RESOURCE USE EFFICIENCY IN SESAME *(Sesamum indicum L.)* PRODUCTION UNDER ORGANIC AND INORGANIC FERTILIZERS APPLICATIONS IN KEANA LOCAL GOVERNMENT AREA OF NASARAWA STATE, NIGERIA

Umar, H. S.
Department of Agricultural Economics and Extension
Nasarawa State University, Keffi (Lafia Campus), Nigeria.
E-mail: umarhsuleiman@yahoo.com

Okoye, C. U.
Departments of Agricultural Economics
University of Nigeria, Nsukka, Enugu State, Nigeria

Mamman, B. D.
Department of Agricultural Extension and Management
College of Agriculture, Lafia, Nasarawa State, Nigeria

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 48 organic and 48 inorganic fertilizers users. Data were collected through structured questionnaire and analyzed using descriptive statistics, 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 than those who applied organic fertilizer. Resources were used at sub-optimal levels under the two technologies. Therefore, it was recommended among others that 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.*

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 (Burden, 2005). The presence of some antioxidants (Sesamun, Sesamolin 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 (Anon, 2008). 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 (Raw Materials Research and Development Council, 2004). 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 (Nasarawa State Government, 2008). 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 (Idowu, 2002). OLAM (2005), 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 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.

METHODOLOGY

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^2 and estimated population of 79,253 people (NPC, 2006). 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, Giza, Kadarko, Aloshi and Agaza districts. The economic activity in the area is largely agrarian with majority of the people as subsistence farmers who cultivated crops such as yam, sesame, rice, cassava, sorghum, millet, cowpea, groundnut and other crops.

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 villages were randomly selected from the four districts to give a total number of eight villages for the study. Thirdly, six organic and six inorganic fertilizers applied sesame farmers production were purposively selected from each of eight selected villages amounting to forty eight farmers using organic and forty eight 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.

Data for 2008/2009 cropping season were collected from primary source by the used of structured questionnaire and interview schedule. Data were collected on the output level, quantity and types of inputs used like fertilizer (organic and inorganic), pesticide, labour, seed and farm size. Descriptive statistic, Production function and Gross margin analyses were used in analyzing data for the study. The linear form of production function is expressed as:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + U$$

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

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

UFC= Unit Factor Cost

MVP= Py.MPP

where:

Py = 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

if r > 1, it means resources are under utilized

GM = GR - TVC

Where:

GM = gross margin (N/ha)

GR = gross revenue (N/ha)

TVC = Total variable cost (N/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

Table1 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. Table1 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 planted per hectare by inorganic fertilizer applied sesame farmers. These quantities were higher than recommended rate of 5kg per/ha (German Technical Cooperation, 2009). 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 (GTZ, 2009). The mean quantity of inorganic fertilizers applied per hectare was

80.5k. 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 the average yield/ha for sesame farms under organic and inorganic applications. The gross return was computed by multiplying the total yield per hectare by the average unit price at the time of study which gives the total for organic and 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 for organic and inorganic fertilizer applied sesame farms and these constitute the total costs of production respectively.

The total cost of Sesame seed was calculated for organic and inorganic fertilizer applied farms. Pesticides were used by most of the respondents, the total cost of pesticides per hectare for organic and inorganic fertilizer applied farms. The total cost of fertilizers per hectare were collected for organic and inorganic fertilizers applied farms. Therefore, total variable cost incurred per hectare were N27196 and N25286 by organic and inorganic fertilizer applied farmers respective. Table 2 reveals that the gross margin earned per hectare by both categories of sesame farmers were N13158 and N16563 respectively. The cost benefit ratios for organic and inorganic fertilizer applied farms were N1.48 and N1.66. That is for every naira invested, 48 kobo and 66 kobo profits were made by organic and inorganic fertilizers applied farmers.

Sesame Farms under organic fertilizer condition: Production function analysis

The result of the production function analysis shows that the linear function had the best fit to the data for organic fertilizers applied farms.Table3 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.

