Analysis of Resource Productivity and the Level of Fertilizer - Manure Substitution Among Vegetable Farmers in the Southern Region of Nigeria

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Doi:10.5901/mjss.2012.v3n2.35

Abstract: *The study analyzed farm input productivity and estimated constant elasticity of substitution of fertilizer for manure for vegetable farmers in the southern region of Nigeria. Primary data obtained from four hundred and eighty vegetable farmers in Uyo and Itu regions of the southern part of Nigeria were used in the study. A combination of analytical tools including descriptive statistics (percentages, frequency and tables), and regression analysis were used for data analysis. The generalized constant elasticity of substitution function was specified and estimated through a system of coefficients relationship after which the constant elasticity of substitution of fertilizer for manure for each crop enterprise was calculated. The empirical results revealed a constant elasticity of substitution of fertilizer for manure of about 27.21% for waterleaf production and 35.11% for fluted pumpkin production in the region. The Cobb-Douglas production function for waterleaf production revealed that planting material, family labor, fertilizer, manure, and water have significant influenced on waterleaf production; while the linear production function for fluted pumpkin production revealed that seed, hired labor, fertilizer, and manure have significant impact on the quantity of fluted pumpkin produced. The result also revealed that the utilization of all significant production inputs of the two crop enterprises were in the rational zone of the classical production surface. A mean total factor productivity of 45.60% and 45.59% were realized for waterleaf and fluted pumpkin farms respectively in the region. The study however recommended that government should increase fertilizer supply to vegetable farmer at a subsidized rate, intensify effort towards increasing research on manure production to adequately complement the use of fertilizer and make land more accessible to vegetable crop farmers in the region. Also, farmers cooperative organizations should be encourage among vegetable farmers as this would make inputs acquisition less cumbersome.*

Keywords: Vegetable, fertilizer, manure, substitution, CES, waterleaf, fluted pumpkin

1.Introduction

In Sub –Saharan Africa, agriculture has continues to be a primary instrument for sustainable development, poverty reduction, attainment of household self food sufficiency and food security at large (World Bank, 2008 and Olwande et al., 2009). This is based on the fact that majority of the population are engaged in agricultural activities. This make the agricultural sector in Africa a top preference for spurring growth, overcoming poverty, and enhancing self food security. However, agricultural productivity in Africa has continued to decline over the last decades and poverty level has increased (Olwande et al., 2009). Scale economies in staple crop production and marketing are small. Staple crop production is especially plagued by many input and factor market failures (Christiaensen and Demery 2010). In Nigeria, more than 60 percent of the population is engaged in agricultural production; most of which are engaged in small scale production (Deckers, 1993 and Olutawosin and Olaniyan, 2001). The ecological zones in the country support varieties of crop production, ranging from cereals in the savanna region, root and tree crops in the rain forest and vegetables in all ecological zones.

Vegetable production has been inconsistent in Nigeria; for instance in 2005 about 4924.9 thousand tonnes were produced, while 2487.7 thousand tonnes were produced in 2006 (CBN, 2006). Vegetables are good sources of protein, mineral salts, sugars, vitamins, and essential oils that increase man's resistance to disease (Hugues and Philippe, 1995 and Christian, 2007). Mlozi, (2003) and Francisca et al., (2006) asserted that increased vegetable production improved food security and offer employment opportunities to many rural women in Nigeria.

In the southern region of Nigeria, vegetable production is popular due to its high consumption rate easily traced to it affordability. Waterleaf (*Talinum triangulare*) and fluted pumpkin (*Telfairia occidentalis*) are among the major leafy vegetables grown by farmers in the southern region of Nigeria. The popularity of these two major vegetable crops had been linked to low cost per unit of resource use in production, short gestation period and quick returns on invested capital compared to other vegetable crops (Udoh, 2005). Sustained production of vegetables in the southern region of Nigeria could only be achieved if farm inputs are readily available and utilized optimally. Therefore, rational farm resources allocation and utilization are prerequisite for attaining higher productivity in vegetable production in the southern region of Nigeria.

