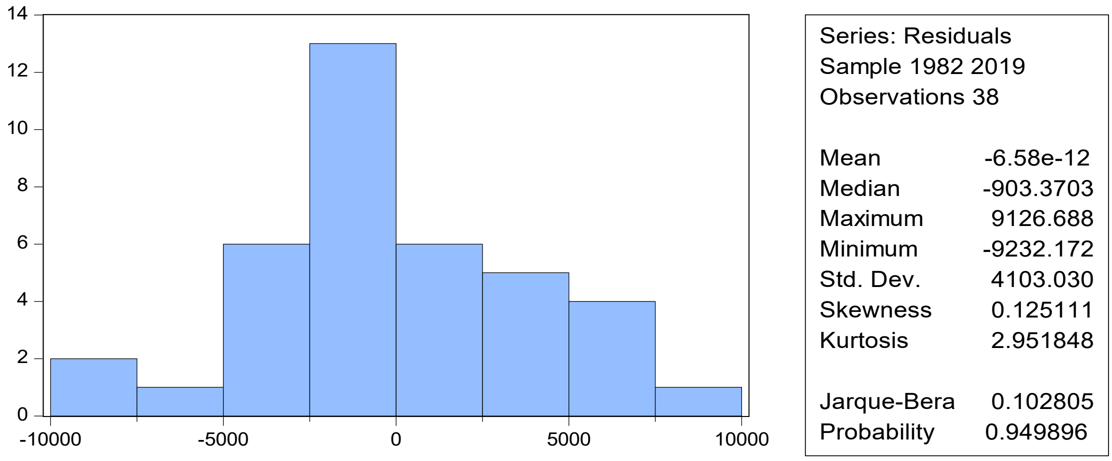

Figure 5a: Normality test for Benue State

Source: Analysed time series output from Eview 10.

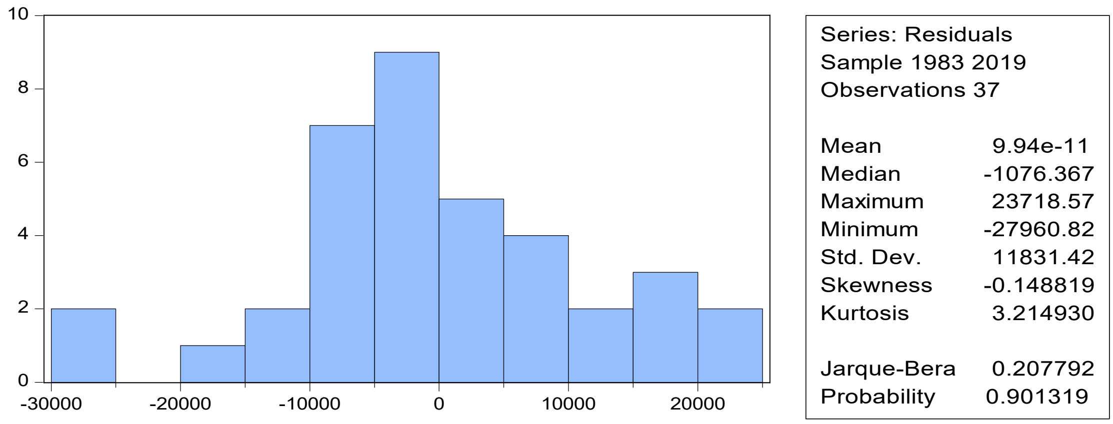

Figure 5b: Normality test for Kaduna State

Source: Analysed time series output from Eview 10.

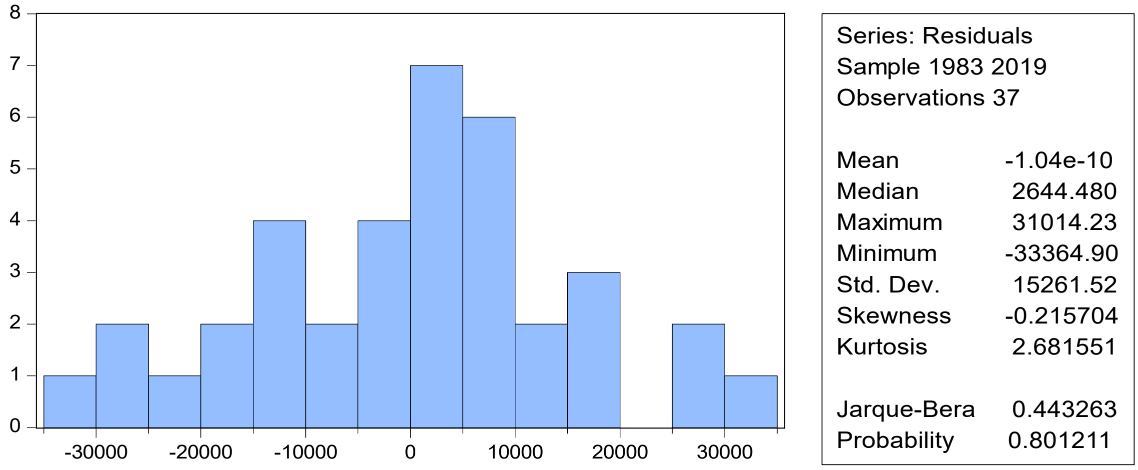

Figure 5c : Jarque Bera Normality test for Pool Sample

Source: Analysed time series output from Eview 10.

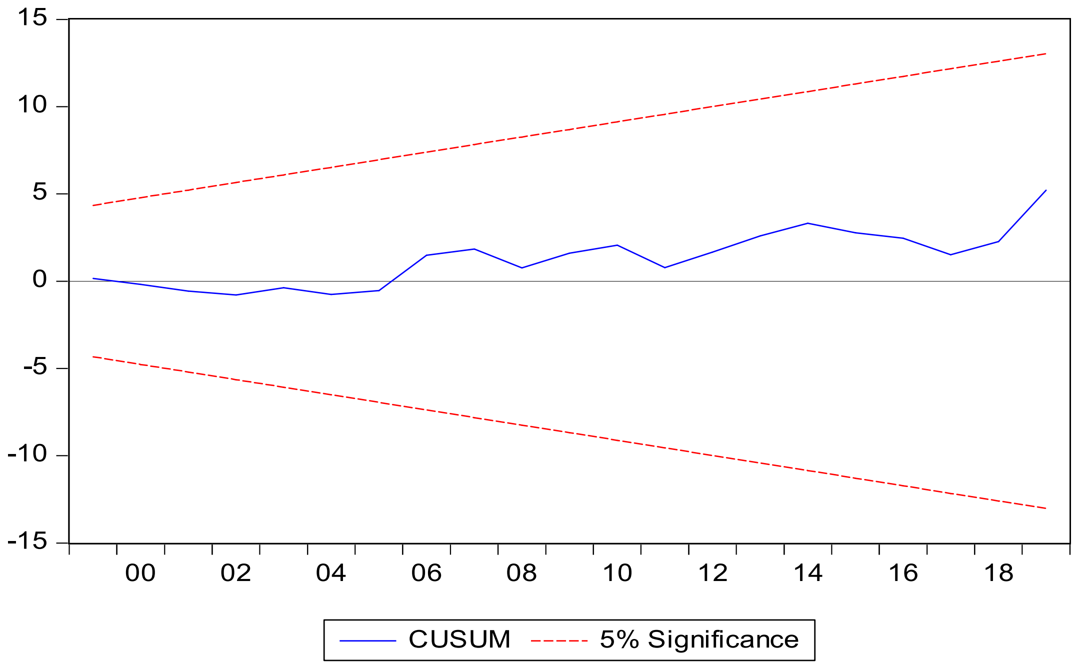

Figure 6a: Cusum stability test for Benue State

Source: Analysed time series output from Eview 10.

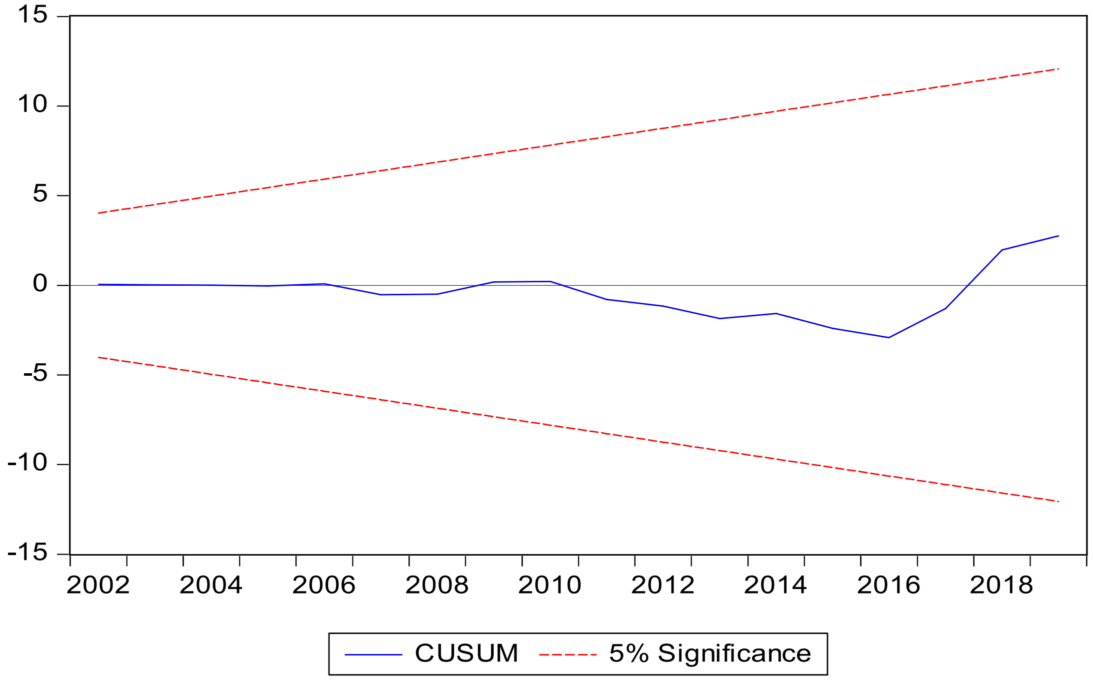

Figure 6b: Cusum stability test for Kaduna State

Source: Analysed time series output from Eview 10.

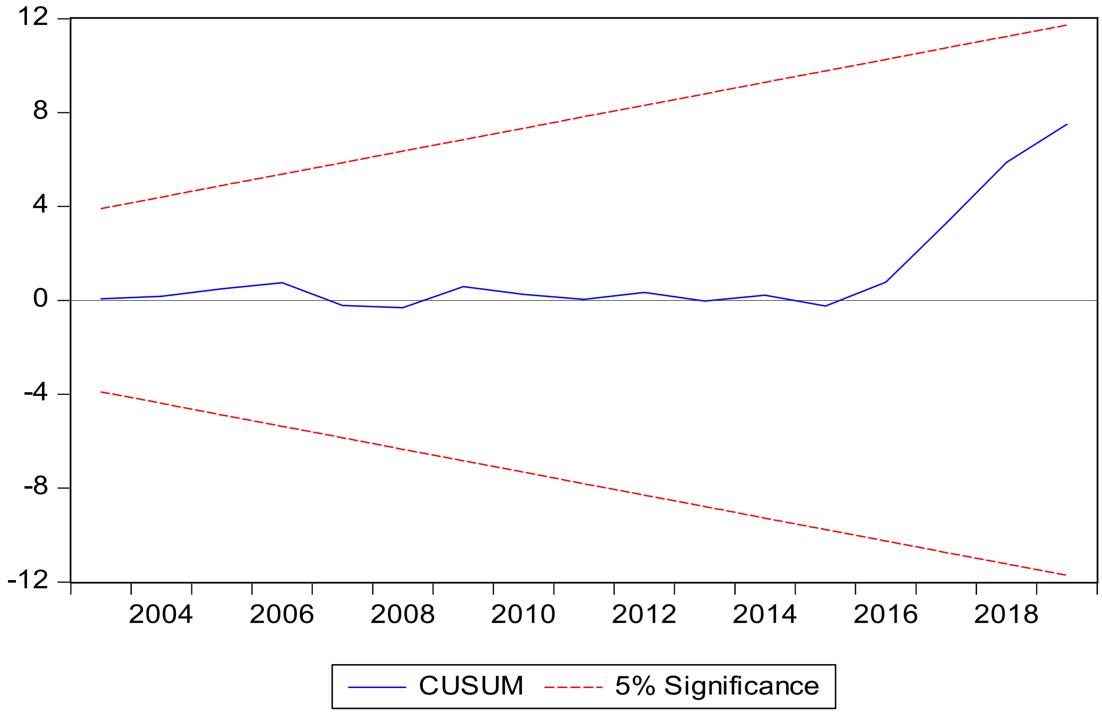

Figure 6c: Cusum stability test for the States combined

Source: Analysed time series output from Eview

4.3 Observed Trend in Ginger Production

Results of the observed trend in ginger production are represented in Figure 7. The results revealed that at the end of operation feed the nation and the commencement of the green revolution in Nigeria (1980-1984), ginger production stood between the range of 180,000 to 200,000 metric tonnes in Kaduna and the combined states respectively. There was a slow and steady rise in ginger production from 1985 to 1990. This period coincided with the structural adjustment programme. According to Alamu *et al.* (2003) free market forces accompanied by increase in price of food items was responsible for increase in production of major crops during this era.

