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Effect of Ill Health on Technical Efficiency of Dry Season Vegetable Farmers in Ojo Local Government Area of Lagos State Nigeria

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Abstract This paper examined the effect of ill health on technical efficiency of dry season vegetable farmers in Ojo Local Government Area of Lagos State, South-West, Nigeria. A total of 80 dry season vegetable farmers were sampled through a multi-stage sampling procedure. Data were analysed using descriptive statistics and stochastic frontier analysis. The results showed that majority (68%) of the farmers were within the economic active age group of 25 and 35 years. The mean number of days absent from farm work due to illness was 3 days while majority (70%) of the farmers had contact with extension workers. The major problems confronting the farmers were inadequate land, capital and pest infestation among others. The return to scale value of 1.15estimated from the Stochastic Frontier Analysis revealed that farmers were operating in stage 1 of the production surface, hence, the need to employ more resources in order to maximize benefits. The mean technical efficiency was 0.701. This implies that the efficiency of the vegetable farmers can be improved at the existing technology by about 29.9% in the short run. The health variable which was captured by illness episodes and number of days absent from work due to illness had positive coefficient and statistically significant at $p < 0.10$. The study therefore concludes that ill health have adverse effect on the technical efficiency of the dry season vegetable farmers in the study area, thereby reducing their productivity levels.

Keywords: *effect, ill health, technical efficiency, dry season, vegetables, farmers*

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1. Introduction

Vegetable can be described as tender edible shoots, leaves, fruits and roots of plants that are eaten whole or part, raw or cooked. Edible leaves from vegetable plants are eaten as supporting food or main dishes and are the cheapest and most accessible source of proteins, vitamins, minerals and essential amino acids. [1] Vegetables, in no small measures, offer people with limited access to meat and fish, rich sources of protein and some vital micro nutrients needed for healthy living [2]. However, the current vegetable supplies in many developing countries including Nigeria cannot even meet one half of Food and Agriculture Organization's (FAO) recommendation. Vegetables are not only important as protective food and highly beneficial for the maintenance of health and prevention of disease, but they are also a source of livelihood for small farmers and foreign exchange earner for the national economy [3]. Almost all households in Nigeria include vegetables in their diets. Nutritionally, vegetables are good sources of vitamins, protein minerals and fiber [4].

In time past the production of vegetables was largely subsistence, with a major portion of the produce consumed by the farm household. Reference [5] reported that dry season vegetable production in Nigeria has become a booming business. Apart from the usual problem confronting food crop farmers in Nigeria, vegetable farmers face other unique problems due to the perishable nature of their products which cause for immediate transportation to the point of consumption in other to reduce losses due to spoilage. In some cases up to 40% post harvest loses had been recorded for some vegetables and fruits. Problem of low productivity and non- availability of vegetable all year round being experienced by the producers and consumers of dry season vegetable is due partly to inefficient management of resources/inputs available to the farmers [6,7].

According to Reference [8] labour is central to any agricultural production activity, vegetable production inclusive. The success of agricultural livelihoods depends on the health of its workforce. Ill health prevents farmers from being fully engaged in their farm activities as it takes farmers away from their farm to seek treatment, care for the sick person or divert money that could have been used to enhance productivity to pay for the cost of health care. [9]. Ill health can also lead to death and the labour contribution of a dead person to household production is permanently lost. According to References [10] and [11] in [12], there is a positive relationship between health and productivity of skilled and unskilled labour. Good health in relation to labour output or better production can enhance farmer`s household income and economic growth. The long-term household impacts of ill health include loss of farming knowledge, reduction of land under cultivation, planting of less labor-intensive crops, reduction of variety of crops planted, and reduction of livestock.

The ultimate impact of ill health is a decline in household income and possible food insecurity— that is, a severe deterioration in household livelihood [9] Achieving self-sufficiency in food production and the much desired growth in agricultural sector of the economy will continue to elude Nigeria if health issues in agriculture are not properly addressed [12] This paper therefore aimed at examining the effect of ill health on the technical efficiency of vegetable farmers in Ojo Local Government Area of Lagos State, Nigeria.

