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### Tempo-Spatial Price Analysis of Factors Affecting Processing Performance of Fresh Tomato in Kano State, Nigeria

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#### Abstract

The study analyzed the tempo-spatial price analysis of factors affecting processing performance of fresh tomato in Kano State, Nigeria. Supply chain actors were sampled through a multi-stage sampling procedure. The overall sample size for the entire study was 808 drawn from four Local Governments, consisting of 101 selected from cluster. Semi-structured questionnaires were used to obtain the required information to answer the research questions for the study. Results showed limited participation of women in the supply chain, as most of the wholesalers and retailers were male represented by (97.3%). The results further show that the majority (87.2%) were married, it could be deduced that (53.0%) of tomato farmers in the study area attended at least primary schools with only a few (4%) of the marketers that have attended tertiary institutions. The results from processing performance shows that, 1 ton (1000Kg) of tomato paste requires about 8 tons of fresh tomatoes (8000Kg) which costs a processor N320,000. This cost of raw materials constitutes about 63% of the total processing cost by the processor. Water has the least cost N 25550 which is about 5% of the total cost followed by depreciation on equipment which represent about 6% of the total cost processing. Fuel and Electricity costs constitute about 14% and 12% of the total processing costs, respectively.

Moreover, the results revealed that an average price of 1 ton of tomato paste is N 725,000. Meanwhile, the processing margin per 1 ton of paste is about N215,000. The results show that the F-statistic which measures how the variables included in the model jointly explained the dependent variable was found to be significant at 1% and the R-square value which measures the overall contribution of the independent variables was found to be 69.6%, implying that 69.6% of the profit margin earned by the processor was due to the variables included in the regression model. The result of the factors influencing the profit margin earned by tomato processors show that, the F-statistic which measures how the variables included in the model jointly explained the dependent variable was found to be significant at 1% and the R-square value which measures the overall contribution of the independent variables was found to be 69.6%, implying that 69.6% of the profit margin earned by the processor was due to the variables included in the regression model. It further revealed that 80% of the variables included in the model were significant. Finally, this study recommended that; female participation should be encouraged to maintain gender balance, producers should observe vigilant supervision during harvesting of tomatoes, all actors should adopt the use of plastic crates.

**Keywords:** Tempo-Spatial Price, Tomato, Nigeria

#### Introduction

Tomato (*Solanumlyco persicum*) is among the major vegetable crops grown in most parts of the world contributing significantly to the income and nutritive security of the majority of the households (Ayoola, 2014)<sup>[1]</sup>. The demand for tomatoes in Nigeria is currently estimated at 2.3 million metric tons per annum (Umar, 2017), and estimated output of 1.8 million metric tons, of which 50% of the estimated output cannot make it to market, it is lost to postharvest losses. These losses are not unconnected with the poor handling, processing, and preservation practices leading to the excess demand gap (Central Bank of Nigeria [CBN], 2021). In the same vein, the Federal Ministry of Agriculture and Rural Development (FMA&RD) 2014<sup>[3]</sup> reported that about 105, 000 metric tons of tomato paste valued at about 16 billion naira are imported annually to bridge the demand gap, as tomatoes account for about 18% of the average daily consumption of vegetables in Nigeria.

Currently, in Nigeria the major value chain segment that has attracted the attention of all concerned stakeholders is processing, to arrest post-harvest losses by value addition and create more job opportunities. There was a lot of financial commitment from private investors in joining the fresh tomato value chain flat form for example in 2015 Dangote foundation established a \$21 million processing plant, the biggest ever in Nigeria, and become a monopsony in the country. In 2016, the price of tomatoes

skyrocketed by 400% within three months, as Tuta Absoluta commonly known as Tomato Ebola destroyed the annual harvest, affecting tomato farms across Kaduna, Kano, Katsina, Jigawa, and Plateau states. Despite the fact that Nigeria is the 16th largest producer of tomatoes in the world and the largest producer of tomatoes in Sub-Saharan Africa, the traders and processing companies were compelled to import tomatoes from neighboring Chad, Burkina-Faso, and Cameroon. This situation has lowered the risk-bearing abilities of a lot of private investors. Thus, evaluating the existing processing practices, postharvest handling, and investigating the factors affecting these processes will enhance the functioning of all actors along the value chain.

### Material and methods

The study was carried out in Kano State, Nigeria.

