

Seasonal price variation analysis of palm oil: case study of Nigeria (2016–2022)

Elizabeth Tobi Adewale¹  · Kafayat Yemisi Belewu²  · Ayodeji Thomas Alabi² · Opeyemi Eytayo Ayinde² 

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Abstract

To enhance the benefits derived from palm oil processing by the farmers, there is a need for the producers (farmers) and buyers of palm oil to understand the seasonal price for making informed decisions on when to buy and sell the commodity. In order to determine price at the appropriate time of the season, the study looked at the seasonal price variation analysis of palm oil and the relationship between producers and buyers. This was done by understanding buyers' requirements, producers' effort, measurements taken, and contracting with buyers' credit from customers. A multiphase sampling strategy was used. Organized interviews and questionnaires were utilized to collect primary data, while the National Bureau of Statistics provided secondary time series data on the average monthly retail price of palm oil from 2016 to 2022. The need for bio-fuel, production growth, governmental regulations, market dynamics, and the seasonality of palm oil products are then identified by the study as important factors influencing palm oil price fluctuation throughout the year. The study then suggests that there's a need for economic diversification to reduce reliance on a single sector. This study will serve as a basis for future research on palm oil price variation analysis.

Keywords Bio-fuel · Palm oil · Price · Processing · Variation

1 Introduction

Given its use as a source of food and farm revenue, palm oil is a valuable commodity in the Nigerian economy [1]. Together, palm oil and palm kernel oil account for around 70% of the nation's total vegetable oil consumption requirements, while also supporting approximately 4 million jobs directly and indirectly [2, 3]. Since then, the Nigerian palm oil sector has expanded tremendously in spite of recent neglect. Its significance has influenced every aspect of the country's economy.

To support families and communities, different geographic areas have different needs when it comes to managing natural and agricultural resources. To give producers and their community's viable livelihood prospects, for example, governments, non-governmental organizations, and civil society organizations are implementing a number of programs. In this regard, palm oil has become more well-known as one of the main products made in West Africa's tropical rain forest region [3].

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✉ Elizabeth Tobi Adewale, adewalee14@gmail.com; Kafayat Yemisi Belewu, belewu.ky@unilorin.edu.ng; Ayodeji Thomas Alabi, omolabi385@gmail.com; Opeyemi Eytayo Ayinde, opeyemi@unilorin.edu.ng | ¹Department of Economics, Cyprus International University, Nicosia, North Cyprus. ²Department of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, Nigeria.



Palm oil accounted for about 36% of the world's oil crops and produced oil [4]. Palm oil and its byproducts have found applications in a wide range of downstream industries, such as food and beverage, cosmetics, pharmaceuticals, oleo chemicals, biodiesel, renewable energy, and cutting-edge materials like carbon nano-tubes [5]. Palm oil is the most accessible and least expensive edible oil [6]. Therefore, it appears that as the commodity's price rises, the cost of food as a whole rises as well, contributing to inflation. A study that was done revealed a significant and positive relationship between inflation and Crude Palm Oil price [7, 8].

As a value addition business, palm oil pays specific supply chain participants for tasks that downstream industries previously completed or for completing tasks that producers thought valuable but had disregarded [9, 49]. It should be noted that the United States Department of Agriculture (USDA) defined value addition as altering a product's state or form, producing goods in a way that increases their value, and physically separating agricultural products in a way that increases their value [10]. Most people agreed that the primary goals of palm oil are frequently to maximize the net farm income and wealth of producers [11]. Expanding the activities in value addition of palm oil processes is crucial if they are to benefit from economies of scale and ensure that they don't just produce for the benefit of downstream participants in their supply chain. Products that result from processing oil palm can be easily divided into three categories, according to Beveridge [12]. Firstly, fruit-based products, such as crude palm oil, fiber, and sludge; secondly, nut-based products, like palm kernel oil, palm kernel cake, and empty shell; and lastly, trunk-based products. These products (cooking and frying oil, margarine, cocoa butter substitute, etc.) are used as food.

Processing oil palm and its benefits could improve national food security and lessen poverty in rural areas. Extra-value products like vegetable oil, palm kernel oil, local soap, oleo chemicals (particle board, pulp, paper, fertilizer, energy, feedstock, starch, and soap, salad oil, detergent, lubricant, and biodiesel, among others) can be sold for a profit in the commercial sector [12]. Additionally, small-scale producers' processing of palm kernels has the potential to boost revenue, lower rural poverty, unemployment, and waste in the processing of oil palm [13]. Prior to the petroleum (oil) boom of the late 1970s, Nigeria was the world's largest producer and distributor of palm oil, according to Bassey [14]. The production of palm oil, which provides a significant amount of employment and income for a sizable portion of the rural population in the southern part of the country, has either generally stagnated or been subject to critical fluctuations, according to data from Gharleghi [15], Iorlamen and Ogah [16], Statista [17], Palm Oil Analytics [18], and many other sources in Nigeria and other West African countries. But the nation's economic development is not aided by the drop in agricultural output and export, especially when it comes to oil palm processing and value addition.