For instance, significant positive impact of fertilizer use on arable crop production in the southern region Nigeria has been reported by Van Reuler and Prins (1993), Udoh (1993), Alimi et al., (2001), Osuhor et al., (2002) and Akpan et al., (2010). On the other hand, Fabiyi and Ogunfowora (1992), Udoh (1993), Chinedu et al., (2002), Udoh et al., (2007), Olayinka et al., (1998), Udoh (2005) and Akpan et al., (2010) asserted significant positive influenced of manure application on arable crop production in Nigeria. Also, significant influenced of labor, capital, land size, planting material fertilizer and manure in vegetable production such as *Talinum triangulare* and *Telfairia occidentalis* has been reported by Udoh (2005), Udoh and Sunday (2007), Omonona and Babalola (2007), Nwachukwu and Onyenwaku (2007) and Enete and Ubokudom (2010) all in Nigeria. Also the cultivation of vegetable crops in Nigeria is gender biased as it is dominated by women (Amali, 1989; Okonjo, 1991; Auta et al., 2000; Mlozi, (2003); Rahman et al., 2003; Francisca et al., 2006; Damisa and Yohanna, 2007; Udoh and Sunday 2007; Nwachukwu and Onyenwaku 2007 and Rahman, 2008).

Due to the population pressure, increasing urbanization and land fragmentation in the southern region of Nigeria; vegetable crops is cutivated in the marginal or less fertile land by smallholder farmers under traditional system of farming (Spencer, 1991; Enete and Ubokudom, 2010 and Udoh and Sunday, 2007). In a situation of small farm sizes couple with the deteriorating condition of the soil, agricultural intensification becomes the means of effectively addressing the problem of self-insufficiency in food production (Pinstrup-Anderson and Pandya–Lorch, 1994). The issues on agricultural intensification have mixed impacts (Senjobi *et al.*, 2000 and DFID, 2002). Sustained vegetable production in the southern region of Nigeria could be achieved under increasing agricultural resources intensification and dynamic economic environment only if resource allocation and utilization occur in the rational stage of the classical production surface (CGIAR, 1988). The attainment of such farm objective especially in the developing countries is constrained by price inelasticity of input demand among others. Farmers in response to these constraints are compelled to adopt strategies to attain certain level of efficiency in resource allocation and utilization. Inputs substitution is one of the strategies widely used by farmers in the developing countries to avert high price of complementing inputs. Among vegetable farmers in the southern region of Nigeria, there is an evidence of increasing substitution of fertilizer for manure in their production activities (Akpan et al., 2010). Despite the inherent advantages the use of fertilizer has on food crop production and welfare of farmers, the adoption of the technology has been hindered by multifarious factors including socioeconomics characteristic of farmers (i.e. education, social status, attitude, social influence, estimated skills and resource endowments), budget constraint, characteristic of the technology (i.e. relative advantage of the technology, its profitability and compatibility), environmental factors, and unhealthy fertilizer policy as well as farmer's related factors (Rogers, 1983; Byerlee, 1997and Manyong et al., 2006).

In the face of the various agricultural programmes and policies implemented over the years by the government of various states in the southern Nigeria to rise farmers' efficiency and productivity in crop production; the important of vegetable sub sector to the economy of the southern region of Nigeria (temporary job creation, self food sufficiency, and good food complement sources), and production constraint inherent in vegetable production; there is an overwhelming need to assess the productivity of vegetable farm resources and determined level at which fertilizer is substituting for manure in the production of vegetables in the region. Indices of farm resource productivity and allocation would help in formulating sustainable policy frame work from which sound farm level policy could be base in the region. For an example, effective fertilizer policy in the region would be promoted if the farm production and allocation index relating to fertilizer use among farmers is known with certainty. If the index is low, the need for intensification policy could be advocated and vice visa. Therefore, the study specifically assessed the resource productivity of vegetable farmers and also determined the constant elasticity of substitution of fertilizer for manure among vegetable farmers in the southern region of Nigeria. We assumed that the index of manure-fertilizer substitution among vegetable farmers in the southern Nigeria is approximately constant due to the insignificant change in the sub sector's output and subsistence nature of production of the enterprise over the years (AKSMA, 2010).