### Sampling method

Multistage sampling technique was adopted for the selection of tomato farmers in this study. In the first stage Wudil, Kura, Garun mallam, Bunkure, and Rano were purposively selected being one of the major producers of tomatoes in the state. In the second stage two (2) production clusters with high concentration of tomato production from each of the selected Local Government Areas were selected. In the third stage of 101 respondents from each selected cluster to come up with a population of 808 respondents. The list of Association registered membership was used as a sample frame and where the list is not available; the sample frame was developed with the aid of community leadership.

### Analytical tools

The tools of analysis used for this study are: Descriptive statistics, Processing margin analysis, Linear regression model and Cointegration test.

### Descriptive statistics

Descriptive statistics tools such as percentages, mean, standard deviation, and frequency were used to visualize and describe the socio-economic characteristics of the respondents'.

$$x = \frac{\sum x_i}{\sum f} \quad (1)$$

$$\delta = \sqrt{\left\{ \frac{\sum x^2}{n} - \left( \frac{\sum x}{n} \right)^2 \right\} / n - 1}, \quad (2)$$

$$\% = \frac{f}{\sum f} \times 100 \quad (3)$$

### Processing Margin

The Net Processing Income model was used to determine the performance of tomato processing. The model is specified below;

$$NPI = TR - (TFC + TVC) \quad (4)$$

where NPI is Net Processing Income, TR is Total Revenue, TFC is Total Fixed Cost and TVC is Total Variable Cost

### Linear regression model

This model was used to determine the factors influencing the processing margin of processed tomatoes as specified below;

$$Y_i = \beta_0 + \beta_1 \text{ fresh tomato price} + \beta_2 \text{ transport cost} + \beta_3 \text{ socioeconomic characteristics} + \beta_4 \text{ quantity supplied} + \mu_i \quad (5)$$

### Cointegration Test

This is used to determine the spatial price variation. It allows the identification of both the degree of integration and its direction between the two markets. While measure the fresh tomato price difference between pairs of markets standard statistical tests such as T-test that compare the price of two markets is misleading and will not allow conducting explicit tests of the significance of parameters.

Let  $P_{it}$  denotes the Price of the commodity under consideration at time  $t$  and location  $i$ . In order to study the interdependence of prices in the study area between any pair of markets  $i$  and  $j$ , extermination is suggested by (Singhi and Dammissa, 2014). The linear relationship between prices in the two markets  $i$  and  $j$  is given by the equation below;

$$P_{it} = \alpha + \beta P_{jt} + \mu t \quad (1)$$

However, since the price series are generally non-stationary, this relationship has interest only if the error term  $\mu t$  is stationary, implying that price changes in the market  $i$  do not drift far apart in the long run from market  $j$ . When  $\mu t$  is stationary, the two series are said to be co-integrated. Thus, each price series in the four locations were examined for stationarity (unit root test or Augmented Dicky Fuller test). Where the price is non-stationary, we take the first difference as follows;

$$k = n, \Delta P_{it} = \alpha_0 + \alpha_1 P_{it-1} + \sum \alpha_k + \Delta P_{it} + E_{it} \quad (2)$$

$$k = 1$$

Where  $\Delta$  refers to the difference operator, that is  $X_t = X_t - X_{t-1}$ . For each variable  $X$ , the null hypothesis is that the series  $P_{i-1}$  is integrated of order 1 and the alternative is that the series is of order 0. If  $t$  statistics for the coefficient is greater in absolute value than a critical value given by the ADF critical value, then the null hypothesis is rejected and the alternative hypothesis of stationery is accepted. If the null hypothesis is not rejected, then one must test whether the series is of order of integration higher than just 1, possibly of order 2. In this case the same regression equation (1) is applied to the second differences  $\Delta^2 P_{it}$ ,  $t = \Delta(P_{it})$ . In the second step, the residual  $U_{it}$ ,  $t$  of the OLS regression (1) between the two series is again tested for stationarity, with the ADF test. If the first step results in two non-stationary series, both integrated of order 1 and the second step results in a stationary error term, then the two series are said to be cointegrated of 1,1. The presence of cointegration is indicative of interdependence between the two series.