Government arrangements and market transactions are the two ways that businesses and individuals can access production resources. Nigeria has not implemented specific sustainability measures (like those used in Indonesia, e. g. set of challenging goals for renewable energy and fiscal incentives provided by regulations to promote green growth), but it does have a patchwork of environmental and land regulations that apply [19]. As of right now, market transactions are the most significant way that businesses in Nigeria can access resources. Farmers must, however, find ways to get access to resources for production, including traveling to villages and making cash payments up front as part of required purchases. The likelihood of a consistent supply is highest for dominant classes in the palm oil processing industry, such as those with access to grants, loans, and contract money. Going back to the study's background, resource access analysis aims to clarify and look into how productive resources are accessed in the palm oil sector.

However, seasonal variation analysis of palm oil is a critical aspect of understanding the dynamics of palm oil production, pricing, and market trends. This analysis involves examining how palm oil production, consumption, factors, and prices change over different seasons of the year.

Palm oil production is influenced by various factors such as weather conditions, harvesting cycles, and agricultural practices. Seasonal variation analysis helps in identifying patterns in production levels across different times of the year. This information is crucial for supply chain management and production planning [20]. The demand for palm oil can be influenced by seasonal factors such as festivals, holidays, and cultural consumption habits. By analyzing these patterns, producers and buyers can make informed decisions about inventory management and pricing strategies [21]. As regards, palm oil prices are subject to fluctuations due to changes in supply and demand dynamics. Seasonal analysis can reveal trends in price movements, helping market participants to anticipate price changes and manage risk [22]. Government policies and regulations related to palm oil production, trade, and environmental concerns can also exhibit seasonal variations. Understanding these variations helps stakeholders anticipate changes and adapt accordingly [23]. Also, the price of palm oil is greatly affected by production or output of the palm oil within that year and the general inflation [24].

A country's economy depends heavily on the palm oil subsector for a number of reasons, the most significant of which is the sheer number of people it employs. It employs significantly more people than all other industries or sectors put together, between 60 and 70 percent of the workforce in a developing country [25]. Related to this is the reality that most

countries carry out their agricultural activities in rural areas; where the majority of the impoverished reside. As a result, a well-developed subsector of the crude palm oil industry has a significant potential to reduce poverty, making it imperative for a country's strategic interests to expand its domestic palm oil industry as opposed to depending on imports. Thus, it is impossible to overstate the significance of palm price variation for Nigeria's goal of achieving sustained growth.

Finally, the study aims to examine the correlation between producers and buyers mostly wholesales and how price is being affected in a season using the descriptive statistics, to identify the elements that influences the various price fluctuation of palm oil throughout the year using time series decomposition and finally investigate how those factors influence the price variation of palm oil, therefore causing price instability through multiple regression.

The knowledge generated by this research study is expected to support the development of appropriate strategies for maximizing the benefits associated with palm oil processing. Additionally, it will facilitate the government and development organizations' comprehension of the workings of the palm oil sector with respect to pricing and availability of palm fruits, strengthening the advocacy for improved institutional and policy frameworks that are necessary to ensure the palm oil industry's profitability and viability.

2 Study area

This study was carried out in Nigeria while primary data was gathered in Ekiti State has highlighted in Fig. 1 below. The entirety of Ekiti State is located in a tropical region. It lies between latitudes $70^{\circ}15'1''$ and $80^{\circ}51'1''$ north of the Equator and longitudes $40^{\circ}51'1''$ and $50^{\circ}45'1''$ east of the Greenwich meridian. With a total land area of 5887.890 square kilometers, it is bordered to the east and south by Ondo State and lies south of Kwara and Kogi State, east of Osun State. There are sixteen Local Government Councils in Ekiti State. The population of Ekiti State was 1,647,822 according to the 1991 Census, and it was estimated to be 1,750,000 when it was established on October 1st, 1996, with Ado-Ekiti serving as the capital. The 2006 population census by the National Population Commission put the population of Ekiti State at 2,384,212 people [26].

Mainly an upland zone rising over 250 meters above sea level, Ekiti has a rhythmically undulating surface. The landscape consists of ancient plains broken by steep-sided outcropping dome rocks. These rocks may occur singularly or in groups or ridges and the most notable of these are to be found in Efon-Alaaye, Ikere-Ekiti and Okemesi-Ekiti. An important feature of the state is the large number of hills it possesses, which are often the site of towns in which much of the population resides. In fact, the word 'Ekiti' was derived from the local term for hill. Ekiti located in the southwestern part of Nigeria has its vegetation consisting of the dry lowland rainforest and the derived savanna.

