ANALYSIS OF TOTAL FACTOR PRODUCTIVITY AMONG SMALL-HOLDER VEGETABLE FARMERS IN AKWA-IBOM STATE, NIGERIA

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ABSTRACT

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The study analyzed factors which affect total factor productivity (TFP) among waterleaf farmers in Uyo and fluted pumpkin farmers in Itu local government areas of Akwa Ibom State, Nigeria. A total of 120 waterleaf farmers and 120 fluted pumpkin farmers were sample using two-stage random sampling technique. Major production variables of the two crop enterprises were fitted on Cobb-Douglas production function to investigate output elasticity with respect to the specific farm inputs and also determine crop enterprise scale of production. We defined TFP in the individual farm as a reciprocal of the average variable cost of each vegetable farm sample. The empirical results revealed that output of vegetables has inelastic relationship with farm resources, and decreasing return to scale exists in both crop enterprises. The Ordinary least squares linear regression estimates of determinants of total Factor Productivity among Waterleaf and Fluted Pumpkin farmers revealed that farm size, hired labor, age, household size, farmer’s income, accessed to credit, experience, water and planting materials are significant factors that affect TFP among waterleaf farms; while farm size, hired labor, income earned, extension visit, credit facilities, fertilizer and planting materials are factors which affect TFP among fluted pumpkin farms. The study however recommended that farm level policies aimed at intensifying extension services among vegetable farmers, provision of water especially for upland vegetable cultivation and credit facilities at a subsidized interest rate to vegetable farmers in the state should be implemented to help sustain vegetable sub sector in the state. Also, policy aimed at encouraging private investment in the vegetable production was strongly advocated.

Key Words: Total Factor Productivity, waterleaf, fluted pumpkin, vegetable, farmers, Akwa Ibom

INTRODUCTION

In Nigeria, the trend in vegetable production has shown undulating pattern; 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, Bakhru, 2003 and Christian, 2007). Mlozi, (2003) and Francisca et al., (2006) asserted that increased in vegetable production improved food security and offered employment opportunities to many rural women in Nigeria. According to Kebede and Gan (1999), the main sources of farm income for small and limited resource farmers are basically arable crop production consisting of vegetable and non-vegetable crops. Asian Vegetable Research Development Centre for Africa (AVRDC) (2004) documented that vegetables are the most affordable and accessible sources of micronutrients and its production is increasingly recognized as a catalyst for rural development and as a means of generating foreign exchange in developing countries.

In Akwa Ibom State, vegetable production is popular due to its high consumption rate easily traced to it affordability. Waterleaf (Talinum triangulare) and pumpkin (Telfairia occidentalis) are among the major leafy vegetables grown by small-holder farmers in Akwa-Ibom State. Their popularity is linked to the low cost per unit of resource use in the production, short gestation period and quick returns on invested capital compared to other crop enterprises (Udoh and Sunday, 2007). Sustained production of vegetables in the state could only be achieved if farm inputs are readily available and utilized optimally. Therefore, rational farm resource utilization is the prerequisite for attaining higher productivity in vegetable production in the state. Empirical evidences abound in the literature on factors that affect arable crop productivity. Some of the factors include technology and labor employment (Piana, 2001), education and training of farm operators (Stefanon and Saxena, 1988; Edet and Etim, 2010), agro-environmental conditions (Gorton and Davidson, 2004), security of land ownership rights (Chistiou, 2001), land, labor, fertilizer and education (Alimi et al., 2001; Osuhor et al., 2002; Bamidele et al., 2008 and Akpan et al., 2010), funding, and physical quantity of output and quantity of inputs required (Huffman and Svenson, 2003), age, credit, income earned from farming and farmer’s experience (Masterson, 2005; Gul Unal, 2008; Okoye et al., 2008 and Ukoha et al., 2010). The important of manure on vegetable production in Nigeria has been also reported by Udoh (2005), Chinedu et al., (2002), Edet and Etim (2010) and Akpan et al., (2010). Also, significant influenced of labor, capital, land size and planting material, fertilizer and manure on vegetable (Talinum triangulare and Telfairia occidentalis) cultivation has been documented by Udoh (2005), Udoh and