2. Research Methodology

2.1 The study area; data sources and collection procedures

The study was conducted in Uyo region and Itu region in Akwa Ibom State and Cross River state all located in the southern region of Nigeria. Uyo region consisted of Uyo, Uruan and Ibesikpo local government areas of Akwa Ibom state. The Itu region consisted of Itu, Odukpani and Calabar local government areas of Akwa Ibom state and Cross River State. Uyo and Itu lie within the humid tropical rainforest zone of Nigeria with an average annual precipitation range of 2000 - 3000mm. Uyo is located between latitude $5^{o}17^{1}$ and $5^{o}27^{1}$N and longitude $7^{o}27^{1}$ and $7^{o}58^{1}$E and covers an area of approximately 35 square kilometers as well as a population of 305,961; while Itu is situated within latitude 40^{o} and 20^{o}N of the equator and longitude 30^{o} and 47^{o}E of the median and has an area of about 128.32 square kilometers as well as a population of 127, 850 (NPC, 2006). The areas are basically an agrarian environment and vegetable production is very prominent among the inhabitants. Two – stage random sampling technique was used to select two hundred and forty waterleaf farmers in Uyo region and another two hundred and forty fluted pumpkin farmer from intense cultivation area in Itu region. Primary data collected from the farmers consisted of socio-economic and production data. Personal interviewed were also conducted to validate the consistency and accuracy of information supplied by the respondents.

2.2 Analytical Techniques

A combination of analytical tools including descriptive statistics (percentages, frequency and tables), and regression analysis were used in the study. The regression analysis involved specification of various forms of production functions. An implicit production function specified was as follows;

$Y_{WP}=f\ (QS, FL, MA, DEP, HL, FER, LNS, WAT)$ ……………………..….......... (1)

Where,
Y_{WP} = Output of waterleaf or pumpkin (kg)
QS_{wp} = Quantity of seed or planting material (kg); HL = (in man days)
FL = Family labour (in man day); FER = quantity of fertilizer used (kg)
MA = Quantity of Manure used (kg); LNS = land size (in hectares)
DEP = Depreciation as a proxy of capital stock (₦)
WAT = quantity of water used (in litres); U = Error term

The study specified only the important production inputs used in vegetable production in the areas. From the survey it was noticed that about 99.9% of vegetable farmers in the regions do not used herbicides or any form of agro chemical in the production of vegetables. Cultural barriers, unfounded rumors and high price were some of the reasons farmers refused to applied chemicals in their farms.

To determine the constant elasticity of substitution of fertilizer for manure by waterleaf and fluted pumpkin farmers in the study areas, the generalized constant elasticity of substitution (CES) production function was specified for each of the crop enterprise as follows (Kmenta, 1967);

$Y_i = f\ (FER, MAN) = A\ [\delta FER^{-\beta} + (1-\delta)\ MAN^{-\beta}]^{-V/\beta}$ ……………………………..…. (2)

Where; A = efficiency parameter $(A>O)$; δ = distribution parameter $(O < \delta < 1)$
β = substitution parameter $(\beta \geq -1)$; Y_N = normalized output of the i_{th} crop in kg
FER and MAN are as defined in equation (1) but were normalized using output price in equation (2).
V = return to scale parameter $(v>o)$

Kmenta (1967) states that in the above CES function, when β is in the neighborhood of zero or when the elasticity of substitution σ is in the neighborhood of unity, that the CES function can be approximated with a Taylor expansion series around $\beta = 0$. Using Taylor expansion series around $\beta = 0$; equation (2) was linearized as in equation (3) and ordinary least squares method used to estimate it in the form of equation (4). Hence,

$In(Y_N)=In(A)+V\delta In(FER)+V(1-\delta)In(MAN)-\beta V\delta/2(1-\delta)In(FER)^2-\beta V\delta/2(1-\delta)In(MAN)^2 + \beta\ \ V\delta(1-\delta)\ \ InFER)\ In(MAN) + e_i$…………………………………………..……..….(3)

Further simplification of equation (3) yield,

$In(Y_N) = bo + b_1 In(FER) + b_2 In(MAN) + b_3 In\{In(FER) - In(MAN)\}^2 + e_i$…....................…..…(4)

The implication of the transformation is that, fertilizer and manure technology is assumed to have a constant elasticity of substitution in the production of vegetable crops in the region due to the production constraints inherent in its production. And this elasticity of substitution is assumed to be in the neighborhood of unity. Following this assumptions, the input and the output values observed for the production of these crops could be fitted to equation (4). It then follow that the restriction stated below could be used to test whether the estimated function does in fact approximate the CES function in equation (2) and thus estimate the CES parameters A, δ, β and V.