Therefore, the vegetation of the state makes it a suitable for the cultivation of several cash and food crops. Agriculture is the main occupation of the people of Ekiti, and it is the major source of income for many in the state. Agriculture provides income and employment for more than 75% of the population of Ekiti State [27]. Some of Ekiti's agricultural

Fig. 1 Map of Nigeria Showing the Location of the Study Area, Ekiti State. Source [28]



produce are: Cash crops such as Cocoa, Oil Palm, Kolanut, Plantain, Bananas, Cashew, Citrus and Timber; Arable /Food Crops such as Rice, Yam, Cassava, Maize and cowpea. Figure 2 shows the map of Ekiti State indicating the various local government areas.

2.1 Sampling procedure

The households in Ekiti State that cultivate palm oil were the study's target population. To create the sample for this study, a three-stage multi-random sampling technique was employed because of the geographical dispersion and complex population structure. This will help increase accuracy [30]. Three local government areas; Irepodun/ifelodun local government; Araromi Obo, Igbemo, Afao, Are, and Iworoko, Ado-local government; Awedele, Okesa, Bisi, Adebayo, and Bashiri, Moba local government; Ijan, Iluomoba, Aisegba, Agbado, and Imesi, were purposefully chosen in the first step because they are famous locations for oil palm in Ekiti State and these are readily accessible, (we can see those local government areas in Fig. 2). This was carried out since their primary agricultural activity is the production of palm oil. Four communities were chosen at random for the second phase. Third stage involves random selection of 10 respondents from each of the selected communities to make a total of 120.

2.2 Sources of data

The primary data was gathered via the use of a questionnaire (focus group discussion, and filled interview questions). The question was read and translated by the researchers to aid adequate communication with those who couldn't read nor write) to obtain details about the means of transportation, the source of funding, price fluctuations, factors influencing the price of palm oil, the relationships between producers and buyers. This method was to establish rigor and trustworthiness. Transferability was also accomplished by giving readers a thorough and detailed explanation of the study's information sources and conclusions [31, 32]. Third, researchers were able to achieve reliability by being transparent and self-critical, taking into account their personal experiences, emotions, and biases in their reflective memos [33]. Data was obtained from wholesalers of palm oil chosen at random. Out of the one hundred and twenty questionnaires, one hundred and ten questionnaires were considered valuable and examined. Secondary time series data is the price variation of palm oil of the whole Nigeria collected from Bureau of Statistics on the average monthly retail price of palm oil while primary data was collected in Ekiti State.

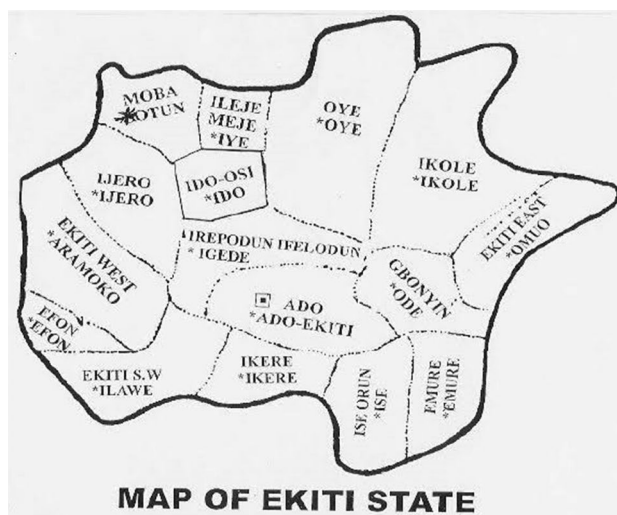
2.3 Analytical techniques

The data analysis that was used for this study includes:

Descriptive statistics is used to describe the relationship of processors to certain types of buyers to determine price at time of the season [34, 35].

Time series decomposition is used to describe the seasonal price variation in the study area [36–38].

Fig. 2 Map of Ekiti State, Nigeria. Source [29]



Multiple regression models is used to determine the factors affecting the price of palm oil [39, 40].

2.4 Descriptive statistics

In order to facilitate easy analysis, the data used for this study was first subjected to descriptive statistics to describe how processors relate to one another and to specific types of buyers in order to determine price at the time of the season. Averages, numbers, tables, graphs, and index numbers were among the descriptive statistics used to characterize the seasonal price pattern and price increase of palm oil in the study area.

2.5 Time series decomposition

An analytical technique called time series decomposition was employed to explain the behavior of price variation in the palm oil study area over time [38].