The growth rate was maintained up to the year 1999 and 2000 where there was a structurer break in ginger production. Ginger production in this period dropped sharply in Benue State but fell slightly in Kaduna and the pooled sample. According to Ezra *et al.* (2017), there was no provision of farm input most especially inorganic fertilizer to support crop production between this era. The output of ginger was unstable after the year 2000 with a continuous rise and fall in ginger production up to the year 2010 where there was a sharp structurer change in ginger production. Ginger production increases from 35660.00 and 455660.55 metric tonnes in 2009 to 50000.69 and 503001.12 metric tonnes in 2010 in Benue and the States combined respectively. This rapid increase in ginger production can be associated to the high increase in the price of ginger as a result of the shortage in supply that occured in 2009. Farmers responded positively to this rise in price by increasing the volume of her production in 2010. Though there was a fall in ginger output in Benue in 2011 but ginger production kept increasing in Kaduna and the pooled sample reaching its peak in 2015. This may be due to the influence of government commercialization policy as exhibited in the Agricultural Transformation

Agenda (ATA) around that period. Ginger is currently identified as a potential focal crop for the export market in the Agricultural Promotion Policy document of Nigeria. The share of crop production in total agricultural production had risen to 89.09% between these periods (Abidemi, 2017). However, there was a sharp drop in ginger production from 56,000 to 27,000 metric tonnes in 2017 and towards 2018.

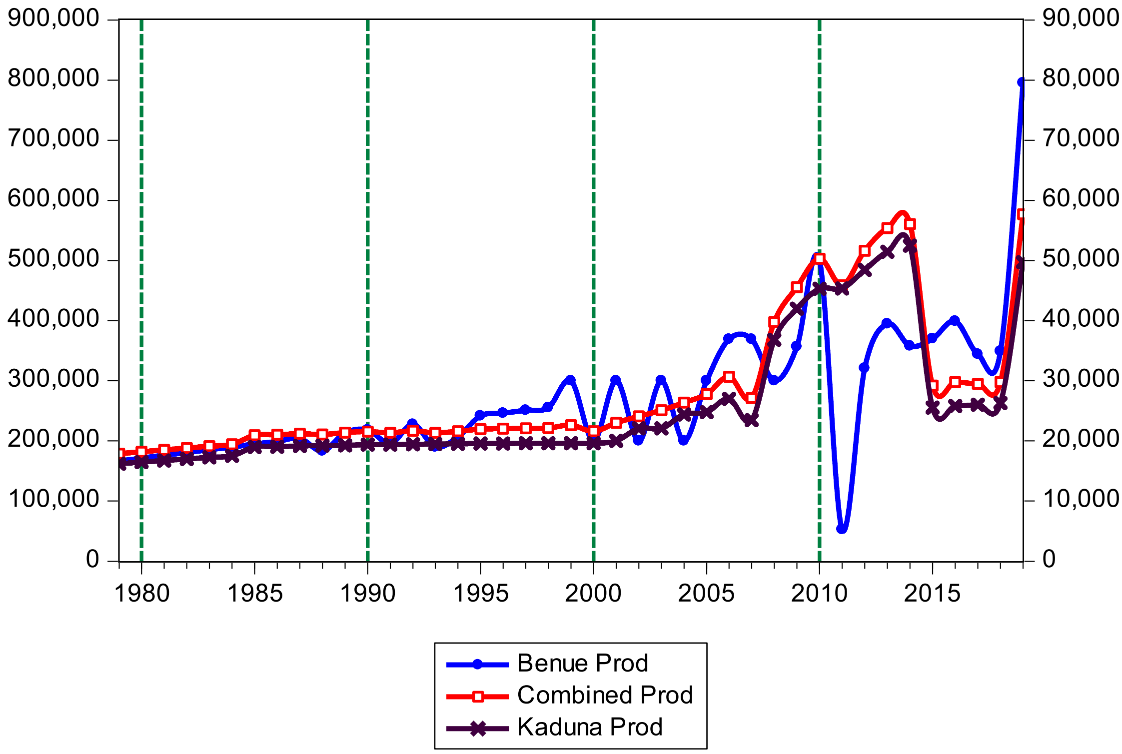

Figure 7: Growth part in ginger production

Source: Analysed time series output from Eview 10.

This is in line with the findings of Ezra *et al.* (2017) who attributed this sharp fall in ginger production to a fall in price of ginger within the period. A bag of ginger that was sold at an average price of ₦22,000 from 2015 to 2016 falls to as low as ₦6000.00 from 2017 to 2018. Sunday *et al.* (2018) associated this sharp change to the free entry and free exit nature of ginger production, farmers from different part of the country acquired land in the producing area whenever there is a rise in price. This often led to excess supply and a fall in the price of ginger. A fall in price attracts few producers which subsequently lead to shortage in supply of ginger and a persistence rise in price. The positive relationship between price and output established in this finding supported the influence of price on ginger production in this period. According to Mani *et al.* (2018) the high revenue realized by ginger farmers between 2015 and 2016 increases the level of ginger production in the study area, attracted other farmers who diversify into ginger production in some part of the North. This led to surplus supply of ginger from 2017 to 2018 and a sharp drop in the price of ginger in various ginger markets.

4.4 Trend Estimates and Joint Point in Ginger Production

The production trend of ginger in Benue, Kaduna and the combined state was analysed. The joint point from the observed series was determined. Different functional forms of the model were used for the ex-ante and ex-post forecast of ginger production.

4.4.1 Delineation of the joint point

Result of the observed ginger trend from which the joint point were selected for Benue, Kaduna and the Pooled sample is shown in figure 8-10. Traditionally, the data was divided into three sub-periods and no attempt was made in this study to go beyond that as this will required a higher polynomial model. However Fuller (1969) opined that the grafted quadratic is considerably superior to the cubic in approximating the response to variables in a higher dimension plane by cutting the domain of the functions with planes. The concept was based on the visual examination of the scatter diagram of the available data series against trend in order to divide the data into sub-periods and to suggest suitable joint points to capture all the sub-periods into a single model (Nmadu *et al.,* 2009).

Casual observation of figure 8 for Benue State reveals a many possible 3 segments. However upon trials on many possible combinations, the curve was grafted from 3 segments with the first joint point at 2011 (JP_1=2011) and the second joint pint at 2018 (JP_2=2018).

A graphical examination of figure 9 for Kaduna State reveals a many possible 3 segments delineation. However upon many possible combinations, the curve was broke into 3 segments using JP_1=2007 and JP_2=2015. Result of the pooled sample in figure 10 shows similar trend to that of Kaduna. This was because Kaduna production overshadows that of Benue in the pooled sample. In this case careful observation of the pooled trend also revealed JP_1 at 2007 and JP_2 at 2015.

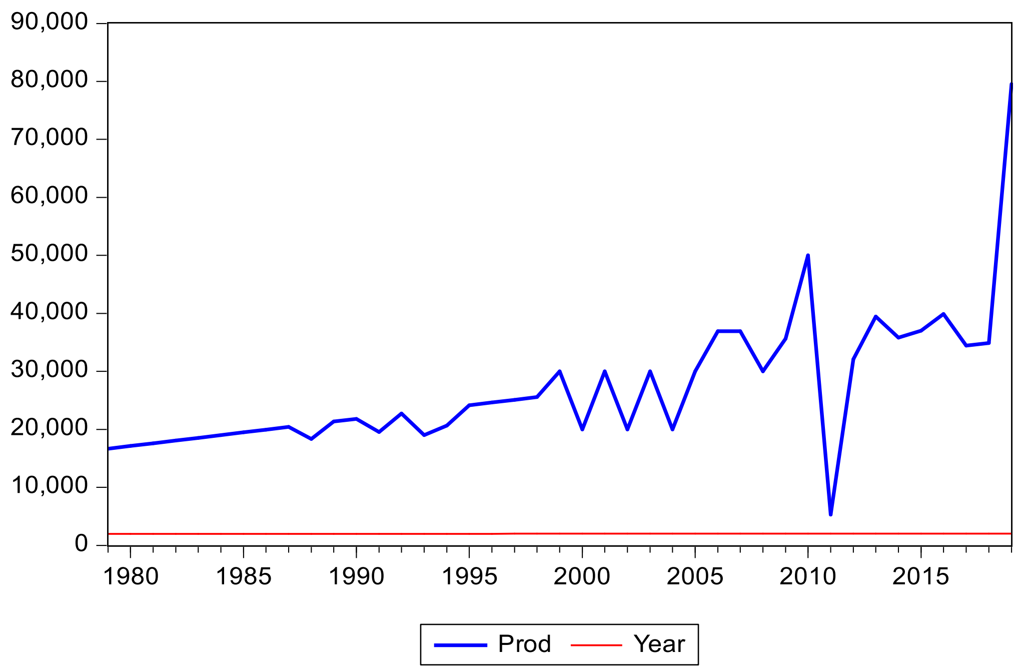

Figure 8: Ginger trend in Benue State

Source: Analysed time series output from Eview 10.

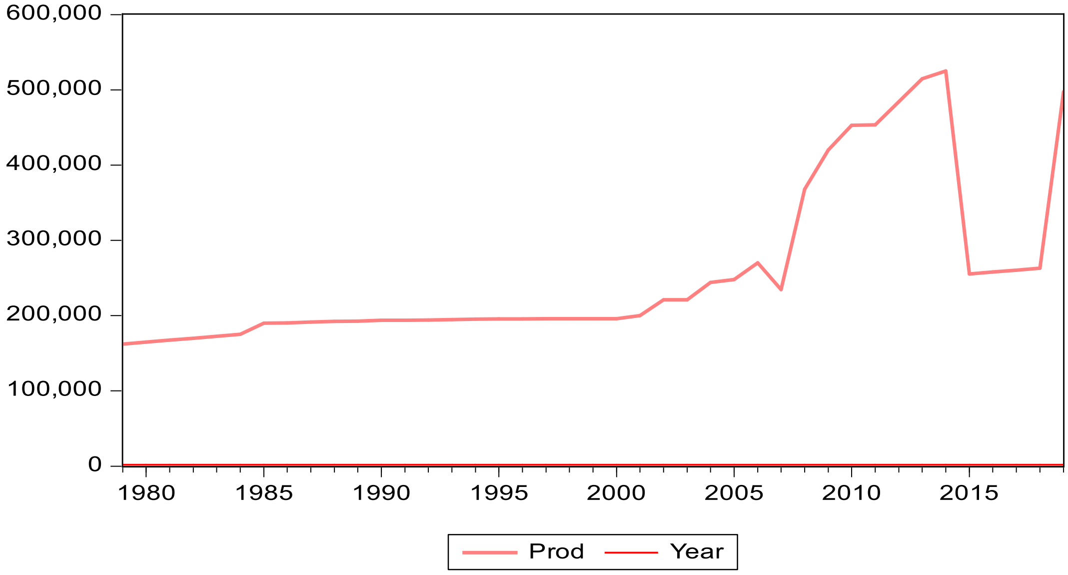

Figure 9: Ginger trend in Kaduna State

Source: Analysed time series output from Eview 10.

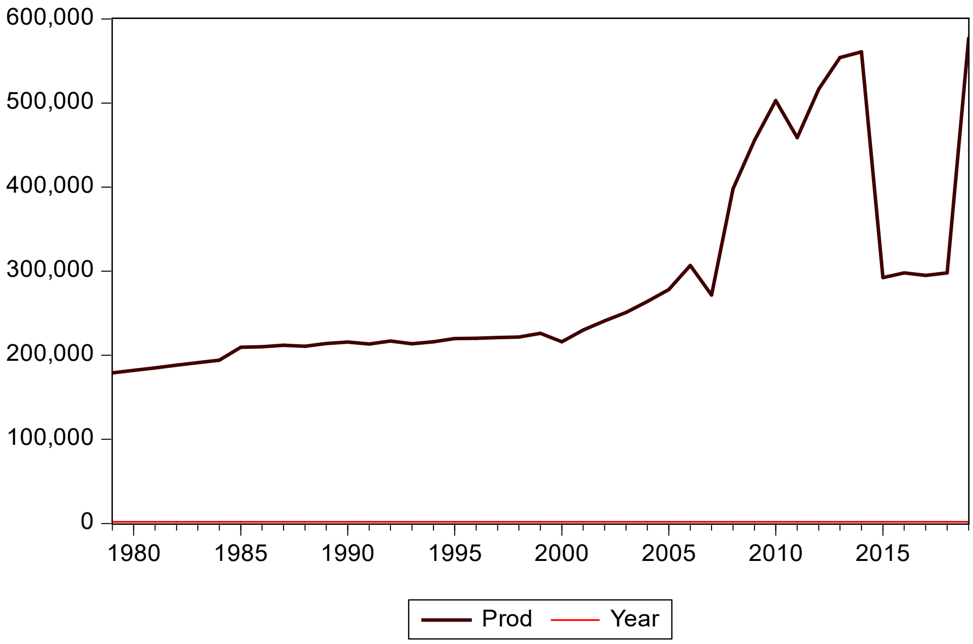

Figure 10: observed ginger trend of the pooled sample

Source: Analysed time series output from Eview 10.

4.4.2 Estimate of structural parameters and the strength of the ex-ante and ex-post forecast

The estimate coefficient and the forecasting strength of the model were presented in table 4.10. Thus, in a practical situation, the choice of functional form will rest upon theoretical considerations, ease of estimation and acceptance by the data (Fuller, 1969). However this study attempted to use different functional forms to prevent errors that could be associated with the selection of joint point as one functional form may appropriately fit into the joint point within the forecasting period than the other (Fuller 1960; Nmadu and Amos, 2002; Nmadu and Philip, 2001; Nmadu *et al*., 2004). Therefore a combination of different functions with one or more linear component was applied. This functions include Linear function(L), Quadratic-Quadratic-Linear(QQL), Linear-Quadractic-Linear(LQL), Quadratic Linear Linear(QLL), Quadractic-Linear-Quadratic(QLQ), Linear-Linear Quadractic(LLQ) and Linear-Quadratic-Quadratic (LQQ). The forecasting ability of each of all the applied models was assessed using Root Mean Square Error (MSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE).