Due to the population pressure, increasing urbanization and land fragmentation in Akwa Ibom state; vegetable production in the state is mostly practiced in marginal or less fertile land by smallholder farmers under traditional system of farming (Akpan et al., 2010). In a situation of small farm size, agricultural intensification is the key to effectively addressing the problem of self-insufficiency in food production (Pinstrup-Anderson and Pandya-Lorch, 1994). The issues on the agricultural intensification have mixed impacts (Senjobi et al., 2000). Sustained vegetable production in the state could be achieved under increasing agricultural resources intensification and dynamic economic environment only if resource utilization occurs in the rational stage of the classical production surface. Given the important of vegetable sub sector to the economy of Akwa Ibom state (job creation, self food sufficiency, and food complement source); the production constraints inherent in vegetable production and various agricultural programmes as well as policies implemented in the state to boost vegetable production; it has become imperative to empirically analyze determinants of total factor productivity among vegetable farms in the state. The indices of farm resource productivity will further guide policy makers in formulating sustainable policy frame work for the improvement of welfare of vegetable farmers, which will lead to increase in productivity. Therefore, the study specifically analyzed farm resource productivity and total factor productivity as well as factors influencing total factor productivity among waterleaf and fluted pumpkin farmers in the state.

**MATERIALS AND METHODS**

**The study area; data sources and data collection procedures**

The study was conducted in Uyo and Itu Local Government areas in Akwa Ibom State, south-south region of Nigeria. Uyo and Itu lie within the humid tropical rainforest zone of Nigeria with an average annual precipitation range of 2000mm - 3000mm. Uyo is located between latitude 5°17' and 5°27’N and longitude 7°27’ and 7°58’E and covers an area of approximately 35 square kilometers and has a population of about 309573 (i.e. 153113 males and 156460 females); while Itu is situated within latitude 4°0’ and 20’N of the equator and longitude 30’ and 47°E of the median and has an area of about 128.32 square kilometers and a population of about 127033 (i.e. 67566 males and 59467 females) (NPC, 2006). Two – stage random sampling technique was used to select 120 (one hundred and twenty) waterleaf farmers and 120 fluted pumpkin farmers from areas of intense cultivation in Uyo and Itu local government areas respectively. Primary data collected consist of socio-economic and production data. Personal interviewed was also conducted to validate the consistency and accuracy of information from the respondents.

**Analytical techniques**

Cobb-Douglas production function was estimated and used to analyze individual factor productivity and scale of production in both waterleaf and fluted pumpkin enterprise. Hence the explicit Cobb Douglas production function was described as follows;

\[ Y_i = A X_1^{\beta_1} X_2^{\beta_2} \]

Where \( \beta_1 \) and \( \beta_2 \) are factor coefficients or elasticity. \( \beta_1 + \beta_2 = 1 \) simply means constant return to scale; \( \beta_1 + \beta_2 > 1 \) implies increasing returns to scale; \( \beta_1 + \beta_2 < 1 \) indicates decreasing return to scale. \( Y \) is a measure of output, while \( X_1 \) and \( X_2 \) represent production inputs. “A” is called the mean total factor productivity because it increases all factors’ marginal product simultaneously (McCloskey 1972). The Cobb Douglas production function for each of the crop enterprise was specified as follows;

\[ \log Y_i = \beta_0 + \beta_1 \log SED + \beta_2 \log HIL + \beta_3 \log FAL + \beta_4 \log FER + \beta_5 \log MAN + \beta_6 \log LAS + \]

\[ \beta_7 \log DEP + \beta_8 \log WAT + U_i \]