A = *antilog of* bo, $V = b_1 + b_2$, $\delta = b_1/(b_1 + b_2)$, $\beta = -2b_3(b_1 + b_2)/b_1 b_2$ *and* $\sigma = 1/(1+\beta)$

Where, **σ** is the elasticity of substitution of fertilizer for manure in the production of each crop output. Given the above definition of **σ,** the following relationships between **σ** and **β** hold (Bruno et al, 2005).

- $\sigma = \infty$ then $(\beta = -1)$: CES takes the linear form and the inputs are perfect substitute so that the farmers have no special preference for any of the inputs.
- $\sigma = 1$ then $(\beta = 0)$: CES becomes Cobb Douglas function and expressed a perfect balance between substitution and complementary effects. That is unity elasticity of substitution between the two inputs.
- $\sigma < 1$ *then* $(\beta > 0)$: CES function becomes production function with significant complementarity's effect between inputs.

- *σ >1 then (β< 0):* CES function shows inputs that are partial substitutes.
- *σ* **=** *0 then (β***=** *∞):* CES takes the form of Leontief production function. This means that, the optimal inputs combination or substitution in the production process does not depend on input prices but fully determined by the parameters defining the production function.

Equation (3) and (4) are similar so that the parameters of CES were estimated using a system of coefficient relationship described above.

3. Result and Discussion

3.1 Socioeconomic Characteristic of Vegetable farmers in the Southern Nigeria

The socioeconomic characteristics of vegetable farmers in the southern region of Nigeria are summarized in Table 1. The survey revealed that female farmers dominated the cultivation of waterleaf (100%) and fluted pumpkin (91.67%) in the southern region of Nigeria. The result revealed the significance of agricultural activities to the sustenance of rural women folk in the southern Nigeria.

Table 1: Socio-economic Characteristics of Vegetable farmers in Uyo and Itu regions of Southern Nigeria.

	Fluted Pumpkin		*Waterleaf Frequency*	
Characteristics	***Frequency***	***Percentage***	***Frequency***	***Percentage***
Sex Distribution				
Male	20	8.33	0	0.00
Female	220	91.67	240	100.00
Total	**240**	**100.00**	**240**	**100.00**
Age Range (Yrs)				
< 30	30	12.50	30	12.50
31-60	192	80.00	204	85.00
> 60	18	7.50	6	2.50
Total	240	**100.00**	**240**	**100.00**
Marital Status				
Single	30	12.50	12	5.00
Married	162	67.50	132	55.00
Divorcee	12	5.00	30	12.50
Widowed	36	15.00	66	27.50
Total	**240**	**100.00**	**240**	**100.00**
House Hold Size (Yrs)				
< 5	66	27.50	60	25.00
5-10	138	57.50	162	67.50
> 10	36	15.00	18	7.50
Total	**240**	**100.00**	**240**	**100.00**
Level of Education (Yrs)				
No Formal Education	18	7.50	36	15.00
Primary School	138	57.50	108	45.00
Secondary School	60	25.00	72	30.00
Tertiary Education	24	10.00	24	10.00
Total	**240**	**100.00**	**240**	**100.00**
Primary Occupation				
Farming	174	72.50	174	72.50
Trading	24	10.00	18	7.50
Civil Service	12	5.00	30	12.50
Others	30	12.50	18	7.50
Total	**240**	**100.00**	**240**	**100.00**
Total Income/annum (₦)				
< 100,000	84	35.00	42	17.50
100,000 – 200,000	72	30.00	132	55.00
200,001 – 300,000	42	17.50	36	15.00
300,001 – 400,000	12	5.00	9	2.50

> 400,000	30	12.50	24	10.00
Total	**240**	**100.00**	**240**	**100.00**
Farming Experience (Yrs)				
< 1	20	8.33	50	20.83
1 – 5	50	20.83	90	37.50
> 5	170	70.84	100	41.67
Total	**120**	**100.00**	**240**	**100.00**
Farm Size (ha)				
< 0.1	40	16.67	70	29.17
0.1 – 1.0	196	81.67	170	70.83
> 1.0	4	1.66	0	0.00
Total	**240**	**100.00**	**240**	**100.00**

Source: Computed by the authors from field Survey, 2010

The finding implies that women are the dominant force in arable crop production in Nigeria and that poverty alleviation programme targeted on women in the southern region of Nigeria would probably performed better through agricultural sector. The result corroborates the findings of Amali, (1989), Okonjo (1991); Auta et al., (2000); Mlozi, (2003); Rahman et al., (2003); Francisca et al., (2006); Damisa and Yohanna, (2007); Udoh and Sunday (2007); Nwachukwu and Onyenwaku (2007) and Rahman, (2008) in Nigeria.

