ANALYSIS OF RESOURCE USE EFFICIENCY IN GARLIC PRODUCTION IN KANO STATE, NIGERIA

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ABSTRACT

A study of the efficiency of resource usage in farm production is necessary to guide the producer on how best to allocate the scarce resources on his farm. Production data were collected from 120 farmers randomly selected from two local government areas of Kano state. The data were analyzed using OLS regression method to estimate the production function and the ratio of marginal value product to marginal factor cost as the measure of resource use efficiency. The lead functional form was the double log function which produced an adjusted R^2 of 0.86. Seed, organic manure and labour inputs have positive effects and were statistically significant at 1 percent level of probability. However, all the inputs were inefficiently utilized with organic manure and labour being under-utilized while seed was over-utilized. Based on these findings, it was suggested that in order to enhance the efficiency of production less seed and more of organic manure and labour should be used.

Keywords: Resource use efficiency, Garlic production, Kano State

Introduction

Garlic (*Allium sativum)* belong to the family *Alliaceae* and consist of an underground bulb and above ground vegetative parts of leaves and flowering parts (Purseglove, 1972). It was reported that China was leading producer followed with a production of 12,088,000 ton per annum was followed by India with 645,000 ton per annum while the aggregated world production was 15,686,310 tons per annum as of June 11, 2008 according to Wikipedia (2011). Africa production was 292,000MT (FAO, 1999).

The production in Nigeria is mainly on a small scale and confined to some parts of the Northern Guinea and Sudan Savannah regions of Borno, Sokoto, Kebbi, Katsina and Kano States (Miko, 1999). The crop is restricted to these zones because of some agronomic factors which makes it cultivation location specific. The crop requires cool and dry weather for growth (Miko, 1999; Jones and Mann, 1963). The harmattan (dry wind and cool low temperature) from November- March and loamy soils are ideal for the crop (NAERLS Extension Bulletin). Garlic is a high valued crop and used as medicine, food, preservative and curative agent. For instance, Miko (1999) reported the use of green parts and the bulbs as spices in salad and seasoning of vegetables; the extract is used as curative agents against ear ache and eye sore, antidote against some poison and antibacterial agent (Debkitanya, *et al.*, (1981); while Purseglove (1972) reported its extract use to reduce cholesterol level in human blood and the volatile sulphurs and oil extracts for treating several skin diseases.

In Nigeria, the statistics of production is not available but Kano State promoted the production of the crop in the state in the 1980s and was reportedly taken up largely in Tudun Wada and Bebeji Local Government Areas (LGAs) of the State (Jobdi (2004). The crop is sold in the local markets in Kano and elsewhere in the country while it is also marketed to the neighbouring countries such as Niger, Chad and Cameroon to earn foreign exchange (Jobdi, 2004). In a study of marketing of garlic in Sokoto state, Saidu (1998) observed that garlic marketing was profitable because both the producers and the middlemen's marketing margins were positive and high enough to take care of their investment in the business.

There need to intensify current production level through improved production practices and efficient use of resources was the main reason behind this study particularly, that garlic was one of the listed eight exportable crops from Nigeria (Jobdi, 2004). These farm resources include irrigated farm size, available garlic seed, inorganic fertilizers, organic manure and farm labour which all have implications its production.

The basic objective of this article therefore is to highlight the basic socio-economic characteristics of the farmers that affect the resource use levels and examine the efficiency of the resources limiting garlic production in the state.

Methodology

Two villages namely Kofar (in Bebeji LGA) and Yaryasa (in Tudun Wada LGA) were purposively selected for the field survey on the basis of being the prominent garlic producing areas in the state. The sample size for the study was 120 farmers with 60 farmers each randomly selected in these villages. The sample was drawn from the list of farmers provided to the researcher during a pre-survey visit which indicated about the same population of farmers cultivating garlic in the two LGAs. The study was conducted in the 2001/2002 irrigation season through a farm survey. The primary data were collected using structured questionnaire administered on the selected respondents. The primary data included socio-economic variables such as age and number of children per respondent and the input (land, labour, in organic fertilizer, manure and seed), output quantities and their prices. The secondary data which include production level statistics and other information were collected from FAO, Wikipedia and other published sources.