The Quadratic-Quadratic-Linear function in Benue and Kaduna state captures the observed trend in ginger production more than all the other models, this was followed by the Linear-Quadratic-Linear function in Benue State and Linear-Quadratic-Quadratic model in Kaduna State. This result agrees with the findings of Fuller (1969) and Philip (1990) who opine that there are two commonly used models, that is, Linear-Quadratic-Linear and Quadratic-Quadratic-Linear models. These are preferred because it is normal to have linear portion at the terminal. However, the result from the pooled sample revealed a deviation from what is obtainable in Benue and Kaduna State, the Linear Quadratic Quadratic function captured the trend in ginger production more than other functions followed by the Quadratic-Quadratic-Linear functions. This is in line with the work of Nmadu *et al.* (2009) where the ex-post and ex-ante forecast from the Linear-Quadratc- Quadratic model compares favourably with the other models for cereal grains production and also compares favourably with results obtained from other series (Rahman and Damisa, 1999; Nmadu and Amos, 2002; Nmadu and Philip, 2001; Nmadu *et al*., 2004).

Table 4.10: Estimate of the coefficient of the ex-ante and ex-post forecast

Variables	**Benue** Coef.(t-value)	**Kaduna** Coef.(t-value)	**Pooled** Coef.(t-value)
X_0	-239071.8	885967.6	800797.9
	(-2.905)***	(2.718)***	(2.352)**
X_1	5947.691	-10999.26	-8259.471
	(3.407)***	(-1.529)	(-1.099)
X_2	400.6073	-1945.269	-1797.090
	(2.749)***	(-3.130)***	(-2.768)***
X_3	-404.2390	2493.743	2343.151
	(-2.605)**	(3.407)***	(3.064)***
RMSE	7631.185	62858.01	65658.12
MAE	4302.983	48823.88	49729.86
MAPE	22.632	18.119	16.386
F	17.9007	24.27307	25.99419
R^2	0.59207	0.663083	0.678212
Adj R^2	0.558996	0.635765	0.652121
N	39	39	39

Source: Analysed result of time series data from 1979- 2018 (EVIEW 10).
*****= implies statistically significant at (1%), **= implies statistically significant at (5%)**
*** = implies statistically significant at (10%), Values in parenthesis are t-values**

However, According to Fuller (1969) and Philip (1990), though a Linear-Quadratic-Quadratic function may properly capture the trend of an observed time series data but the result with Quadratic terminal is kinked at the joint points which is against one of the major requirement of the spline or grafted models. In that regard, it is advised that all possible spline or grafted models as applied in this study should be tried and the ones that give best result should be utilized. Therefore, the Quadratic-Quadratic-Linear model was adopted for this study. According to Adedokun *eta l.* (2016) it was assumed that different functional forms may fit different segments of a time series or response studies, segments of polynomials can be used to approximate production surfaces or frontiers and to forecast time series, however segment that end in linear form are better and frequently used to forecast time series data as in trend studies. These segmented curves are restricted to be continuous and differentiable at the joined points.

The result of the quadratic-quadratic-linear model adopted for this study is represented in table 4.10. The estimates of the coefficients on X as presented in table 4.10 revealed that the calculated t-values for the functions in the trend model for X_1 and X_2 in Benue State was statistically significant at 1%. The significant level of X_3 for the quadratic-quadratic-linear (QQL) model was at 5% probability level, this suggests that all the trend models in Benue State must have captured and infused all the observed key and major local trends in the models.

Result of the coefficients estimates in table 4.10 for Kaduna State indicated that the trend variable x_1 was not a significant factor affecting ginger production while X_2 and X_3 were both significant at 1% probability level for the model. Further result for the pooled sample shows that the trend variable X_1 was not significant in the model. The trend model for X_2 and X_3 in the pooled sample were both significant at 1% probability level for the quadratic-quadratic-linear (QQL) function. This implies that the trend models in Kaduna and the States combined must have captured and infused the observed key and major local trends of X_2 and X_3 in the models.

4.4.3 Mean estimate of the observed and forecasting models

Some economic time series might exhibit linear relationships over an entire sample period while others may not (Nmadu *et al*., 2004). The linearity of the observed series at the end point is a determinant factor for the proper model that can fit into the trend (Alabi, 2008). The result of the mean forecast for the quadratic-quadratic-linear function compared to the observed mean from 1979-2018 using an interval of ten years is presented in table 4.11. The essence is to examine how the model captured the observed series within a given forecasting period of ginger production. The mean corresponding to this sub-period was captured from the regression analysis for evaluating the predictive performance of quadratic-quadratic-linear function in relation to the observed ginger series within a given period.

The mean forecasts suggest that between each period of production, the quadratic-quadratic-linear function provides more reliable predictions of ginger production by capturing the observed series more closely in Benue, Kaduna and the combined States. According to Akpan *et al.* (2007) the strength of the quadratic-quadratic-linear in capturing observed trend is what makes the model generally acceptable in predicting time series data using the grafted polynomial model.

Table 4.11: Observed and mean forecast of ginger output

Variables	Observed	Benue QQL($\bar{x}$)	Kaduna QQL($\bar{x}$)	Pooled QQL($\bar{x}$)
1979-1988	18521.27	15788.09	177980.00	196382.83
1989-1998	22080.39	23283.02	176294.90	199280.17
1999-2008	28382.01	27582.83	217600.60	242920.40
2008-2018	34459.16	36815.65	378798.60	416897.96

Source: Analysed result of time series data from 1979- 2018 (EVIEW 10)
QQL=Quadratic-Quadratic-Linear(QQL).
Mean ($\bar{x}$)

According to Odedokun *et al.* (2016) the failure of the Linear function to reliably predict observed trend in production is due to the fact that, the linear (mean) function does not entrenched the key and major observed local trends in the forecasting framework which has prevent a more relevant time series prediction over the entire sample period compared to the grafted polynomials models.

4.4.4 The trend estimate of the ex-ante and ex-post forecast of ginger production.

A graphical illustration of the ex-ante and ex-post forecast for ginger production in Benue, Kaduna and the pooled sample is presented in figure 11. Result in figure 11 for Benue State shows that the curve of the quadratic-qudratic-linear model had a positive slope that trend upward in ginger production. These imply that the ex-ante and ex-post forecast values for ginger production increases over time with a rapid increase at the terminal point towards 2040. The curve of the ex-ante and ex-post forecast of ginger for Kaduna State and the Pooled sample shows some interesting results. The trend for the quadratic-quadratic-linear function were similar, this was in line with the earlier observed graphical trend of ginger production in Kaduna State and the pooled sample. The model revealed a trend with both positive and negative slope. The negative slope shows a fall in ginger production in both Kaduna and the States combined from 1970 to 1989. Ginger production in Kaduna State increases rapidly between 1990 and 2015 and experience a sharp fall towards the near future. Result of the pooled sample from figure 11 further revealed that there was a constant return to scale in ginger production between 1992 and 1997 and the production rose sharply in 1998. The terminal end of the curve for the combined States is symptotic to X-axis. This is an indication that ginger production falls gradually in subsequent years towards 2040.

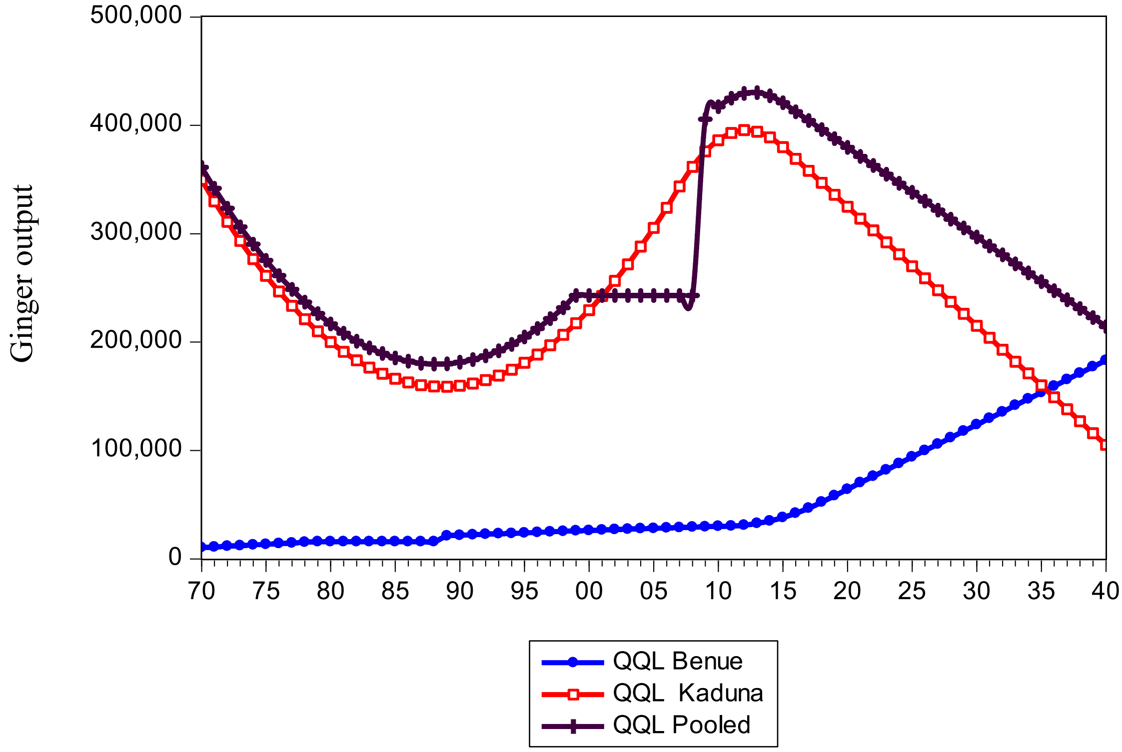

Figure 11: Ex-ant and ex-post forecasts of ginger production in Benue, Kaduna and Combined States.
Source: Analysed time series output from Eview 10.

4.5 Constraints to Ginger Production

The constraints faced by the ginger farmers in the study area are presented according to Climatic constraints, environmental constraints, seed constraints, Institutional constraints, extension service constraints and marketing constraints.

4.5.1 Climatic constraints

Result from table 4.12 shows the climatic constraints faced by ginger farmers. The result indicated that majority of the respondents in Benue (32.25%) were faced with intensity high of sunlight in ginger production while majority of the respondent in Kaduna(25.00) and the pooled sample (22.96%) complained of excessive rainfall. The result in Benue was followed by inadequate rainfall l(25.80%) and excessive rainfall(16.12%). However the result in Kaduna was followed by excessive rainfall

(23.07%), and inadequate rainfall (20.19%). This is similar with the pooled sample with inadequate rain fall and excessive rainfall each (21.48%).

4.5.2 Environmental constraints confronting ginger production

Environmental constraints confronting ginger production as shown in Table 4.12. Weed infestation 35.78% in Benue, 46.97% in Kaduna and 44.30% in the pooled sample were the major constraints encountered by farmers in ginger production followed by disease incidence 26.31%, 20.13% and 21.6% respectively. The growth of weed has been found to wrestle the soil nutrients with ginger resulting to limited nutrients available for ginger to flourish well. This is in consonance with the work of Orkwor and Melifonwu (1988) who stipulated that weed is one of the major constraints militating against ginger production as farmers are required to weed their farm at an interval of three weeks if they are to expect any significant output in ginger production. This finding is also in line with the work of Anamayi (2018) who stated that farmers often complained of disease attacking their crops both in the field and while in the storage resulting in varying degrees of crop damage and reduction in yield.

4.5.3 Seed constraints confronting ginger production

The seed constraints as presented in Table 4.12 revealed that the major constraints in Benue were improper seed storage (42.85%), High cost of seedlings (31.42%) and inadequate improved seed variety (14.28%) while in Kaduna and the Pooled result shows that high cost of seedlings rank first as the major constrain (40.91%) and (39.83%) followed by improved seed varieties improper seed storage (30.45%) and (31.86%) then inadequate improve seed varieties (19.08%) and (18.50%) respectively.

Table 4.12: Constraints faced by ginger farmers

Contraints	Benue		Kaduna		Pooled	
	Freq	**(%)**	**Freq**	**(%)**	**Freq**	**(%)**
climatic constraints						
Inadequate rainfall	8	25.80	21	20.19	29	21.48
Excessive rainfall	5	16.12	24	23.07	29	21.48
High Intensity of Sunshine	10	32.25	18	17.30	28	20.74
Excessive wind	5	16.12	26	25.00	31	22.96
Low relative humidity	**3**	**9.67**	**15**	**14.42**	**18**	**13.33**
Total	**31**	**100.00**	**104**	**100.00**	**135.00**	**100.00**
Environmental constraints						
Disease incidence	25	26.31	60	20.13	85	21.6
Erosion menace	14	14.73	37	12.41	51	12.98
Inadequate soil fertility	12	12.63	52	17.44	64	16.28
Pest invasion	10	10.52	9	3.02	19	4.83
Weed infestation	34	35.78	140	46.97	174	44.30
Total	**95**	**100.00**	**285**	**100.00**	**393.00**	**100.00**
Seed constraints						
Inadequate improved seed variety	10	14.28	104	19.08	114	18.5
Seed is not certified	8	11.42	52	9.5	60	9.7
Seed is costly to procure	22	31.42	223	40.91	245	39.83
Seed is not properly stored	30	42.85	166	30.45	196	31.86
Total	**70.00**	**100.00**	**545**	**100.00**	**615**	**100.00**
Institutional problems						
land procurement and acquisition	23	17.82	108	14.65	131	15.12
Inadequate loan and credit	41	31.78	256	34.73	297	34.29
Poor farm gate price	35	27.13	222	30.12	257	29.67
Inadequate storage & transport facilities	30	23.25	151	20.48	181	20.90
Total	**129**	**100.00**	**737**	**100.00**	**866**	**100.00**
Extension constraints						
Inadequate visits	38	32.20	244	33.15	282	33.02
Inadequate extension services	32	27.11	231	31.38	263	30.79
Low technological adoption	15	12.71	112	15.21	127	14.87
Inadequate fund to enhance adoption	33	27.96	149	20.24	182	21.31
Total	**118**	**100.00**	**736**	**100.00**	**854**	**100.00**
Marketing Constraint						
Inadequate Market	43	31.85	262	37.53	305	36.61
Low market price	22	16.29	188	26.93	210	25.21
Inadequate market storage	37	27.40	126	1.05	163	19.56
Inadequate transport facilities	33	24.4	122	17.47	155	18.60
Total	**135**	**100.00**	**698**	**100.00**	**853**	**100.00**

Source: Field survey 2018

Ezra *et al.* (2017) in his findings also stated that the major challenges to ginger production were high cost of inputs especially ginger seedlings, inputs for ginger production such as improved seeds are not available and for few available inputs the cost was very high. In addition to that farmers are also facing difficulties in marketing their products.