Eighty percent of waterleaf farmers and eighty five percent of fluted pumpkin farmers fell within the age bracket of 30 and 60 years with an average age of about 42 years for both enterprises. This implies that, active labor force is involved in the cultivation of waterleaf and fluted pumpkin and this has a positive implication for vegetable production in southern Nigeria. This is an incentive to agricultural innovation dissemination as younger farmers are more likely to adopt new technology in agricultural production (Udoh and Sunday, 2007 and Akpan et al., 2010).

The surveys also revealed that majority of vegetable farmers (i.e. 67.50% for fluted pumpkin farmers and 55% for waterleaf farmers) in the region are married and have household size range of 5 to 10 members (57.50% for pumpkin and 67.50% for waterleaf) as well as an average household size of 6 members. The result could be explained by the fact that most vegetable farmers in the region used the proceeds from the vegetable enterprise to augment family income and employed relatively large and cheap family labor in vegetable production. These have a positive implication on farmers' welfare, sustainability of the enterprise and cost minimization objective of vegetable farms in southern Nigeria.

Also, majority of vegetable farmers have at least 6 years of formal education with an average of 8 years for all respondents. The result implies that there is a high probability of innovation adoption and diffusion among vegetable farmers in the southern Nigeria. Around 35% of fluted pumpkin farmers made less than ₦100,000 per annum with an average of about ₦200,000/annum; while 55% of waterleaf farmers made between ₦200,001 and ₦300,000 per annum with an average of about of ₦270,000/annum. This means that vegetable cultivation is profitable in the southern Nigeria. In addition, the result showed that majority of vegetable farmers in the region (about 70% for waterleaf and 41.67% for fluted pumpkin) have farming experience greater than 5 years with an average farming experience of about 7 years for fluted pumpkin and 6 years for waterleaf farmers. This indicates that vegetable cultivation is an emerging enterprise in the in southern Nigeria with vast potentials for increase private investment.

About 80% of fluted pumpkin farmers and 70.83% of waterleaf farmers have farm size that is between 0.1 ha to 1.0 ha with a mean farm size of 0.65 and 0.12 for fluted pumpkin and waterleaf farms respectively. The result could be attributed to the continuous subsistence nature of cultivation of vegetable crops in the southern Nigeria imposed by increasing land fragmentation and urbanization. The finding consolidated the research report by Nwachukwu and Onyenwaku (2007) and Akpan et al., (2010).

4. Result of the regression Analysis

The estimates of production functions for waterleaf and fluted pumpkin in the southern region of Nigeria are presented in Tables 2 and 3. Various functional forms were estimated for each crop enterprise. The diagnostic tests and number of significant variables as well as the information criteria were used as basis for selecting the lead or best equation. Double log production function was selected as the best functional form for vegetable production.

Table2: Regression results for waterleaf production in Uyo region in southern Nigeria.

Variable	Linear	Exponential	Semi-log	Double-log (L*)
Constant	61.787 (2.083)**	4.742 (35.034)***	-55.801 (-1.856)*	1.517 (1.728)*
Planting Material	0.534 (4.932)***	0.002 (4.483)***	17.775 (4.447)***	0.108 (6.789)***
Hired Labor	-0.001 (-0539)	-5.65e-006 (-0.834)	2.055 (0.490)	0.002 (0.179)
Family Labor	0.001(-0.358)	8.08e-009 (0.154)	2.687 (3.508)***	0.007 (4.657)***
Fertilizer	0.114 (0.195)	0.001 (0.398)	8.731 (1.794)*	0.005 (2.500)**
Manure	0.014 (0.238)	0.001 (0.761)	-3.099 (-0.126)	0.084 (2.466)**
Land size	-3.948 (-1.238)	-0.304 (-0.250)	-5.150 (-1.653)*	-0.108 (–1.074)
Depreciation	0.002 (1.680)	7.86e-006 (1.256)	17.857 (1.361)	0.047 (1.215)
Water	0.022 (1.165)	0.001 (1.857)*	1.958) (2.606)**	0.440 (2.849)***
		Diagnostic Statistics		
R^2	0.848	0.757	0.813	0.877
Adjusted R^2	0.809	0.694	0.764	0.846
F – Statistic	21.600***	12.040***	16.817***	27.745***
Akaike Criterion	444.31	212.36	95.61	24.43
Schwarz Creterion	459.51	127.56	98.34	27.45
Hannan-Quinn	499.81	117.86	92.63	27.42
RESET test	1.96(0.172)	33.09(0.000)***	2.300(0.201)	4.67(0.0300)**
Normality test	0.35 (0.838)	6.560(0.038)	17.778(0.000)***	17.78(0.000)***

