

## Resource Use Efficiency in Sesame (*Sesamum indicum* L.) Production under Organic and Inorganic Fertilizers Applications in Keana Local Government Area, Nasarawa State, Nigeria.

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**Abstract:** The study examined resource use efficiency in Sesame production under organic and inorganic fertilizers applications in Keana Local Government Area, Nasarawa State. Multi-stage random sampling was used in selecting 96 sesame farmers; made up of 48 organic and 48 inorganic fertilizers users. Data were collected through structured questionnaire and analyzed using descriptive statistics (mean, standard deviation and coefficient of variation), production function and gross margin analysis. Results show that inputs were used not based on recommended rates by both categories of farmers. On the average, farmers that applied inorganic fertilizer earned higher income (₦16563) than those who applied organic fertilizer (₦13158). Resources were used at sub-optimal levels under the two technologies. High cost of inorganic fertilizer, poor extension service and poor road network were major constraints confronting sesame farmers. Therefore extension agents should incorporate sesame farmers into their extension service so that they will be guided on the recommended quantity of inputs to be used and be encouraged to substitute high cost inorganic fertilizer for low cost organic fertilizer, applied at recommended quantity to ensure higher yield.

**Key words:** Resource use efficiency, organic and inorganic fertilizers.

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### INTRODUCTION

Sesame (*Sesamum indicum*) is one of the world's oldest spice and oil seed crops grown mainly for its seeds that contain approximately 50% oil and 25% protein <sup>[1]</sup>. The presence of some antioxidants (Sesamun, Sesamol and Sesamol) makes the oil one of the most stable vegetable oils in the world. The world production is estimated at 3.66million tones with Asia and Africa producing 2.55 and 0.95 million tones, respectively <sup>[2]</sup>. In Nigeria, sesame is cultivated on over 80,000 ha across most of the Northern States for food and oil. Benue and Nasarawa States are the highest sesame producers in Nigeria with an annual output of not less than an average of 40,000MT each per annum <sup>[3]</sup>. As a raw export commodity, sesame seed from Nigeria is enjoying a rising profile on the world market where overall global demand has risen to 3.3 million tons.

Sesame is one of the major cash crops grown in Nasarawa State. It is a very popular crop among the rural farmers because of the good local and

international markets for its seed and oil. The Nasarawa State Government has identified sesame as a major revenue earner and established a sesame seeds cleaning plant in the state to serve as a catalyst for industrial development. There are already buyers from China and other parts of Asia that patronize the product <sup>[4]</sup>. Keana Local Government Area is one of the major sesame producing areas in the State.

An average yield of 500kg of sesame is obtainable per hectare in Nasarawa state while the potential yield is 800kg – 1000kg per hectare <sup>[5,6]</sup> observed that the poor sesame yield is due to low and unstable yield potential of the available production technology, increase in the cost of input particularly inorganic fertilizers, lack of technical and extension support, a complex of distinctive agricultural policies, as well as non adoption of improved technology for sesame production. In view of the growing gap between the demand for and supply of sesame against the background of an increasing pressure on land, the efficiency with which the farmers use available resources and technology becomes a priority subject of

investigation. It is believed that agricultural production can be increased either through an efficient use of traditional technologies and practices, or through the introduction of a package of improved technologies like fertilizer, improved seeds, and cultural practices provided that no production gains are possible through better use of the traditional practices <sup>[7]</sup>.

This paper reports the findings of a study of resource use efficiency in sesame production under organic and inorganic fertilizers applications. Specifically the study aimed at: determining inputs and outputs levels of sesame production under organic and inorganic fertilizers applications; estimating the relationship between inputs and outputs in sesame production under organic and inorganic fertilizers conditions; estimating the resource use efficiency in sesame production under organic and inorganic fertilizers applications; estimating the costs and returns of sesame production under two applications; and, identifying constraints to increased sesame production in the area.

## MATERIALS AND METHODS

**Description of the Study Area:** Keana Local Government Area is located in Southern part of Nasarawa State (North Central Nigeria) between latitude 7°N and 8°N and longitude 7°E and 8°E with an approximate mean temperature of 23°C-33°C. The area shares boundaries with Guma Local Government Area of Benue State to the South, Obi Local Government Area to the North, Awe Local Government Area to the East and Doma Local Government Area to the West all in Nasarawa State. It has an estimated landmass of 4,861km<sup>2</sup> and estimated population of 79,253 people. The major towns that make up the local government area are: Keana the headquarters, Kadarko, Giza, Aloshi, Agaza and Kwara. It comprises six districts namely; Keana South, Keana North, Kadarko, Giza, Aloshi and Agaza districts. The economic activity in the area is largely agrarian with majority of the people live as subsistence farmers who cultivate crops such as yam, sesame, rice, cassava, sorghum, millet, cowpea, groundnut and other crops.