Where

- \( Y_i \) = Quantity of leafy waterleaf or leafy fluted pumpkin produced by \( i \)th farmer (Kg)
- \( SED \) = Quantity of seed or planting material (kg)
- \( HIL \) = Hired labor (in mandays)
- \( FAL \) = Family labor (in mandays)
- \( FER \) = Fertilizer (kg)
- \( MAN \) = Manure (kg)
- \( LAS \) = Farm size (ha)
- \( DEP \) = Depreciation of fixed asset (₦/Kg)
- \( WAT \) = Water (in litres)
- \( \beta \)’s = Vegetable output elasticity with respect to various inputs
Following Key and McBride (2003); Bamidele et al., (2008) and Ukoha et al., (2010), individual farm TFP can be measured as the inverse of unit variable cost. This is so since TFP is the ratio of the output to the Total Variable Cost (TVC) as shown in equation 3.

\[ TFP = \frac{Y}{TVC} = \frac{Y}{\sum P_i X_i} \]  

But since

\[ AVC = \frac{TVC}{Y} \]

then

\[ TP = \frac{Y}{AVC} = \frac{1}{AVC} \]

Where \( Y \) = quantity of output in kg and TVC = Total Variable Cost, \( P_i \) = unit price of variable input and \( X \) = quantity of variable input. This methodology ignores the role of Total Fixed Cost (TFC) as this does not affect both the profit maximization and the resource-use efficiency conditions. Besides, it is fixed and as such a constant. To determine factors which affect total factor productivity (TFP) among vegetable farmers in Akwa Ibom state, the Ordinary Least Square regression method was applied on diverse econometric specifications, namely, the linear, Cobb-Douglas, semi-log, and the exponential functional forms for each of the crop enterprise. The linear model gave the best fit of the explanatory variables and was selected as the lead equation. The model implicitly is described as thus:

\[ TEP = \phi_0 + \phi_1 LAS + \phi_2 HIL + \phi_3 AGE + \phi_4 HHS + \phi_5 EDU + \phi_6 INV + \phi_7 EXT + \phi_8 CRE + \phi_9 EXP + \phi_{10} FER + \phi_{11} DEP + \phi_{12} WAT + \phi_{13} SED + U \]  

Where:
- TFP = Total Factor Productivity of individual farm
- LAS = Farm size (ha)
- HIL = Hired labor (Mandays)
- AGE = Age of the farmers (years)
- HHS = Farmer’s household size (number)
- EDU = Educational attainment (years)
- INV = Income earned from vegetable enterprise 
- CRE = Credit access (1 = access, 0 = non access)
- EXP = Farmer’s experience (years)
- FER = Fertilizer use (Kg)
- DEP = Depreciation cost of fixed capital (Proxy of Capital Utilization)
- WAT = Quantity of water used (liter)
- SED = Quantity of planting material (Kg)
- U = Stochastic error term

RESULTS AND DISCUSSIONS

Table 1 presents estimates of the Cobb-Douglas production function for Waterleaf and Fluted pumpkin Farmers in Akwa Ibom State, Nigeria. The results of diagnostic test show \( R^2 \) values of 0.983 and 0.723 for waterleaf and fluted pumpkin production respectively. This means that about 98.30% and 72.30% of variations in waterleaf and fluted pumpkin outputs respectively are caused by the specified farm inputs. The F-statistic values of 7.036 and 3.040 for waterleaf and fluted pumpkin function are statistically significant at 1% probability level respectively, denoting the correctness and fitness of the Cobb Douglas regression model. The RESET test result is significant at 5% and 1% probability levels for waterleaf and fluted pumpkin enterprises respectively. This indicates that the equations are not mis-specified and that the assumption of log linearity among variables in the models is correct. The normality test for both equations are statistically significant at 1% and 5% probability levels respectively, thus justifying the use of ordinary least square method of estimation for the Cobb-Douglas models. The information criteria indicate the relevant of the specified explanatory variable presented in the models. 