1.1. Theoretical Framework

Efficiency describes how well an organization uses its resources to produce goods and services. It focuses on resources (inputs), goods and services (outputs) and the rate (productivity) at which inputs are transformed to outputs. Reference [13] cited in [14] defined technical efficiency as the ability of a producer to produce maximum output from a given set of inputs. Measurement of technical efficiency is important for the following reasons: First, it is a success indicator of performance measure by which production units are evaluated. Second, measurement of causes of inefficiency makes it possible to explore the sources of efficiency differentials and elimination of causes of inefficiency. Finally, identification of sources of inefficiency is essential to the institution of public and private policies designed to improve performance. The methods for calculating technical efficiency are: deterministic production frontier estimated via linear programming; a statistical production frontier estimated by corrected ordinary least squares; a statistical production frontier that assumes a gamma-distributed efficiency term and is estimated using maximum-likelihood techniques; and a stochastic production frontier with a composed error structure which is also estimated using maximum-likelihood techniques. These four methods are parametric in the sense that they assume a specific functional form for the production frontier: The first three methods are deterministic, which means that the entire deviation from the frontier is attributed to inefficiency. A common criticism of the first three deterministic methods is that no account is taken for the effects of the measurement errors and other noise along the frontier [15]. The fourth method, by contrast, attributes only part of the deviation from the frontier to inefficiency [16].

The first method to measure the technical, allocative, and economic efficiency was proposed by Farrell assuming that the production function is not known. But, since the underlying production function is seldom known in practice, Farrell suggests that the production function could be estimated from the sample data using parametric or non-parametric functions. Reference [17] estimated a parametric frontier production function of a Cobb-Douglas form, for a sample of data. The model was defined by:

$$\ln\left(y_i\right) = \ln x_i \beta - u_i \quad i = 1, 2, \ldots, N \tag{1}$$

Where ln (y_i) is the logarithm of output of the *ith* farm, *ln* x_i is the logarithm of input quantities used by *i*th farm, β*i* is unknown parameters, and u_i is random shock.

1.1.1. The Stochastic Frontier Production Functions

Researchers in the past have applied the use of the stochastic frontier production function to estimate technical and economic efficiency respectfully. Reference [18] used the stochastic frontier production to study the technical efficiency in food crop production in Gombe State. The result showed that the best farm had technical efficiency of 89%. Reference [19] also assessed the efficiency of small scale food production in Ondo state. The result showed an average technical efficiency of 78.2%, allocative efficiency of 87.7% and economic efficiency of 64.8% and reference [14] studied technical efficiency of broiler farms in central region of Saudi Arabia using stochastic frontier production function.

The main strength of the stochastic frontier approach is that it deals with stochastic noise. Tests of hypotheses regarding production structure technology and the existence of inefficiency can be performed on a stochastic frontier. The main problems with the stochastic frontier production function are, that the selection of a distributional form for the inefficiency effects may be arbitrary; the production function must be specified by a particular functional form, and the stochastic frontier approach is only well-developed for single output technology [15].

A production function can be specified for cross-sectional data with an error term containing two components one that accounts for technical inefficiency (v_i) and a second one that accounts for random effects (u_i). The frontier production function proposed by [18] is as follows:

$$y_i = f\left(x_i; \beta\right) + e_i \quad i = 1, 2, \ldots, N \tag{2}$$

where *yi* is the quantity of output of the *ith* farm; X_i is a (*kx1*) vector of quantities of input employed by the *ith* farm to produce *y*; and β is a vector of unknown production function parameters to be estimated. e_i is an error term made up of two components,

$$e_i = v_i - u_i \tag{3}$$

the v_i's are assumed to be independent and identically distributed random errors having a normal distribution with mean zero and variance σ_v^2. Thus, the v_i accounts for measurement error and other factors that are beyond the farmers control. The *vi*'s are assumed to be independent of the u_i's which are non-negative random errors ($u_i \geq 0, \varphi_I$). The u_i's are assumed to account for technical inefficiency in production and assumed to be independent and identically distributed exponential or half-normal random variables.