Note: Values in bracket represent t-values; asterisks*,**, and *** represent significance levels at 10%, 5% and 1%. Variables are as defined in equation (1). Where L* represents the lead equation.

The result of the diagnostic test showed the R^2 value of *0.877* for the lead equation. This means that about 87.70% of variations in waterleaf output (Y_W) are caused by the specified independent variables. The F-statistic value of *27.745* for the lead equation is statistically significant at 1% probability level, suggesting that that R^2 is significant and this implies goodness of fit for the log linear model. The RESET test result is significant at 1% probability level and this indicates that the equation is not mis-specified and that the assumption of log linearity among variables is correct. The information criteria indicate the relevant of the selected equation. The normality test confirmed the appropriateness of the ordinary least squares technique.
The empirical result showed that, planting material (QS_w) has a significant positive relationship with the waterleaf output. This implies that when the quantity of planting materials is increased, the output of waterleaf would also increase. The result corroborates the research findings reported by Udoh (2005); Udoh and Sunday (2007) and Omonona and Babalola (2007) on vegetable production in Southern Nigeria. Also, family labor (FL) and fertilizer (FER) have a stimulating or positive correlation with the quantity of waterleaf output in the region. In a similar way increasing these inputs would result in increase in waterleaf output in the region. Udoh and Sunday (2007) and Enete and Ubokudom (2010 have reported similar result for waterleaf production in Akwa Ibom state in the southern Nigeria. In a similar way, the quantity of manure (MA) and volume of water (WAT) used by waterleaf farmers have significant positive impact on waterleaf output in the region; this also indicates a stimulating influence of these inputs on waterleaf output. Udoh (2005) reported similar result for vegetables farmers in south-south zone of Nigeria.

Table 3: Estimated Cobb-Douglas production parameters for waterleaf production in Uyo region of southern Nigeria.

Variable	Average productivity	Marginal productivity	Elasticity of production
Planting Material	5.9824	0.6464	0.108
Family Labour	0.6145	0.0043	0.007
Fertilizer	3.8223	0.0182	0.005
Manure	0.4759	0.0400	0.084
Water	0.0450	0.0198	0.440

Source: computed by the authors

The estimated parameters showed that the average productivities of all significant variables are greater than their marginal productivities respectively. This implies that the level of input utilization in the production of waterleaf in the southern region of Nigeria is in the rational zone in a classical production surface. Since waterleaf production enterprise in the southern Nigeria has the features of perfect market structure, it therefore means that farmers are price-takers; as such optimum input/output combination occurs in stage II in a classical production surface. Therefore a unit increase in these inputs would only result in marginal increase in the output of waterleaf produced by farmers. For instance, 10% increase in planting material (QS_W), family labor (FL), fertilizer (FER), manure (MAN) and water (WAT) would result in 6.5Kg, 0.04Kg, 0.18Kg, 0.40Kg, and 0.19Kg units' marginal increase in waterleaf produced respectively. Also the production elasticity value with respect to each significant input revealed inelastic relationship with the waterleaf output. This implies that a unit change in the significant inputs would result in a less than equivalent unit change in the waterleaf output. The scale of production of waterleaf enterprise in the region revealed a decreasing return to scale value of 0.644. This means that continuous increase in the utilization of the specified inputs would result in a decreasing waterleaf output in the long run. The mean total factor productivity (TFP) of about 4.56 {i.e. antilog (1.517)} is obtainable among waterleaf farms in the region. This implies that inputs productivity among waterleaf farms in the southern region of Nigeria is high; and this further revalidates the rational used of farm inputs among waterleaf farmers in the region.