Table 1: Estimates of Cobb-Douglas production Parameters for Waterleaf and Fluted pumpkin Farmers in Akwa Ibom State, Nigeria.
Analysis of farm resource productivity in waterleaf production in Uyo area of Akwa Ibom State

The empirical result showed that, planting material (SEDW) has a significant positive relationship with the waterleaf output. This implies that when the quantity of the planting material is increase, the output of waterleaf would also increase. The result corroborates the research findings reported by Udoh and Sunday (2007); Udoh (2005) and Omonona and Babalola (2007) on vegetable production in the Southern Nigeria. Also, manure (MAN), family labour (FAL) and quantity of water applied (WAT) have stimulating influences on waterleaf output. In a similar way increasing these inputs (i.e. WAT, MAN and FAL) would result in increase in waterleaf output. Udoh and Sunday (2007) and Enete and Ubokudom (2010) have reported similar result for waterleaf production in the central part of Akwa Ibom state. On the other hand, depreciation cost (DEP) which was a proxy of capital utilization has a significant negative impact on waterleaf output. This means that increased in depreciation cost of fixed asset used in the production of waterleaf would result in reduction of waterleaf output. However this is contrary to the report of Udoh (2005) among vegetables farmers in south-south zone of Nigeria. The magnitude of elasticity of waterleaf output with respect to planting material (0.340), family labour (0.079), manure (0.222) and water usage (0.667) is less than unity. This means that the average productivity of these inputs is greater than the marginal productivity. As such, the utilization of these inputs is in stage II or the rational stage in the classical production surface. It therefore follows that these inputs are optimally utilized in waterleaf production in the study area. The scale of return in waterleaf enterprise in Akwa Ibom state revealed a decreasing return to scale value of 0.832. This means that continuous increase in utilization of the specific inputs in the production of waterleaf would result in a decrease in waterleaf output in the long run. An average total factor productivity (TFP) of about 5.795 (i.e. antilog (1.757)) was obtained among waterleaf farms in the study area. This implies that the contribution of variable inputs productivity to total factor productivity among waterleaf farms in Akwa Ibom State is high.

Analysis of farm resource productivity in leafy fluted pumpkin production in Itu area of Akwa Ibom State

The empirical result revealed that the coefficient of pumpkin seed (SEDW) has a significant positive relationship with the quantity of fluted pumpkin (leafy) produced by farmers. The result implies that fluted pumpkin output has inelastic relationship with the quantity of seed planted by farmers in the study area. Similarly, the slope coefficients of hired labor (HIL), fertilizer (FER) and quantity of manure (MAN) used in the production of fluted pumpkin has a stimulating influence respectively on the leafy pumpkin output. This indicates that a unit increase in hired labour, fertilizer and manure would result in 0.181units, 0.069units and 0.061units increase in fluted pumpkin output respectively. On the other hand, the slope coefficient of depreciation has a significant negative impact on fluted pumpkin output in the study area. The results imply that 100 percent increase in depreciation cost of fixed asset of fluted pumpkin farmers would result in 11.60% decrease in pumpkin output. In addition, the result shows that apart from depreciation cost of fixed asset, the utilization of other variables occur in stage II in the production surface. This means that, these variables are optimally utilized in the production of fluted pumpkin in the study area. The scale of production in pumpkin enterprise in the study area revealed a decreasing return to scale value of 0.661. This means that continuous increase in utilization of the specified inputs would result in a decrease in fluted pumpkin output in the long run. An average total factor productivity (TFP) of about 4.540 (i.e. antilog (1.513)) was obtained among fluted pumpkin farms in the study area. This implies that the contribution of
variable inputs productivity to total factor productivity among fluted pumpkin farms in Akwa Ibom State is remarkable.

Factors affecting Total Factor Productivity among Vegetable Farmers in Akwa Ibom state

Table 2 shows the result of the econometric estimation of determinants of total factor productivity among small-holding waterleaf farms in Uyo and fluted pumpkin farms in Itu local government areas of Akwa-Ibom state, Nigeria.