4.5.4 Institutional constraints confronting ginger production

Table 4.12 present the institutional constraints faced by ginger farmers. Inadequate loan and credit 31.7%, 34.78% and 34.29% was the major constraint in ginger production in Benue, Kaduna and Pooled result respectively. This was followed by poor farm gate price 27.13%, 34.73%, 29.67% trailed by inadequate storage and transport facilities 23.25%, 20.48% and 20.90% respectively.

This finding is supported by Ajakaiye (1998) who observed that the Nigerian farmer needs credit especially for their farm product because of the vicious circle of poverty, low productivity and low farm income levels with virtually no savings to invest in the capital required in the transformation of their production technology

4.5.5 Extension service constraints confronting ginger production

Results from Table 4.12 representing extension service constraints indicated that majority of the respondents complained of inadequate visits in Benue (32.20%), Kaduna (33.15%) and pooled sample (33.02%). This was followed by inadequate fund to enhance adoption of extension service in Benue (27.96%), inadequate extension service in Kaduna (38.38%) and the pooled sample (30.79%). The result is Shehu *etal.* (2013) who reported that apart from inadequate extension visit the reasons for farmers non – adoption of agricultural practices are reluctance to let go their old ways and unfavorable product prices in the market.

4.5.6 Marketing constraints confronting ginger production

Marketing constraints are presented in Table 4.12 .The results revealed the respondents are majorly affected by inadequate market (31.85%), (37.53%) and (36.61%) in Benue, Kaduna and the pooled result respectively. This was trailed by inadequate market storage facilities (27.40%) and inadequate transport facilities (24.40%) in Benue State but low market price (26.93%) and inadequate transport facilities (17.47%) in Kaduna State. However the pooled sample result shows 25.21% for low market price and 19.56% for inadequate market facilities.

This finding is supported by the report of Ayodele and Banake (2016) who opine that about 55%, 50% and 45% of the farmers agreed that inadequate market, lack of storage facilities and lack of good road and high transportation cost prevent them from carrying their produce (Ginger) from the farm to their houses and market at the right time. Farmers had to face the uneatable task of searching for profitable market for their product and renting a vehicle at the very exorbitant price to take their produce home and to the market because of the unavailability of market storage facilities and condition of the road.

4.6 General Linkages and Applications of the Study

Ginger production was not stable from the result of the ARDL model supported by the observed trend in ginger production. This instability was mostly as a result of the positive or negative effect of price and land area on ginger production. The influence of these variables varies based on the period of production. They are mostly negative in the short-run period but mostly positive in the long run. This shows how ginger farmers easily adjust towards equilibrium in the long run. Disequilibrium in ginger production is mostly associated to short-run period of production. This is because the short run period is too short enough to vary all factors of production. An expansion in land area may not necessary be accompanied by increase in ginger production because the period may be too short enough for ginger farmers to finance their farm activities with good management practices. Result from the observed trend of ginger production indicated how government policies can influence ginger production at different time period.

Policies could be effective in ginger production when such policies are targeted towards price stability and increase in land area allocated for ginger production in the long run as captured by the ARDL model.

Export promotion policies that increases ginger production to its peak by 2015 was as a result of the provision of good marketing environment that command premium price leading to increase in farm size and ginger output. This is always the long run effect of such policy on ginger production as supported by the positive effect of price and land area on ginger production in the long run specification of the ARDL model. Unavailability of farm input as discussed in the observed growth path was the major reason for the sharp fall in ginger production between 1999 and 2000. The study further supported these findings by identifying unavailability of farm input as the major constraint faced by ginger farmers in the study area. Price, market factors and also climatic factors that affect proper land manager was also a major constraint in ginger production. Since result from the ARDL model, observed growth path of ginger and the constraint faced by ginger farmer's link a positive or negative effect of any of this factors, it is possible to expect a sharp drop in ginger production in the near future as predicted by the quadratic-quadratic-linear model. This will coincide with what was obtained in the structurer break of ginger production between 1999 and 2000.

Land use act that support large scale ginger production can only be effective if the policy is supported by the provision of farm input for ginger farmers for good farm management practices. Recent agricultural policies that discourage the importation of goods and services including farm produce can only be effective if such policies are accompanied with price regulation, market availability and more export promotion policies especially in ginger production.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Ginger productivity in Nigeria is crucial topic of discourse owing to the economic importance of the crop for employment creation through value addition and as an important export earner. The male dominated ginger farming because of the tedious nature of ginger production. Majority of ginger farmers are married with an average household size of 8 persons. Most ginger farmers are small-scale farmers with secondary education and well experienced in their farm practices. Ginger output's responded positively to yield, land area and price change in the long run implying that an increase in any of these variables will increase ginger production in the long run. However in the short run, ginger output responded positively or negatively to yield, land area and price based on their lag level. Productivity of ginger in the previous seasons (-1) and second previous seasons (-2) had positive influence on ginger production in the short run. Land used for ginger production in current and previous years had negative or positive effect on the productivity of ginger in the short run. Price of ginger positively affect ginger production in the current years but had negative impact on the previous years. Ginger farmers can easily adjust to errors associated to ginger production; the speed at which disequilibrium in the short run is being adjusted in the long in ginger production is high. Result from the findings revealed that the trend of ginger production in different period could be unstable based on price variation or the influence of Government policies or agricultural development programmes directed towards ginger production. The Quadratic-Quadratic-Linear function captured the ex-ante and ex-post forecast of ginger production more than other models. The Quadratic-Quadratic-Linear which is one of the strongest forecasting models predicted a future fall in ginger output. Inadequate rainfall, high intensity sunlight, weed infestation, disease incidence, high cost of seedlings, inadequate improved seed variety, Inadequate loan and credit, inadequate market extension service were serious constraint faced by ginger farmers in the study area.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made to promote the production of ginger in the study area

1) Price regulation by the government is essential for ginger production. Price is a significant determinant of ginger productivity both in the long run and short run. There should be reasonable and favourable stable prices that would encourage ginger production in the study area. This can also be achieved through establishing guaranteed minimum price control system and creating available domestic and export market for ginger farmers.

2) Availability and accessibility to more land with the basic inputs are essential for the increased production of ginger in Nigeria. The land tenure system in operation should be made flexible by given farmers the freedom to put into use any land that has been kept dormant over some period of time. This will enable ginger farmers access more lands to enable mechanization and increased output.

3) Agricultural labour available in Nigeria is widely regarded as unskilled and insufficient for the agricultural production. Training and farming skills acquisition programmes should be continuously done for the smallholder farmers especially using extension worker to educate the farmers. Increased level of farm mechanization is required to increase the productivity of ginger. A number of

machines should be made available for sale and hire at a cheap cost to encourage large scale production.

4) More Government commercialization policy that will identified ginger as potential focal crop for the export market should be created and implemented consistently to maintain steady pattern in ginger production.

5) Ginger farmers should be taught proper adaptation strategies against climatic factors affecting ginger production in the study area. In addition to this, extension services on good production techniques should be provided to ginger farmers in the study area.

6) Measures should be put in place to guard against serious constraint and significant factors affecting ginger production. These includes: adequate supply of agro chemicals to guard against weed infestation and disease incidence. Adequate supply of other farm input such as improved ginger seedlings, loan and credit facilities and storage facilities. The supply of this input at a subsidize price will be an encouragement to ginger farmers in the study area.

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,
SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY
DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION TECHNOLOGY

Dear Sir/Madam,

I am a Postgraduate student with the above institutional affiliation. This questionnaire is designed to collect data for a PhD Thesis titled Analysis of Supply Response and Trend Estimation of Ginger Production in Kaduna State, Nigeria.

The information you will avail me will be treated with strict confidence and will be used for academic purpose only. No attempt will be made to identify you as a respondent.

MARCUS, PHILEMON LEKWOT

PhD/SAAT/14/594

RESEARCHER

Form No ……..

HOUSEHOLD QUESTIONNAIRE

SECTION A: IDENTIFICATION

**State:……………………………Zone:…………………..…..…..LGA:…………………
…**

Village: ………………………………Ward: …………………

SECTION B: SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

1. Name of Household Head…………………… …………………

2. Age of Household Head…………………………………………………..years

3. Gender. (a) Male (b) Female

4. Phone No of Household Head ………………………….

5. What is your major occupation?

i. Farming [ ] ii. Fishing [ ] iii. Hunting [ ]

iv Trading [ ] v. Civil Servant [ ] vi. Craft Man [ ]

vii. Others (specify) [ ]

6. For how long have you been farming (years) ……………………………….?

7. Please fill the table below on your level of education and number of years spent in school?

Level of Education	**Numbers of years spent**
i. No formal education	
ii. Attended Primary School but did not complete	
iii. Completed Primary School	
iv. Completed Primary School	
v. Attended Junior Secondary School	
vi. Attended Senior Secondary School	
vii. Attended Tertiary Institution	
viii. Religious Studies	
ix. Adult Education	
x. None of them above	

8. Do you have access to credit facilities?

i. Yes [ ] ii. No [ ]

S/N	Source*	Amount	Cash/kind (If in kind pls specify the (kind)	Mode of disbursement installment/once	Interest	Charges/other cost
1						
2						
3						
4						
5						

9. If no to Q8 above proceed to Q10 but if yes please provide the following information about the credit you acquired during the last cropping season:

*** Select from the list (a)friends (b) Relatives (c) Commercial Banks (d) Co-operatives**
(e) Local money lenders (f) Others(Specify)..

10. Marital Status of Farmer

i. Married [ ] ii. Never married [ ] iii. Divorced [ ]

iv Separated [ ] v. Widowed [ ]

11. If married what is the total size of your household …………………………?

12. Do you have access to extension education? i) Yes ii) No

13. If yes to Q12 above, how many times were you visited by an extension agent during 2015/2016 cropping season?..

14. Do you belong to any co-operative or ginger growers' association?

i. No [ ] ii. Yes [ ]

15. State the name/form of group you belong to:

i. ginger growers association [ ] ii. Farmers group [ ]

iii. Co-operative society [ ] iv. Farmers' support club [ ]

v. Others (specify) ……………………………………………..

16. State the benefits derived from the group.

i. Procurement of inputs [ ] ii. Marketing of output [ ]

iii. Granting loans or credit [ ]

iv. Others (specify) ………………………………………………….

(C) PRODUCTION INFORMATION/INPUT INFORMATION

17. How many farm plots do you have? ....

18. For each of the plots you own, please provide the following information:

Plot	Size (ha)	Method of acquisition*	If by purchase how much(₦)	If by rent, how much per annum(₦)	If by pledge what is the pledge
1					
2					
3					
4					
5					

*** (a) Purchase (b) Rent (c) Pledge (d) Leasehold (e) Inheritance41.**

19. What type of cropping system did you adopt?

i. Sole cropping [ ] ii. Mixed [ ] iii.Sole and Mixed [ ]

iii. Others (specify) ……………………………………………..

20. Do you practice mulching in 2015/2016 farming activities **…………………..?**

21. Do you use organic manure for your farming practice………………………………..?

22. If no to Q21 above proceed to Q23 but if yes please provide the following information about the organic manure you used during the last cropping season:

Types of organic manure used	Sources of organic manure	Method of manure application	Quantity applied (kg)
i.Cow dung	i.Farm	i. Applied in Clumps	
ii.Chicken Dung	ii.Market	ii. Applied in pieces	
iii.Debris	iii.Co-operative	iii. Both (i) and (ii)	
iv. Others	iv. Others	iv. Others	

23. Do you applied inorganic fertilizer for your farming practice…………………………..?

24. If no to Q23 above proceed to Q25 but if yes please provide the following information about the

fertilizer you used during the last cropping season:

Types of inorganic fertilizer used	Sources of inorganic Manure	Method of fertilizer application	Quantity applied (kg)
i.NPK	i. MANR/ADP	i. Basal Application	
ii. SSP	ii. Market	ii. Broadcasting	
iii. CAN	iii. Co-operative	iii. Spot application	
iv. UREA	iv. Financial institution	iv. Dressing	
v. Others	v. Others	v. Others	

25. Do you use Agro chemicals for your ginger production…………………………..?

26. If no to Q25 above proceed to Q27 but if yes please provide the following information about the

Agro chemicals you used during the 2015/2016 cropping season:

Types of inorganic agro chemicals used	Sources of inorganic manure	Number of times sprayed	Spraying interval
i. Herbicide	i. MANR/ADP	i. once	i. one month
ii. Insecticide	ii. Market	ii. Twice	ii. two month
iii. Pesticide	iii. Co-operative	iii. Thrice	iii. Three month
iv.	iv. Financial institution	iv. Four times	iv. Four month
v. Others	v. Others	v. Others	v. Others

27. Did you use family labour for ginger cultivation in 2015/2016 season? Yes/No

(a) If No please proceed to question 28
(b) If yes please provide the following information requested in the table below

Operation	**No. of labour**	**No. of Hours/days work**	**No. of days**	**Cost of labour per operation/day(₦)**
(i) Land preparation /mound making				
(ii) Planting				
(iii)Chemical application				
(iv) Fertilizer application				
(v)Weeding				
(vi) Harvesting				
(vii) Slicing and Drying				
(viii) Bagging				
ix) Others, specify…..				
Total				

(28) Do you use hired labour for ginger cultivation in 2015/2016 season? (Yes)/(No)
(a) If No please proceed to question 29

(b) if yes please provide the following information requested in the table below.