The Ordinary Least Square (OLS) Regression analysis was used to determine the production function, which measures the technical relationship between the resource inputs and the product output (Upton, 1973). The implicit model was specified as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, U) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

Y = Garlic yield (kg)
X_1 = Land area (hectares)

X_2 = Seed (kg)
X_3 = Chemical fertilizer (kg)
X_4 = Organic manure (kg)
X_5 = Labour used (man-hrs)
U = Error term

The linear, Semi-log, double-log, quadratic and square root production functions were fitted to the data and the lead equation chosen based on the R^2, *a priori* signs of the coefficients and significance of the co-efficient. The explicit forms of these functions are specified as:

$$Y = a + b_1 X_1 + \ldots + b_5 X_5 + e \text{ (linear)} \ldots\ldots (2)$$

$$Y = a + b_1 \text{Log } X_1 + \ldots + b_5 \text{Log } X_5 + e \ldots \text{ (Semi – log)} \ldots (3)$$

$$\text{Log } Y = a + b_1 \text{Log } X_1 + \ldots + b_5 \text{Log } X_5 + e \ldots \text{ (double Log)} \ldots (4)$$

$$Y = a + b_1X_1 + \ldots + b_5 X_5 - b_6X_1^2 - \ldots - b_{10}X_5^2 + b_{11}X_1X_2 + \ldots$$

$$\ldots + b_{20}X_iX_j + b_{21}X_1X_2X_3X_4X_5 + e \ldots \text{ (Quadratic)} \ldots\ldots (5).$$

$$Y = a + b_1X_1 + \ldots + b_5X_5 + b_6X_1^{0.5} + \ldots + b_{10}X_5^{0.5} + \ldots + b_{11}X_1^{0.5}X_2^{0.5}$$

$$+ \ldots + b_{20}X_i^{0.5}X_j^{0.5} + \ldots + b_{21}X_1^{0.5}X_2^{0.5}X_3^{0.5}X_4^{0.5}X_5^{0.5} \text{ (Square root)} \ldots\ldots (6)$$

Where;

$Y, X_1 \ldots X_5$ are as defined in equation (1)

$X_i X_j$ = Interaction terms between variables i and j

a = Constant term

e = error term

$b_1 - b_{21}$ = estimated regression coefficients with the expected signs of b_6 to b_{10} to be negative in equation (5) and positive in equation (6). In other equations, the bs can take either positive or negative sign.

The estimation of resource use efficiency was based on the economic theory that the economic optimum is obtained where the extra cost of producing one more unit of the output equals the extra returns derived from that unit output (Upton (1973).

The efficiency ratio (r) equals unity at that point and it is given by

$$r = MVP/MFC = 1 \ldots\ldots (7)$$

where;

r = is the efficiency ratio

MFC = Marginal factor cost (unit cost of the resource (N/Kg)

MVP = Marginal value product of the particular input (= $\delta Y/\delta X_i \times PY$)

The MPP_{Xi} ($\delta Y/\delta X_i$) IS estimated as follows:

$MPP_{Xi} = b_i$ for equation (2)

$MPP_{xi} = b_i/\breve{A}$ for equation (3)

$MPP_{Xi} = b_i \frac{\hat{Y}}{\bar{A}}$ ……………………for equation (4)

Where;

$\acute{Y}$ and $\bar{A}$ are the arithmetic mean values of the output (Y) and the ith input (X)

b_i = estimated regression coefficient of input X_i

P_y = Unit price of garlic (N/Kg)

Where;

r = 1, it implies that the resource is efficiently utilized (i.e. MVP =MFC)

r > 1, it implies the resource is under-utilized

r < 1, it implies that the resource is over-utilized

These models have been used variously by several authors in their studies for measuring resource use efficiency and productivity (Saini, 1969; Carlos, 1972; Ahmed, 1985; Ajobo and Tijani, 1997; Kudi *et al.*, 2008; Gani and Omonona, 2009)

