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# Promoting Urban Agriculture: A case of Cabbage – Lettuce Production under Irrigation in Jos North Local Government Area of Plateau State, Nigeria

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***Abstract***
*The study focused on promoting urban agriculture through the production of Cabbage-Lettuce under irrigation in Jos North Local Government of Plateau States. Multi stage sampling procedure was used in the selection of 78 respondents who mainly grow vegetable on rivers banks within the study area. Questionnaires were used to collect data from the selected farmers. Data collected were analyzed using gross margin and stochastic frontier model. The gross margin revealed that Cabbage-Lettuce is profitable with gross margin of ₦19,419 and ₦20,300 for cabbage and lettuce respectively while the profitability index showed that for each naira invested, farmers made ₦0.46 and ₦0.49 for Cabbage and Lettuce respectively. Resultsfurther showed that the estimated coefficients of labour and farm size were significant determinants of both vegetables output, while fuel was significant for only lettuce.Therefore it is recommended that agro inputs should be made available at affordable prices and timely too to urban farmers. Also small earth dams should be built around urban areas. Urban vegetables farmers should be encouraged to adopt technologies of net or green houses and hydroponics to boost their production. This is expected to mop up the excess labor concentrated in these urban areas, thereby increasing the production of vegetables.*
***Keywords:*** *Urban agriculture, Cabbage, Lettuce, Irrigation*

## INTRODUCTION

According to a report by the United Nations Food and Agricultural Organization (FAO) it is estimated that about 200 million urban dwellers participate in urban farming all over the world. The report also maintained that urban agriculture is gaining greater attention and has been expanding in many countries such as China, Singapore, Kenya, Uganda, Togo, Sierra Leone and including Nigeria (FAO, 2013). However, most urban farmers in these countries are low-income men and women who grow food largely for self- consumption and cash income, on smallplots that they do not own, with little if any support or protection from the government.

Nigeria is urbanizing at an intense pace, generating little or no jobs for poor households. By 2030, it's estimated that 156 million Nigerians will be living in urban areas. Nevertheless, commercial urban and peri- urban farming in Lagos, Oyo, Rivers, Kogi, Plateau, Borno, Kano and Niger States are surviving and thriving. It is worth noting that economic development plans like NEEDS ignored the contribution of urban and peri urban farming; "the word appears in only three of 37 state strategies." Urban poverty and a teeming population of unemployed youth is a worry to all the tiers of governments. What will solve the problem is agriculture.

Commercial urban farming in Nigeria started late 1970s when the Operation Feed the Nation (OFN) was launched. OFN urged urban residents to use "vacant land as source of food andincome." At the time, Nigeria's urban population was 16.6 million with 48 million in rural areas but today it is the reverse. Half of Nigerians (80.6 million) now live in urban areas, according to the FAO. Despite lack of land, insecure property rights, gender disparity, poor linkages betweenextension services and growers, and inputs, urban and peri-urban farmers are playing a great role in ensuring food security especially in urban cities of Nigeria.

It is widely acknowledged that the scope for agricultural production can be expanded and sustained by peasant farmers within the limits of existing resource base and available technology if farm productivity is raised by efficiency use of resources (Harwood, 1987; Ali, 1996; Udoh, 2000). Several studies pertaining to traditional agriculture are modelled to investigate input mix and the resultant output level with particular reference to input-output space with given technology. Issues of low marginal productivities, elasticities of production and high yield gap are mostly evaluated in these studies. As such, policy options nevertheless suggest progressive introduction of modern technology and new production possibilities that would see the evolution of large farms (Singh, 1992). These options however negate the premise that farmers practicing traditional agriculture could be poor, but efficient in resource use. Therefore, operating on frontier due to productivity growth may not necessarily be a function of size provided that adequate technological innovations are involved. This could be the case for urban vegetable farmers in Jos metropolis. Given this backdrop, this study is aimed at: (i) measuring the costs of and return to Cabbage – Lettuce farming and the profitability of these vegetables in the study area and (ii) determining the resource use efficiency in Cabbage – Lettuce farming in the study area.

**Theoretical Framework**

The most popular methods of measuring efficiency, are parametric (the stochastic frontier method) and the non-parametric (Data Envelopment Analysis) which assumes the presence of inefficiency effects in the production system. Coelli (1995) made a comparison of the two methods and asserted that the main strengths of the stochastic frontier approach are its ability to deal with stochastic noise and the incorporation of statistical hypothesis tests pertaining to production structure and the degree of inefficiency. Therefore the frontier production function differs from the Ordinary Least Square estimation in the structure of the error term. Bravo-Ureta and Pinheiro (1997), Ajibefun and Abdulkadri (1999), Sharma *et. al.* (1999) and Ajibefun*et al.* (2002) used the stochastic parametric model to estimate efficiencies in agricultural production in their studies.

