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Analysis of Supply Function for Millet (*Pennisetum glaucum*) in Kaduna and Kano States of Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors OOA, AFL and YAA jointly conduct the field survey, code, summarize and analyze data collected. Authors OOA, AFL and YAA jointly write and correct the article report. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

This study analyzed supply function for millet in Kaduna and Kano States of Nigeria. Secondary data used for the investigation were sourced from Kano Agricultural and Rural Development Authority; Kaduna Agricultural and Rural Development Authority; National Programme for Food Security (NPFS). Descriptive statistics, Nerlove adaptation hypothesis and grafted polynomials model were used for the analysis of data. The results showed that price of fertilizer lagged one year and cost of production were the significant factors influencing output supply of millet in Kaduna State at 5% and 1% probability levels respectively. The price of millet lagged one year and fertilizer cost lagged one year were the significant factors influencing output supply of millet in Kano State at 1% and 5% probability levels respectively. The grafted polynomials model used for forecasting output supply of millet in tonnes for Kaduna and Kano States showed an increase in output of

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millet for a forecast period of 2006-2015.It is recommended that more agricultural inputs should be provided for farmers in Kaduna and Kano States by the Government to enable those farmers increase their millet output.

Keywords: Supply function; Nerlove adaptation hypothesis; Millet; Nigeria.

1. INTRODUCTION

Millet (*Pennisetum glaucum*) constitutes the most important cereal produced in Nigeria [1]. The current national production figure for millet was estimated at 7 million tonnes [2]. In Nigeria millet and sorghum account for over 60% of cereal grain production [3,4] reported that farmers in the semi-arid tropics of West Africa produced about 9.6 million tonnes of pearl millet on average between 1995-1997. Nigeria accounts for about 70% of the total sorghum production and more than half of the pearl millet production in West Africa [4] stated that farmers in West Africa semi-arid tropics planted over 14 million hectares of pearl millet between 1995-1997. Nigeria and Niger account for less than 15% of the West African's pearl millet acreage [4]. Millet is still the most important food again in West Africa. Since, 1984, production and area planted have been increasing. However, production growth results from area expansion rather than yield. The returns to the major factor of production (land and labour) for millet must be raised to stimulate yield enhancing production practices [5]. Supply enhancing technologies, land and water management techniques and technology to improve productivity such as the use of improved varieties combined with fertilizers are well known and labour saving technologies have the potential of alleviating the labour constraints [5,6,7] reported that in Kaduna state, most important cereals and food crops grown in terms of hectare and quantity are: maize, sorghum, millet and roots/tubers. In Kano state, production of millet, cowpea, maize and rice had increased [8]. Cereals are generally deficient in some important amino acids including lysine and tryptophan, which are required by humans, that is why it is important to supplement cereal-based food with legumes, which in addition to their high protein content are good sources of minerals such as calcium and iron as well as vitamins, these cereals are now used for the wide range of products including baby food, edible oils, syrups, sugar, industrial starch, corn flakes, biscuits and beverages and a range of all product [9].

1.1 Research Questions

This study intends to provide answers to the following research questions:-

(i) What are the variability in output and price of millet in Kaduna and Kano States?
(ii) What is the supply function for millet in Kaduna and Kano States?
(iii) What will be the forecast for millet in Kaduna and Kano States?

1.2 Objectives of the Study

The broad objective of this study is to analyzed supply function for millet in Kaduna and Kano States of Nigeria. The specific objectives are to:-

(i) Describe variability in output and price of millet in Kaduna and Kano States;
(ii) Estimate supply function for millet in Kaduna and Kano States;
(iii) Forecast for (10) years the output supply for millet in Kaduna and Kano States.

2. METHODOLOGY

This study was conducted in Kaduna and Kano States of Nigeria. Kaduna State is located between Latitudes 9^0N and 12^0N and Longitudes 6^0E of the prime meridian. It shares common borders with Abuja in the South-East and six other states namely, Katsina, Kano, Zamfara, in the North-North Nasarawa, Plateau in the North-East, Niger in the North-West. The climate varies from North to South of the state. The vegetation in the state is divided into Northern Guinea Savanna in the North and Southern Guinea Savanna in the South. Kaduna State is one of major producers of millet with annual production of 489,000 metric tonnes [10]. The State has a population of 6,066,562 people according to 2006 census [11]. Kano State lies with Savanna except the southern part where Guinea Savanna predominates; it is located between Latitudes 10^0N and Longitudes 8^0E and 9^0E of the prime median. The population of the state on the basis of a census conducted in 2006 was out at 9,383,682 people [11]. The secondary data used were sourced from Kano Agricultural and Rural Development Authority; Kaduna Agricultural and Rural Development Authority, and National Programme for Food Security(NPFS) Abuja, Nigeria, Variables Collected over twenty years(20) periods include, price of fertilizer per tonne for each State, cost of production in Naira per hectare for each State, price of millet Naira per tonne in each State, amount of rainfall in 'mm' in each State, output of millet in tonnes in each State etc.