Results and discussions

The result of the socio-economic characteristics of the farmers (table 1) show that the mean age of the farmers was 46 years even though their age ranges from 20 to 70 years and were all males. Farmers within the age group of 30-40 constitute about 30% meaning that they were young and energetic and could cope with the tedious agronomic practices required of the crop. They were all males because in the Muslim north, males are generally the farmers and they are the producers of such commercial crops like onion, tomato and other vegetables. The household size was usually large with high number of children. From the study average number of child per household was 7 with about 44% of the households having 6-10 children per household. This was a major source of farm labour to the family. The majority (64%) of the farmers has no formal education but only Islamic education while 29% had primary education. This level of literacy is enough to enable farmers follow basic farm instructions in the Hausa language and help adoption of new innovation like the garlic crop and productivity.

From economic theory, the linear function is not appropriate in production function because it does not exhibit diminishing returns to the inputs used and it is therefore dropped as a lead equation. The double log form was chosen as the lead function for this study because the coefficients (bs) in the double log measure directly, the elasticity of production with respect to the inputs used.

The data from each village was subjected to a test of homoscedasticity using Bartlett's Test to determine if the variances from the two samples were statistically different from the population variance. If they were the same, then the data from the two samples could be pooled and analyzed as one otherwise, they would be analyzed separately. The test result (not shown here) but reported in Jobdi (2004) indicated that the variance of the two samples were not statistically different and consequently, the regression estimation was made for each sample and the pooled data. The estimated parameters from the two samples and the pooled data are presented in table 2. The result had an adjusted R^2 of 0.83 for Kofar and 0.87 for Yaryasa village respectively meaning that 83% and 87% respectively of the variability in yield of Garlic in these villages were explained by the specified explanatory variables (Land, seed, inorganic fertilizer, organic manure and farm labour). In addition, the F- statistics for each location was statistically significant at 1% level of probability which suggest that the Cobb Douglas model was well specified.

In terms of the specific variable input, organic manure and labour were statistically significant at 1 percent level of probability while farm size and the seed were statistically significant at 10% level in Kofar. Further analysis show that while the signs for farm size, seed, organic manure and farm labour were positive and consistent with a *priori* expectation of their positive impact on garlic production, inorganic fertilizer sign was negative and thus, tend to reduce production at present level of usage.

However, in Yaryasa, only farm labour significantly affect garlic production at 1% level while organic manure and farm size affect production at 10% (critical t= 1.29 for N>30 at 10% level of probability). The observed signs of the variables followed that observed for Kofar. In all cases the inorganic fertilizer was found not to be critical in garlic production. For the pooled data, Seed, Organic manure and farm labour were found to be statistically significant at 1% level of probability and all have the expected positive signs while farm size and inorganic fertilizer have negative signs contrary to the expectations. However, the adjusted R^2 of 0.86 shows that 86% of the variability in yield of garlic across the study villages was accounted for by the specified model. In the case of Kudi *et al.*, (2008) with four explanatory variables which included land, labour, inorganic fertilizer, agro-chemical and seed, the adjusted R^2 was 0.89 meaning that the model explained 89% of the variability in garlic yield for the area.

The estimation of the resource use efficiency was based on the ratio of Marginal Value Product to Marginal Factor Cost as in equation (7) and shown in Table 3 for the pooled data. The analysis showed that there was inefficiency in seed usage. There is over utilization of seed with resource use efficiency ratio of 0.85. The farmer can increase its efficiency by using less seed to reduce cost of production. The over utilization may be attributed to the poor quality of seed often kept from previous harvest by farmers (Kudi *et al.*., (2008). On the other hand the efficiency of Organic manure (X_4) and labour (X_s) were higher than unity (10.74 and 12.25 respectively) meaning that they were under- utilized. They were under-utilized because they were readily available and cheap and therefore farmers can use more quantities in order to increase their efficiencies. In a similar study by Kudi *et al.*., (2008), seed was also found to be over- utilized while labour was under-utilized.

The result of the partial elasticity of production of the inputs in deed indicates that an increase by one unit of seed only increase the garlic production by 12% whereas, increasing the use of organic manure and farm labour by one unit each results in 15% and 89% increase in garlic yield. The effects of land and inorganic fertilizer on the productivity of garlic in the pooled data were negative and insignificant and also show that increasing them by one unit each will results in decreasing garlic yield by 68% and 94% respectively.

