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ANALYSIS OF MAIZE PRICES AND MARKET INTEGRATION IN ADAMAWA AND TARABA STATES OF NIGERIA

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Abstract

The study analyzed maize prices and market integration in Adamawa and Taraba States of Nigeria from 2012 – 2023. Specifically, the study characterizes the behaviour of maize price in the region, determine the degree of maize market integration between spatial markets and find out the market that causes integration and direction of causality. The findings from the Impulse Response Function (IMC) analysis indicated a high level of market integration for both white and yellow maize. The IMC for white maize was 0.6843, and for yellow maize, was 0.842, both significantly below 1. The Granger causality test results further confirmed the close relationship between maize prices in area. The significant price fluctuations observed, for yellow maize, suggests underlying factors as supply disruptions or speculative behavior in the market. It is recommended to encourage greater cross-states trade and collaboration through the reduction of trade barriers, improved road infrastructure, and the provision of incentives.

Keywords: Maize, Prices, Price Fluctuations, Market Integration, Marketing Performance, Price Volatility

INTRODUCTION

Maize (*Zea mays*) has been a traditional food in Adamawa, Taraba States and Nigeria at large. This crop is one of the most grown crops in most of the localities of the North-Eastern States of Nigeria. The climatic and vegetation nature, being the Savannah-Sahel belt makes it favourable for the growth of cereal crops. The recent increase in prices of both local and foreign rice has swung the consumers' attention to alternative food crops such as maize. Marketing is the performance of all business activities in the flow of corn or corn flour from the point of initial maize production until it is in the hands of the ultimate consumers at the right time, in the right place and form, at the profit margin that can keep the farmers in their farming operation (Olukosi, Isitor and Ode, 2007). The marketing of cereals such as maize in Nigeria starts with collection of the produce from the rural farmers in the rural markets to the urban area or urban markets. The corn maize is in some cases transformed into other form such as corn flour and then move to areas within the region or the Country where demand is higher. Prices are main indications in the resource allocation process that takes place through markets. The ability of free markets to allocate resources in a way suitable to allow the whole economy to reach an optimal equilibrium is a fundamental result of the economic theory. In addition, free markets through price adjustment allow the economy to reach a new optimal mechanism at domestic level and, in case of free trade between countries, at international level. To promote free trade all over the world is hinged on the belief that free trade will engender an optimum equilibrium among the countries of the world and consequently induce a higher global welfare.

Problem Statement

In Nigeria, most serious attention seems to be given to challenges in agricultural production in the first phase than the last phase, that is marketing and pricing functions. Most countries in the world have developed successful measures in mitigating challenges that surround marketing of agricultural produce or products. However, controversies still engulf the usefulness of such an interventionist policy especially in maize marketing. As a result, the understanding of price formation process is very important to enable having efficient policies and to evaluate cost and sustainable returns from the ventures.

Despite the importance of prices in the allocation of resources, it is not too clear what role prices play in the allocation of resources in Nigeria's agriculture and in particular in the Northeastern region of the Country on maize economy. After the devastating crisis in the region as the result of Boko Haram fight efforts are now on how to rebuild our markets especially those of food crops to revamp the economy and food economic of the region. In addition, the factors that explain maize price levels and variations in time and space are generally unclear.

Furthermore, the relationship between the maize prices both at the rural and urban markets remains to be explored. Some of these issues form the focus of this study in the region.

Objective of the Study

The main objective of the study was to examine the extent and degree of maize price integration in Adamawa and Taraba States of Nigeria. The specific objectives were to:

i) characterize the behaviour of maize price in Adamawa and Taraba States of Nigeria;

ii) determine the degree of maize market integration between different spatial markets of the States;

iii) find out the market that causes integration and determine the direction of causality in the study area;

iv) identify the structural factors which tend to enhance the integration of maize markets in the region; and,

v) proffer appropriate policy measures to enhance the role of the market mechanism in the price transmission and maize distribution in the region.

LITERATURE REVIEW

The global production of cereals went up to 64million metric tonnes while in Nigeria, Maize production amounted to 12.75million metric tonnes in 2021 (FAO, 2022). This slight increased from the previous years where the volume reached 12.4 metric tonnes, this is the highest within the observed period. The quantity of maize produced in the country has generally increased since 2010. This increase in production needs to be augmented with suitable and efficient marketing systems. To determine a robust marketing system, the key concept of price or pricing is very vital because it influence quantity of goods to be supplied or demanded.

Olukosi, *et al*. (2007), defined spatial market integration as the smooth transmission of price signals and information across spatially separated markets. However, Goodwin and Schroeder (1991) observed that if price changes in one market are fully reflected in an alternative market, then these markets are said to be spatially integrated which indicates overall market performance. Therefore, price transmission among markets is central to understanding the extent of the integration in the market process. In order to facilitate the agricultural development process, analysis of market integration is considered pertinent, and it is expected that favourable pricing efficiency will stimulate production and marketing.

In price integration, simple bivariate correlation coefficients measure price movements of a commodity in different markets. This is one of the easiest ways to measure the spatial price relationship between two markets. Early studies on spatial market integration by Lele (1967) and Jones (1968) have used this method to achieve the objective. Though, the method has some limitations, as it was not able to measure the direction of price integration between two markets. The co-integration procedure measures the degree of price integration and takes into recognition the direction of price integration. This econometric tool gives more information than the correlation procedure, as it permits for the identification of both the integration process and its direction between two markets.

Measuring the degree at which prices are transmitted lacks a single explicit empirical test as identified by Kilima (2006) because of market dynamic relationship that arise due to discontinuity and nonlinear ties that arise due to distortion in arbitrage. However, in this study co-integration and vector error correction was used for the study while Augmented Dickey-Fuller (ADF) test was used to test for stationarity of variables. The test statistic from the testing regression is known as the statistic critical values (Dickey & Fuller, 1981). The regressions provide a t-statistic of the estimated δ. The t-statistic is then compared to the critical value t-statistic, If the value of the ADF statistic is less that is more negative, (because these values are always negative) than the critical value at the conventional significant level (usually the five percent significant level) then the series (Y_t) is said to be stationary and vice versa.

Many reasonable numbers of studies about price transmission and market integration have been conducted by various researchers in Nigeria. Some of the major studies include: Bako et al., (2021) who conducted a study on price dynamics of local and imported rice in Lagos State Nigeria, using unit root test, Granger causality test and index of market concentration (IMC); revealed that all the price series became stationary after 1st differencing with an order of integration of I(1), implying that the prices of both local and imported rice in rural and urban markets were trending upwards in an irregular pattern. Alege et al. (2021) in analyzing the market integration of maize rural and urban markets in Oyo State showed that the ADF test result of the price series were non-stationary at levels but became stationary after first differencing. They further deduced that the co-integration test revealed the presence of co-integration between the rural and urban market price of maize in the area. Similarly, Mpkado et al., (2018) studied price transmission and market integration of rural and urban rice market in Nigeria and the result showed that price series were integrated but the level of integration was low.

Ani et al., (2017) studied market integration of retail prices of soya beans in Benue and Enugu States, where the results indicated that retail prices of soya bean in Benue State did not granger cause the retail prices in Enugu State. On the other hand, Marwa et al., (2017) investigated market integration of agricultural products at both producer and consumer levels and showed that prices of agricultural products were integrated at both levels with bi-directional causalities between producer and consumer prices. While Oladapo and Momoh (2017) analyzed food price differences and market integration in Oyo State and revealed that prices of food in Oyo State were not stationary at their various levels but became stationary at first difference with the existence of co-integration among the price series in the study area.