Operation	**No. of labour**	**No. of Hours/days work**	**No. of days**	**Cost of labour per operation/day(₦)**
(i) Land preparation /mound making				
(ii) Planting				
(iii)Chemical application				
(iv) Fertilizer application				
(v)Weeding				
(vi) Harvesting				
(vii) Slicing and Drying				
(viii) Bagging				
ix) Others, specify…..				
Total				

(29). Do you own Work Bulls for your production activities? Yes/No.

(a) If No proceed to Question (32).
(b) If yes, how much do you purchase one ₦.....................................?
(c) How many do you own…………………………………………?
(d) how long do you use the bulls in years before you dispose them? ………………
(e) how much will you sale one of them when they can no longer be used for farming? ₦………………………

(30) Please provide information on the implements attached to the bullock in the table below.

Implement	Purchase price	Life Span	Salvage Value

- Please select from the list (a) Oxy-Drawn Cultivator & accessories (b) Oxy-Drawn Ridger & accessories (c) oxy-Cart & Accessories

(31). Please supply the following information about the bullock labour you utilized in

Operation	**Owned**		
	No. of labour	No. of days	Amount paid operating the work bull(₦)
Land clearing Ploughing Harrowing Ridge making			
Weeding Harvesting Haulage Others Specify Total			

(32). Do you hired Work Bulls in 2015/2016 season? (Yes)/(No).
(a) If No proceed to question (33)
(b) If Yes provide the following information requested in the table below.

Operation	**Hired**	
	No. of days	**Amount Paid(₦)**
Land clearing Ploughing Harrowing Ridge making		
Weeding Harvesting Haulage Others Specify Total		

(33). Do you own tractor? Yes/No

(a) If No proceed to question (36)
(b) If Yes, how much did you buy it? ₦..........................
(c) What is the expected life span of the tractor ?………………
(d) how much will you want to sell it when you are done with it? ₦……………………

(34) Please provide the information on the following operation of the tractor on the table below

Operation	Owned Amount paid to the person operating the tractor(₦)
	No. of days
Land clearing Ploughing Harrowing Ridge making	
Weeding Harvesting Haulage Others Specify Total	

(35) Please provide information on the implements attached to the tractor in the table below.

Implement	Purchase price	Life Span	Salvage Value

Please select from the list (a)Disc Plough (b) Mould Board Plough (c) Chisel Plough (d) Under Buster Plough (e) Disc Harrows (f) Spike Tooth Harrows (g) Sprint – tined Harrows (h) Post-hole digger (i) Farm trailer (j)Boom Sprayer (k)Loader (l) Others Specified.

(36). Do you hire tractor Yes/No
(a) If No proceed to question (38)
(b) If Yes how much did you spend as cost for tractor hiring in 2015/2016? ₦.................

(37). Please provide the following operations information of the tractor on the table below?

Operation	**No. of Days**	**Amount Spent (₦)**
Land clearing		
Ploughing		
Harrowing		

Ridging		
Weeding		
Harvesting		
Haulage		
Others Specify…		
Total		

(38). What other farm inputs such as herbicides, insecticides, fertilizers etc did you use? Please provide the following information about the inputs

Input	**.**	**Variables**
	Qty Bought	**Amount spent(₦) Cost of Maintenance**
(i) Herbicides (litr)		
(ii)Insecticides(litr)		
iii) Pesticides		
(iv) Fertilizers bag/mudu		
(v) Manures (Basin/Donkey load)		
(vi) Ginger stem/seed (kg)		
(vii) Hoes		
(viii) Axes		
(ix)Oxen drawn Ploughs		
(x) Matched		
(xi)Tractor drawn plough		
(xii) Baskets		
(xiii) Harrow		
(xiv)Cutlasses		
(xv) Ridger		
(xvi)Sprayer		
Others Specify		
Total		

39. Provide in the space below information on your crop yield (output)

Crop	Plot	Output (Bags)	Output (Basin)	Output(kg)
Ginger	1			
	2			
	3			
	4			
	5			

40. What is the equivalent of a bag of ginger in Kg? ………………….

41. What is the numbers of basin in a bag?…………………………….

42. Please provide the information for 2015/2016 farming season in the table below.

Unit	Quantity of ginger consumed	Quantity of ginger sold to the market	Market price of ginger per unit	Total value or amount of ginger sold
Bags				
Bassin				
Kilogramme (Kg)				

43. How much did you spend for the following activities in ginger production?

S/N	Activities	Amount Spent (~~N~~)
1.	i. Harvesting/Picking	
2.	ii. Processing	
3.	iii. Bagging/Assembling	
4.	iv. Storage	
5.	v. Bargaining	

SECTION D: GINGER PRODUCTION CONSTRAINTS

44. State the type of climatic constraints you frequently encountered in ginger production.
i. Inadequate rainfall [ ] ii. Excessive rainfall [ ]
iii. High Intensity of Sunshine [ ] iv. Excessive wind [ ]
v. Low relative humidity [ ]

45. Mention other environmental or farm problems you faced in ginger production.
i. Pest invasion [ ] ii. Disease incidence[ ] iii. Weed Infestation [ ]
iv Inadequate soil fertility [ ] v. Erosion menace [ ]
vi. All of the above …………………………………… vii Others, specify…………………………………………

46. What are the genetic constraints which affected your ginger production?
i. Inadequate improved seed variety [ ] ii. Seed is not certified [ ]
iii. Seed is costly to procure [ ] iv. Seed is not properly stored [ ]

47. State some of the institutional problems affecting ginger production.
i. Problem of land procurement and acquisition [ ]
ii. Inadequate loan and credit supply [ ]
iii. Poor farm gate price and pricing system [ ]
iv. Inadequate storage and transportation facilities [ ]
v. Inadequate extension services [ ]

48. What are some of the extension constraints encountered?
i. Inadequate visits and dissemination of improved technologies. [ ]
ii. Complexity of some technological packages hampering adoption. [ ]

iii. Insufficient fund to enhance adoption of improved technologies [ ]

iv. Others, specify ……………………………………..

49. What type of market did you use to sell your ginger?

i. Contract [ ] ii. Local market [ ] iii. Village market [ ]

iv Urban market [ ] v. Organized market [ ]

vi Others (specify) ………………………………..

50. Is there any organized market institutions through which you sell your ginger?

i. Marketing agents/co-operative market [ ]

ii. Commodity exchange market [ ] iii. Licensed marketers [ ]

iv Buying agents/Contract buyers [ ] v. Others (specify)……….

51. What problem did you encounter in marketing your ginger (Tick as applicable)?

i. Low price [ ] ii. Inadequate storage facilities [ ]

iii. Inadequate processing facilities[ ] iv. Inadequate transportation[ ]

V. Others, specify ______________________________

Enumerators name & Signature **Supervisor Name & Signature**………………………………..

Appendix

Table 1: Kaduna State Data

Year	Prod	Yield	Land	Prices
1979	162254.70	7.41	16713.57	31.19
1980	164839.40	7.49	17204.14	32.39
1981	167424.10	7.56	17694.71	33.58
1982	170008.80	7.63	18185.28	34.78
1983	172593.50	7.71	18675.85	35.97
1984	175178.20	7.78	19166.42	37.17
1985	190000.00	8.39	22650.00	38.36
1986	190280.00	8.37	22722.00	30.00
1987	191500.00	8.40	22800.00	40.75
1988	192350.00	8.37	22980.00	41.94
1989	192550.00	8.35	23050.00	38.00
1990	193785.00	8.33	23254.00	44.33
1991	193885.00	8.32	23286.00	45.52
1992	194208.00	8.33	23301.00	46.72
1993	194598.00	8.32	23376.00	47.91
1994	195445.00	8.36	23376.00	49.11
1995	195578.00	8.36	23394.00	50.30
1996	195685.00	8.36	23398.00	42.50
1997	195985.00	8.35	23480.00	44.31
1998	195998.00	8.36	23450.00	41.55
1999	196000.00	8.34	23000.50	45.00
2000	196000.00	8.17	24000.00	48.20
2001	200000.00	8.20	24000.40	50.22
2002	221000.00	8.50	26000.00	49.76
2003	221000.00	8.50	26000.00	51.25
2004	244000.90	9.24	26000.50	53.13
2005	248000.80	9.25	26000.90	54.34
2006	270000.60	10.03	26000.98	56.00
2007	234626.30	10.03	25000.86	75.20
2008	368000.00	10.08	36000.50	76.85
2009	420000.55	10.66	39000.47	64.50
2010	453000.43	9.97	45000.49	109.08
2011	453410.00	9.76	32411.81	78.89
2012	484320.79	10.00	32902.38	70.60
2013	514639.00	11.26	45692.93	71.80
2014	524932.86	12.34	42539.13	76.20
2015	255303.90	12.58	34374.09	154.60
2016	257888.60	12.83	43000.10	75.38
2017	260473.30	16.52	48000.44	76.57
2018	263058.00	10.27	35845.80	77.77

Source: Kaduna State Agricultural Development Programme and National Bureau of Statistics.

Table 2: Benue State Data

Year	Prod	Yield	Land	Prices
1979	16669.66	3.56	1254.54	30.74
1980	17137.32	3.58	1458.68	31.48
1981	17604.98	3.61	1662.82	32.22
1982	18072.64	3.64	1866.96	32.97
1983	18540.30	3.67	2071.10	33.71
1984	19007.96	3.69	2275.24	34.45
1985	19475.62	3.72	2479.38	35.19
1986	19943.28	3.75	2683.52	35.93
1987	20410.94	2.52	2887.66	36.67
1988	18350.00	2.71	3450.00	37.41
1989	21346.26	3.83	3295.94	38.15
1990	21813.92	2.88	3500.08	38.90
1991	19550.00	3.89	3800.00	39.64
1992	22749.24	3.91	3908.36	40.38
1993	19000.00	3.10	4230.00	41.12
1994	20660.00	3.56	4550.00	41.86
1995	24152.22	3.78	4520.78	30.15
1996	24619.88	4.02	4724.92	43.34
1997	25087.54	4.05	4929.06	44.08
1998	25555.20	4.08	5133.20	44.83
1999	30000.00	4.24	6600.00	32.40
2000	20000.00	4.17	4800.00	33.52
2001	30000.00	4.18	6700.00	40.11
2002	20000.00	4.14	5800.00	41.22
2003	30000.00	4.19	6200.00	37.23
2004	20000.00	4.07	5400.00	38.33
2005	30000.00	4.19	6200.00	40.50
2006	36910.00	4.29	6110.00	42.00
2007	36910.00	4.15	6110.00	45.30
2008	30000.10	4.57	6700.00	51.00
2009	35660.00	4.52	6900.00	44.17
2010	50000.69	4.38	10000.30	80.00
2011	5290.00	4.44	7787.02	102.74
2012	32102.44	4.46	7991.16	55.20
2013	39460.00	4.49	5700.00	55.95
2014	35810.00	4.52	5790.00	56.69
2015	37007.60	4.55	7337.00	57.43
2016	39911.68	7.78	8807.72	58.17
2017	34440.74	7.38	9011.86	58.91
2018	34908.40	4.63	9216.00	59.65

Source: Benue State Agricultural Development Authority, National Bureau of Statistics, National Programme for Food Security, National Agricultural Extension Research and Liaison Services

Table 3: Grafted polynomial model output

Year	QQL Benue	QQL Kaduna	QQL Pooled
1970	10349.36	349733.5	361204.1
1971	10982.72	329819.9	341835.7
1972	11608.81	311003.2	323559.4
1973	12227.64	293283.5	306375.1
1974	12839.21	276660.8	290283.1
1975	13443.51	261135	275283.1
1976	14040.55	246706.2	261375.3
1977	14630.33	233374.3	248559.6
1978	15212.84	221139.3	236836
1979	15788.09	210001.3	226204.5
1980	15788.09	199960.3	216665.1
1981	15788.09	191016.2	208217.9
1982	15788.09	183169	200862.8
1983	15788.09	176418.8	194599.8
1984	15788.09	170765.5	189428.9
1985	15788.09	166209.2	185350.2
1986	15788.09	162749.9	182363.5
1987	15788.09	160387.5	180469
1988	15788.09	159122	179666.6
1989	21141.1	158953.5	179956.4
1990	21636.45	159881.9	181338.2
1991	22124.54	161907.3	183812.2
1992	22605.36	165029.7	187378.3
1993	23078.92	169248.9	192036.5
1994	23545.22	174565.2	197786.9
1995	24004.26	180978.3	204629.3
1996	24456.03	188488.5	212563.9
1997	24900.54	197095.6	221590.6
1998	25337.78	206799.6	231709.4
1999	25767.76	217600.6	242920.4
2000	26190.48	229498.5	242920.4
2001	26605.93	242493.4	242920.4
2002	27014.13	256585.2	242920.4
2003	27415.05	271773.9	242920.4
2004	27808.72	288059.7	242920.4
2005	28195.12	305442.3	242920.4
2006	28574.25	323921.9	242920.4
2007	28946.13	343498.5	242920.4
2008	29310.74	361678.3	242920.4
2009	29668.09	375967.5	405723.9
2010	30018.17	386366.2	417232.4
2011	30360.99	392874.4	425146.7
2012	31100.79	395492	429466.9
2013	32641.8	394219.1	430192.8

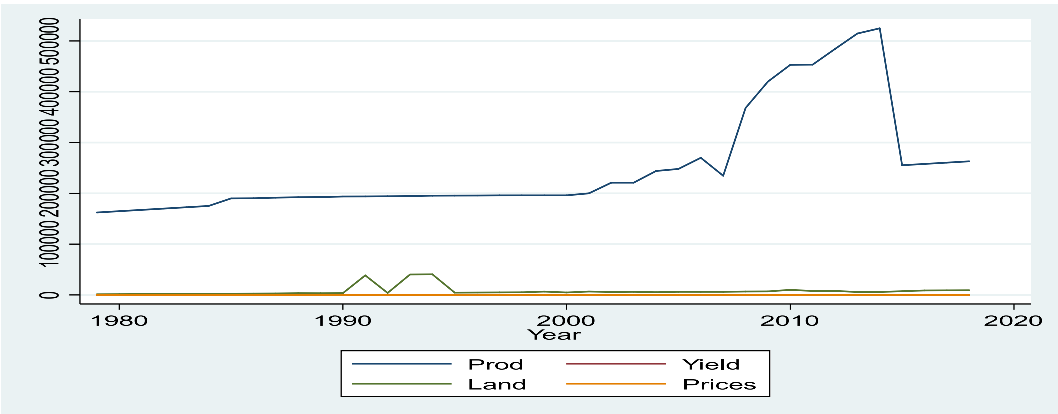
2014	34984.02	389055.6	427324.6
2015	38127.46	380001.6	420862.3
2016	42072.11	369002.4	412602.8
2017	46817.98	358003.1	404343.3
2018	52365.07	347003.8	396083.9
2019	58312.76	336004.6	387824.4
2020	64260.45	325005.3	379564.9
2021	70208.14	314006.1	371305.4
2022	76155.83	303006.8	363046
2023	82103.52	292007.5	354786.5
2024	88051.21	281008.3	346527
2025	93998.9	270009	338267.6
2026	99946.59	259009.7	330008.1
2027	105894.3	248010.5	321748.6
2028	111842	237011.2	313489.1
2029	117789.7	226012	305229.7
2030	123737.4	215012.7	296970.2
2031	129685	204013.4	288710.7
2032	135632.7	193014.2	280451.3
2033	141580.4	182014.9	272191.8
2034	147528.1	171015.7	263932.3
2035	153475.8	160016.4	255672.8
2036	159423.5	149017.1	247413.4
2037	165371.2	138017.9	239153.9
2038	171318.9	127018.6	230894.4
2039	177266.6	116019.4	222635
2040	183214.3	105020.1	214375.5

Source: Analysed output from EVIEW 10

KADUNA STATE STATIONARITY TEST.