The implication of these results is that land and inorganic fertilizer were not constraints to production whereas; seed, organic manure and labour were limitations. This result agreed partially with the result from Kudi *et al.*., (2008) on garlic production in Bebeji LGA of Kano State where Kofar village belong. The result from their study shows that a unit increase in seed and labour which were the common variables in the two studies increased garlic production by 1% and 23% respectively.

Conclusion and recommendations

The findings of this study reveal that there is inefficiency in resource usage for garlic production in the study areas. There is room to increase the productivity from the present average level of 3787kg/ha to the optimum level of 4000-5000kg/ha (Jobdi, 2004). To attain the optimum productivity, it is recommended that the quantity of seed should be reduced while the quantities of organic manure and labour should be increased from their present usage levels. In doing so, the cost of production will be reduced by using less of the expensive input (seed) and more of the less expensive inputs (organic manure and labour) and the profitability which has been found to positive (Kudi *et al.*., 2008) will be greatly enhanced.

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Table 1: Socio-economic characteristics of garlic producers in Kano State

Age distribution of respondents		
Age group	Frequency in group	Percentage in group
10-20	1	0.83
21-30	13	10.83
31-40	36	30.00
41-50	34	28.34
51-60	20	16.67
61 and above	16	13.33
Total	120	100.00
Number of children per Respondent		
Number of children group	Frequency	Percentage
1-5	47	39.17
6-10	53	44.17
11-15	16	13.33
16-20	1	0.83
21 and above	3	2.5
Total	120	100.0
Educational level of respondents		
Educational level	Frequency	Percentage
Islamic education	77	64.2
Primary School	35	29.2
Secondary School	7	5.8
Tertiary School	1	0.8
Total	120	100.00

Table 2: Estimated Cobb-Douglas production function for garlic in Kano State.

Input Variables	**Kofar Village**		**Yaryasa Village**		**Pooled Data**	
	Coefficient	**T-Value**	**Coefficient**	**T-Value**	**Coefficient**	**T-Value**
Constant	0.6484	1.192	1.1217	3.462	- 0.0404	- 0.161
	(0.5438)		(0.3440)		(0.2502)	
Farm Size (X_1)	0.1114	1.708***	0.0516	1.418***	- 0.0186	- 0.676
	(0.0652)		(0.3640)		(0.0275)	
Seed (X_2)	0.1061	1.829***	0.0173	0.347	0.1215	3.223**
	(0.0580)		(0.4999		(0.0377)	
Fertilizer (X_3)	-0.0149	- 0.249	-0.0258	-0.508	-0.0391	-0.944
	(0.0599)		(0.0508)		(0.0414)	
Organic Manure	0.2035	2.838**	0.0527	1.510***	0.1525	3.640**
(X_4)	(0.0717)		(0.0349)		(0.4189)	
Labour (X_5)						
	0.7152.	7.344**	0.1519	4.279**	0.8876	17.506* *
F – Value	(0.0974)		(0.3555)		(0.0507)	
	169.05**		450.08**		539.28**	
Adjusted R^2						
Σbs	0.83		0.87		0.86	
	1.12		0.248			

NB: *, ** and *** means variable is significant at 5, 1 and 10% percent respectively level of probability while figure in parenthesis indicate standard error of the coefficient.

Table 1: Estimation of the resource use efficiency among garlic producers in Kano State

Variable	**Coefficient (b_s)**	**Mean garlic yield (kg/ha)**	**Mean input level**	**MPPxi**	**Average of output (Py)**	**MVPx (N/unit)**	**Average unit price of input (MFC)**	**r =MVP/MFC**
Seed (X_2)	0.1215	3787	628 (kg/ha)	0.7323	N105/kg	76.89.	N90 (N/kg)	0.85
Organic Manure (X_4)	0.1525		8309 (kg/ha)	0.0695		7.30	N0.68 (N/kg)	10.74
Farm labour (X_5)	0.8876		720 (Man-hr)	4.6668		490.01	N40 (N/man-hr)	12.25