If we combine equation (2) and (3), assuming a Cobb-Douglas specification, the stochastic frontier production function could be rewritten as follow:

$$\ln y_i = \beta_0 + \sum \beta_i \ln x_{ij} + v_i - u_i \quad i = 1, 2, \ldots, N \tag{4}$$

Where y_i is the output of farm i, x_{ij} is the amount of input j used by farm i, β_j are parameter to be estimated. The output values are bounded above by the stochastic variable, exp ($X_i\beta$ + v_i). The random error, v_i, can be positive or negative and so the stochastic frontier.

$$TE = \frac{y_i}{\exp(x_i\beta)} = \frac{\exp(x_i\beta - u_i)}{\exp(x_i\beta)} = \exp(-u_i) \tag{5}$$

Where y_i is the observed output, and exp ($x_i\beta$) is the estimated value of the frontier output. This is called an output-oriented Farrell measure of technical efficiency. The parameters, β, can be estimated with linear programming, where $\sum_{i=1}^{N} u_i$ is minimized, subject to the constraints that $u_i \geq 0$, i=1,2… N [15]. This efficiency measure takes the values between 0 and 1 with smaller ratio indicating greater inefficiency.

1.1.2. Maximum Likelihood Estimation

Assuming independence between v_i and u_i, the parameters of the stochastic frontier function (b), defined by equation (4), can be estimated using the maximum-likelihood (ML) method. ML is more computationally demanding, than COLS. ML requires numerical maximization of the likelihood function. The ML estimator is asymptotically efficient. According to reference [15] the basic elements of obtaining ML estimators for the parameters of the stochastic frontier model are consistent with the case of a half-normal distribution for the technical inefficiency effects, because it has been most frequently assumed in the empirical applications. Reference [20] showed that the log-likelihood function equals to

$$\begin{aligned} &\ln L\left(y|\beta\gamma\sigma 2\right) \\ &= -\frac{N}{2}\ln\left(\frac{\pi}{2}\right) - \frac{N}{2}\log\left(\sigma 2s\right) \\ &+ \sum_{i=1}^{N}\ln\left[1-\phi\left(Z\right)\right] - \frac{1}{2\sigma 2s}\sum_{i=1}^{N}\left(\ln y_i + x_i\beta 2\right) \end{aligned} \tag{6}$$

Where $\sigma 2 = \sigma 2u + \sigma 2v, \quad \gamma = \frac{\sigma u}{\sigma v} z_i = \frac{\left(\ln y_i - x_i\beta\right)}{\sigma s}\sqrt{\frac{y}{1-\gamma}}$

and $\phi(\cdot)$ is the cumulative distribution function of the standard normal random variable. The ML estimates $\beta\sigma 2$ and γ are obtained by finding the maximum of the log-likelihood function defined in equation (6). The ML estimators are consistent and asymptotically efficient. The parameters of the stochastic frontier model may be estimated by software such as FRONTIER Version 4.1.

2. Materials and Methods

2.1. The Study Area

The study was conducted in Ojo Local Government Area of Lagos State, Nigeria. The Local Government had a total land mass of 180sq km with about 30% of it constituting the Reverine Area and a population of 598,071 in 2006 Census. Despite the fact that the indigenous inhabitants are the Aworis, Ojo is a mini Nigeria, inhabited by Yorubas, Igbos, Hausas and other Nigerians. Ojo today is a natural habitat of the Igbos, who deals in Electronics and Electrical materials at the popular Alaba International Market created in 1973 within the Local Government Area and the Hausas who trade rams and cows. The Ojo indigenes are mainly farmers, mat weavers, fishermen, hunters and petty traders.

2.2. Sampling Method

A multistage random sampling procedure was adopted to collect data from four vegetable growing communities in the study area. Twenty respondents were then selected from each of the communities making a total of eighty respondents. The selected communities were London, Volks, Dongoingida and Barracks. Data were collected from respondents using well structured questionnaires, interview schedules and focused group discussion (FGD).