Trend Variation Trend (T): This is the long-term price movement linked to macroeconomic variables like the overall economy's inflation and deflation as well as variables unique to agricultural products, [41, 42]. Simple linear regression analysis using the ordinary least squares method was used to analyze it [43]. Annual time series data of prices of palm oil during 2016 to 2022 were used as dependent variables, and time trend as independent variable. So, the equations to describe them are as follows:

$$PPO_t = b_0 + b_1TIM_t$$

where

PPO_t , An average prices of palm oil (Naira per liter); TIM_t , Time trend (1, 2, 3,.....0.24); b_0 , The coefficients for the respective variables in the function; b_1 , The trend component of the time series.

Seasonal variation (S): Owing to climatic conditions in various seasons and the biological growth process of crops, this is a regular repeating price pattern that is completed once every twelve months [41, 42]. As a result, seasonal variations exist in the supply and demand of agricultural products. We used monthly time series data on palm oil prices from 2016 to 2022. Thus, the following equations can be used to describe them:

$$\begin{aligned} PPO_t = & b_0 + b_1JAN_t + b_2FEB_t + b_3MAR_t + b_4APR_t \\ & + b_5MAY_t + b_6JUN_t + b_7JUL_t + b_8AUG_t \\ & + b_9SEPT_t + b_{10}OCT_t + b_{11}NOV_t + b_{12}DECT \end{aligned}$$

where JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC, are dummy variables as a proxy variable representing seasonal factors (January, February, March, April, May, June, July, August, September, October, November, and December).

2.6 Multiple regressions

A statistical technique for examining the relationship between several independent variables and one dependent variable is multiple regression analysis [44]. This analysis can be used to assess how financial and economic conditions are affecting the palm oil industry in relation to the price of the product. It enables the identification of important variables that could impact the cost of palm oil and its production, such as fluctuations in exchange rates, the demand for bio-fuels, and technological advancements. Consumer desire, Producers can more effectively adjust to market conditions and make well-informed decisions regarding their operations by being aware of these factors.

The model is given as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12})$$

$$Y = \beta_0 + \beta_n X_n + \epsilon$$

where;

Y , Price of palm oil (Naira (₦)); β_0 , Intercept (Constant term); β , Co-efficient of the independent variables; n , 1, 2, 3, 4, 5, 6, ..., n ; ϵ , Error term; $B_1 - B_{13}$, Regression coefficients; X_1 , Currency fluctuation (5-point Likert scale; strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD)); X_2 , How biofuel demand determine palm oil price

variation (SA, A, N, D, SD); X3, Bad road (SA, A, N, D, SD); X4, Irregular measurement (SA, A, N, D, SD); X5, Increases in production costs (SA, A, N, D, SD); X6, Weather Conditions (SA, A, N, D, SD); X7, Government Policies (SA, A, N, D, SD); X8, Economic conditions (SA, A, N, D, SD); X9, Technological advancements (SA, A, N, D, SD); X10, Alternative on price (SA, A, N, D, SD); X11, Cultural practices (SA, A, N, D, SD); X12, Seasonality (SA, A, N, D, SD).

3 Limitation of the study

A significant obstacle encountered during the investigation was the wholesaler's inadequate record-keeping. Since memory recall was the main source of information from the wholesales, estimates of the input used, yield realized, cost price, and selling price may include margins of error.

The most significant factor is the commodity's (palm oil) price volatility, which may be influenced by seasonal factors (off-season period). Additionally, the respondents exhibited a lack of willingness and a negative attitude when it came to providing the study with the information it needed, particularly when it came to the price of their commodities.

4 Results and discussion

The data findings and discussions regarding the seasonal price variation analysis of palm oil are presented in this section. This contains a thorough explanation of the seasonal price fluctuations in the research region, as well as the variables influencing palm oil prices and the relationship between producers and buyers.

4.1 Frequency distribution tables of the socio-economic characteristics

The respondents' socioeconomic characteristics are displayed in Table 1. According to the age group, there are 8.33% of respondents under 30 years, 30% of people between 31 years and 40 years, 21.67% of respondents between 41 years and 50 years, 20.83% of respondents between 51 years and 60 years, and 19.17% of people over 60 years. This shows that the majority of palm oil users are energetic young people who can complete the tasks quickly. However, moderate percentage of the youth participates in oil palm farming. According to the studies [45, 46] that looks into young people's participation in palm oil production, it shows that average number of the youth participate in oil palm production. This aligns with the result of this study.

The breakdown of years of marketing experience shows that those with less than five years are 40%, those with six to ten years are 44.17%, those with eleven to fifteen years are 10%, those with sixteen to twenty years are 1.67%, and those with more than twenty years are 4.17%. This suggests that the majority of responders have expertise in the palm oil industry with lower percentage with long-term experience, but their experience aids in their effective use of capital. This backs up a study that was carried out in light of oil marketing expertise and a knowledge gap regarding the ROI of marketing palm oil as a means of sustaining livelihoods [47].