In the recent studies conducted by Alege, et al. (2021) showed that the Index of Market Concentration (IMC) was less than one ($p \leq 0.05$) which implies the existence of short-run market integration between rural and urban markets in the study area. They also found that the result of Granger causality shows both uni-directional and bi-directional causalities between rural and urban markets in the study area, therefore, concluded that there were both short and long run market integration between rural and urban markets with uni-directional and bi-directional causalities between the stated markets in the study area.

MATERIALS AND METHODS

The study was carried out in Adamawa and Taraba States of Nigeria. This region formed what was called Gongola State before 1991. It has border with international communities such as Cameroun at Northeastern region, Niger republic at the Northern region. The Area also borders with internal communities within the Country by Cross River and Benue States at South-South region. It lies within the Sahel-Savannah belt with most farmers cultivating cereals such rice, maize, guinea corn and millet.

Data collected for this study were from secondary sources. It was collected from: a) Federal Ministry of Agriculture, b) National Bureau for Statistics, c) Central Bank of Nigeria (Agriculture and Credit Sub-sector) and d) the various States' Ministry of Agriculture. Prices of maize are in two phases that of wholesale and retail levels, because of complication in identifying the differences, retail price was solely used in this research. The monthly data retail prices of maize were collected for the period of 11 years, from 2012-2023. The choice of this period was because of some economic and political challenges ranged from the peak of Boko Haram crisis in the North Eastern region from 2012-2015, emergence of economic recession in 2016, Corona pandemic in 2019-2020 and banned in importation of food and other essential goods in 2015-2023 by the immediate past administration in the Country.

The analytical tools that were used includes Descriptive statistics such mean, percentages and so on, while inferential statistical tools such as Augmented Dickey Fuller (ADF) Test, Error Correction Model (ECM) and Granger Causality Tests were used to test the market integration among rural and Urban maize markets in the areas.

The data collected were reviewed and examined for consistency and reliability before an analytical process involving the determination of patterns, variation, and differences in magnitude of prices. Analytical processes using correlation and co integration tools will also be carried out to achieve the stated objectives using E-View version 9 Package. The procedure and rules of the analysis using the intended tools can be summarized as follows:

Co-integration method is use in testing the market integration and this requires that:

(i) Two variables, take Pit and Pjt are non-stationary in levels but stationary in first differences i.e P_{it} = I(1) and P_{jt} = I(1).

(ii) (ii) There exists a linear combination between these two series, which is stationary, i.e

U_{it} (=P_{it}- â - ЪP$_{jt}$) = I(0).

So, the first step is to test whether each of the univariate series is stationary. If they are both I(1), then we may go to the second step to test co-integration. The Engle and Granger (1987) procedure is the common way to test co-integration and it was used by Mukhtar and Javed (2008).

Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1981) is usually applied to test stationarity. It tests the null hypothesis that a series (P_t) is non-stationary by calculating a t-statistics for b=0 in the following equation:

$$\partial P_t = a + bP_{t-1} + g_t + \sum_{k=2}^{n} d_k \partial P_{t-k} + e_t \qquad (1)$$

Where $\partial P_t = P_t - P_{t-1}$,$\partial P_{t-k}$ = P_{t-k} - P_{t-k-1} and k= 2, 3,….., n

and, where P_t, P_{t-1}, $P_{t-k}$and P_{t-k-1} are the prices at time t, t-1, t-k and t-k-1 respectively. While a, b, g and d are the parameters to be estimated and et is white noise error term.

If the value of the ADF statistic is less than the critical value at the conventional significance level (usually the five percent significant level) then the series (p_t) is said to be stationary and vice versa. If the P_t is found to be non-stationary then it should be determined whether p_t is stationary at first differences ie $\partial P_t (= P_t - P_{t-1})$~ I(0) by repeating the above procedure. If the first difference of the series (∂P_t) is stationary then the series (P_t)may be concluded as integrated of order one that isP_t~ I(1). . Now the second step is to check co-integration.

In order to test co-integration, we will apply two-step residual-based test of Engle and Ganger (1987). In the first step we apply OLS to the following regression equation in which all variables are found to be integrated of same order ie I(1).

$P_{it} = \ell_1 + \ell_2 P_{jt} + u_{it}$ (2)

Where P_{it} is the price in market I at time t, P_{jt} is the price in market j at time t, ℓ_1 and ℓ_2 are parameters to be estimated and u_{it} are the white noise error terms.

The 2nd step involves testing whether the residual term uit from the co-integration regression are non-stationary using a modified ADF test ie$\partial u_t = \ell u_{t-1} + \sum_{k=2}^{n} q_k \partial u_{t-k} + m_t$ (3)

Where u_t, u_{t-1}, u_{t-k} and ∂u_{t-k-1} are respectively, residuals at time t, t-1, t-k, and t-k-1. And where l and q are parameters to be estimated while u_t is the residual term.

The null hypothesis of l = 0 is tested to check the stationarity of the residual. If the value of t-statistic of the l coefficient is less than the critical value, then the null hypothesis of non-stationarity is rejected and the residual is found to be stationary at levels. This in turn leads to the conclusion that long-run co-integration holds between two time series. Mukhtar and Javed (2008), Moses (2017) and Alege *et al.* (2021) applied this model in analyzing co-integration in maize rural and urban markets in Pakistan and Oyo State in Nigeria respectively.

In analyzing price behaviour in the short run or long run, Error Correction Model (ECM) can incorporate such short run and long run changes in price movements. Therefore, ECM can be formulated as:

$$\partial P_{it} = g_1 + g_2 \partial P_{jt} - \alpha u_{it-1} + n_{it} \qquad (4)$$

In this model, g_2 is the impact multiplier (the short-run effect) that measures the immediate impact that a change in P_{ji} will have on a change in P_{it}. On the other hand, α is the feedback effect or the adjustment effect that shows how much of the disequilibrium is being corrected, that is the extent to which any disequilibrium in the previous period effects any adjustment in the P_{it} period. Of course, $u_{i-1} = P_{it-1} - r_1 - r_2 P_{jt-1}$, therefore, from this equation we also have r_2 being the long-run response.

The test was also be checked of the direction of the change in price using Granger Causality Test. If a pair of series is co-integrated then there must be Granger causality in at least one direction, which reflects the direction of influence between series (in this case price). Theoretically, if the current or lagged terms of a time-series variable, say P_{jt}, determine another time-series variable say P_{it}, then there exists a Granger- causality relationship between P_{jt} and P_{it}, in which P_{it} is Granger caused by P_{jt}. This test was first introduced by Bessler and Brandt (1982) and applied by so many scholars in analysis of market integration to check which market leads. The model is formulated as shown below:

$$\partial P_{it} = q_{11} \partial P_{it-1} + .. + q_{1n} \partial P_{it-n} + q_{21} \partial P_{jt-1} + .. + q_{2n} \partial P_{jt-n} - g_1(P_{it-1} - \alpha P_{jt-1} - d) + e_{1t} \qquad (5)$$

$$\partial P_{jt} = q_{31} \partial P_{jt-1} + .. + q_{3n} \partial P_{jt-n} + q_{41} \partial P_{it-1} + .. + q_{4n} \partial P_{it-n} - g_2(P_{it-1} - \alpha P_{jt-1} - d) + e_{2t} \qquad (6)$$

The following two assumptions are tested using the above two models to determine the Granger causality relationship between prices.