STATIONARITY TEST LINE GRAPH AT LEVEL 1(0)

Line graph



Source: Analysed Kaduna output from STATA 13

reg prod yield land prices

```
      Source |       SS           df       MS      Number of obs   =        40
-------------+----------------------------------   F(3, 36)        =      7.29
       Model |  1.5910e+11         3  5.3035e+10   Prob > F        =    0.0006
    Residual |  2.6208e+11        36  7.2799e+09   R-squared       =    0.3778
-------------+----------------------------------   Adj R-squared   =    0.3259
       Total |  4.2118e+11        39  1.0799e+10   Root MSE        =     85322

------------------------------------------------------------------------------
        prod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |   15008.13   10590.98     1.42   0.165    -6471.363    36487.63
        land |  -.5289245   1.443382    -0.37   0.716    -3.456238    2.398389
      prices |   1762.392   812.2318     2.17   0.037     115.1099    3409.675
       _cons |   17982.77   75469.66     0.24   0.813    -135076.8    171042.3
------------------------------------------------------------------------------
```

. estat dwatson

Durbin-Watson d-statistic(4, 40) = .8963062

ADF STATIONARITY TEST RESULT AT 1(0)

Result with trend are result with constant term
Result with noconstant are result without constant term.

dfuller prod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

```
                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.091            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.5510

------------------------------------------------------------------------------
D.prod       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        prod |
         L1. |  -.2584771   .1236015    -2.09   0.044    -.5096655   -.0072887
         LD. |   .1523179   .1760015     0.87   0.393    -.2053602     .509996
      _trend |   1487.296   1147.831     1.30   0.204    -845.3776    3819.969
       _cons |   36895.41   21917.38     1.68   0.101    -7646.071    81436.88
------------------------------------------------------------------------------
```

. dfuller prod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

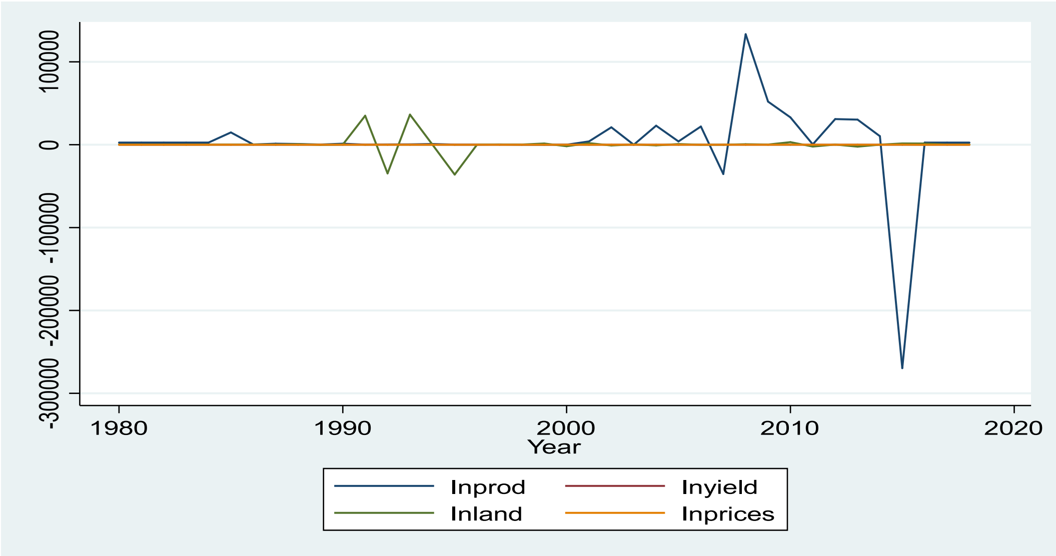
```
                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.338            -2.639            -1.950            -1.605

------------------------------------------------------------------------------
      D.prod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        prod |
         L1. |  -.0106266   .0314385    -0.34   0.737    -.0743869    .0531336
```

```
         LD. |  .0207056  .1678753    0.12   0.903   -.3197613   .3611724
------------------------------------------------------------------------------


. dfuller yield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.245            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.9960

------------------------------------------------------------------------------
D.yield      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |
         L1. |  .0537898   .2193485     0.25   0.808      -.39198    .4995596
         LD. | -1.514606   .3902929    -3.88   0.000    -2.307776   -.7214351
      _trend |  .0253225   .0259981     0.97   0.337    -.0275121    .0781571
       _cons | -.5802603   1.546557    -0.38   0.710    -3.723243    2.562722
------------------------------------------------------------------------------

. dfuller yield, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              2.571            -2.639            -1.950            -1.605

------------------------------------------------------------------------------
     D.yield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |
         L1. |  .0462816   .0180038     2.57   0.014     .0097682     .082795
         LD. | -1.354117   .2393513    -5.66   0.000    -1.839544   -.8686904
------------------------------------------------------------------------------


. dfuller land, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.946            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1479

------------------------------------------------------------------------------
D.land       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        land |
         L1. | -.5945975   .2018454    -2.95   0.006    -1.004797   -.1843984
         LD. | -.1941949   .1669652    -1.16   0.253    -.5335089    .1451191
      _trend |  .7473281   141.1036     0.01   0.996    -286.0096    287.5043
       _cons |  4923.792   3533.548     1.39   0.173    -2257.242    12104.83
------------------------------------------------------------------------------
```

```
. dfuller land, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                         ---------- Interpolated Dickey-Fuller ---------
               Test        1% Critical      5% Critical      10% Critical
             Statistic          Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -1.855           -2.639           -1.950           -1.605

------------------------------------------------------------------------------
     D.land |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       land |
        L1. |  -.2724302   .1468919    -1.85   0.072    -.5703409    .0254804
        LD. |  -.3502726    .157691    -2.22   0.033    -.6700847   -.0304605
------------------------------------------------------------------------------


. dfuller prices, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38
                         ---------- Interpolated Dickey-Fuller ---------
               Test        1% Critical      5% Critical      10% Critical
             Statistic          Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -4.053           -4.260           -3.548           -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0074

------------------------------------------------------------------------------
D.prices     |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     prices |
        L1. |   -.968173    .238855    -4.05   0.000    -1.453585   -.4827612
        LD. |   .0093645   .1722517     0.05   0.957    -.3406932    .3594222
     _trend |   1.589104   .4592429     3.46   0.001     .6558105    2.522398
      _cons |   22.43579   7.403872     3.03   0.005     7.389312    37.48227
------------------------------------------------------------------------------

. dfuller prices, noconstant regress lags(1)


Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                         ---------- Interpolated Dickey-Fuller ---------
               Test        1% Critical      5% Critical      10% Critical
             Statistic          Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -0.097           -2.639           -1.950           -1.605

------------------------------------------------------------------------------
   D.prices |      Coef.   Std. Err.       t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     prices |
        L1. |  -.0050297   .0517641    -0.10   0.923    -.1100121    .0999528
        LD. |  -.4676825   .1508084    -3.10   0.004     -.773536   -.1618289
------------------------------------------------------------------------------
```

RESULT OF STATIONARITY TEST LINE GRAPH AT FIRST DIFFERENCING 1(1).

The line graph



Source: Analysed Kaduna output from STATA 13

reg lnprod lnyield lnland lnprices

Source	SS	df	MS		
				Number of obs =	39
				F(3, 35) =	4.49
Model	2.7502e+10	3	9.1672e+09	Prob > F =	0.0091
Residual	7.1515e+10	35	2.0433e+09	R-squared =	0.2777
				Adj R-squared =	0.2158
Total	9.9017e+10	38	2.6057e+09	Root MSE =	45203

lnprod	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnyield	39.78183	5946.038	0.01	0.995	-12031.32	12110.88
lnland	-.0119108	.6347574	-0.02	0.985	-1.300537	1.276715
lnprices	-1300.757	354.8891	-3.67	0.001	-2021.221	-580.2943
_cons	4135.502	7265.124	0.57	0.573	-10613.48	18884.49

. estat dwatson

Durbin-Watson d-statistic(4, 39) = 1.532143

DFA STATIONARITY TEST RESULT AT FIRST DIFFERENCING FOR KADUNA 1(1)

Result with trend signifies with constant
Result with noconstant signifies without constant term.

dfuller lnprod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 37

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.127	-4.270	-3.552	-3.211

```
MacKinnon approximate p-value for Z(t) = 0.0057

------------------------------------------------------------------------------
D.inprod     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inprod |
         L1. |  -1.013219   .2454929    -4.13   0.000    -1.512678   -.5137605
         LD. |   .0185727   .1740476     0.11   0.916    -.3355299    .3726753
      _trend |  -361.1722     845.52    -0.43   0.672    -2081.396    1359.051
       _cons |   9842.311   19214.87     0.51   0.612    -29250.64    48935.27
------------------------------------------------------------------------------

. dfuller inprod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.200            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
    D.inprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inprod |
         L1. |  -.9974388   .2374608    -4.20   0.000     -1.47951   -.5153676
         LD. |   .0106823   .1690212     0.06   0.950     -.332449    .3538137
------------------------------------------------------------------------------


. dfuller inyield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.571            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0012

------------------------------------------------------------------------------
D.inyield    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |
         L1. |  -2.284173   .4996817    -4.57   0.000    -3.300783   -1.267563
         LD. |  -.1661132   .4470225    -0.37   0.713    -1.075587    .7433609
      _trend |   .0306112   .0159783     1.92   0.064    -.0018969    .0631193
       _cons |  -.2118346   .3279176    -0.65   0.523     -.878988    .4553187
------------------------------------------------------------------------------

. dfuller inyield, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.429            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
   D.inyield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |
```

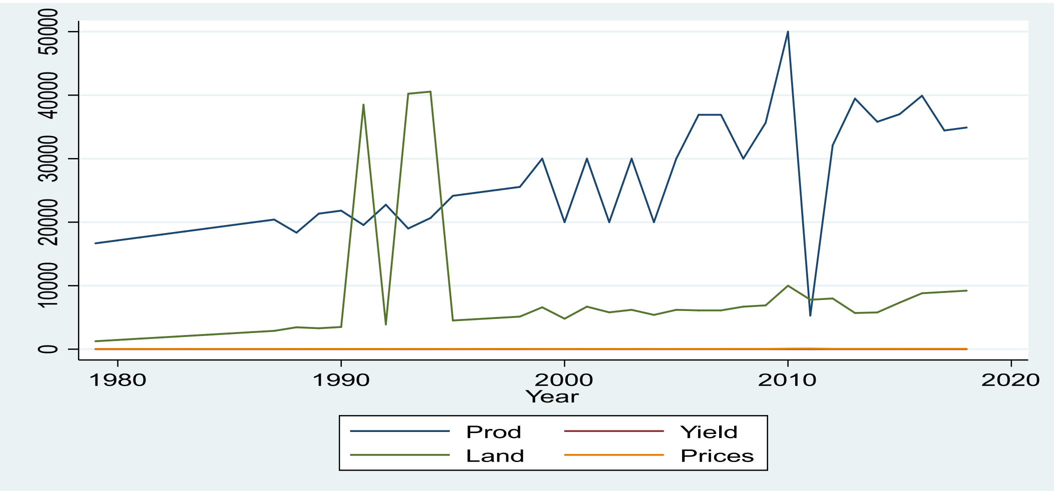
```
         L1. |  -1.506336   .4393524    -3.43   0.002    -2.398269   -.6144032
         LD. |  -.6557033   .4389274    -1.49   0.144    -1.546773    .2353668
------------------------------------------------------------------------------


. dfuller inland, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                         ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.997            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inland     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inland |
         L1. |  -1.983673   .2834936    -7.00   0.000    -2.560445   -1.406901
         LD. |   .3315017   .1642344     2.02   0.052    -.0026356    .6656391
      _trend |  -47.56137   157.1585    -0.30   0.764    -367.3027      272.18
       _cons |   1356.175   3564.968     0.38   0.706    -5896.807    8609.156
------------------------------------------------------------------------------

. dfuller inland, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                         ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -7.179            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
    D.inland |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inland |
         L1. |   -1.97761   .2754761    -7.18   0.000    -2.536856   -1.418364
         LD. |   .3284702   .1596521     2.06   0.047     .0043593    .6525812
------------------------------------------------------------------------------


. dfuller inprices, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                         ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.986            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inprices   |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inprices |
         L1. |  -1.969165     .28188    -6.99   0.000    -2.542654   -1.395675
         LD. |   .3342198   .1640673     2.04   0.050     .0004223    .6680172
      _trend |  -.0197261   .2832199    -0.07   0.945    -.5959412    .5564891
       _cons |    2.74315    6.43271     0.43   0.673     -10.3443     15.8306
------------------------------------------------------------------------------
```

```
. dfuller inprices, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root        Number of obs  =       37

                    ---------- Interpolated Dickey-Fuller ---------
              Test         1% Critical       5% Critical      10% Critical
            Statistic         Value             Value             Value
------------------------------------------------------------------------------
 Z(t)          -7.086            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
  D.inprices |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inprices |
         L1. |  -1.944929   .2744827    -7.09   0.000    -2.502158   -1.387699
         LD. |   .3221018   .1600223     2.01   0.052    -.0027608    .6469645
------------------------------------------------------------------------------
```