2.1 Descriptive Statistics

Such as percentage, frequency distribution table, arithmetic mean and coefficient of variation were used to group and summarized the data collected from the field. The coefficient of variation is expressed as:

$$CV = \frac{S}{\bar{X}} \times 100$$

Where, CV = Coefficient of Variation, S = Standard Deviation, $\bar{X}$ = Arithmetic Mean

2.2 Supply Function

Nerlove adaptive expectation hypothesis was used to estimate supply function.

$$Q_{t=}\, \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 F_{t-1} + \alpha_3 R_t + \alpha_4 C_P + V_t$$

Where, Q_t = Output of millet in year "t" in tonnes, α_0= Constant term; P_{t-1} = Price of millet in year t-1 (₦/tonnes); F_{t-1} = Price of fertilizer in year t-1 in (₦/tonnes); R_t = Amount of rainfalls in mm in year t; C_P = Cost of production in year t (₦/hectare); α_1 - α_4= Structural parameters to be estimated; V_t= Error terms.

2.3 Grafted Polynomials or Spline Function

These models are also referred to as grafted relationship or grafted function or spline function. Segment of polynomials can be used to forecast time series. These segmented curves are restricted to be continuous and have continuous derivation at a joint [12]. For quadratic – linear function, the mean function can be representing as:

$$Y_t = \alpha_2 + \beta_2 t + \lambda dt$$

$$d_t = \begin{cases} (K-t)^2 \; for \; t < K \\ 0 \; for \; t > K \end{cases}$$

Y_t =Estimate forecast in the year (t) for millet; K = Joint point; α_2, β_2, λ = Structural parameters; t =Time factors in years.

$$X_1 = t \text{ for all t,}$$

$$X_2 = \begin{cases} (t-K_1)^2 \\ 0, Otherwise \end{cases},$$

$$X_3 = \begin{cases} K_2^2 - K_1^2 - 2(K_2 - K_1)t \;\; for \; K_1 \leq t \\ (K_2 - t)^2 \qquad\qquad\qquad for \; K_1 \leq t \leq K_2 \\ 0, Otherwise \end{cases}$$

3. RESULTS AND DISCUSSION

3.1 Variation for Output and Prices of Millet

The price of millet in Kaduna State fluctuated widely within the sampled period with a coefficient of variation of 64%. The production of millet in Kano State fluctuated widely with a coefficient of variation of 92% within the sampled period for the study Table 1.

3.2 Supply Function Analysis

The lagged price; cost of fertilizer; cost of production and amount of rainfall explained about 90% of supply variation for millet within the sampled period in Kaduna State Table 2. The cost of production and fertilizer cost lagged one year were significant at 1% and 5% level of probability respectively. Price lagged one year of millet in this case was not a strong factor that determines output of millet in Kaduna State. This agrees with the findings of [13] which revealed that farmers were less responsive to price, and that macroeconomic factors such as exchange rate and food import policies had strong and significance influence on the production of cereals which overshadowed the price influence. However the amount of rainfall was positively related to the estimated production of millet. The study observed the Coefficient of Multiple Determinations, R^2 of 0.57 for millet in Kano State supply with respect to Nerlove adaptive expectation hypothesis. This implies that 57% of the variation in millet supply within the sampled period was explained by the variables included in the model Table 3. The price of millet lagged one year and fertilizer cost lagged one year had significant influence on output of millet at 1% and 5% levels of probability respectively Table 3. The regression coefficient for the fertilizer cost lagged one year had a negative relationship with the supply of millet in Kano State. This implies that millet farmers are less responsive to fertilizer cost lagged one year based on production equation form Table 3.