In addition to determining the efficiency levels, for policy formulation purposes, it is also useful to identify the sources of these inefficiencies. The stochastic frontier production function proposed has firm effects that are assumed to be distributed as truncated normal random variables and also are permitted to vary systematically with time. The model may be expressed as:

**Model Specification**

The frontier model is expressed as:

$$Y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_j X_{jit} + (V_{it} - U_{it}) \quad , i = 1, \ldots, N, t = 1, \ldots, T \text{…………. (1)}$$

Where:

$Y_{it}$denotes (the logarithm of) the production of the *i-th* firm in the *t-th* time period;

$X_k$ represents the k-th (transformations of the) input quantities;

$\beta_k$stands for the output elasticity with repect to the *k-th* input;

$V_{it}$ is a random variable which is assumed to be iidN(0,$\sigma v^2$), and distributed independently of the $U_{it}$ which has the specification:

$U_{it} = U_i \eta_{it} = U_i \exp(-\eta(t-T_i))$ ……………………………………………………….(2)

Where:

$U_i$ is a non-negative random variable which is assumed to account for technical inefficiency in production and are assumed to be *id* as truncations at zero of the N($\mu\sigma_\mu^2$) distribution and η is a parameter to be estimated.

The last period ($t=T_i$) for firm *i* contains the base level of inefficiency for that firm ($U_{it} = U_i$). If $\eta > 0$, then the level of inefficiency decreases toward the base level. If $\eta < 0$, then the level of

inefficiency increases to the base level, and if $\eta = 0$, then the level of inefficiency remain constant (Jorge and Suarez, 2004). If the firm effects are time invariant, then the technical efficiency is obtained by replacing $\eta_{it} = 1$ and $\eta = 0$.
Battese and Coelli(1995) replaced $\sigma v^2$ and $\sigma\mu^2$ with $\sigma^2 = \sigma v^2 + \sigma\mu^2$ and $\gamma = \sigma\mu^2/(\sigma v + \sigma\mu^2)$ and stated that the parameter, $\gamma$, must lie between 0 and 1 (i.e., $0 \leq \gamma \leq 1$). Gamma $\gamma$ is the total output attained at the frontier which is attributed to technical efficiency. Similarly, $1 - \gamma$ measures the technical inefficiency of the farmers. The predictions of individual firm's technical efficiencies from the estimated stochastic production frontiers are defined as:

$$EF_{it} = exp(-U_{it}) = E[exp(-U_{it})/Ei] = \left\{\frac{1-\emptyset[\eta_{it}\sigma_i^* - (\mu_i^*/\sigma_i^*)]}{1-\emptyset[-\mu_i^*/\sigma_i^*]}\right\} \exp\left[-\eta_{it}\mu_i^* + \frac{1}{2}\eta_{it}^2\sigma_i^{*2}\right] \quad .... (3)$$

Where:

$E_i$ represents the ($T_i$ x 1) vector of $E_{it}$'s associated with the time periods observed for the $i$th firm, where $E_{it} = V_{it} - U_{it}$,

$$\mu_i^* = \frac{\mu\sigma_v^2 - \eta_i E_i \sigma^2}{\sigma_v^2 + \eta_i \eta_i \sigma^2} \quad \ldots (4)$$

$$\sigma_i^{*2} = \frac{\sigma_v^2 \sigma^2}{\sigma_v^2 + \eta_i \eta_i \sigma^2} \quad \ldots (5)$$

Where:

$\eta_i$represents the ($T_i$ x 1) vector of $\eta_{it}$'s associated with the time periods observed for the $i$th firm, and $\Phi(.)$ represents the distribution function for the standard normal random variable. The Cobb-Douglas functional form was used to estimate the technical efficiency in the stochastic production frontier. The function requires few independent variables. The specific model estimated is in the form:

$$\ln Y = \ln\beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \epsilon \quad \ldots (6)$$

Where:
Y, βs and $X_i$ are as defined earlier

## METHODOLOGY

### The Study Area

Jos North Local Government is one of the seventeen (17) Local Government Areas of Plateau state. Jos north is located northwest of Plateau State, a region in the middle belt of Nigeria, it is located between latitude $7^0$ $11^0$ North and longitude $7^0$ $25^0$ East.It is located at an altitude of about 1,200m above sea level. The vegetation of the area is typically guinea savannah, the area has an average annual rainfall of 1400mm with a duration of 4 to 6 month starting from April to October, with the temperature of about $25^0$C to $30^0$C. The area has quite a number of rivers on whose bank irrigation farms like Fari-Gada irrigation farming,Dadin-Kowa irrigation farming, Federal Low Cost irrigation farming, Kabong irrigation farming,Babale irrigation farming and Mazah irrigation farming are carried out.