2.3. Analytical Techniques

The stochastic frontier production function was used for the analysis of the effect of ill health on technical efficiency of vegetable farmers. It was presented in terms of a Cobb-Douglas production function as follows:

$$\begin{aligned} \text{InY}_i &= \beta_0 + \beta_1\text{InX}_1 + \beta_2\text{InX}_2 + \beta_3\text{InX}_3 \\ &+ \beta_4\text{InX}_4 + \beta_5\text{InX}_5 + \beta_6\text{InX}_6 + \text{V} - \text{U} \end{aligned} \tag{7}$$

Where;
Y_i = Vegetable output (kg)
X_i = Farm size (Number of beds)
X_2 = Quantity of seed planted (kg)
X_3 = Labour (type)
X_4 = Quantity of insecticides used (litres)
X_5 = Quantity of fertilizer (kg)
X_6 = Manure used (bags)
V_i = random variable which is assumed to be independently and identically distributed (iid) $N(0,\sigma_v^2)$) and independent of U. Ui = non-negative random variable associated with technical inefficiency in production, and is assumed to be independently and identically distributed half normal (iid)N(o, σ_u^2) where the conditional mean μ is assumed to be related to farm and farmers-related socioeconomic characteristics

The inefficiency model is specified as:

$$\begin{aligned} \text{Ui} &= \delta_0 + \delta_1\text{D}_1 + \delta_2\text{D}_2 + \delta_3\text{D}_3 \\ &+ \delta_4\text{D}_4 + \delta_5\text{D}_5 + \delta_6\text{D}_6 + \delta_7\text{D}_7 \end{aligned} \tag{8}$$

Where;
U_i = Inefficiency effect
D_I = number of illness episodes/season
D_2 = Number of days absent from farm due to illness/season
D_3 = Age (years)
D_4 = Sex (1-male, 0- female)
D_5 = Household Size (Number of people)
D_6 = Farming experience (years)
D_7 = Educational level (years)
δ= Parameters to be estimated.

3. Results and Discussion

3.1. Socio-Economic Variables/Characteristics

Table 1. Summary statistics of variables in the SFA model and other socio-economic variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Output (Kg)	84	51.708	20	118
Farm size (No of beds)	115.63	50.110	40	210
Qty of seeds (Kg)	2.31	1.023	1	4
Insecticide used (L)	1.46	0.544	1	3
Fertilizer (Kg)	3.21	1.720	1	10
Manure (No of bags)	7.18	3.055	3	13
Illness episodes (No)	1	0.000	1	1
No of days absent	2.69	1.143	1	5
Age (yrs)	27.45	7.602	17	45
Household size	6.51	3.646	2	15
Farming experience (yrs)	7.00	4.128	1	17
Educational level (yrs)	4.75	0.785	2	7

Source: Field survey

The summary statistics of the variables for the frontier estimation is presented in Table 1. They include the, sample mean, the standard deviation and the minimum and maximum value for each of the variables. The mean value of 84 kg as average vegetable output for the season was obtained from the data analysis. The standard deviation of 51.708 (in kg), revealed that there was a great inequality in the output of the farmers as shown by the large dispersion around the mean. The mean value of number of beds cultivated by the farmers was 115.63. This is relatively large considering the size of land available to them. The mean value of the quantity of seed planted was 2.31 kg. They used more of family labour than hired labour. The mean value of insecticides used was 1.46 litres per bed. The average level of fertilizer used was 3.21 kg. This low level of fertilizer used was augmented by manure with a mean value of 7.18 bags. Variables representing the demographic characteristics of the farmers employed in the analysis of the technical efficiency include; age of the farmers, educational level, farming experience etc. The mean age of the farmers was approximately 28 years indicating that all farmers interviewed were within the economically active age. The mean household size of farmers was approximately 7 persons. This is likely to increase the availability of family labour in the study area. The mean years of vegetable farming experience was 7 with majority unable to complete primary education. This could have negative consequences on their capacity to exploit latent opportunities and adoption of improved technology in their farming activities. All the sampled farmers reported an illness episode with a mean of 2.69 days as number of days absent from farm due to illness.

Table 2 shows that majority (70%) of the farmers had contact with extension workers, while 60% of the farmers had no access to credit. The major problems encountered by the vegetable farmers in the study area includes: Inadequate land for farm expansion, capital constraint which was due to lack of collateral by the farmers and the high interest rate charged by the financial institutions coupled with long queue before getting access to loans ranked as the most important problem after land acquisition in the study area. Other common problems are; pest infestation, shortage of water and low vegetable prices.