According to the respondents' gender, there are 17.50% more women than men (82.50%). As a result, women produce and trade the majority of palm oil [48]. The study shows that women in the study area process palm oil primarily on their own, but because they share a processing location, they identify as a group. This result aligns with earlier studies carried out by Sarku [49], Budu and Sarpong [50], and Adjei-Nsiah et al., [51] that when it comes to palm fruit processing, women predominate. In Africa, where palm oil is abundant, women are reminded that processing palm fruit is a traditional practice. The relationship that producers have with buyers and fruit sellers may affect their ability to obtain a steady supply of palm fruits and the palm oil market with regard to the pricing of palm fruits and palm oil. Ekpe [52], asserts that markets determine how resources are allocated, which in turn affects the decisions made by economic agents regarding the production and consumption of goods. As a result, palm oil's economic activity is based on prices and markets. This is so because the marginal economic desirability of various consumption options and the marginal profitability of various production options are determined by markets. Markets, however, are fallible and may provide inaccurate information regarding the worth of palm oil.

According to the respondents' marital status, there are 4.17% of singles, 83.33% of married respondents, 8.33% of divorced respondents and 4.17% of widowed respondents. This demonstrates that most farmers are married, and family members who process palm oil can provide a steady labor force, particularly for small-scale to medium-sized palm oil operations. This can lower labor expenses and produce a workforce that is committed.

Table 1 Shows the frequency distribution tables of the socio-economic characteristics. Source [54]

	Frequency	Percentage
Age group		
< 30	10	8.33
31–40	36	30.00
41–50	26	21.67
51–60	25	20.83
Above 60	23	19.17
Total	120	100.00
Gender of the respondents		
Male	21	17.50
Female	99	82.50
Total	120	100.00
Marital status		
Single	5	4.17
Married	100	83.33
Divorce	10	8.33
Widowed	5	4.17
Total	120	100.00
Education level		
No education	3	2.50
Quranic	23	19.17
Primary	77	64.17
Secondary	15	12.50
Tertiary	2	1.67
Total	120	100
Source of finance		
Personal savings	61	50.83
Bank loan	3	2.50
Relatives and friends	6	5.00
Money lender	36	30.00
Others	14	11.67
Total	120	100
Cooperative memberships		
Yes	33	27.50
No	87	72.50
Total	120	100
Access to extension workers		
Yes	6	5.00
No	114	95.00
Total	120	100
Extent of extension workers visitation		
Regular basis	6	5.00
When issues arise	114	95.00
Total	120	100

In terms of education, the percentages are as follows: 2.50% have never attended formal school; 19.17% have studied the Quran; 64.17% have completed primary school; 12.50% have completed secondary school; and 1.67% have completed tertiary education. It's evident that most farmers possess primary education. This enhances knowledge of the palm oil industry's worldwide trends and the market. Thus, having an oil palm plantation was not restricted by one's level of education, despite the fact that access to information was a key factor in better managing the plantation. Understanding the importance and application of innovations in oil palm depends critically on the educational attainment of farmers. High

levels of literacy are thought to facilitate the dissemination of better agricultural techniques linked to the production of oil palm [53]. It was found that the respondents' primary source of income is palm oil, with 24.17% reporting that they trade part-time and 75.83% reporting that they trade full-time. The sources of palm oil purchases are as follows: 1.87% and 0.83% come from other sources, while 5.83%, 35.83%, and 0.83% come from own farms and farm gates respectively. Purchasing palm oil from the local market can frequently be more affordable because it involves fewer logistics and transportation costs. This can be crucial for companies trying to cut expenses on overhead.

Of the total financing sources, 50.83% come from personal savings, 2.50% come from bank loans, 5% come from friends and family, 30% come from money lenders with no financing from Esusu, and 11.67% come from cooperatives. A sizable percentage of palm oil entrepreneurs and businesses rely on their own personal funds to launch, run, or grow their operations, as evidenced by the statistic that 50.83% of palm oil businesses are financed through their owners' personal savings. There are benefits to this method of business financing that come with no interest.

When analyzing the methods used to get palm oil to market, 29.17% use trucks, 67.50% use taxis, 1.67% use personal vehicles, and 1.67% use head portages. It is evident that the majority of respondents use taxis, which offer them the most convenient mode of transportation. Respondents' sales to whom they sell indicate that 2.50% sell to retailers, 21.67% sell to consumers, and 75.83% sell to both. Diversifying a farmer's revenue streams is achieved by selling to both retailers and consumers. This can increase revenue stability and lessen the company's reliance on a particular market niche, strengthening its ability to withstand changes in the market.

Table 1 also shows that all respondents (100% of the respondents) affirmed that the dry season had the highest prices. This demonstrates how the price of palm oil varies with the season. It is evident that 27.50% of the respondents are members of a palm oil association, whereas 72.50% do not belong to any such organization. This reveals that the majority of respondents lack interest in affiliation. This explains why only 1.67% of respondents receive benefits from the association, while the remaining 98.33% of respondents do not receive association support or promotion of sustainable palm oil production practices. As a result, the respondent does not enjoy from the majority of the associations' marketing benefits.