Similarly the estimated production functions for fluted pumpkin are presented in Table 3. The linear form was picked as a lead equation (L*) because it has the highest coefficient of determination (R^2 = 0.685) and more significant explanatory variables compared to other models estimated. For the lead equation, the F-statistic (3.531) is highly significant at 1% level which justifies the goodness of fit of the lead equation.

Table 4: Regression results for Pumpkin production in Itu region in southern Nigeria.

Variable	Linear L*	Exponential	Semi-log	Double-log L
Constant	255.89 (2.483)**	5.341(25.709)***	-1125.94 (-1.296)	1.524 (0.941)
Planting Material	0.78 (2.167)**	0.001 (1.765)*	142.15 (1.421)	0.341 (1.830)*
Hired labor	0.001 (1.680)*	4.96e-006(1.835)*	42.32 (0.682)	0.149 (1.287)
Family Labor	-0.002 (-0.815)	-2.76e-006 (0.730)	-22.001 (-1.055)	-0.057 (-1.459)
Fertilizer	1.470 (1.861)*	0.002 (1.753)*	0.328 (0.005)	-0.064 (-0.502)
Manure	0.080 (3.773)***	1.86e-005 (0.045)	5.839 (0.071)	0.062 (0.407)
Land Size	-0.546(-6.067)***	-0.006 (-0.022)	-23.03 (-2.239)**	-0.033 (-2.183)**
Depreciation	0.0001(0.300)	1.64e-006 (0.689)	33.031 (0.761)	0.099 (1.219)
Diagnostic Statistics				

R^2	0.685	0.535	0.284	0.423
Adjusted R^2	0.590	0.491	0.111	0.384
F – Statistic	3.531***	2.216**	1.640	3.040***
Akaike Criterion	60.96	65.94	526.54	61.44
Schwarz Creterion	75.85	78.83	539.43	74.33
Hannan-Quinn	53.51	70.49	531.09	65.98
RESET test	0.219(0.044)**	0.009(0.095)*	0.11(0.742)	0.002(0.968)
Normality test	20.56(0.000)***	5.18(0.075)*	31.30(0.000)***	5.28(0.071)*

Note: **A**sterisks*,**, and *** represent significance levels at 10%, 5% and 1%. Variables are as defined in equation (1). Figures in bracket are t-values and L* represents the lead equation.

The RESET test result is significant at 1% probability level indicating that the equation is not mis-specified and that the assumption of linearity among variables is correct. The information criteria and normality test indicate the important and correctness of the selected equation and the used of ordinary least squares technique respectively.

The empirical result revealed that the coefficient of pumpkin seed (QS_p) has a significant positive relationship with the quantity of fluted pumpkin produced by farmers. The result implies that 10 percent increase in the quantity of seed used would result in 7.8 percent units increase in pumpkin output. Similarly, the coefficient of hired labor (HL) used in the production of fluted pumpkin has a stimulating influenced on the pumpkin output. This indicates that a unit increase in (HL) would result in 0.001 units increase in the fluted pumpkin output.

The slope coefficients of fertilizer (FER) and manure (MAN) have significant positive impact on fluted pumpkin output in the study area. The results imply that 100 percent increase in both inputs would result in 147.0 and 8.0 percent increase in pumpkin output respectively. On the other hand, the coefficient of land size (LNS) has a significant negative relationship with fluted pumpkin output. The result indicates that a unit increase in land size would retard fluted pumpkin output by 0.546 units. The reasons for the result might be explained by declining soil fertility in the study area attributed to increase soil intensification and the issue of high cost of mineral fertilizer in the region. The mean total factor productivity (TFP) of about 4.59 {i.e. antilog (1.524)} was obtainable among fluted pumpkin farms in the region. This implies that inputs productivity among fluted pumpkin farms in the southern region of Nigeria is high; and this further reaffirmed the rational used of farm inputs among pumpkin farmers in the region.

Table 5: Estimated Linear production function Parameters for Fluted Pumpkin in Itu region of southern Nigeria

Variable	Average productivity	Marginal productivity	Elasticity of production
Planting Material	0.29105	0.078	0.26700
Hired Labour	0.01234	0.001	0.08104
Fertilizer	7.32953	1.470	0.19885
Manure	1.38695	0.080	0.05768
Land Size	636.34266	-0.546	-0.00086

Source: Computed by authors

The average productivities of all significant variables are greater than their marginal productivities respectively. This means that the level of input use in the production of fluted pumpkin in the study areas is in the rational zone in a classical production surface. The elasticity of production of fluted pumpkin with respect to each of the significant variable; planting material (QS_p), hired Labor (HL), fertilizer (FER), manure (MAN), and land size (LANS) revealed an inelastic relationship. The scale of production in fluted pumpkin enterprise in the study area revealed a decreasing return to scale value of 0.6037. This means that continuous increase in significant inputs would result in a decreasing fluted pumpkin output in the long run.