Sesame Farms under inorganic fertilizer application: Production function analysis

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.Table5 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 in 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.

Constraints to Sesame Production

Sesame farmers are confronted with many constraints. The major constraints included high cost of inorganic fertilizer, absence of extension service, poor road network and high cost of transportation. Others were poor access to credit and low market price for sesame grains (Table7).

CONCLUSION AND RECOMMENDATIONS

Resources used in production of sesame under organic in organic 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 (GTZ, 2009). 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.

Table1: Inputs and Outputs level of Sesame farms

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

SD = Standard Deviation   CV = Coefficient of Variation

Source: Field Survey, 2009.

Table 2: Gross Margin Analysis of Sesame Farmers

Variables	Organic fertilizer applied farmers			Inorganic fertilizer applied farmers		
Gross returns	Average Qty (per/ha)	Unit price (N)	Value (N/ha)	Average Qty (per/ha)	Unit price (N)	Value (N/ha)
Average yield (kg)	333.5	121	40353.5	363.9	15	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.

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	1.442NS	16.169**
Farm size X_1	122.365	50.942	2.402* *	
Seed X_2	-8.840	7.923	-1.116NS	
Labour X_3	0.066	0.247	0.267NS	
Pesticide X_4	15.744	14.985	1.051NS	
Fertilizer X_5	2.195	0.509	4.315***	

R^2 = 0.658
NS = Not significant
* * = Significant at 5% level of probability
*** = Significant at 1% level of probability

Source: Regression result, 2009.

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*	7.415*
Farm size X_1	0.583	0.181	3.219* *	
Seed X_2	0.357	0.184	1.935***	
Labour X_3	0.266	0.170	1.562NS	
Pesticide X_4	-0.276	0.183	-1.507NS	
Fertilizer X_5	0.013	0.113	0.113NS	

R^2 = 0.638
NS = Not significant
** = Significant at 5% level of significant
*** = Significant at 1% level of significant
* = Significant at 10% level of significant

Source: Regression result, 2009.

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	-8840	18.9
Labour	0.066	0.79
Pesticide	15.744	-56
Fertilizer	2.195	0.059

Source: Regression result, 2009.

Table 6: 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	1st
Poor extension services	85	2nd
Poor road network	83	3rd
High cost of transportation	79	4th
Poor access to credit	68	5th
Low market price	57	6th
Total	458*	

* Multiple choice was considered, hence total frequency is more than sample size.

Source: Field survey, 2009.

REFERENCES

Arega, A. (2002). Resource Use Efficiency in Maize Production under Traditional and Improved Technology in Western Ethiopia. *http.// www.tropentag.de /2002/proceedings/node200.html.* Accessed on 26/8/2009.

Anon, O. (2008). World Sesame Situation: American Sesame Growers' Association. *http//www.worldstatuofsesame.mht.* Accessed on 24/ 8/2009.

Burden, D. (2005).Sesame Profile. *http//www.cropprofile.mht.*Accessed on 26/8/2009.

German Technical Cooperation (GTZ) (2009). Package of Practices for Sesame Production. Employment-oriented Private Sector Development Programme(EoPSD). USAID Market. pp23.

Idowu, A.A. (2002). Strategies for Effective Development of Beniseeds in Nigeria. Training manual on Beniseed production Technology, National Research Institute, Badeggi, Niger State, Nigeria.

Nasarawa State Government (2008). Precious Nasarawa Nigeria Investor's Haven. An information brochure on the investment and tourism potentials of Nasarawa State. A publication of the Nasarawa State Government.

NPC, (2006). *National Population Census Result as Concern Nasarawa State.* Abuja: NPC.

OLAM, (2005). Improved Package of Practices for Sesame Production Out-Grower (Training Manual). Lagos: OLAM Nigeria Limited.

Raw Materials Research and Development Council (2004). *Report on Survey of Agro-Raw materials in Nigeria: Beniseed* (1st ed). Abuja: Raw materials Research and Development council Garki.