When it comes to information and assistance regarding palm oil, only 5% of people have access to extension workers, whereas 95% do not. This shows that, as a result of extension workers' inadequate information dissemination, the majority of farmers are unaware of innovations. 5% attested to extension workers' visits, while 95% said they only come when certain problems arouse. It reveals that respondents only get to meet extension workers when there's an emergency situation and not very often.

4.2 Relationship of producers to certain types of buyers to determine price at time of the season

The question regarding the relationship between buyers and producers is addressed in this segment. Table 2 below shows that specialized palm oil derivatives or tailored solutions to meet the needs of particular customers are enjoyed by over 95.83% of respondents, whereas only 4.17% do not enjoy this. Producing unique palm oil derivatives enables

Table 2 Relationship of producer to certain types of buyers to determine price at time of the season. Source [54]

Item	Frequency	Percentage
Buyers requirements		
Yes	115	95.83
No	5	4.17
Producer effort		
Strong	4	3.33
Little	116	96.67
Measures taken		
Strong	118	98.33
Little	2	1.67
Contracting with buyers		
Yes	99	82.50
No	21	17.50
Credit from customers		
Yes	99	82.50
Total	120	100.00

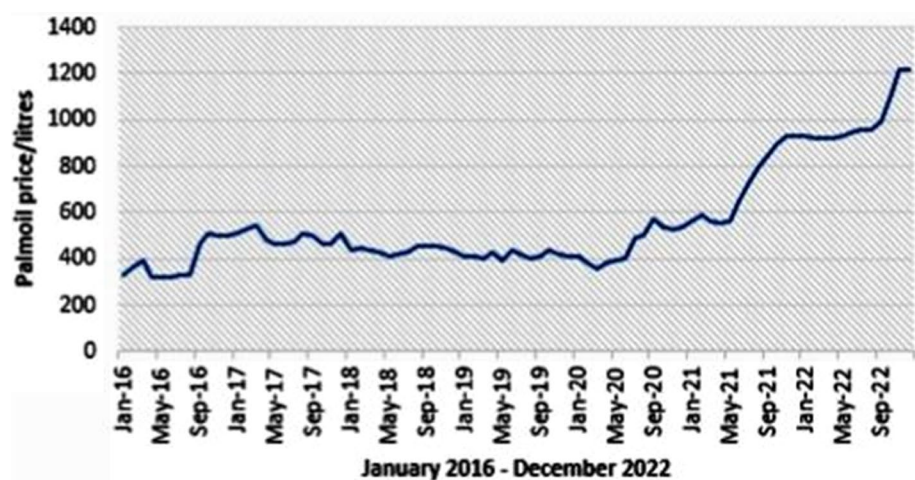
manufacturers to distinguish themselves in the marketplace. In highly competitive industries, this distinguishing can play a pivotal role in drawing in customers who are in search of customized or unique solutions, and long-term connections. Companies that can meet their clients' needs exactly can win partnerships and long-term contracts. Customization (customer preference; in this context means customizing palm oil. For example, some buyers may prefer light palm oil to the heavy palm oil because it maintains its current state in a cool weather condition while the heavy palm oil may tend to solidify in cool weather condition. While some buyers prefer the heavy palm oil because they believe it increases in quantity at warm temperature) frequently necessitates extra manufacturing processes or specialist processing tools, which raises the cost of production. For instance, it might take more time, labor, or specialized equipment to produce palm oil derivatives with particular traits or qualities. As a result, the price of palm oil changes over time. Just 3.33% of sellers interact with customers to learn about their unique needs and preferences, compared to the 96.667% who do not. Missed opportunities to enhance sustainability practices and address social and environmental issues can arise from not interacting with them. This is in line with the research done by Huang and Sarigöllü [55] that investigates the relationship between market outcome and brand awareness.

Accurate measurements are taken by about 98.33% of the respondents, which would guarantee the steady quality of products made from palm oil. In order to fulfill client expectations and industry standards, this is crucial. This is because accurate measurements can spot differences in quality and quantity, enabling manufacturers to make the necessary corrections/adjustment. Inaccurate measures can push away customers if they sense any form of dishonesty in the quality and quantity of palm oil they purchase. While 1.67% takes minimal steps, this percentage takes significant steps to guarantee the sustainability of the palm oil production and processing methods.

It is noted that 82.5% of respondents have contracts in place with buyers to obtain loans for production; these loans will facilitate a seamless and uninterrupted production flow. In contrast, 17.5% of respondents do not have such contracts in place. The majority of respondents (82.5%) got credit from clients prior to the production of palm oil, whereas just 17.5% did not receive credit from clients before the production of palm oil. This suggests that palm traders have access to customer microcredit. This idea facilitates continuous cycle of seamless production of palm oil. This is line with the study conducted by Omain et al., [61] cited by Koh et al., [62] which explains that building customer relationship focuses on joint venture or long-term agreement.