Table 2: Linear regression estimates of determinants of total factor productivity among waterleaf and fluted pumpkin farmers in Akwa - Ibom State, Nigeria

<table>
<thead>
<tr>
<th>Variable</th>
<th>Waterleaf</th>
<th>Fluted Pumpkin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.475 (4.1467)***</td>
<td>2.574 (1.515)</td>
</tr>
<tr>
<td>Farm size</td>
<td>-0.867 (-3.379)***</td>
<td>0.277 (2.379)**</td>
</tr>
<tr>
<td>Hired Labor</td>
<td>-4.3e-05 (-1.880)*</td>
<td>2.5e-05 (3.021)**</td>
</tr>
<tr>
<td>Age</td>
<td>0.034 (1.845)*</td>
<td>0.011 (0.417)</td>
</tr>
<tr>
<td>Household size</td>
<td>-0.172 (-1.843)*</td>
<td>-0.037 (-0.465)</td>
</tr>
<tr>
<td>Education</td>
<td>0.012 (0.323)</td>
<td>0.007 (0.075)</td>
</tr>
<tr>
<td>Income</td>
<td>2.26e-05 (4.537)**</td>
<td>1.0e-05 (12.028)**</td>
</tr>
<tr>
<td>Extension visit</td>
<td>0.060 (0.834)</td>
<td>0.239 (1.686)*</td>
</tr>
<tr>
<td>Credit</td>
<td>0.453 (2.120)**</td>
<td>0.265 (3.517)**</td>
</tr>
<tr>
<td>Experience</td>
<td>0.131 (1.918)**</td>
<td>0.105 (1.502)</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.001 (0.099)</td>
<td>-0.084 (2.211)**</td>
</tr>
<tr>
<td>Depreciation</td>
<td>-2.0e-05 (-0.833)</td>
<td>-3.1e-06 (-0.516)</td>
</tr>
<tr>
<td>Water</td>
<td>0.640 (4.746)**</td>
<td>-</td>
</tr>
<tr>
<td>Planting Material</td>
<td>-0.0045(-2.33)**</td>
<td>-0.00049 (-1.758)*</td>
</tr>
<tr>
<td>R²</td>
<td>0.8558</td>
<td>0.903</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.359</td>
<td>0.855</td>
</tr>
<tr>
<td>F - Statistic</td>
<td>2.823</td>
<td>18.630</td>
</tr>
</tbody>
</table>

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

The R² values of 0.856 and 0.903 for waterleaf and fluted pumpkin farms respectively imply that about 86% and 90% of variations in total factor productivity in both crop enterprises are explained by the specify explanatory variables in the respective models. The F-ratios for both crop enterprises are significant at 1% respectively which implies that the data attest to the overall significant of the regression equation.

Determinants of total factor productivity in waterleaf farms in Uyo, Akwa Ibom State

The result revealed that the coefficients of farm size, hired labor and household size as well as planting materials are negative and significant at 1%, 10%, and 10% as well as 5% levels of probability respectively. This implies that a 10% increase in farm size, hired labor, household size and planting material of waterleaf farmers will reduce TFP of waterleaf farms by 8.6%, 0.00043%, and 1.72% as well as 0.045% respectively. Cultivation of large farm land would involve increase in production cost which is capable of constraining the acquisition of other production inputs. Following this, some farm inputs would be irrationally utilized and as a consequent, TFP of farms would decline. Also, increase in man-day of hired labor would tend to restraint the use of other farm inputs through increase in variable cost. In addition, farmers with large household sizes will likely allocate most of their financial resources to family’s essential needs such as education and food consumption. This again would constrain the utilization of other farm resources and will adversely impact on TFP. In a similar way, increase use of planting material in the finite or small farm land might result in unnecessary competition among crop stands that could lead to reduce output. The findings corroborate the results of Okoye et al., (2008) on cocoyam farmers in Anambra State and Ukoha et al., (2010) on Cassava farmers in Abia State.