### Results and discussion

#### Results of Socio-economic Characteristics of Fresh Tomato Farmers

The results presented in Table 3 show that majority (97.3%) of fresh tomato retail marketers in the study area were male. while 2.7% of tomato farmers were female which is closely related to the work of Haruna *et. al.*, (2018) who reported that male was dominant (88%) in the marketing of fresh tomato in Bauchi Metropolis Local Government Areas. The results further show that the majority (87.2%) of tomato

farmers in the study area were married which shows some level of responsibility among farmers in the study area and this is closely related to the findings of Gaurav (2017). It further indicates that 27.1% of tomato farmers attended primary school, 21.5% attended secondary school, 4% attended tertiary institutions, and marketers that attended informal schools constituted 47% of the total farmers. Moreover, the results show that an average farmer in the study area aged 39.6 years. The study further revealed that the population of the youngest farmers (64%) in the first three age groups that were either youths or adults within their productive age bracket is greater than that of the old (36%) in the last two age groups. This could mean that tomato farming may not suffer deflation of resources in the long run (*ceteris paribus*). This is in line with the findings of Wongnaa (2014) who reported the majority (33%) of tomato farmers in Benue State were within their productive age. The household in the study area has 10 members, minimum of 1 and maximum of 46 members. Researchers in various fields of agricultural economics have identified experience as the major factor that increases performance and profit/income. The results show that on average the tomato farmers in the study area have experience of 15. This is closely related to the findings of Adeoye *et. al.* (2019) [2] who reported about (50%) of the retail marketers in Ughelli Local Government Area of Delta State fell within the experience age group of 6-10 years.

**Results of Processing Performance Based on Quantity of Tomato Supplied by Farmers**

Table 1 presents the results of the processing margin of 1 tone of tomato paste. The results show that 1 ton (1000Kg) of tomato paste requires about 8 tons of fresh tomatoes (8000Kg) which costs a processor N320,000. This cost of raw materials constitutes about 63% of the total processing cost by the processor. Water has the least cost N 25550 which is about 5% of the total cost followed by depreciation on equipment which represent about 6% of the total cost processing. Fuel and Electricity costs constitute about 14% and 12% of the total processing costs, respectively. Moreover, the results revealed that an average price of 1 ton of tomato paste is N 725,000. Meanwhile, the processing margin per 1 ton of paste is about N215,000.

**Table 1:** Socioeconomic Characteristics of Fresh Tomato Farmers

Socioeconomic Variable	Frequency	Percentage	Min	Max	Mean
Sex					
Male	786	97.3			
Female	22	2.7			
Total	808	100			
Marital Status					
Single	98	12.1			
Married	705	87.2			
Widowed	5	0.7			
Total	808	100			
Educational Status					
Primary	222	27.5			
Secondary	174	21.5			
Tertiary	32	4			
Informal	380	47			
Total	808	100			
Age (years)			22	57	39.6
Household Size			1	46	20
Experience (years)			2	25	15

Source: Field Survey, 2021

**Results of Regression Analysis of Factors Influencing the Gross Processing Margin**

Table 2 presents the result of the factors influencing the profit margin earned by tomato processors. The results show that the F-statistic which measures how the variables included in the model jointly explained the dependent variable was found to be significant at 1% and the R-square value which measures the overall contribution of the independent variables was found to be 69.6%, implying that 69.6% of the profit margin earned by the processor was due to the variables included in the regression model. It further revealed that 80% of the variables included in the model were significant. The coefficient value for age was -1.919 which is significant at a 1% probability, implying that a year increase in the age of the farmer supplying the processor decreased the processor’s margin by N1.919, the coefficient value of 10.64 for years of educational attainment of the farmer supplying the processor implies that a year increase in the educational attainment of the farmer results in the corresponding increment in the profit margin earned by N10.64, the regression coefficient of -6.35 for household size implies that one person increase in the household size of farmer supplying the processor reduces the profit margin earned by the processor by N6.35, the coefficient value of 0.57 for years of farming experience implies that a year increase in the experience of the farmer supplying the processor increase the profit margin earned by the processor by N0.57, the coefficient value of -1.02 for purchase price implies that any 1 naira increase in the purchase price fresh tomatoes increases the processor’s profit margin by 1.02, the regression coefficient of 1.01 for quantity supplied result in 1.01 increment in the profit margin earned by processor when quantity supplied increase by 1 kg. The coefficient value of -0.121 for transportation cost implies that a 1 Naira increase in the transportation slashes the profit margin earned by the by N0.121, the coefficient value of -0.869 for fresh market price implies that any 1 naira increase in fresh market price decreases the profit margin earned by the processor by N0.869, the coefficient value of -1.244 time taken to receive payment implies that any 1 hour delay in the payment time decreases the profit margin earned by the processor by -1.244.