**Sampling Technique:** A multi-stage sampling procedure was employed for selection of respondents for the study. Keana Local Government Area has six districts namely; Keana South, Keana North, Kadarko, Giza, Aloshi, and Agaza districts. The first stage of sampling involved random selection of four districts in the local government area. In the second stage, two (2) villages were randomly selected from the four (4) districts to give a total number of eight (8) villages for the study. Thirdly, six (6) organic and six (6)

inorganic (fertilizers applied) sesame farmers canclules were purposively selected from each of eight (8) selected villages amounting to forty eight (48) farmers using organic and forty eight (48) farmers using inorganic fertilizers.

The reason for purposive selection is to facilitate identification and classification of sesame farmers into organic and inorganic (fertilizers applied) farmers.

**Method of Data Collection:** Data for 2008/2009 cropping season were collected from primary sources through structured questionnaire and interview schedule. Data were collected on the following variables; output level, quantity and types of inputs used like fertilizer (organic and inorganic), pesticide, labour, seed and farm size.

**Method of Data Analysis:** Descriptive statistic, Production function and Gross margin analyses were used in analyzing data for the study.

**Production function:**The linear form of production function can be expressed as follows

$Y = b_0 + b_1X_1 + b_2 X_2 + b_3X_3 + b_4 X_4 + b_5X_5 + U$ . Where;  
 $Y =$  Output (kg);  $X_1 =$  Farm size (ha);  $X_2 =$  Seed (kg);  $X_3 =$  Labour (Man-hour);  
 $X_4 =$  Pesticides (Lt);  $X_5 =$  Fertilizers (inorganic or organic) (kg);  $b_0 =$  Constant;

$b_1 - b_5 =$  Regression coefficients and  $U =$  Error term or random variable. Different functional forms were fitted but the best fit was chosen base on the following criteria; signs of estimated coefficients, standard error, t-value and coefficient of determinant ( $R^2$ ). These forms are semi log and double log:

$Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + U$ .

$\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + U$ .

Resource use efficiency was computed as:

$$r = \frac{MVP}{UFC}$$

Where;  $r =$  Efficiency ratio;  $MVP =$  Marginal Value Product and  $UFC =$  Unit Factor Cost.

$MVP = P_y \cdot MPP$  where;  $P_y =$  Price of Unit Output and  $MPP =$  Marginal Physical Product. If  $r = 1$ , it means that resources are efficiently utilized; if  $r < 1$ , it means that resources are over utilized and if  $r > 1$ , it means resources are under utilized.

$Gross\ Margin\ (GM) = GR - TVC$  Where;  $GM =$  gross margin (₦/ha);  $GR =$  gross revenue (₦/ha) and  $TVC =$  Total variable cost (₦/ha). This involved the cost of fertilizer (organic or inorganic) (kg), seeds (kg), labour (man hour), pesticides (litre)

## RESULTS AND DISCUSSION

**Inputs and Outputs levels of Sesame Farms:** Table 1 indicates that organic (fertilizer applied) farmers recorded an average output of 334kg/ha of sesame as against 364kg/ha output of sesame under inorganic fertilizer application. Organic (fertilizer applied) farmers cultivated an average land area of 2 hectares per farmer which is less than 2.1 hectares for inorganic (fertilizer applied) farmer. Table 1 also shows that the mean quantity of sesame seed planted/hectare by organic (fertilizer applied) farmers was 8.4kg which is 1.51kg higher than the average quantity of seed (6.89) planted per hectare by inorganic (fertilizer applied) sesame farmers. These quantities were higher than recommended rate of 5kg per/ha<sup>[8a]</sup>. The mean quantity of organic fertilizers used per hectare of sesame farm was 88.5kg which is grossly inadequate compare to recommended rate of five tons per hectare<sup>[8b]</sup>. The mean quantity of inorganic fertilizers applied per hectare was 80.5kg. Organic (fertilizer applied) farmers recorded higher mean labour usage of 144 man-hours/ha than 122 man- hours/ha used by inorganic (fertilizer applied) farmers. The mean pesticides applied by both organic and inorganic (fertilizers applied) farmers were 1.5 litres and 1.78 litres per hectare respectively.