The graphical depiction of palm oil prices in liters from January 2016 to December 2022 is shown in Fig. 3 below. The price of palm oil was over 300 naira per liter in January 2016 and stayed that way until January 2017, when it increased to 500 naira. The price fluctuated until January 2020, after which it increased dramatically to 1,200 naira in September 2022. This shows that the price of palm oil fluctuates during the year. This aligns with the study conducted by Omosehin et al., [57] which assessed how changes in the price of palm oil affect the welfare of Nigerian palm oil producers based on yearly time series data (1980–2018). According to the study's long-term estimates, there was a slight but positive correlation between palm oil prices and the well-being of palm oil producers. While short-term projections indicate that the price of palm oil and the exchange rate have negative and noteworthy impacts on the well-being of palm oil producers, whereas the inflation rate has a positive and noteworthy influence on welfare.

Fig. 3 Graph showing the price per liter of palm oil from January 2016 to December 2022. Source [56]



4.3 Factors affecting the price of palm oil

The Multiple Regression Analysis was used to examine the factors influencing the price of palm in the research area. The price of palm oil in the study area is influenced by only five variables, (X_2 , X_5 , X_7 , X_8 , and X_{12}) as indicated in Table 3 below: "Bio-fuel demand (X_2), Increase in production costs (X_5), Government policies (X_7), Economic condition (X_8), and Seasonality of palm oil (X_{12})". The remaining variables (X_1 , X_3 , X_4 , X_6 , X_9 , X_{10} , and X_{11}) did not exhibit statistical significance. Therefore, we'll only focus on the detailed explanation of the five variables, (X_2 , X_5 , X_7 , X_8 , and X_{12}).

The independent variables in the model appear to explain roughly 51.9% of the variation in the dependent variable, according to the R square value of 0.519.

The demand for bio-fuel (X_2) was statistically significant at 5%, meaning that a unit increase in bio-fuel demand (X_2) corresponds to a 3.87 unit increase in palm oil prices. This is in line with research by Koh and Ghazoul [58], which explains the advantageous effects of producing bio-fuels derived from palm oil. The researchers further explained the need for increasing palm oil production which also increases the production of its byproducts (e.g. feedstock), and this could have a positive economic impact on palm oil producers. In areas that produce palm oil, the increased demand may boost rural economies. This also aligns with the findings from Syahza [59] that concludes that the demand for palm oil plantation improves the economy of the rural sectors.

The price of palm oil will rise by 4.0 units for every unit increase in production (X_5). This shows a 5% statistically significant positive impact on palm oil prices can be attributed to increase in production. The price of palm oil is largely determined by the fundamental economic concept of supply and demand [62]. Prices for palm oil typically decline as production rises and supply outpaces demand [60]. On the other hand, prices usually rise in response to drops in production or increases in demand [60]. At this time, buyers compete for the limited available palm oil.

One-unit increase in the impact of government policies (X_7) is associated with a -0.531 unit decrease in the price of palm oil suggests that government policies have a 5% statistically significant negative impact on palm oil prices. This implies that policy made by government can influence the supply and demand of palm oil which as a result affects its price. For instance, if government implements policies that make the production of palm oil easier, then the increased supply could lower the price. On contrary, policies that limits palm oil production or increase demand can bring about price increase. This result aligns with the study by Ata [63] which shows how government policies affects price, production, exportation, supply and demand of palm oil.

Increase in economic conditions (X_8) is associated with a -0.785 unit decrease in the price of palm oil. 0.075 is somewhat close to the typical significance at 10%. This suggests that an increase in economic conditions such as overproduction (which causes surplus and reduce price); this results in higher demand and economic growth, global economic down turn (which causes reduced demand owing to reduced consumer spending), reduced demand for palm oil as a bio-fuel feedstock among other factors may have a borderline statistically significant negative impact on palm oil prices. This result aligns with studies which investigates the impacts of palm oil price fluctuation on the economy [57, 64–66]. Therefore, it is concluded that decrease in palm oil price can increase demand and consumption.

Table 3 Factors affecting palm oil price. Source: [54]

Price of Palm oil	Coeff.	T	P> t
Currency fluctuation	0.924	0.26	0.796
Bio-fuel demand	3.868**	2.21	0.029
Bad road on price	- 4.582	- 0.70	0.484
Irregular measurement	7.960	1.39	0.166
Increases in production	4.000**	2.18	0.032
Weather conditions	2.508	0.79	0.432
Government policies	- 0.531**	2.33	0.022
Economic conditions	- 0.785*	- 1.80	0.075
Effect of palm oil alternatives	1.570	0.68	0.498
Cultural practices	0.587	0.14	0.888
Seasonality of palm oil product	- 0.278**	- 2.19	0.030
_cons	1.884	11.97	0.000

***' **' * indicates significance levels at 1% , 5%, 10% respectively; Number of observation=119. F(11, 107) = 21.31 Prob> F = 0.0000 R-squared = 0.5189 Adj R-squared = 0.4984, Root MSE = 13.186

Also, if the economic conditions improve, there could be new trade agreement which reduces tariffs and as a result increase competition and eventually brings down the price of palm oil.