Table 1. Variations for output and prices of millet in Kaduna and Kano states of Nigeria, Kaduna Kano

Estimates	Output (tonnes)	Price (₦/tonnes)	Output (tonnes)	Price (₦/tonnes)
Maximum	523,087.20	43,117.00	2,163,840.00	35,000.00
Minimum	57,260.00	5,547.00	195,000.00	5,486.00
Average	341,614.70	18,580.50	157,339.80	21,575.95
Standard Deviation	173,235.30	11,897.50	1,441,896.81	10,419.96
Coefficient of Variations (%)	50.71	64.03	92.09	48.29

Source: Field Survey, 2007

Table 2. Estimate supply function for millet in Kaduna state based on Nerlove adaptive expectation hypothesis

Variable	Coefficient	t-Value	Level of Significance
Constant	109884.00	1.409	NS
P_{t-1}	-0.014	0.054	NS
F_{t-1}	-0.0569	2.404	0.05
C_p	1.419	4.134	0.01
R_t	0.087	0.564	NS
$R^2 = 0.90$			

Source: Field Survey, 2007

Table 3. Estimate supply function for millet in Kano state based on Nerlove adaptive expectation hypothesis

Variable	Coefficient	t-Value	Level of Significance
Constant	37394.20	0.022	NS
P_{t-1}	0.162	2.977	0.01
F_{t-1}	-0.832	3.793	0.05
C_p	0.518	0.916	NS
R_t	0.448	0.994	NS
$R^2 = 0.57$			

Source: Field Survey, 2007

Table 4. Estimates of the parameters of the output of millet in tonnes for Kaduna state (grafted function)

Variable	Coefficient	t-Value	Level of Significance
Intercept	-14885.00	0.275	NS
X_1	58452.90	2.61	0.05
X_2	-18054.90	1.161	NS
X_3	13912.74	2.746	0.05
R^2	0.547		
$d.f = 15$			
$F - Value$	2.812		

Source: Field Survey, 2007

This study agrees with [14] who reported in his study on agricultural supply response for four cereal crops in Nigeria that prices of maize, sorghum, millet and rice lagged one year had a positive and significance on the supply of these cereals in the subsequent years. The structural coefficients of output of millet in Kaduna State were presented in Table 4. The estimate coefficients for X_1 and X_3 were significant at 5% probability level. The estimate of the grafted function was utilized to obtain expost forecast of output of millet (tonnes) in Kaduna State of Nigeria. The structural coefficients of output of millet in Kano State were presented in Table 5. The estimate of the coefficients on X_2, X_3 and $F \quad -Value$ were significant at 1% level of probability. The estimate of the grafted function was utilized to obtain expost forecast output of millet (tonnes) in Kano State of Nigeria. This study agrees with [15] who reported in his study using grafted polynomial function to forecast maize production trend in Nigeria that the intercept, coefficients of X_1 and X_2 were significant at 1% probability levels respectively. Table 6 shows the expost forecast of millet in tonnes for Kaduna and Kano States of Nigeria. It can be observed from Table 6 that there is a slow gradual increase in output supply of millet produced in Kano and Kaduna States in tonnes over the forecast period of 2006-2015.

Table 5. Estimates of the structural parameters of the output of millet in tonnes for Kano state (grafted function)

Variable	Coefficient	t-Value	Level of Significance
Intercept	-183474.00	0.586	NS
X_1	4374572.00	1.135	NS
X_2	-1453572.00	7.556	0.01
X_3	176718.70	7.962	0.01
R^2	0.938		
$\mathrm{d.f} \quad = 15$			
$\mathrm{F} - \quad \mathrm{Value}$	35.26***		

*Source: Field Survey, 2007, ***-Significant at 1% Probability Level*

Table 6. Expost forecast of millet (tonnes) in Kaduna and Kano States

Year	Output in Tonnes (Kaduna)	Output in Tonnes (Kano)
2006	436046.38	1800822.14
2007	537400.37	2144911.60
2008	638754.46	1581977.10
2009	631783.65	742129.40
2010	624814.60	255719.00
2011	613703.00	122746.00
2012	630417.68	166491.70
2013	674957.40	210237.40
2014	733409.00	253983.20
2015	791862.39	297728.90

Source: Field Survey, 2007

4. CONCLUSION AND RECOMMENDATION

This study evaluated supply function analysis for millet based on Nerlove [16] adaptive hypothesis in Kaduna and Kano States which is greatly influenced by fertilizer cost lagged one year and cost production for millet in Kaduna State and price of millet and fertilizer cost

lagged one year in Kano State respectively. Based on the results, more agricultural inputs should be given to farmers in Kaduna and Kano States by the Government of each State to produce more millet.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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