$q_{21} = \ldots = q_{2n} = \ldots = g_1 = 0$ (no causality from P_{jt} to P_{it})

$q_{41} = \ldots = q_{4n} = \ldots = g_2 = 0$ (no causality from P_{it} to P_{jt})

RESULTS AND DISCUSION

Behaviour of Maize Price in the Adamawa and Taraba States of Nigeria

The findings of the descriptive statistics analysis on maize price in the northeastern region of Nigeria. The data includes the mean, minimum, maximum, and standard deviation, providing a clear picture of the price dynamics white and yellow maize over the given period. For price white maize in Adamawa, the minimum, maximum and mean value were 168.8900 USD/tonnes, 267.0800 USD/tonnes and 212.9108 USD/tonnes. The Std. Deviation was of 44.42551, along with a Skewness and Kurtosis value of 0.316685 and 1.142845 respectively. The descriptive statistics analysis provides a clear understanding of the price dynamics of white and yellow maize in Adamawa and Taraba States in northeastern Nigeria. For white maize in Adamawa, the minimum price was 168.89 USD/tonne, the maximum was 267.08 USD/tonne, and the mean price was 212.91 USD/tonne. The standard deviation of 44.43 USD/tonne indicates significant price variability, while the skewness and kurtosis values of 0.3167 and 1.1428, respectively, suggest a slight right skew and a relatively flat distribution. This implies that while the prices are mostly centered around the mean, occasional sharp increases or decreases might occur due to specific market factors, such as production shocks or supply chain disruptions. Ogunleye et al. (2024) observe that significant price variation, as evidenced by the high standard deviation, reflects market instability and the influence of unpredictable factors such as weather and policy changes on maize prices.

In the case of white maize in Taraba, the minimum, maximum, and mean prices were 143.63 USD/tonne, 237.51 USD/tonne, and 189.15 USD/tonne, respectively. The standard deviation here was 38.69 USD/tonne, which is lower than Adamawa's, suggesting that while there is variability in prices, it is relatively less pronounced. The skewness (0.3167) and kurtosis (1.2052) values for Taraba's white maize prices indicate a slightly positive skew, which means there are occasional price increases above the mean, though the distribution is still quite normal. Ayinde et al. (2024) explain that a lower standard deviation in price suggests a more stable market, where factors like local production and market policies are relatively more predictable and controlled, leading to more consistent pricing trends.

For yellow maize in Adamawa, the price range was much wider, with a minimum of 33.18 USD/tonne, a maximum of 882.10 USD/tonne, and a mean price of 310.46 USD/tonne. The standard deviation of 33.18 USD/tonne indicates that there is a significant fluctuation in yellow maize prices over the period. The skewness of 0.8443 and kurtosis of 3.0686 suggest a positive skew with fat tails, indicating that the price distribution is highly variable, with several instances of sharp increases in price. This could be due to factors such as climatic conditions affecting yellow maize production or speculative trading in the market. Ogunwale et al. (2024)

argue that such a high degree of fluctuation often reflects market uncertainty and vulnerability, particularly in regions with limited access to infrastructure, which can exacerbate price volatility.

Finally, for yellow maize in Taraba, the price range was between 156.20 USD/tonne and 485.00 USD/tonne, with a mean of 330.35 USD/tonne. The standard deviation of 95.48 USD/tonne is considerably higher than that of white maize in either state, which indicates a significant variation in prices during the period. The negative skewness of -0.1109 suggests that there are more instances of prices being below the mean, whereas the kurtosis value of 2.2925 indicates a relatively normal distribution with moderately heavy tails. Salami et al. (2024) highlights that such variations in prices are often linked to both local production issues and external factors, such as demand from international markets or trade policies that affect the price of maize, especially yellow maize, which is in higher demand for both human consumption and animal feed.

Table 1: Descriptive Information on maize price in the region

	Price white maize		Price yellow maize	
	Adamawa	Taraba	Adamawa	Taraba
Mean	212.9108	189.1508	310.4600	330.3500
Median	182.6050	170.7400	285.7500	326.8000
Maximum	267.0800	237.5100	882.1000	485.0000
Minimum	168.8900	143.6300	33.18000	156.2000
Std. Dev.	44.42551	38.68651	255.2077	95.48455
Skewness	0.316685	0.236971	0.844342	-0.110936
Kurtosis	1.142845	1.205166	3.068610	2.292472
Jarque-Bera	1.925091	1.723025	1.428181	0.274911
Probability	0.381919	0.422522	0.489637	0.871573
Sum	2554.930	2269.810	3725.520	3964.200
Sum Sq. Dev.	21709.88	16463.10	716440.5	100290.3
Observations	12	12	12	12

Source: Data Analysis print out, 2025

Graphical presentation of price of white maize in Adamawa state Nigeria from 2011-2023

The price trend of white maize in Adamawa State, Nigeria, from 2011 to 2023, as depicted in Figure 1, reveals a fluctuating decreasing pattern, with both periods of price growth and declines between 2012 and 2018. The price of maize in Adamawa saw a significant increase in 2019, rising from 168.89 USD/tonne to 267.08 USD/tonne, which marked the peak price within this period. After the peak, the price slightly declined to 260.07 USD/tonne in 2023.

This price pattern suggests a dynamic and unpredictable maize market in the region, where external factors such as climatic changes, supply chain disruptions, and policy interventions likely played significant roles. According to Adebayo et al. (2022), such price fluctuations are characteristic of agricultural markets in developing countries, particularly where the agricultural sector is heavily influenced by environmental conditions and external market forces.

The sharp increase in maize prices in 2019, from 168.89 USD/tonne to 267.08 USD/tonne, can be attributed to several factors, including climatic conditions, such as droughts, floods, or changes in rainfall patterns, which can severely affect maize production. Ayinde et al. (2023) emphasize that price spikes in staple crops like maize are often linked to disruptions in local production due to adverse weather conditions or agricultural input constraints. In Adamawa, where maize farming is a major agricultural activity, such shocks could lead to supply shortages, thereby causing the sharp increase in prices. Furthermore, the 2019 price hike could also be linked to changes in domestic or international demand, such as an increase in maize consumption or export demand, which would further pressure the prices upward.

The subsequent slight price decline from 2019 to 2023 may reflect a market adjustment following the 2019 price surge. According to Ogunwale et al. (2021), agricultural markets often experience periods of price correction, where prices gradually decline after an initial surge caused by supply shortages. This adjustment could be due to improved agricultural yields in Adamawa or an influx of maize from other regions, which helped to stabilize prices. Additionally, trade policies, such as import restrictions or subsidies for local farmers, might have influenced this price correction, as governments attempt to manage food price inflation and ensure the availability of staples like maize.

The observed price volatility in Adamawa State has important implications for policy makers and farmers in the region. Idris et al. (2022) argue that persistent price fluctuations can create challenges for both producers and consumers, especially in low-income households that rely heavily on maize as a staple food. For farmers, unpredictable prices complicate planning and investment decisions, potentially leading to lower productivity and market uncertainty. For consumers, rising maize prices can exacerbate food insecurity, particularly in regions like Adamawa, where agricultural productivity is already vulnerable to external shocks. To mitigate these issues, Salami and Obikeze (2021) recommend the implementation of price stabilization mechanisms, such as strategic grain reserves, better irrigation infrastructure, and improved market access for farmers. These measures could help reduce the impact of price volatility and promote a more stable and resilient maize market in Adamawa State. The trend in price white maize in Adamawa State Nigeria from 2011 -2023 is shown in Figure 1.