4.2 Estimates of constant elasticity of substitution of fertilizer for manure for vegetable farmers in Uyo and Itu regions in the southern part of Nigeria.

The first part of the result in Table 6 shows the estimated equation (4) for waterleaf and fluted pumpkin farms. The F-values of (11.287) for waterleaf, and (3.864) for fluted pumpkin production are statistically significant at 1 percent level respectively. This indicates goodness of fit for the specified double log linear model in equation (4). The value of R^2 for each crop enterprise shows considerable variations in outputs were caused by the use of fertilizer and manure.

Table 6: Constant elasticity of substitution parameters for vegetable farmers in Uyo and Itu regions of Southern Nigeria.

Variable	Waterleaf	Pumpkin
bo	-0.899 (-3.167)***	-0.536(-1.899)*
b_1	0.026(0.399)	0.306(1.236)
b_2	0.485(4.775)***	0.691(2.346)**
b3	-0.033(-1.668)*	-0.196(-2.361)**
R^2	0.485	0.510
F-cal	11.287***	3.864***
CES		
A	0.1262	0.2911
V	0.511	0.997
δ	0.0508	0.3069
β	2.6745	1.848
σ	**0.2721**	**0.3511**

Note: figures in bracket are t-values, while *,** and*** represent 10%, 5%, and 1% significance levels respectively. Variables are as defined in equation 2.

The second part showed the approximated CES parameters and the last part revealed the constant elasticity of substitution of fertilizer for manure in the production of waterleaf and fluted pumpkin crops. The result revealed that in the production of waterleaf and pumpkin, the constant elasticity of substitution of fertilizer for manure is 0.2721 and 0.351 respectively and is less than unity. This implies that the use of fertilizer and manure inputs in the production of vegetables in southern region of Nigeria has a significant complementarity effect between them. This means that manure is frequently used to complement fertilizer in the production of waterleaf and fluted pumpkin in approximated constant rate of 0.2721 and 0.351 respectively in the southern region of Nigeria. The efficiency parameters (A) with respect to the used of fertilizer and manure in waterleaf production is about 12.62% and 29.11% for fluted pumpkin production. The scale of production (V) revealed a decreasing return to scale of 0.511 for waterleaf production and 0.997 for fluted pumpkin production. The substitution parameters are less than unity for both crops and revealed one-sided substitution of one input for another. This further validates the fact that more manure is used than fertilizer by vegetable farmers in the region.

5. Summary and Recommendations

The study analyzed farm input productivity and fertilizer - manure substitution among waterleaf and fluted pumpkin farmers in the southern region of Nigeria. Descriptive statistics and Ordinary Least Squares regression model were used in the analysis. Empirical results revealed that planting material, family labor, fertilizer, manure, and water are significant farm inputs affecting the production of waterleaf; while planting material, hired labor, fertilizer, manure, and land size affect fluted pumpkin production in the southern region of Nigeria. Constant Elasticity of Substitution of fertilizer for manure less than unity was discovered for the crop enterprises. The result also indicated that the level of farm resources use in both waterleaf and fluted pumpkin production in the region were in the rational stage of classical production surface. In addition, the findings revealed the presence of decreasing return to scale in waterleaf and fluted pumpkin production.

The study therefore recommended that the state government of the region should increase fertilizer supply to vegetable farmer at a subsidized rate. Also, government and private investors should intensify effort towards increasing research on manure production to adequately complement the use of fertilizer among vegetable farmers in the southern region of Nigeria. In addition, the regional governments should make land more accessible to vegetable crop farmers in the region. This could be achieved through land extensification programmes such as: land reclamation, development of Fadama and provision of accessible roads to interior or undulating landscape areas. Farmers cooperative organization should be encourage among vegetable farmers as this would make inputs acquisition less cumbersome. Vegetable production is a profitable venture in the southern part on Nigeria, thus increase private investment is strongly advocated.

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