**Cost and Returns Analysis:** Table 2 shows that average yield/ha was 334kg for sesame farms under organic Fertilizers application and 364kg for farms under inorganic Fertilizers application. The gross return was computed by multiplying the total yield per hectare by the average unit price at the time of data collection, which gives the total of ₦40354 for organic and ₦41849 for inorganic (fertilizer applied) sesame farmers. In estimating the total cost of production, only the variable cost components were considered. This consists of costs incurred on inputs such as labour, seed, pesticide, and fertilizers were considered. Labour costs were ₦23760/ha for organic and ₦17108/ha for inorganic (fertilizer applied) sesame farms and these constitute 87% and 68% of the total costs of production respectively. The total cost of Sesame seed was calculated as ₦1419.6/ha for organic and ₦1260.9/ha of inorganic (fertilizer applied) farms. Pesticides were used by most of the respondents, the total cost of pesticides per hectare was ₦1573.5 for organic and ₦1926 for inorganic (fertilizer applied) farms. The total cost of fertilizers per hectare were ₦442.5 for organic and ₦4991 for inorganic (fertilizers applied) farms. Therefore, total variable cost incurred per hectare were ₦27196 and ₦25286 by organic and inorganic (fertilizer applied) farmers respectively. Table 2 reveals that the gross margin earned per hectare

by both categories of sesame farmers were ₦13158 and ₦16563 respectively. The cost benefit ratios for organic and inorganic (fertilizer applied) farms were ₦1.48 and ₦1.66. That is for every naira invested, 48 kobo and 66 kobo profits were made by organic and inorganic (fertilizers applied) farmers.

**Production Function Analysis of Sesame Farms Under Organic Fertilizer Condition:** The result of the production function analysis shows that the linear function had the best fit to the data for organic (fertilizers applied) farms. Table 3 shows that four variables; farm size, labour, pesticide and fertilizer had positive regression coefficients indicating direct relationship between each of the variables and the output. Only seed had a negative coefficient and this is because seed was over used by sesame farmers. The result further reveals that about 66% of the variation in sesame output under organic fertilizer condition was accounted for by the inputs included in the model. Farm size and fertilizers were significant at 5% and 1% levels of probability

**Production Function Analysis of Sesame Farms Under Inorganic Fertilizer Application:** The double log functional form had the best fit to data from inorganic (fertilizer applied) farms. Table 4 shows that farm size, seed, labour and fertilizer had positive regression coefficients indicating their direct relationship with output. Only pesticide had a negative coefficient. The result reveals that about 64% of the variation in sesame output was accounted for by the inputs included in the model. Farm size and seed were significant at 5% and 10% levels of probability.

**Marginal Physical Product of Inputs Used in Sesame Farms:** The MPP is the addition to total product resulting from a unit increase in particular input. Table 5 shows that farm size has the highest MPP (122.365 and 101) while seed and pesticide have the least MPP (-8.840 and -56) for both enterprises. This implies Unit increase in farm size would increase output more than any other inputs.

**Resource Use Efficiency Sesame Farms:** The results of analysis of resource use efficiency in sesame farms are presented in the table 6. Pesticide and fertilizer were under utilized in farms under organic fertilizer condition, while labour and seed were over utilized. On the other hand, labour, pesticide and fertilizer were over utilized in farms under inorganic fertilizer condition. But the quantity of seed was under used. The result implied that resources were inefficiently utilized by both categories of sesame farmers.

**Table 1:** Inputs and Outputs level of Sesame farms

Variable	Sesame Farms Under Organic Fertilizer Application					Sesame Farms Under Inorganic Fertilizer Application				
	Max.	Min.	Mean	SD	CV	Max.	Min.	Mean	SD	CV
Output (kg)	1067	75	333.5	182	55	2400	28.6	363.9	344.7	95
Land (ha)	5.5	0.5	2	1.4	70	8.5	0.5	2.1	1.6	76
Seed (kg)	60	1.6	8.4	8.9	106	15	0.8	6.89	2.38	35
Labour (man-hours)	648	31.1	144	112	78	733	15.5	122.2	120.7	99
Pesticide(lt)	20	0	1.5	3	200	10	0	1.78	1.72	97
Fertilizers (kg)	500	12.5	88.5	112	127	250	17	80.5	55.6	69

Source: Field Survey, (2009).

SD = Standard Deviation CV = Coefficient of Variation

**Table 2:** Gross Margin Analysis of Sesame Farmers

Variable	Organic (fertilizer applied) farmers			Inorganic (fertilizer applied) farmers		
	Average Qty (per/ha)	AV. Unit price (₦)	Value (₦/ha) (per/ha)	Average Qty (₦)	AV. Unit price	Value (₦/ha)
Gross returns						
Average yield (kg)	333.5	121	40353.5	363.9	115	41848.5
Input						
Labour (man hour)	144	165	23760	122.2	140	17108
Seed (kg)	8.4	169	1419.6	6.89	183	1260.9
Pesticide (lt)	1.5	1049	1573.5	1.78	1082	1926
Fertilizers (kg)	88.5	5	442.5	80.5	62	4991
Total variable			27195.6			25285.9
Gross margin			13158			16562.6

Source: field survey, (2009).