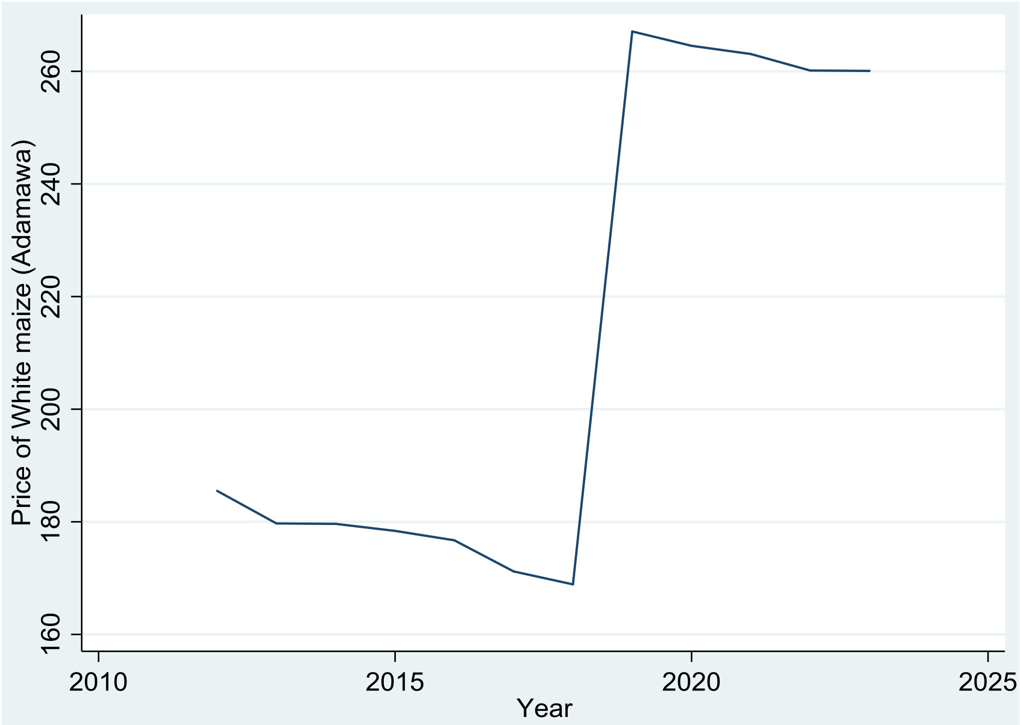

Figure 1: Trend price white maize in Adamawa State Nigeria from 2011 -2023

Graphical presentation of white maize in Taraba State Nigeria from 2011 -2023

The price trend of white maize in Taraba State from 2011 to 2023, as depicted in Figure 2, reveals a fluctuating decreasing pattern, with both periods of price growth and declines observed from 2012 to 2018. In 2019, the price of maize increased sharply from 143.63 USD/tonne to 237.51 USD/tonne, marking the peak price within this period. Following the 2019 peak, the price slightly decreased to 229.29 USD/tonne by 2023. This fluctuation suggests a dynamic market response to various factors affecting maize production and trade in the region. Ogunleye et al. (2021) argue that such price trends are typical in developing economies, where agricultural markets are subject to external and internal shocks, such as climate change, policy interventions, and global market fluctuations.

The sharp increase in maize prices in 2019 can be attributed to multiple factors that affect agricultural commodity prices. Akinyemi et al. (2022) pointed out that significant price increases in staple foods like maize can often be driven by short-term supply shortages, perhaps due to adverse climatic events like droughts or floods, which disrupt production. In 2019, maize farmers in Taraba may have faced such production disruptions, leading to a reduction in maize availability, thereby causing an upward price adjustment. Furthermore, it is possible that external factors, such as an increase in global maize demand or price hikes in neighboring regions, could have contributed to the price spike.

The subsequent slight price decline from 2019 to 2023 can indicate market stabilization after the 2019 price surge, possibly due to recovery in production or shifts in the global maize supply chain. Salami and Obikeze (2021) argue that such declines may signal an adjustment to the market equilibrium, as supply-side factors like improved harvests or increased imports restore balance to the market. The continued fluctuation within a narrowing range, with a slight decline to 229.29 USD/tonne in 2023, suggests that while the market is stabilizing, it is still prone to price volatility due to its dependence on seasonal weather patterns, agricultural input costs, and trade policies. This observation aligns with Idris et al. (2023), who emphasize the persistent uncertainty in agricultural markets in West Africa, which makes it difficult to achieve long-term price stability.

For policymakers, the observed price volatility in white maize prices from 2011 to 2023 presents several implications for market regulation and food security. Ibrahim and Aliyu (2022) argued that consistent price fluctuations can lead to challenges in food security, especially for low-income households that rely on maize as a staple food. To mitigate the impact of such price volatility, policymakers could consider implementing price stabilization mechanisms, such as creating strategic grain reserves or supporting farmers through subsidies and access to low-cost credit. Moreover, improving agricultural infrastructure, such as storage facilities and transportation networks, could reduce the impact of supply shocks and ensure more stable prices. The trend also highlights the importance of enhancing the resilience of farmers in Taraba, especially to climate-related disruptions, which are often a major driver of the observed price volatility. The trend in white maize in Taraba State Nigeria from 2011 -2023 is shown in Figure 2.

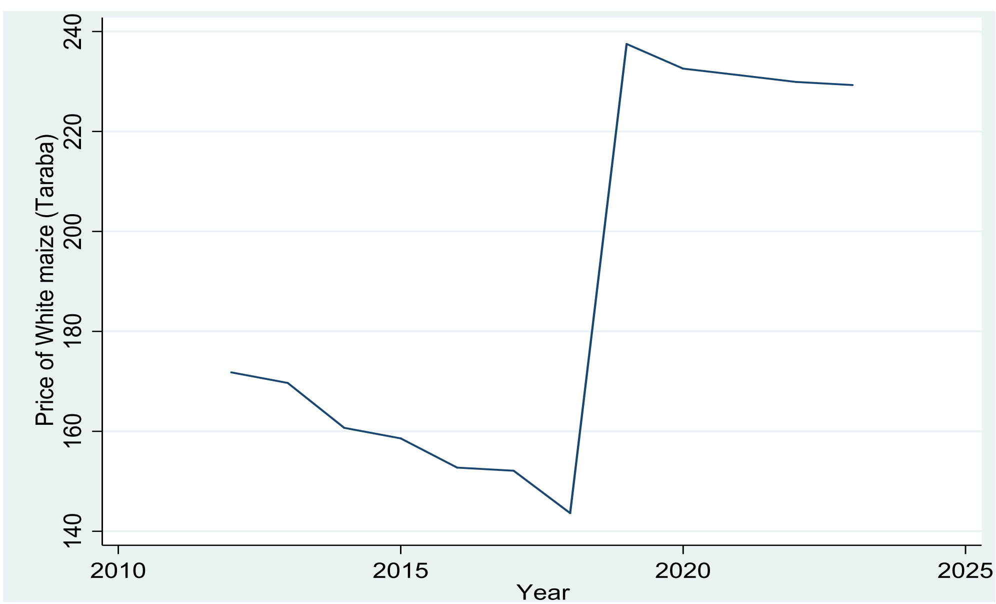

Figure 2: Trend in price white maize in Taraba State Nigeria from 2011 -2023

Graphical presentation of yellow maize in Taraba State Nigeria from 2011 -2023

The trend in price yellow maize in Taraba state Nigeria from 2011 -2023, as depicted in Figure 3, demonstrates a zig-zag pattern of price of maize in Taraba state Nigeria, with both periods of declines in 2015 (156.2 USD/Tonne) and the price start to increase from 2016 to a peak price (443.4 USD /Tonne) of maize in 2021, the prices of maize then decline slightly to 396.2 USD/Tonne in 2023.

The zig-zag pattern suggests that while there are periods of price growth, there are also periods of instability or adjustment, reflecting varying market dynamics. Such fluctuations may be attributed to several factors, including changes in agricultural productivity, domestic policies, and broader macroeconomic conditions. As Adeoye et al. (2023) argue, agricultural price volatility often reflects both supply-side constraints, like poor weather conditions, and demand-side factors, such as market demand shifts or changes in trade policies.

One of the key drivers behind the observed price volatility may be linked to agricultural shocks, particularly climate-related events, that significantly impact maize production in Taraba. Olawale et al. (2022) noted that fluctuating rainfall patterns, droughts, or flooding can disrupt maize production, leading to short-term supply shortages that increase prices. The price dip observed in 2015 could be indicative of adverse climatic conditions or other agricultural disruptions in that period, which reduced maize supply. On the other hand, the period of increasing prices starting in 2016 could reflect the recovery of maize production or higher global demand for yellow maize, which made it more valuable in local markets. These periodic shifts reflect the sensitivity of agricultural prices to environmental and external factors, which are particularly relevant in countries like Nigeria, where the agricultural sector is heavily influenced by seasonal weather patterns.