### Sampling procedure and sample size

Data were collected with the aid of a structured questionnaire. A multi-stage sampling technique was used. The first stage involved the random selection of 3 different River banks in the study which are FarinGada, Babale and Maza. The second stage involved random selection of 40 farmers in FarinGada; 30 in Babale and 30 in Maza to give the total of (100) respondents.

### Data collection and analysis

The data used for this study was obtained from primarysource. The primary data were generated from a set of questionnaire designed in line with the objectives of the study.The Data was analyzed using gross margin analysis (to determine cost and return to Cabbage and Lettuce) andthe stochastic frontier production model (to determine technical efficiency of farmers in the study area).

**Gross Margin**

It is given as follows:

GM = TR-TVC ………………………………………………………………………. (7)

Where; GM = Gross Margin (₦)

TR = Total revenue (₦)

TVC = Total variable cost (the cost of variable inputs) (₦)

**Stochastic Frontier Production Function**

The data were subjected to Cobb-Douglas stochastic frontier production function using the maximum likelihood method, which is specified as follows:

$Y = X_{it}\beta + E_{it}$ ………………………………………………………………… (8)

Where:

$E_{it} = V_1 - U_1$ …………………………………………………………………… (9)

Taking logarithm of both sides, the equation becomes

$\ln Y = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + V_1 - U_1$ ……………………….. (10)

where:

Y = Output of cabbage - lettuce in (kg)

$\beta_1$ = coefficient of the parameter estimated

$X_1$ = labor (man days)

$X_2$ = seeds (kg)

$X_3$ = quantity of fertilizer (kg)

$X_4$ = fuel (litres)

$X_5$= farm size (ha)

$V_1$-$U_1$ are as defined earlier

The inefficiency model based on Battese and Coelli (1995) specification was

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + W_i$ …………………….. (11)

Where:

$Z_1$ = age of the farmer (number of years)

$Z_2$ = extension contact (dummy: 1=yes, 0=otherwise) and

$Z_3$ = experience of the farmers (number of years spent farming ginger)

$Z_4$ = educational level of farmers (years of schooling)

$Z_5$ = household size (number of people in the farmer's house)

$Z_6$ = Marital Status (dummy: 1= married, 0 = Not married)

$Z_7$=Gender (dummy: 1= male, 0 = female)

$Z_1 - Z_7$ = parameters to be estimated

$W_i$ = error term.

**Profitability of Cabbage – lettuce production**

Cost and Returns to Cabbage - Lettuce Farming: The farmers were mostly small scale farmers. Their costs were dominated by variable costs which include; cost of seed,labour,fertilizer/chemicals and transportation. The average prevailing market prices of the various inputs were used to derive the total cost of production. The gross margin analysis is shown in Table 1. The study reveals that labour was the highest variable cost item with 42% and

48% for cabbage and lettuce respectively; closely followed by fertilizer with 25% and 23%. The average gross revenue for cabbage and lettuce in the study area was found to be₦61,395.66 for either vegetables while the GM was₦19,419.65/ha and ₦20,300.00/ha. Profitability analysis shows that for every naira invested, the farmers earn revenue of ₦1.46 and ₦1.49 on the average for cabbage and lettuce respectively, which is quite profitable compared to the current bank interest rate on savings put at 10% per annum on the average (Amodu, 2010).

**Table 5: Cost andGross Marginin Cabbage - Lettuce Farming**

| **Variable/ha** | **Cabbage (₦)** | **Lettuce (₦)** |
|---|---|---|
| (a) variable cost | | |
| Seed | 11,777.21 | 9,777.21 |
| Labor | 17,802.97 | 19,802.93 |
| Fertilizer/chemicals | 10,385.44 | 9,485.44 |
| Fuel | 554.45 | 554.45 |
| Transportation | 1,455.94 | 1,455.94 |
| Total of variables | 41,976.0 | 41,095.66 |
| (b) Total Revenue | 61,395.66 | 61,395.66 |
| Gross margin = TR – TVC | 19,419.65 | 20,300 |
| Profitability index | 1.46 | 1.49 |

**Result of the Stochastic Frontier Function**

The result of the stochastic frontier production function model shows that the coefficient of labour was positive and significant at 10% level. This shows the importance of labour in Cabbage-Lettuce production in the study area. This is in line with several studies that have confirmed the importance of labour in farming. Studies by Umoh (2006) and Okike (2000) have shown the importance of labour in farming, particularly in developing countries where mechanization is rare on small scale farms in the study area.