Source: Analysed Kaduna output from STATA 13

STATIONARITY TEST RESULT FOR BENUE STATE

STATIONARITY TEST LINE GRAPH AT LEVEL 1(0)



Source: Analysed Benue output from STATA 13

```
      Source |       SS       df       MS              Number of obs =      40
-------------+------------------------------           F(3, 36)      =    5.09
       Model |  909406444     3  303135481           Prob > F      =  0.0048
    Residual |  2.1425e+09    36  59512733           R-squared     =  0.2980
-------------+------------------------------           Adj R-squared =  0.2395
       Total |  3.0519e+09    39  78252944.4           Root MSE      =  7714.4

------------------------------------------------------------------------------
        prod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |   4605.119   1467.241     3.14   0.003     1629.417    7580.821
        land |  -.0276989   .1310082    -0.21   0.834    -.2933959    .2379982
      prices |   61.78798   99.04993     0.62   0.537    -139.0946    262.6705
       _cons |   4445.661   5820.025     0.76   0.450    -7357.897    16249.22
```

. estat dwatson
Durbin-Watson d-statistic(4, 40) = 2.086837

ADF STATIONARITY TEST RESULT FOR BENUE AT LEVEL 1(0)

PRODUCTION WITH CONSTANT TERMS
dfuller prod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-5.882	-4.260	-3.548	-3.209

MacKinnon approximate p-value for Z(t) = 0.0000

D.prod	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
prod						
L1.	-1.576911	.2680965	-5.88	0.000	-2.121749	-1.032073
LD.	.2269989	.1672072	1.36	0.184	-.1128071	.5668048
_trend	870.3769	174.2826	4.99	0.000	516.192	1224.562
_cons	23459.56	4403.991	5.33	0.000	14509.57	32409.54

PRODUCTION WITHOUT CONSTANT TERM
dfuller prod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-0.094	-2.639	-1.950	-1.605

D.prod	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
prod						
L1.	-.0048716	.0520974	-0.09	0.926	-.11053	.1007868
LD.	-.5552921	.141959	-3.91	0.000	-.8431983	-.2673859

YIELD WITH CONSTANT TERM
dfuller yield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-4.791	-4.260	-3.548	-3.209

MacKinnon approximate p-value for Z(t) = 0.0005

```
D.yield      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |
         L1. |  -.9247346   .1930218    -4.79   0.000    -1.317002   -.5324671
         LD. |   .4423555     .20682     2.14   0.040     .0220468    .8626643
      _trend |   .0502058   .0140502     3.57   0.001     .0216524    .0787592
       _cons |   2.767257   .6171447     4.48   0.000     1.513068    4.021446
------------------------------------------------------------------------------
```

.YIELD WITHOUT CONSTANT

dfuller yield, noconstant regress lags(1)

```
Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.167            -2.639            -1.950            -1.605

------------------------------------------------------------------------------
     D.yield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |
         L1. |  -.0053937   .0323921    -0.17   0.869     -.071088    .0603006
         LD. |   -.140401   .2074233    -0.68   0.503     -.561075     .280273
------------------------------------------------------------------------------
```

.LAND AREA WITH CONSTANT TERM

dfuller land, trend regress lags(1)

```
Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.946            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1479

------------------------------------------------------------------------------
D.land       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        land |
         L1. |  -.5945975   .2018454    -2.95   0.006    -1.004797   -.1843984
         LD. |  -.1941949   .1669652    -1.16   0.253    -.5335089    .1451191
      _trend |   .7473281   141.1036     0.01   0.996    -286.0096    287.5043
       _cons |   4923.792   3533.548     1.39   0.173    -2257.242    12104.83
------------------------------------------------------------------------------
```

LAND AREA WITHOUT CONSTANT

dfuller land, noconstant regress lags(1)

```
Augmented Dickey-Fuller test for unit root         Number of obs   =        38
```

```
                  ---------- Interpolated Dickey-Fuller ---------
         Test       1% Critical     5% Critical     10% Critical
       Statistic       Value           Value           Value
------------------------------------------------------------------------------
 Z(t)        -1.855        -2.639          -1.950          -1.605

------------------------------------------------------------------------------
     D.land |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       land |
        L1. |  -.2724302   .1468919    -1.85   0.072    -.5703409    .0254804
        LD. |  -.3502726    .157691    -2.22   0.033    -.6700847   -.0304605
------------------------------------------------------------------------------
```

PRICE WITH CONSTANT

dfuller prices, trend regress lags(1)

```
Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                  ---------- Interpolated Dickey-Fuller ---------
         Test       1% Critical     5% Critical     10% Critical
       Statistic       Value           Value           Value
------------------------------------------------------------------------------
 Z(t)        -3.780        -4.260          -3.548          -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0176

------------------------------------------------------------------------------
D.prices     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     prices |
        L1. |  -.6836458   .1808405    -3.78   0.001    -1.051158   -.3161337
        LD. |   .1837373   .1683592     1.09   0.283    -.1584098    .5258844
     _trend |   .5858242   .2097244     2.79   0.009     .1596129    1.012035
      _cons |   18.88032   5.861303     3.22   0.003     6.968721    30.79192
------------------------------------------------------------------------------
```

.PRICE WITHOUT CONSTANT.

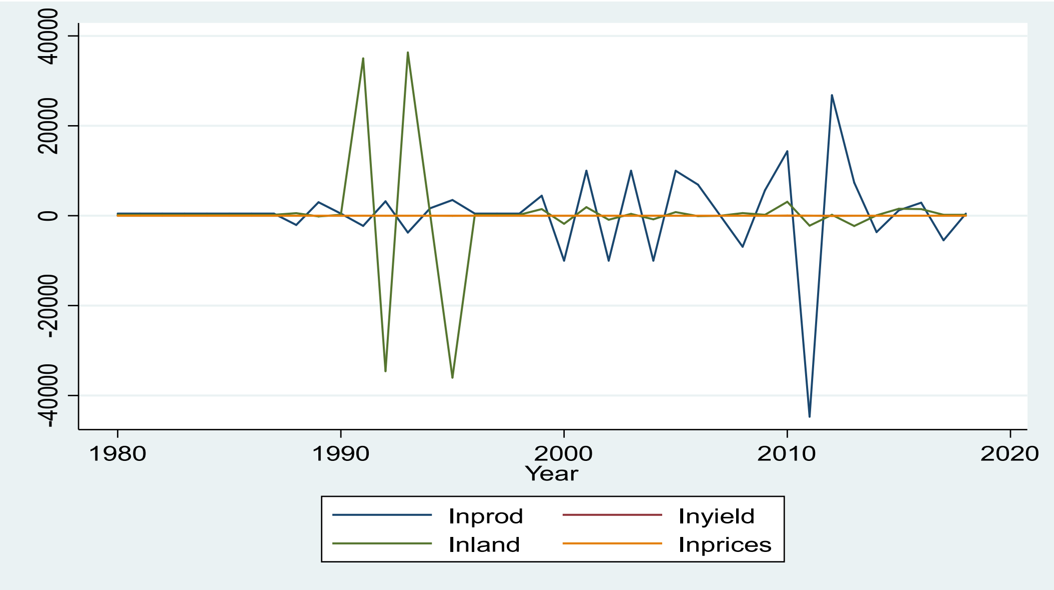
dfuller prices, noconstant regress lags(1)

```
Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                  ---------- Interpolated Dickey-Fuller ---------
         Test       1% Critical     5% Critical     10% Critical
       Statistic       Value           Value           Value
------------------------------------------------------------------------------
 Z(t)        -0.162        -2.639          -1.950          -1.605

------------------------------------------------------------------------------
   D.prices |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     prices |
        L1. |  -.0065134   .0401233    -0.16   0.872    -.0878872    .0748605
        LD. |  -.1473583   .1675244    -0.88   0.385    -.4871136     .192397
------------------------------------------------------------------------------
```

Source: Analysed Benue output from STATA 13

STATIONARITY TEST RESULT FOR BENUE AT THEIR FIRST DIFFERENCING 1(1)

STATIONARITY TEST LINE GRAPH FOR BENUE AT THEIR FIRST DIFFERENCING 1(1)



Source: Analysed Benue output from STATA 13

reg inprod inyield inland inprices

```
      Source |       SS       df       MS              Number of obs =      39
-------------+------------------------------           F(3, 35)      =    3.08
       Model |   800283019     3   266761006           Prob > F      =  0.0399
    Residual |  3.0298e+09    35    86564949           R-squared     =  0.2089
-------------+------------------------------           Adj R-squared =  0.1411
       Total |  3.8301e+09    38   100790954           Root MSE      =    9304

------------------------------------------------------------------------------
      inprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |   442.2279   1894.169     0.23   0.817    -3403.141    4287.596
      inland |  -.0094376   .1312846    -0.07   0.943    -.2759595    .2570842
    inprices |  -410.7963   136.7523    -3.00   0.005    -688.4181   -133.1744
       _cons |   761.0946   1494.356     0.51   0.614    -2272.609    3794.799
------------------------------------------------------------------------------
```

. estat dwatson

Durbin-Watson d-statistic(4, 39) = 3.105898

ADF STATIONARITY TEST RESULT FOR BENUE AT THEIR FIRST DIFFERENCING 1(1)

Result with trend means with constant term
Result with non constant means without constant term.

dfuller inprod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 37

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-8.743	-4.270	-3.552	-3.211

MacKinnon approximate p-value for Z(t) = 0.0000

D.inprod	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
inprod						
L1.	-2.345586	.2682908	-8.74	0.000	-2.891427	-1.799744
LD.	.5019683	.1520572	3.30	0.002	.1926057	.8113309
_trend	9.75912	119.0489	0.08	0.935	-232.4478	251.966
_cons	982.3213	2699.142	0.36	0.718	-4509.124	6473.767

. dfuller inprod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 37

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-8.841	-2.641	-1.950	-1.605

D.inprod	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
inprod						
L1.	-2.316626	.2620188	-8.84	0.000	-2.848552	-1.784699
LD.	.4867736	.1486347	3.27	0.002	.1850292	.7885181

. dfuller inyield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 37

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-7.669	-4.270	-3.552	-3.211

MacKinnon approximate p-value for Z(t) = 0.0000

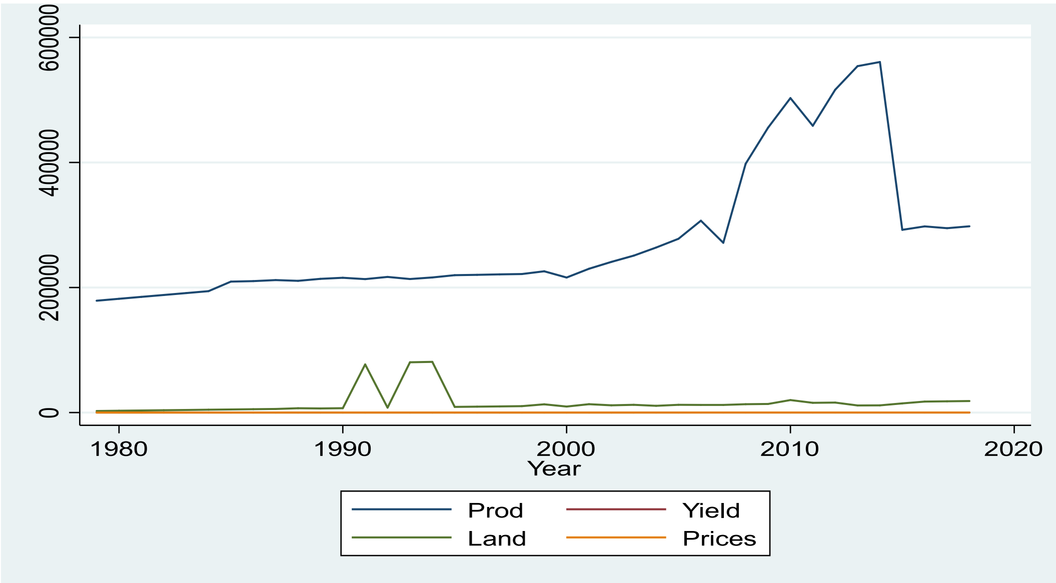
```
------------------------------------------------------------------------------
D.inyield    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |
         L1. |  -2.231056   .2909354    -7.67   0.000    -2.822969   -1.639143
         LD. |   .8154119   .1811662     4.50   0.000     .4468266    1.183997
      _trend |   .0168054   .0110019     1.53   0.136    -.0055781     .039189
       _cons |  -.1708231   .2375855    -0.72   0.477    -.6541944    .3125481
------------------------------------------------------------------------------

. dfuller inyield, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -7.339            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
   D.inyield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |
         L1. |   -1.97989   .2697832    -7.34   0.000    -2.527579   -1.432201
         LD. |   .6830126   .1733557     3.94   0.000     .3310817    1.034943
------------------------------------------------------------------------------



. dfuller inland, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.997            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inland     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inland |
         L1. |  -1.983673   .2834936    -7.00   0.000    -2.560445   -1.406901
         LD. |   .3315017   .1642344     2.02   0.052    -.0026356    .6656391
      _trend |  -47.56137   157.1585    -0.30   0.764    -367.3027      272.18
       _cons |   1356.175   3564.968     0.38   0.706    -5896.807    8609.156
------------------------------------------------------------------------------

. dfuller inland, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
```

```
             Test        1% Critical      5% Critical     10% Critical
           Statistic         Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -7.179           -2.641           -1.950           -1.605

------------------------------------------------------------------------------
   D.inland |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inland |
         L1. |   -1.97761   .2754761    -7.18   0.000    -2.536856   -1.418364
         LD. |   .3284702   .1596521     2.06   0.047     .0043593    .6525812
------------------------------------------------------------------------------

. dfuller inprices, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                        ---------- Interpolated Dickey-Fuller ---------
             Test        1% Critical      5% Critical     10% Critical
           Statistic         Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.856           -4.270           -3.552           -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inprices   |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inprices |
         L1. |  -1.646083    .240096    -6.86   0.000    -2.134562   -1.157604
         LD. |   .4221675   .1578045     2.68   0.012     .1011118    .7432232
      _trend |   .0133414   .1641172     0.08   0.936    -.3205577    .3472404
       _cons |   .9517196   3.723122     0.26   0.800    -6.623029    8.526468
------------------------------------------------------------------------------

. dfuller inprices, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                        ---------- Interpolated Dickey-Fuller ---------
             Test        1% Critical      5% Critical     10% Critical
           Statistic         Value            Value            Value
------------------------------------------------------------------------------
 Z(t)            -6.973           -2.641           -1.950           -1.605

------------------------------------------------------------------------------
  D.inprices |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inprices |
         L1. |  -1.629092   .2336276    -6.97   0.000    -2.103381   -1.154802
         LD. |   .4136716   .1538901     2.69   0.011     .1012581    .7260851
------------------------------------------------------------------------------
```