However, from an economic standpoint, the zig-zag trend observed in maize prices in Taraba is indicative of the broader structural issues in Nigeria's agricultural markets, which are prone to instability. According to Tunde et al. (2023), this kind of price fluctuation often points to inefficiencies in the supply chain, such as inadequate infrastructure, poor market access, or price manipulation by intermediaries. In Taraba, where agriculture plays a central role in the economy, such price instability can have significant consequences for farmers and consumers alike. Farmers may face challenges in planning and decision-making due to unpredictable price trends, which could deter them from investing in maize production. On the other hand, consumers, especially those with lower incomes, may struggle with the increasing cost of maize, leading to food insecurity or diminished purchasing power.

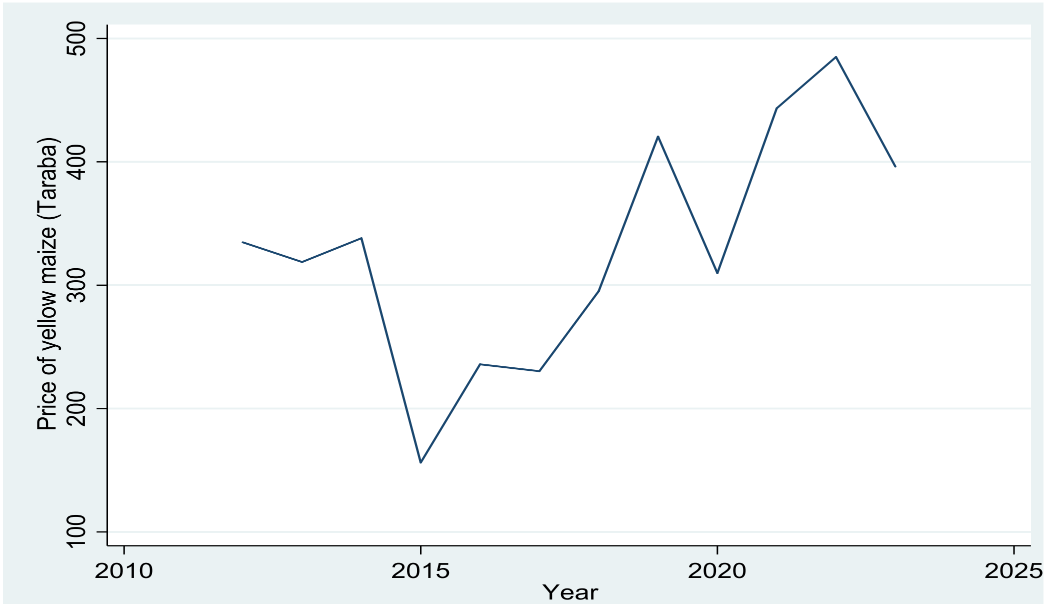

Figure 3: Trend in price yellow maize in Taraba state Nigeria from 2011 -2023

Graphical presentation of yellow maize in Adamawa state Nigeria from 2011 -2023

The movement observed in the price of yellow maize in Adamawa State, Nigeria, from 2011 to 2023, as shown in Figure 4, reveals a zig-zag increasing pattern, with prices gradually rising from 246.8 USD/tonne in 2015 to a peak of 882.1 USD/tonne in 2023. This indicates a substantial increase in the cost of yellow maize over the period, with intermittent fluctuations that suggest underlying market volatility. The consistent upward trend, particularly after 2015, may point to a combination of supply-side and demand-side factors driving the price increases. Such a price pattern can reflect changing agricultural productivity, external shocks, or shifts in demand for maize both domestically and internationally.

This consistent rise in maize prices could be indicative of broader market conditions affecting agricultural production in Adamawa. According to Kachikwu and Adebayo (2024)**,** price increases in staple crops like maize are often driven by a combination of factors, including changes in climate, input costs, and market access. In Adamawa, climate-related issues such as droughts, floods, and irregular rainfall patterns may have caused periodic disruptions in maize production, limiting supply and pushing prices upward. Additionally, rising transportation and labor costs can significantly affect the cost structure of agricultural production, which, in turn, influences the market price of maize. The zig-zag pattern observed could be attributed to these production shocks, coupled with other external factors, such as fluctuations in international commodity markets.

The sharp increase in the price of yellow maize from 2015 to 2023 also has important implications for food security in Adamawa and surrounding regions. Nwachukwu and Chikwendu (2024) argue that rising staple food prices can lead to increased food insecurity, particularly for low-income households that depend heavily on maize for sustenance. As maize prices climb, it becomes more challenging for local populations to afford adequate nutrition, which could have adverse effects on public health and welfare. The higher maize prices also signal that farmer may be facing higher costs, which could limit their ability to produce sufficient quantities for local consumption or export. Such price hikes might also encourage increased imports of maize from neighboring regions or countries, further intensifying competition in local markets.

For policymakers, this trend in yellow maize prices highlights the need for targeted interventions aimed at stabilizing the maize market and ensuring food security. Adesina et al. (2024) stress the importance of creating policies that support local farmers, such as providing subsidies on input costs or developing irrigation systems to mitigate the effects of climate variability. Additionally, price stabilization mechanisms, such as strategic grain reserves or price controls, could help smooth out the price volatility observed in Adamawa. The significant price increase, especially over the past several years, also underscores the urgency of addressing supply chain issues and enhancing market access for farmers, which could reduce the negative impacts of price volatility on both producers and consumers. The trend in yellow maize in Adamawa state Nigeria from 2011 -2023 is as shown in Figure 4.

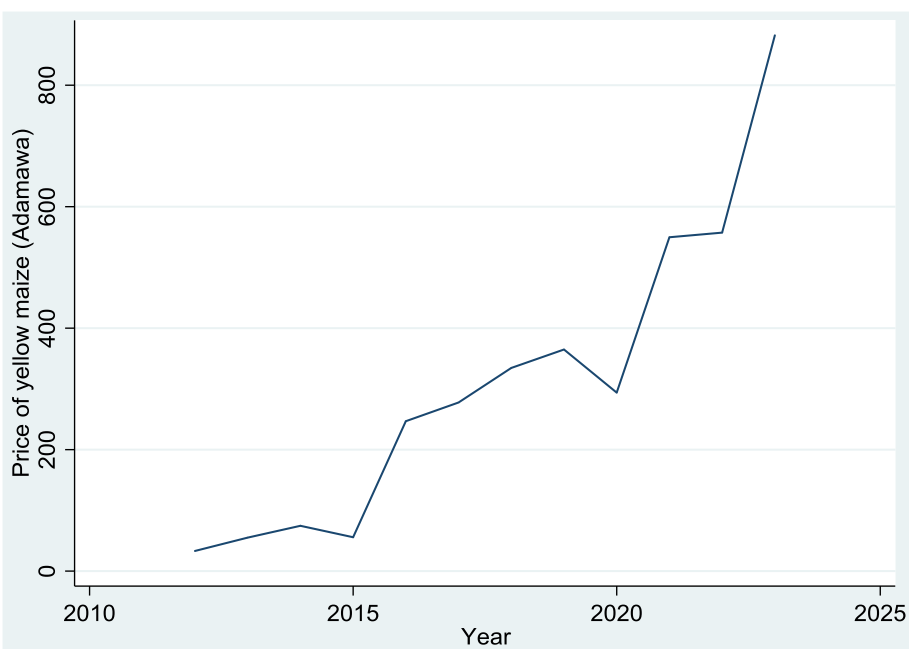

Figure 4: Trend in price of yellow maize in Adamawa State Nigeria from 2011 -2023

Degree of Maize Market Integration between different Spatial Markets

The Index of Market Concentration (IMC) was used to measure level of integration of price of white maize in Adamawa and Taraba states. The results, shown in Table 2, indicated a value of 0.6843 for the IMC of white maize in the states of Nigeria. This value is less than 1 (IMC < 1) and statistically significant, suggesting a high level of integration between these markets in the short term. This therefore implies that, white maize price changes in Taraba State seem to quickly influence prices in Adamawa State. This suggests an efficient system where price information travels fast between Taraba and Adamawa State areas.