The coefficient of farm size was found to be positive and significant at 1% level. The result is in line with the finding to Umah (2006) study of urban farming in South – south Nigeria and Okike (2000) study of farmers in the savanna zone of Nigeria. They both reported farm size to be significant and positive; the result could mean that it is possible to expand farming activity in the study area. Statistically, the magnitude of the coefficient of farm size show that total value of farm output is inelastic to land cultivated if farm size is increase by 1%, total value of farm output level will improve by 0.91% and 0.67% for cabbage – lettuce respectively.

The coefficient of fuel was found to be positive and significant at 1% level for Lettuce production it was however not significant for Cabbage production. The reason for this would not be noted. The coefficient of fertilizer and seed were positive but not significantly different from zero. The production elasticity with respect to fertilizer are seed are 0.154 and 0.0009 respectively. By increasing the quantity of fertilizer and seed by 10% value of farm output will only increase by 0.098 and 0.25 respectively.

Technical Inefficiency Model shows that the signs and significance of the estimated parameter coefficients in the inefficiency mode had important implications on the resource use. The results reveal that for sigma ($\delta^2$) and gamma ($\lambda$) were 0.3102 and 0.311 respectively. The sigma was significant at 1% while the gamma was not significant. The result further showed that while parameters ofAge $Z_1$ and Education $Z_4$ were significant at 1%, Extension $Z_2$ and Household size $Z_5$ were significant at 5% for both cabbage and lettuce.

**Table 2: Maximum Likelihood Estimate Result of Statistic Frontier Production Function (Technical Efficiency) of Cabbage and Lettuce**

| Variable | Parameters | Model 1 cabbage | Model 2 Lettuce |
|---|---|---|---|
| **Production Function** | | | |
| Constant | $\beta_0$ | 2.762 (1.839*) | 4.5621(4.887***) |
| Labour | $\beta_1$ | 0.2942 (1.871*) | 0.1481 (-1.65*) |
| Seed | $\beta_2$ | 0.0009 (0.0007$^{NS}$) | 0.2594 (0.713$^{NS}$) |
| Fertilizer | $\beta_3$ | 0.1543 (0.789$^{NS}$) | 0.0985 (0.621$^{NS}$) |
| Fuel | $\beta_4$ | 0.2040 (1.288$^{NS}$) | 0.5340 (4.755***) |
| Farm size | $B_5$ | 0.911 (3.960***) | 0.6736 (4.471***) |
| **Inefficiency model** | | | |
| Constant | $Z_0$ | 0 | |
| Age | $Z_1$ | 0 | 0.0168 (0.100)*** |
| Extension | $Z_2$ | 0 | -0.3029 (-2.653)** |
| Farming Experience | $Z_3$ | 0 | -0.0050 (-0.600$^{NS}$) |
| Education | $Z_4$ | 0 | -0.3741 (2.966)*** |
| Household Size | $Z_5$ | 0 | 0.2771 (2.222)** |
| Marital Status | $Z_6$ | 0 | -0.2264 (-0.7867$^{NS}$) |
| Gender | $Z_7$ | 0 | -0.0592 (-0.228$^{NS}$) |
| **Diagnostic Statistic** | | | |
| Sigma-Square | $\partial$ | 0.3102 | 0.3102 (6.370***) |
| Gamma | Γ | | 0.0311(0.231) |
| Log Likelihood (f) | llf | | -63.516 |
| LR test | Lr | | 16.190 |
| Total No of Mean efficiency | N | | 76 |

*** = Significant at 1% level
** = Significant at 5% level
* = Significant at 10%
NS = Not significant

## CONCLUSION AND RECOMMENDATIONS

The result of the study revealed a gross margin of₦19,419:65 and ₦20,300:00was realized by the vegetables farmers for cabbage and lettuce per hectare. Profitability analysis shows that for every naira invested; the vegetable farmers earn an average of ₦0.46 and ₦0.49 for cabbage and lettuce respectively, thus indicating that returns were reasonable to serve as incentives to younger farmers. This should be explored by policy makers to alleviate youths out of poverty. The result further showed that the estimated coefficients of labour and farm size were significant determinants of both vegetables output, while fuel was significant for only lettuce.Therefore it is recommended thatagro inputs should be made available at affordable prices and timely too to urban farmers. Also small earth dams should be built around urban areas. Urban vegetables farmers should be encouraged to adopt technologies of net or green houses and hydroponics to boost their production. This is expected to mop up the excess labor concentrated in these urban areas, thereby increasing the production of vegetables.

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