It has been noted that a rise in the seasonality of palm oil products (X_{12}) is linked to a -0.278 unit drop in palm oil prices. This shows that the statistical significance of the negative impact of seasonality on palm oil prices is 5%, which reveals how palm oil seasonality affects price variations. For instance, higher production of palm oil during peak seasons could lead to production surplus which causes the price to drop. Also, reduced demand during off-peak seasons can cause the price to reduce. During festive period, there could be fluctuation in demand which results in price drop. This result aligns with the study by Foster and Chang [67], Omosehin et al., [57], and Phitthayaphinant et al., [38].

Number of obs = 119

F [1,1] = 21.31 Prob > F = 0.0000 R-squared = 0.5189

Adj R-squared = 0.4984 Root MSE = 13.186

4.4 How the factors influence price variation of oil palm

The pricing of palm oil is seasonal. Table 4 below shows that prices can increase twice between peak production season (when prices are lowest) and the off season. Given these price swings, the value of SPO maintains its value at a higher level during the peak season, since its use is more standardized.

The table above shows the margin earned by each category of actors. Middle men (buyers) appeared to benefit more from the palm oil business due to inefficiencies resulting from weak value chain coordination. Another factor that determines the prices of palm oil is the location of the point of sales from the production unit. The cheapest place to get palm oil is in the markets in the South especially Eastern Nigeria. Below are the current prices of palm oil today.

Current prices of palm oil today.

- 25 L of palm oil = ₦25,000 Lagos
- 25 L of palm oil = ₦24,000 Abuja
- 25 L of palm oil = ₦23,000 Average price
- 25 L of palm oil = ₦20,000 Imo

Source [68, 69].

5 Conclusions

The study found that producers and buyers play significant roles in the palm oil system. This means that the buyers' demand keeps the production cycle going. Their relationship determines the equilibrium price and quantity as well as the livelihoods of the people involved in the palm oil industry. The study concludes that various factors influence price fluctuation of palm oil throughout the year but the five variables, (Bio-fuel demand (X_2), Increase in production costs (X_5), Government policies (X_7), Economic condition (X_8), and Seasonality of palm oil (X_{12})) is unique to the study area. However, Nigeria's dependence on palm oil exportation makes it susceptible to price fluctuation. Therefore there's a need for economic diversification to reduce reliance on a single sector. The results of this study aides in the development

Table 4 showing the seasonal prices of palm oil. Source [67]

S/N	Category of actor in value chain	Season	Average selling price per 20 L (₦)		Average price (L + H)/2 (₦)
			Low	High	
1	Farmers/producers	Peak	1500	2500	2000
		Off	2500	4000	3250
2	Wholesaler/dealer	Peak	1800	3000	2400
		Off	3000	5500	4250
3	Retailer	Peak	2000 @ 100 per liter	3000 @ 150 per liter	2500
		Off	3600 @180 per liter	6000 @300	4800

of effective plans to increase the advantages of processing palm oil. Additionally, it would facilitate the government's and development organizations' comprehension of the palm oil industry's workings, including how pricing and fruit availability are determined. This will bolster the advocacy for improved institutional and policy frameworks, which are necessary to ensure the palm oil industry's sustainability and profitability.

Thus, the research on the seasonal price variation analysis of palm oil has produced a number of recommendations, one of which is the establishment of a suitable transportation infrastructure. According to the study, the government should set up a suitable transportation network to support producers and buyers, increasing productivity and efficiency. According to the study, trainings from the various value chains should be held to help people understand their roles and how to increase output. To increase local farmers' productivity, the study strongly advises palm oil producers to work with other groups, non-governmental organizations, and agricultural agencies both inside and outside the nation. Grants, loans, and credit facilities; a variety of reasonably priced credit options ought to be made available to palm oil farmers to increase production. Infrastructure and contemporary technologies should be made available to producers of palm oil and buyers. For palm oil producers and buyers to maximize profits and effectively manage risks, they must anticipate shifts in supply and demand. This paper was developed from a full thesis project.

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Declarations

Ethics approval and consent to participate Informed consent was obtained from all individual participants included in the study. The ethical approval was exempted by the University of Ilorin, Ilorin, Nigeria, Faculty of Agriculture, Department of Agricultural Economics and Farm Management.

Competing interests The authors declare no competing interests.

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