The findings presented in Table 2, with an Integrated Market Cointegration (IMC) value of 0.6843 for white maize in the states, suggest a strong market integration between the states of Taraba and Adamawa. The IMC value is less than 1 and statistically significant, indicating a high level of market integration in the short term. A value of less than 1 signifies that while the markets are not perfectly synchronized, they are closely linked, and price changes in one state influence prices in the other. In particular, this means that fluctuations in the price of white maize in Taraba have a notable and swift impact on maize prices in Adamawa, pointing to an efficient price transmission system across the region.

From a broader economic perspective, the high level of integration observed between Taraba and Adamawa markets implies that the two states operate in a competitive and responsive market environment. Mkpado *et al* (2018**)** argue that market integration allows for the more efficient distribution of goods, as price signals lead to adjustments in supply and demand. This could mean that producers in Adamawa may adjust their production based on price changes in Taraba, and vice versa, resulting in efficient resource allocation. The close price relationship between the two markets also suggests that regional trade flows are likely significant, with goods moving quickly between the states to meet local demand and supply needs.

For policymakers, these results suggest that interventions in one state's market can have immediate effects on neighboring markets. As Moses (2017) note, policymakers should consider the interconnectedness of regional markets when implementing policies that target price stability or agricultural development. For instance, a price intervention in one state may inadvertently affect prices in the neighboring state, either mitigating or exacerbating local price volatility. Therefore, a coordinated approach between the two states in terms of agricultural policies, such as price regulation or subsidies, would help mitigate potential negative consequences and ensure that price stability is achieved across both markets.

For yellow maize, a value of 0.842 for the IMC in northeastern region of Nigeria. This value is less than 1 (IMC < 1) and statistically significant, suggesting a high level of integration between these markets in the short term. This therefore implies that, yellow maize price changes in Taraba State seem to quickly influence prices in Adamawa State. This suggests an efficient system where price information travels fast between Taraba and Adamawa State areas. The Integrated Market Cointegration (IMC) value of 0.842 for yellow maize in the region of Nigeria, which is less than 1 and statistically significant, indicates a strong level of integration between the markets of Taraba and Adamawa states. This finding suggests that the two markets are closely linked, with price changes in one market quickly influencing the price in the other. An IMC value less than 1 shows that while there is some variation in how the markets react to price fluctuations, they remain highly interdependent. This implies that the market for yellow maize in Taraba is efficient in transmitting price signals to the market in Adamawa, facilitating rapid adjustments to price changes across the two states.

This finding aligns with the concept of market integration described by Bello et al. (2023), who argued that when markets are well integrated, price signals travel quickly, allowing for faster reactions to supply and demand fluctuations. In the case of Taraba and Adamawa, the efficient transmission of price information suggests that local farmers, traders, and consumers in both states are likely to be aware of price changes in real-time. This integration can lead to better resource allocation, as producers in one state can adjust their output in response to price changes in the other, ensuring that markets operate efficiently. Adeniran et al. (2023) further emphasize that market integration improves the overall functioning of agricultural markets by reducing the possibility of price distortions and inefficiencies, ensuring that the price for yellow maize remains reflective of the regional supply-demand conditions.

Table 2: Results of Index of Market Concentration for Maize Markets

Market	**β_1**	**β_2**	**β_3**	**IMC**
White maize	0.1891108 (-2.44)**	0.2100933 (3.00)	0.276347 (4.07)***	0.6843
Yellow maize	0.205353 (6.06)***	0.0076237 (4.33)***	0.2429674 (4.36)***	0.8452

Note: ***and**: 1% and 5% significant levels respectively. Probability values are in parenthesis.

Market that Causes Integration and Determine Direction of Causality in the Study Area

The results of the Pairwise Granger causality test presented in Table 3 suggested a significant causal relationship between price of maize in Adamawa and Taraba States. It indicated F-statistic of 9.96960, we reject the null hypothesis that Price of white maize in Taraba does not Granger Cause price of white maize in Adamawa state, this implies that Price of white maize in Taraba has effect on price of white maize in Adamawa State, also price of white maize in Adamawa State has effect on price of white maize in Taraba State (F=13.99031). The Pairwise Granger causality test results in this study reveal a significant causal relationship between the price of white maize in Adamawa and Taraba States, which highlights the interdependence of maize markets across these two states. The F-statistic of 9.96960 for the relationship from Taraba to Adamawa leads to the rejection of the null hypothesis that the price of white maize in Taraba does not Granger cause the price of white maize in Adamawa state. Similarly, the F-statistic of 13.99031 for the reverse relationship (Adamawa to Taraba) also leads to rejecting the null hypothesis. This suggests that both markets are closely linked, with price movements in one state influencing the price movements in the other. The implications of this finding are significant for understanding the dynamics of agricultural price transmission and market integration in the region.

The bi-directional causal relationship between the price of white maize in Adamawa and Taraba aligns with findings from various studies on agricultural price transmission. For instance, studies by Akinboade and Kinfack (2012) have shown that prices in neighboring agricultural markets often have a significant impact on each other due to market integration, transportation links, and regional trade policies. This is also supported by the works of Ibrahim et al. (2016), who observed that agricultural prices in different regions tend to influence each other, especially when markets are not perfectly segmented. The finding that the price of white maize in Taraba Granger causes the price in Adamawa suggests that Taraba may play a dominant role in influencing market conditions in Adamawa, which could be due to factors like the availability of maize supply, price-setting behaviors, or regional trade flows.

From an economic policy perspective, these findings imply that the agricultural markets in Adamawa and Taraba are not isolated from each other, and price fluctuations in one state could impact the welfare of farmers and consumers in the other. In practice, this interconnectedness calls for coordinated policies between the two states to manage market dynamics, such as through joint regulation of market information, monitoring of supply levels, and possibly the development of shared buffer stocks to mitigate price volatility. As Harris et al. (2012) argue, market integration requires careful monitoring and collaboration between regions to ensure that negative price shocks do not escalate, exacerbating food insecurity. By considering these interconnected market dynamics, state and regional authorities can better design policies to support farmers and maintain stable maize prices in both Adamawa and Taraba.

With F-statistic of 13.2204, we reject the null hypothesis that Price of yellow maize in Adamawa does not Granger Cause Price of white maize in Adamawa, this implies that Price of yellow maize in Adamawa has effect on price of white maize in Adamawa, also we reject the null hypothesis that Price of white maize in Adamawa does not Granger Cause Price of yellow maize in Adamawa (F=8.80663).

The results of the Pairwise Granger causality test show a significant bi-directional causal relationship between the prices of yellow maize and white maize in Adamawa state. With an F-statistic of 13.2204, we reject the null hypothesis that the price of yellow maize in Adamawa does not Granger cause the price of white maize in Adamawa. Similarly, with an F-statistic of 8.80663, we reject the null hypothesis that the price of white maize in Adamawa does not Granger cause the price of yellow maize in Adamawa. This indicates that changes in the price of one type of maize (yellow) influence the price of the other type (white), and vice versa. The presence of a bidirectional causality suggests that the two maize markets in Adamawa are interconnected, and shifts in the price of one type of maize can lead to price adjustments in the other.