**Table 2:** Results of Processing Performance per 1000kg (1 ton) of Tomato Paste

Item	Amount	Cost/price (N)	(%) of TC
a. Fresh Tomatoes	8000Kg	320,000	62.78
b. Water	70m3/MT	25550	5.01
c. Fuel	130.9l/MT	70,250	13.78
d. Electricity	8Kw/MT	58902	11.56
e. Depreciation of Equipment	-	35040	6.87
Total cost	-	509,742	
f. Price per ton of Paste	-	725,000	
g. Processing Margin per ton		215258	

Source: Field Survey, 2021

**Seasonal and Spatial Retail Price Variability of Fresh Tomato**

**Seasonal Price Analysis**

The analysis undertaken in this study decomposed the time series into four components to isolate the seasonal components and explore the pattern of its variability over time in the study area. Seasonality was measured as any single month’s deviation from the average value of 100. The

results in Table 3 revealed that the GSI values for each of the calendar months show a deviation from 100. This implies that seasonality exists and the null hypothesis which suggests that seasonal variation in the retail price of fresh tomatoes in the study area was not statistically significant

may be false as the t-values for most of the month were less than  $\pm 3.182$ . The pattern of the seasonal price changes as represented by the movement of the GSIs from May to April is graphically illustrated.

**Table 3:** Results of Multiple Regression Analysis of Factors Influencing the Processing Margins (N100,000) Earned by the processor

Variables	Coefficient	SE	T-value	Sig.
(Constant)	-90.444	175.2	-0.516	0.071**
Age	-1.919	2.282	-0.841	0.002***
Sex	-64.332	127.3	-0.505	0.614 <sup>NS</sup>
Years of Education	10.643	3.155	-3.373	0.001***
Household Size	-6.35	2.895	-2.193	0.030**
Years of Experience	0.572	2.523	-0.227	0.021**
Fresh tomatoes Price	-1.016	0.010	-105.31	0.000***
Quantity supplied	1.011	0.006	164.69	0.000***
Transportation Cost	-0.121	0.025	-4.881	0.000***
Fresh market Price	-0.869	0.084	-10.34	0.000***
Time taken to receive payment	-1.244	6.900	-0.180	0.857 <sup>NS</sup>

\*\*\*-Significant at 5%, \*\*-Significant at 10%, NS-Not Significant

**Table 4:** Summarized Results of Seasonal Price Analysis of Fresh Tomato in Kano State

	May	Jun	Jul	Aug	Sep	Oct	NOV	Dec	Jan	Feb	Mar	Apr	
SI	104.74	91.58	79.86	77.24	93.88	103.69	107.91	107.23	85.52	54.58	88.42	96.09	1090.76
GSI	115.23	100.76	87.86	84.98	103.29	114.07	118.72	117.97	94.09	60.04	97.28	105.72	1200.00
GSI+SE	115.42	100.97	87.96	85.04	103.31	114.14	118.78	118.04	94.15	60.07	97.33	105.89	
GSI-SE	115.05	100.54	87.77	84.91	103.26	114.01	118.65	117.90	94.03	60.02	97.22	105.55	
(null=mean is 100)	3.06	3.09	0.39	1.23	2.62	-1.97	-1.71	1.83	1.64	0.99	1.54	-3.11	

**Conclusion**

The prospect of tempo-spatial price analysis of factors affecting processing performance of fresh tomato of Kano state were found to be full time occupation providing employment opportunities and generating income for a large number of individuals. This could be attributed to the number of profits realized in both activities. The socio-economic characteristics that enhance higher processing performance were age, household size, years of experience and level of income.

**Recommendations**

Based on the findings of the study the following recommendations were made:

1. Tomato producers and marketers should form strong and viable corporative groups which will make them have access to more institutional support.
2. Since tomato production and marketing is a profitable enterprise more youth should be encouraged to venture in to the enterprises this will go a long way in reducing unemployment in the study area.
3. There is need for government and its development partners to encourage people to go into farming so that there will be an increase in the quantity of cereals and legume which subsequently lead to an increase in the availability of livestock feeds.

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