Source: Analysed Benue output from STATA 13

.
.

POOLED STATE STATIONARITY LINE GRAPH AT LEVEL 1(0)



Source: Analysed Pooled output from STATA 13

reg prod yield land prices

```
     Source |       SS       df       MS              Number of obs =      40
-------------+------------------------------           F(3, 36)      =   12.13
      Model |  2.3173e+11     3  7.7245e+10           Prob > F      =  0.0000
   Residual |  2.2925e+11    36  6.3681e+09           R-squared     =  0.5027
-------------+------------------------------           Adj R-squared =  0.4613
      Total |  4.6099e+11    39  1.1820e+10           Root MSE      =   79800

------------------------------------------------------------------------------
        prod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       yield |   3990.174   6480.081     0.62   0.542    -9152.04    17132.39
        land |  -.4219089   .6769977    -0.62   0.537   -1.794924    .9511059
      prices |   3999.201   981.7149     4.07   0.000    2008.191    5990.211
       _cons |   29750.04   67269.85     0.44   0.661   -106679.5    166179.6
------------------------------------------------------------------------------
```

. estat dwatson

Durbin-Watson d-statistic(4,   40) = 1.219328

POOLED ADF STATIONARITY TEST RESULT AT LEVEL 1(0)

dfuller prod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root   Number of obs   =   38

```
                          ---------- Interpolated Dickey-Fuller ---------
             Test         1% Critical       5% Critical      10% Critical
           Statistic         Value             Value             Value
------------------------------------------------------------------------------
 Z(t)        -2.098            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.5470

------------------------------------------------------------------------------
D.prod       |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
       prod |
        L1. |  -.264469   .1260307    -2.10   0.043    -.5205943   -.0083437
        LD. |  .1403323   .1764255     0.80   0.432    -.2182073     .498872
     _trend |  1669.216   1224.763     1.36   0.182    -819.8029    4158.235
      _cons |  41976.68   23511.32     1.79   0.083    -5804.077    89757.44
------------------------------------------------------------------------------

. dfuller prod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.245            -2.639            -1.950            -1.605

------------------------------------------------------------------------------
     D.prod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       prod |
        L1. | -.0071917   .0293896    -0.24   0.808    -.0667965    .0524131
        LD. |  .0044368   .1680385     0.03   0.979    -.3363612    .3452347
------------------------------------------------------------------------------


. dfuller yield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.041            -4.260            -3.548            -3.209
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1211

------------------------------------------------------------------------------
D.yield      |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      yield |
        L1. | -.7969935   .2621202    -3.04   0.005    -1.329686   -.2643011
        LD. |  .5280527   .5183541     1.02   0.316    -.5253695    1.581475
     _trend |  .1302569   .0435226     2.99   0.005     .0418082    .2187055
      _cons |  7.907698     2.6905     2.94   0.006     2.439945    13.37545
------------------------------------------------------------------------------

. dfuller yield, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        38

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)              0.913            -2.639            -1.950            -1.605

------------------------------------------------------------------------------
    D.yield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      yield |
        L1. |  .0212536    .023274     0.91   0.367    -.0259481    .0684554
        LD. | -.6512619   .3318858    -1.96   0.057    -1.324357    .0218337
------------------------------------------------------------------------------

. dfuller land, trend regress lags(1)
```

Augmented Dickey-Fuller test for unit root Number of obs = 38

	---------- Interpolated Dickey-Fuller ---------		
Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.946	-4.260	-3.548	-3.209

MacKinnon approximate p-value for Z(t) = 0.1479

D.land	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
land						
L1.	-.5945975	.2018454	-2.95	0.006	-1.004797	-.1843984
LD.	-.1941949	.1669652	-1.16	0.253	-.5335089	.1451191
_trend	1.494656	282.2072	0.01	0.996	-572.0193	575.0086
_cons	9847.585	7067.097	1.39	0.173	-4514.484	24209.65

. dfuller land, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-1.855	-2.639	-1.950	-1.605

D.land	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
land						
L1.	-.2724302	.1468919	-1.85	0.072	-.5703409	.0254804
LD.	-.3502726	.157691	-2.22	0.033	-.6700847	-.0304605

. dfuller prices, trend regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-3.606	-4.260	-3.548	-3.209

MacKinnon approximate p-value for Z(t) = 0.0293

D.prices	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
prices						
L1.	-.7402705	.2052672	-3.61	0.001	-1.157424	-.3231173
LD.	.0336213	.1714783	0.20	0.846	-.3148645	.382107
_trend	.924038	.3001809	3.08	0.004	.3139971	1.534079
_cons	18.96803	6.090554	3.11	0.004	6.590535	31.34552

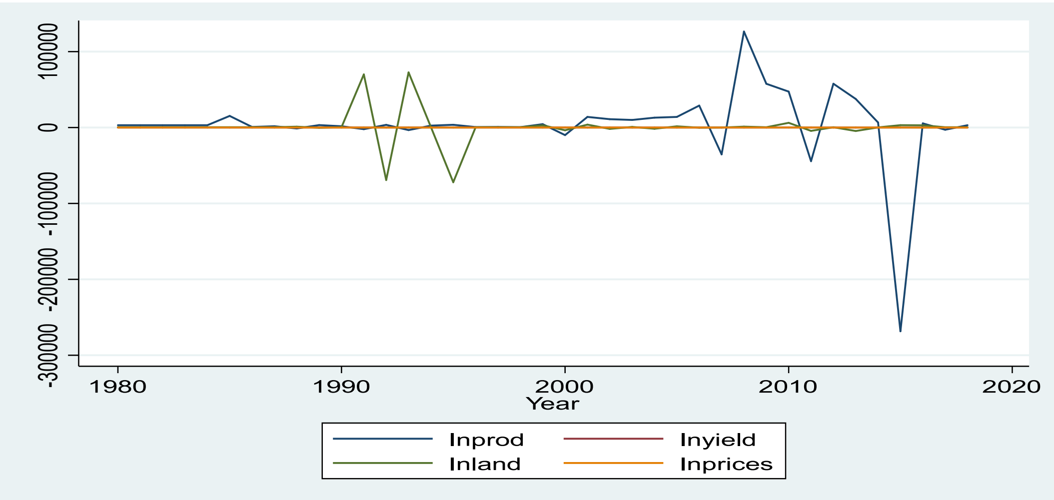
. dfuller prices, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root Number of obs = 38

---------- Interpolated Dickey-Fuller ---------

```
             Test        1% Critical    5% Critical    10% Critical
          Statistic        Value          Value           Value
------------------------------------------------------------------------------
 Z(t)          0.119         -2.639         -1.950         -1.605

------------------------------------------------------------------------------
   D.prices |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     prices |
        L1. |    .004504   .0378741     0.12   0.906    -.0723082    .0813162
        LD. |  -.3322571   .1603173    -2.07   0.045    -.6573956   -.0071186
------------------------------------------------------------------------------
```

POOLED STATIONARITY TEST LINE GRAPH AT FIRST DIFFERENCING 1(1)



reg inprod inyield inland inprices

```
      Source |       SS           df       MS      Number of obs   =        39
-------------+----------------------------------   F(3, 35)        =      2.88
       Model |  2.0454e+10         3  6.8178e+09   Prob > F        =    0.0498
    Residual |  8.2940e+10        35  2.3697e+09   R-squared       =    0.1978
-------------+----------------------------------   Adj R-squared   =    0.1291
       Total |  1.0339e+11        38  2.7209e+09   Root MSE        =     48680

------------------------------------------------------------------------------
      inprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |  -2322.787   4654.986    -0.50   0.621    -11772.91    7127.336
      inland |   .0077131   .3423894     0.02   0.982    -.6873743    .7028004
    inprices |  -1911.805   652.8296    -2.93   0.006    -3237.119   -586.4903
       _cons |   5134.021   7843.685     0.65   0.517    -10789.51    21057.55
------------------------------------------------------------------------------
```

. estat dwatson

Durbin-Watson d-statistic(4, 39) = 1.729701

POOLED STATE ADF STATIONARITY TEST RESULT AT FIRST DIFFERENCING 1(1)

Result with trend signifies with constant term
Result with noconstant signifies without constant term

dfuller inprod, trend regress lags(1)

Augmented Dickey-Fuller test for unit root   Number of obs   =   37

```
                   ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.216            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0042

------------------------------------------------------------------------------
D.inprod     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inprod |
         L1. |  -1.042098   .2471818    -4.22   0.000    -1.544993    -.539203
         LD. |   .0320255   .1739525     0.18   0.855    -.3218836    .3859346
      _trend |  -372.2395    863.339    -0.43   0.669    -2128.716    1384.237
       _cons |   10630.79   19634.65     0.54   0.592    -29316.21    50577.78
------------------------------------------------------------------------------

. dfuller inprod, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                   ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.285            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
    D.inprod |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      inprod |
         L1. |  -1.024529   .2390969    -4.28   0.000    -1.509921   -.5391363
         LD. |    .023352   .1689839     0.14   0.891    -.3197036    .3664076
------------------------------------------------------------------------------

. dfuller inyield, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                   ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -7.213            -4.270            -3.552            -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inyield    |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inyield |
         L1. |  -2.853065   .3955462    -7.21   0.000     -3.65781   -2.048321
         LD. |   1.396946   .3387351     4.12   0.000     .7077844    2.086108
      _trend |   .0476568   .0251386     1.90   0.067     -.003488    .0988016
       _cons |  -.3290529   .5137441    -0.64   0.526    -1.374273    .7161673
------------------------------------------------------------------------------

. dfuller inyield, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                   ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
```

```
 Z(t)          -6.443          -2.641          -1.950          -1.605

------------------------------------------------------------------------------
  D.inyield |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inyield |
        L1. |  -2.221755   .3448416    -6.44   0.000    -2.921821    -1.52169
        LD. |   1.111611    .347226     3.20   0.003     .4067049    1.816518
------------------------------------------------------------------------------

. dfuller inland, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)          -6.997          -4.270          -3.552          -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inland     |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inland |
        L1. |  -1.983673   .2834936    -7.00   0.000    -2.560445   -1.406901
        LD. |   .3315017   .1642344     2.02   0.052    -.0026356    .6656391
      _trend |  -95.12274    314.317    -0.30   0.764    -734.6054      544.36
       _cons |   2712.349   7129.936     0.38   0.706    -11793.61    17218.31
------------------------------------------------------------------------------

. dfuller inland, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)          -7.179          -2.641          -1.950          -1.605

------------------------------------------------------------------------------
   D.inland |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     inland |
        L1. |   -1.97761   .2754761    -7.18   0.000    -2.536856   -1.418364
        LD. |   .3284702   .1596521     2.06   0.047     .0043593    .6525812
------------------------------------------------------------------------------


. dfuller inprices, trend regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)          -6.886          -4.270          -3.552          -3.211
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

------------------------------------------------------------------------------
D.inprices   |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   inprices |
```

```
        L1. |  -1.824599   .2649809    -6.89   0.000    -2.363707   -1.285491
        LD. |   .3650411   .1620648     2.25   0.031     .0353178    .6947644
     _trend |  -.0018064   .1802228    -0.01   0.992    -.3684725    .3648598
      _cons |   1.801883   4.094301     0.44   0.663    -6.528035     10.1318
------------------------------------------------------------------------------

. dfuller inprices, noconstant regress lags(1)

Augmented Dickey-Fuller test for unit root         Number of obs   =        37

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.943            -2.641            -1.950            -1.605

------------------------------------------------------------------------------
  D.inprices |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    inprices |
        L1. |  -1.792757   .2582213    -6.94   0.000    -2.316974   -1.268539
        LD. |     .34912   .1583951     2.20   0.034     .0275608    .6706791
------------------------------------------------------------------------------
```
Source: Analysed Pooled output from STATA 13

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