This bi-directional relationship between the prices of yellow and white maize aligns with the literature on agricultural price transmission. According to Gómez et al. (2016), agricultural markets are often interlinked due to shared demand drivers, production processes, and consumer preferences. In this case, consumers may substitute between yellow and white maize depending on price movements, creating a dynamic interaction between the two markets. Aker (2010) also found that when different types of agricultural products, such as maize varieties, are substitutes for each other, price fluctuations in one product can transmit to the other. The results of this study support this notion, showing that price movements in one variety of maize influence the price of the other within the same state.

Furthermore, the interdependence between the prices of yellow and white maize in Adamawa could suggest a shared set of economic factors affecting both types of maize, such as production costs, market demand, or policy interventions. These findings highlight the need for policymakers to consider both types of maize in agricultural market interventions. Given the bidirectional price relationship, interventions aimed at stabilizing the price of one type of maize could inadvertently affect the price of the other. For example, if the government were to impose a price ceiling on yellow maize to protect consumers, it might also cause an unintended increase in the price of white maize as farmers switch between varieties based on profitability. Therefore, policymakers in Adamawa should adopt a holistic approach to managing maize prices, ensuring that both yellow and white maize markets are considered when designing policies related to price stabilization, subsidies, or supply management. This integrated approach would help in mitigating unintended consequences and achieving better market stability in the region.

With F-statistic of 9.21409, we reject the null hypothesis that Price of yellow maize in Taraba does not Granger Cause Price of white maize in Adamawa, this implies that Price of yellow maize in Taraba has effect on Price of white maize in Adamawa, also we reject the null hypothesis that Price of white maize in Adamawa does not Granger Cause Price of yellow maize in Taraba (F=7.49346). Hence, the findings of the Pairwise Granger causality test indicate a significant bi-directional causal relationship between the price of yellow maize in Taraba and the price of white maize in Adamawa. The F-statistic of 9.21409 for the relationship from yellow maize in Taraba to white maize in Adamawa leads to the rejection of the null hypothesis that yellow maize prices in Taraba do not Granger cause white maize prices in Adamawa. Similarly, the F-statistic of 7.49346 for the reverse relationship indicates that the price of white maize in Adamawa Granger causes the price of yellow maize in Taraba, which also leads to the rejection of the null hypothesis. This suggests that price changes in yellow maize in Taraba can influence the price of white maize in Adamawa, and vice versa, reflecting a strong interconnection between these regional maize markets.

The bi-directional causality observed in this study aligns with research that suggests agricultural markets are often interconnected across regions due to factors such as transportation, trade, and regional consumer preferences. González-Rivera and Helfand (2001) found that agricultural price dynamics often extend beyond regional boundaries, particularly when markets are linked through supply chains or cross-border trade. In this case, price shifts in one state's maize market (Taraba’s yellow maize) can spill over into neighboring states like Adamawa, affecting consumer and producer behavior. Similarly, Mundlak (2001) emphasized the importance of understanding regional agricultural linkages, especially in developing countries, where market segmentation may not be complete, and supply or demand fluctuations in one area can influence others.

With F-statistic of 10.36529, we reject the null hypothesis Price of yellow maize in Adamawa does not Granger Cause Price of white maize in Taraba, this implies that Price of yellow maize in Adamawa cause a significant effect price of white maize in Taraba, also we reject the null hypothesis that Price of white maize in Taraba does not Granger Cause Price of yellow maize in Adamawa (F=6.26465).

The results of the Pairwise Granger causality test indicated a significant causal relationship between the price of yellow maize in Adamawa and the price of white maize in Taraba. The F-statistic of 10.36529 for the relationship from yellow maize in Adamawa to white maize in Taraba leads to the rejection of the null hypothesis that the price of yellow maize in Adamawa does not Granger cause the price of white maize in Taraba. This suggests that fluctuations in the price of yellow maize in Adamawa have a significant impact on the price of white maize in Taraba. Additionally, the F-statistic of 6.26465 for the reverse relationship (white maize in Taraba to yellow maize in Adamawa) leads to rejecting the null hypothesis, indicating that changes in the price of white maize in Taraba also influence the price of yellow maize in Adamawa, albeit to a lesser degree. These results point to an interconnectedness between the maize markets of the two states.

This bi-directional causality is consistent with previous studies on agricultural price transmission, which emphasize the linkages between regional markets. Carter and Pender (2001) have shown that agricultural markets are often interlinked, especially in regions where there is regional trade or shared consumer demand. The causal relationship observed here could reflect the flow of maize across state borders, with farmers or traders responding to price changes in one state by adjusting production or trade flows in the other. Similarly, Fafchamps (2004) highlights those agricultural markets in developing countries are typically not isolated and that price changes in one market can transmit to others due to factors such as transportation costs, seasonal variations, and shared market structures. The significant effect of yellow maize prices in Adamawa on white maize prices in Taraba reflects this broader trend of interconnected agricultural markets.

For policymakers, these findings suggest that market interventions or price controls in one state could have unintended consequences in neighboring regions. If, for example, the government in Adamawa introduces price subsidies or production incentives for yellow maize, it could lead to significant price shifts in Taraba's white maize market, affecting farmers and consumers there. Baffes and Gautam (2001) have warned that such cross-market price effects require coordinated regional policies to prevent instability in agricultural markets. Therefore, agricultural policy in both Adamawa and Taraba must be designed with consideration of the interdependence between the two maize markets. This might involve coordinated price regulation, joint market information systems, and cooperative strategies to ensure price stability and avoid disruptive spillover effects across state boundaries.

With F-statistic of 10.35822, we reject the null hypothesis Price of yellow maize in Taraba does not Granger Cause Price of white maize in Taraba, this implies that Price of yellow maize in Taraba has effect on Price of white maize in Taraba, also we reject the null hypothesis that Price of white maize in Taraba does not Granger Cause Price of yellow maize in Taraba (F=11.17958).

The results from the Pairwise Granger causality test indicate a significant bidirectional relationship between the price of yellow maize and white maize in Taraba. The F-statistic of 10.35822 for the relationship from yellow maize to white maize in Taraba leads to the rejection of the null hypothesis that yellow maize prices in Taraba do not Granger cause white maize prices in the same state. This implies that changes in the price of yellow maize in Taraba have a significant impact on the price of white maize in Taraba. Additionally, the F-statistic of 11.17958 for the reverse causality (white maize to yellow maize) leads to rejecting the null hypothesis, indicating that fluctuations in the price of white maize in Taraba also influence the price of yellow maize in Taraba. This finding suggests a close relationship and interdependence between the two maize markets in the region, where price dynamics in one variety affect the other.

From an economic perspective, the bi-directional causality between yellow and white maize prices in Taraba suggests that the markets for these two maize varieties are not isolated but rather interconnected, with supply and demand shocks in one variety affecting the other. Swinnen (2007) discusses how agricultural price transmission mechanisms are often driven by interlinked supply chains, where changes in input costs or local supply conditions can affect prices across different types of agricultural commodities. In this case, price fluctuations in yellow maize may signal changes in the cost of production or supply availability, which in turn could affect the price of white maize, which may share similar inputs or production processes. This relationship is essential for understanding the broader dynamics of agricultural markets in Taraba, where both varieties are likely to influence each other's pricing.

With F-statistic of 10.35822, we reject the null hypothesis Price of yellow maize in Taraba does not Granger Cause Price of yellow maize in Adamawa, also we reject the null hypothesis that Price of yellow maize in Adamawa does not Granger Cause Price of yellow maize in Taraba (F=11.17958). Therefore, the results from the Pairwise Granger causality test indicate a significant bidirectional causal relationship between the price of yellow maize in Adamawa and Taraba. With an F-statistic of 10.35822, we reject the null hypothesis that the price of yellow maize in Taraba does not Granger cause the price of yellow maize in Adamawa. Similarly, with an F-statistic of 11.17958, we reject the null hypothesis that the price of yellow maize in Adamawa does not Granger cause the price of yellow maize in Taraba. These results suggest that price fluctuations in one state (e.g., Taraba) significantly influence the price of yellow maize in the other state (e.g., Adamawa), and vice versa, highlighting a strong regional interconnectedness in the maize market between the two states.