₦150 = \$

**Table 3:** Linear Production Function Result of Organic Sesame Farms under Organic Fertilizer Application.

Variable	Regression coefficient	Standard Error	T-values	F-value
Constant	114.492	79.42	1.442 <sup>NS</sup>	16.169 <sup>**</sup>
Farm size X <sub>1</sub>	122.365	50.942	2.402 <sup>* *</sup>	
Seed X <sub>2</sub>	-8.840	7.923	-1.116 <sup>NS</sup>	
Labour X <sub>3</sub>	0.066	0.247	0.267 <sup>NS</sup>	
Pesticide X <sub>4</sub>	15.744	14.985	1.051 <sup>NS</sup>	
Fertilizer X <sub>5</sub>	2.195	0.509	4.315 <sup>***</sup>	

Source: Regression result, (2009).

R<sup>2</sup> =0.658

NS = Not significant

\* \* =Significant at 5% level of probability

\*\*\* = Significant at 1% level of probability

**Table 4:** Double Log Production Function Result for Sesame Farms under Inorganic Fertilizer Application.

Variable	Regression coefficient	Standard Error	T-values	F-value
Constant	3.925	1.029	3.815 <sup>*</sup>	7.415 <sup>*</sup>
Farm size X <sub>1</sub>	0.583	0.181	3.219 <sup>* *</sup>	
Seed X <sub>2</sub>	0.357	0.184	1.935 <sup>***</sup>	

**Table 4:** Continue

Labour X <sub>3</sub>	0.266	0.170	1.562 <sup>NS</sup>
Pesticide X <sub>4</sub>	-0.276	0.183	-1.507 <sup>NS</sup>
Fertilizer X <sub>5</sub>	0.013	0.113	0.113 <sup>NS</sup>

Source: Regression result, (2009).

R<sup>2</sup> =0.638

NS = Not significant

\*\* =Significant at 5% level of significant

\*\*\* =Significant at 1% level of significant

\* = Significant at 10% level of significant

**Table 5:** Marginal Physical Product of Inputs Used in Sesame Farms under Organic and Inorganic Fertilizer Applications.

Input	Marginal Physical Product of Farms Under Organic Fertilizer Application	Marginal Physical Product of Farms under inorganic Fertilizer Application
Farm size	122.365	101
Seed	-8.840	18.9
Labour	0.066	0.79
Pesticide	15.744	-56
Fertilizer	2.195	0.059

Source: Regression result, (2009).

**Table6:** Resource-use Efficiency in Sesame Farms under Organic and Inorganic Fertilizer Applications.

Resource	Organic Fertilizer Application			Inorganic Fertilizer Application		
	MVP	UFC	E. Ratio	MVP	UFC	E. Ratio
Seed	-1069.6	169	-6.3	2169	183	11.9
Labour	7.986	165	0.05	91	140	0.65
Pesticide	1905.0	1049	1.76	-6491	1082	-5.5
Fertilizers	265.6	5	53	6.76	62	0.10

Sources: Regression result, (2009).

**Table 7:** Constraints to sesame production.

Constraints	Frequency	Rank
High cost of inorganic fertilizer	86	1 <sup>st</sup>
Poor extension services	85	2 <sup>nd</sup>
Poor road network	83	3 <sup>rd</sup>
High cost of transportation	79	4 <sup>th</sup>
Poor access to credit	68	5 <sup>th</sup>
Low market price	57	6 <sup>th</sup>
Total	458*	

Source: Field survey, (2009).

\* Multiple choices were considered; hence total frequency is more than sample size.

**Conclusion and recommendation:** Resources used in production of sesame under organic and inorganic fertilizers applications were not efficiently utilized, hence average yields per hectare from both categories of farms (under organic and inorganic fertilizers conditions) were below expected 600kg yield per hectare. Therefore the following recommendations are

made: Extension agents should consider sesame farmers as their target farmers so that they will be guided on the recommended quantity of inputs to be used. Farmers should be encouraged to substitute high cost inorganic fertilizer for low cost organic fertilizer and should be applied at recommended quantity to ensure higher yield. Feeder roads should be rehabilitated to

facilitate easy movement of farm produce to urban markets where prices are relatively attractive.

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