The coefficient for age, income earned from waterleaf production, credit accessed, experience and water usage is positive and significant at 10%, 1%, 5%, 5%, and 1% levels of probability respectively. This implies that 1% increase in age, income, credit access, experience and water usage will increase TFP of waterleaf farms by 0.034%, 0.000023%, 0.453%, 0.131% and 0.640% respectively. The result exhibited a priori expectation and is similar to the findings of Ukoha et al., (2010) for age, credit, income and experience but is contrary to the findings of Gul Unal (2008); Okoye et al., (2008) and Masterson (2005) for age. Increase in income earned from waterleaf production and increase accessed to credit would tend to facilitate easy acquisition and efficient management of farm resources; and this has a positive implication on TFP of farms. Increase water usage in waterleaf production is inevitably especially for upland cultivation (Udoh, 2005). Based on the magnitude of marginal effect of the explanatory variables, the findings revealed that water usage, accessed to farm credit; farmers’ household size and farming experience are major incentives available to regulate the total factor productivity among water leaf farmers in the study area.
Determinants of Total factor productivity in leafy fluted pumpkin farms in Itu, Akwa Ibom State.

The result of the analysis indicates that the coefficient of fertilizer and planting materials are negative and significant at 5% and 10% level of probability respectively. This indicates that 10% increase in planting materials will reduce TFP among fluted pumpkin farms by 0.84% and 0.0049% respectively. In Akwa-Ibom state, fluted pumpkin is mostly planted in organic rich soil along coastal plain lands. As such increase application of fertilizer might intoxicate the soil and reduced the yield of the crop. The cost of fertilizer is also an impediment to it usage, as increase in fertilizer usage could reduce the availability of other inputs due to the cost implication. Since the farm lands for cultivating fluted pumpkin are small, increased in the quantity of planting materials (seeds) in a finite land area might retard crop growth due to undue crop competition or overcrowding. On the other hand, the slope coefficients of farm size, hired labor, income earned from pumpkin production, extension agent visit and credit accessed are positive and significant at 1%, 1%, 1%, 10% and 1% levels of probability respectively. The results imply that 1% increased in farm size, hired labour; income earned from fluted pumpkin cultivation, extension agent visit and accessed to credit facilities would lead to 0.277%, 0.000025%, and 0.000011%, 0.239% and 0.265% increase in TFP in fluted pumpkin farms in the state. Increase in extension agent contacts would lead to more awareness on improved technologies on fluted pumpkin production. The results agree with the findings of Udoh (2005), Udoh and Sunday (2007), Nwachukwu and Onyenweaku (2007) and Enete and Ubokudom (2010). However judging from the magnitude of the marginal effect of explanatory variables with respect to TFP in fluted pumpkin farms, the finding revealed that farm size, extension agent visit, accessed to credit and quantity of fertilizer use are the major policy variables available to boost farm resources productivity among fluted pumpkin farmers in the study area.

SUMMARY AND RECOMMENDATIONS

The study analyzed the farm resource productivity and total factor productivity among waterleaf farmers in Uyo and fluted pumpkin farmers in Itu local government areas of Akwa-Ibom state. The analysis of farm resource productivity revealed that all farm resources (exception of capital utilization proxy by depreciation cost) were rationally used in the production of both crop enterprises. The total factor productivity index was generated for individual farm and factors that affect it were determined using ordinary least squares technique. Empirical results revealed that, significant factors which affect total factor productivity of waterleaf farmers were; farm size, hired labor, age of a farmer, household size, farmer’s income, accessed to credit, experience, and water availability and quantity of planting material. On the other hand, variables which affect total factor productivity of fluted pumpkin farmers in the state include; farm size, hired labor, income earned, extension visit, credit facilities, fertilizer and planting materials. The findings therefore calls for farm level policies aimed at intensifying extension services among vegetable farmers, provision of water especially for upland vegetable cultivation and credit facilities at a subsidized interest rate to vegetable farmers in the state to help sustain the current level of factor productivity. Also, policy that should encourage farm mechanization in vegetable production is strongly advocated in the state as it will reduce the effect of high labor cost. In addition, birth control policies of the federal government are strongly upheld; as these would enable vegetable farmers to allocate farm inputs more efficiently. Increase private investment in the sub sector is also advocated as it might increase the productivity of vegetable production in the state.

REFERENCES