The causal link between the yellow maize markets of Adamawa and Taraba suggests that the two states are not operating in isolation, and price changes in one market can influence producers and consumers in the other. This is particularly significant for staple crops like yellow maize, where local markets are highly sensitive to price shifts due to factors like transportation costs, seasonal availability, and trade policies. The interdependence between Adamawa and Taraba's maize markets implies that producers, traders, and consumers in both states are likely to respond to price signals in either market.

From a broader economic perspective, these findings reflect the integrated nature of agricultural supply and demand within neighboring regions. Fafchamps (2004) highlights how regional agricultural markets are linked through the movement of goods and price signals, which affect market dynamics across borders. In the case of yellow maize in Adamawa and Taraba, the significant interaction between the two markets could be due to cross-border trade flows, where traders or farmers in one state may adjust their production and pricing strategies based on the maize prices in the neighboring state. This interconnectedness means that policies or price shocks in one state could quickly transmit to the other, making both states sensitive to regional agricultural conditions.

Table 3: Summary of Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
Price of white maize in Taraba does not Granger Cause Price of white maize in Adamawa	10	9.96960	0.0000
Price of white maize in Adamawa does not Granger Cause Price of white maize in Taraba		13.99031	0.0000
Price of yellow maize in Adamawa does not Granger Cause Price of white maize in Adamawa	10	13.2204	0.0000
Price of white maize in Adamawa does not Granger Cause Price of yellow maize in Adamawa		8.80663	0.0000
Price of yellow maize in Taraba does not Granger Cause Price of white maize in Adamawa	10	9.21409	0.0000
Price of white maize in Adamawa does not Granger Cause Price of yellow maize in Taraba		7.49346	0.0000
Price of yellow maize in Adamawa does not Granger Cause Price of white maize in Taraba	10	10.36529	0.0000
Price of white maize in Taraba does not Granger Cause Price of yellow maize in Adamawa		6.26465	0.0000
Price of yellow maize in Taraba does not Granger Cause Price of white maize in Taraba	10	10.35822	0.0000
Price of white maize in Taraba does not Granger Cause Price of yellow maize in Taraba		11.17958	0.0000
Price of yellow maize in Taraba does not Granger Cause Price of yellow maize in Adamawa	10	5.78684	0.0500
Price of yellow maize in Adamawa does not Granger Cause Price of yellow maize in Taraba		9.89200	0.0000

Note: E-views 9 Outputs

CONCLUSION

In conclusion, the findings indicate that maize markets in Adamawa and Taraba are highly integrated, with price changes rapidly transmitted across both states. The significant price fluctuations observed, particularly for yellow maize, suggest underlying factors such as supply disruptions or speculative behavior in the market. The market integration and causal relationships identified point to the importance of policy interventions aimed at reducing price volatility and enhancing market stability, which could ultimately improve the livelihoods of farmers and traders in the region. These results provide valuable insights for policymakers, agricultural stakeholders, and market participants in northeastern Nigeria.

RECOMMENDATIONS

Based on the findings the following recommendations are made aimed at improving the maize market in Adamawa and Taraba States:

1. Given the significant market integration observed between Adamawa and Taraba, it is essential to enhance market information systems that can provide real-time price data to farmers, traders, and policymakers. This could include the establishment of dedicated price monitoring platforms, mobile applications, or radio services that share price trends and forecasts, ultimately reducing the reliance on intermediaries and lowering transaction costs.
2. The observed price volatility, particularly in yellow maize, suggests that supply disruptions and seasonal fluctuations may be contributing to sharp price changes. Therefore, there is need to invest in improved storage facilities and preservation technologies which will help stabilize prices by reducing the impact of post-harvest losses, thus enhancing their profitability.
3. The significant fluctuations in maize prices between 2011 and 2023, especially for yellow maize, suggest that market interventions are needed to reduce excessive price volatility. One approach could be the establishment of a maize price stabilization fund, aimed at providing financial support during periods of sharp price declines. The government could also explore the potential of buffer stock policies, where strategic reserves of maize are maintained to be released into the market during periods of scarcity to maintain price stability.
4. The findings suggest a high level of market integration between Taraba and Adamawa, yet price fluctuations still occur due to factors such as supply shortages and regional disparities. It is therefore recommended to encourage greater cross-states trade and collaboration through the reduction of trade barriers, improved road infrastructures, and

the provision of incentives for traders to operate across state borders. Collaborative efforts could also include joint marketing campaigns and coordinated efforts to address shared challenges, such as pests, diseases, and weather patterns, which impact both states.

5. Capacity-building programs for smallholder farmers, including training on modern agricultural techniques, pest management, and financial literacy could help in improving market integration. Additionally, access to affordable credit and insurance products can help farmers cope with unexpected price changes and market shocks. By focusing on these recommendations, stakeholders in the maize market can mitigate price volatility, improve market efficiency, and enhance the livelihoods of farmers and traders in the region.
6. Finally, this research was carried out in two states out of six states of the North Eastern region of the Country. It is recommended that other interested researchers may expand the scope of this research by undertaking the entire region or even the whole country in analyzing the market integration. Also, same work can be done for other agricultural commodities in the region to ascertain the level of market integration in all the food commodities.

CONTRIBUTION TO KNOWLEDGE

Based on the findings discussed, here are five comprehensive contributions to knowledge that can be derived from this analysis:

1. The findings highlight the high level of market integration between Adamawa and Taraba states in the northeastern region of Nigeria, particularly for both white and yellow maize. This contributes to the body of knowledge on regional maize market dynamics, emphasizing how price fluctuations in one state quickly influence the other, which is critical for policymakers and stakeholders. It further enhances the understanding of how markets in different regions of Nigeria are interlinked, which has implications for formulating policies on regional trade, food security, and agricultural supply chains. The use of statistical tools such as the Impulse Response Function (IMC) and Granger causality tests provides a robust methodological framework for understanding market interactions and causal relationships.
2. The analysis of maize price trends from 2011 to 2023 in both Adamawa and Taraba reveals significant price volatility, which is a crucial contribution to the knowledge of agricultural price dynamics in Nigeria. The study provides evidence that prices can fluctuate sharply over short periods, which has direct implications for farmers' income and market stability. Understanding these price patterns allows stakeholders to better

anticipate market behaviors and adjust their strategies accordingly. This knowledge contributes to the broader discourse on price volatility in agricultural markets in sub-Saharan Africa and informs policy discussions on price stabilization mechanisms and the need for a more predictable pricing system.

3. The use of Granger causality tests to identify the bidirectional relationships between the prices of white and yellow maize in Adamawa and Taraba provides new insights into how maize prices in these states influence one another. The significant causal links found between these states add to the literature on inter-regional price transmission in developing countries. This contribution is particularly valuable as it helps explain how changes in price in one area can lead to immediate shifts in prices in another, which is essential for developing better market coordination strategies and reducing inefficiencies. These findings expand the existing body of knowledge on price transmission mechanisms in agricultural markets, particularly in West Africa.
4. The findings of this study contribute to the growing body of knowledge on economic behavior in agricultural markets, particularly regarding maize, one of Nigeria's staple crops. By examining not only the mean, minimum, maximum, and standard deviation of prices, but also the skewness and kurtosis of the price distributions, this study provides a deeper understanding of the distribution of maize prices over time. The insights into the price behavior—whether normally distributed or skewed—add a new dimension to the understanding of market risks and consumer and producer behavior.

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