Table 2. Distribution of farmers by extension contact, access to credit and problems encountered by vegetable farmers

Variable	Frequency	Percentage
Extension contact	56	70
Have contact	24	30
No contact		
Access to credit		
Have access	32	40
No access	48	60
Problems encountered		
Inadequate land	78	97.5
Capital	70	87.5
Pest infestation	80	100
Shortage of water	72	90
Low vegetable prices	75	93.8

Source: Field Survey, 2013

3.2. Production Analysis for Vegetable Farmers

Maximum-likelihood estimates of the parameters of the stochastic frontier model are presented in Table 3. Estimates of the parameters of the stochastic frontier production model revealed that all the estimated coefficients of the variables of the production function were positive. The positive coefficient of farm size, quantity of seed planted, labour, insecticide used, fertilizer and manure impliy that vegetable output increases with increase in these variables. The farm size measured by the number of beds cultivated by the farmers had a significant relationship with output at $p < 0.10$. Therefore a 1% increase in number of beds cultivated by the farmers will increase vegetable output by 0.34%. The coefficients of quantity of seed planted ($p < 0.05$), insecticide (0.01) and fertilizer ($P < 0.05$) used also had significant relationship with output, implying that an increase in the usage of these inputs will lead to increase in vegetable output in the study area. The type of labour employed on the farm and number of bags of manure used did not have any significant effect on vegetable output as shown by the values of their t-ratio. This implies that increase in the level of labour use and manure will not increase vegetable output in the study area.

The study revealed that technical inefficiency effects existed in vegetable production in the study area. The estimate of the sigma-square was significantly different from zero at one percent value, attesting to the goodness of fit of the model. Reference [12] defined gamma as the total of variation of output from the frontier which can be attributed to technical efficiency i.e. efficient use of existing technology. Therefore the gamma value of 89.9% indicated that about 90% of the total variance in output of the vegetable production was due to technical inefficiencies of the vegetable farmers. Thus, on the average, the vegetable farmers were just realizing about 10% of their potential output feasible in the prevailing socio-economic, physical and health environment which calls for the attention of the policy makers.

The significant negative coefficient of age ($p < 0.01$) and farming experience ($p < 0.05$) of the vegetable farmers imply that the older and more experienced farmers in vegetable production were more efficient than the younger ones meaning that as the age and the experience of the farmers increase in the study area, their inefficiencies decrease. This is in conformity with the assumption that farmers' age affects the production efficiency since farmers different ages have different levels of experience and ability to obtain and process information. This is similar to the findings of [21] that aged and most experienced farmers in Ondo State maize production were more cost efficient than the younger ones. The household size of the vegetable farmers was also negative and significant ($p < 0.01$). This implies that the efficiencies of the vegetable farmers increase with increase in number of household size as a larger number of people in the household contribute to family labour. Educational level of the vegetable farmers increase their inefficiencies as it was positive and significant ($p < 0.01$). This is because of the high level of illiteracy of the vegetable farmers in the study area.

Table 3. Maximum likelihood estimate and the inefficiency function

Production variables	Coefficients	Standard error	t-ratio
Constant β_0	2.663***	0.753	3.536
Farm size (No of beds) β_1	0.340*	0.194	1.753
Quantity of seed planted (Kg) β_2	0.548**	0.197	2.780
Labour(Type) β_3	0.102	0.130	0.785
Insecticideused(L) β_4	0.098***	0.231	4.231
Fertilizer(Kg) β_5	0.041**	0.017	2.386
Manure(bag) β_6	0.022	0.069	0.319
Inefficient model			
Intercept δ_0	0.966	0.740	1.305
Illness-episodes(No) δ_1	0.986*	0.874	1.869
Absenteeism(Noofdays) δ_2	0.141*	0.093	1.913
Age(yrs) δ_3	-0.074***	-0.023	-3.225
Sex δ_4	-0.102	0.112	-0.911
Household size (No of people) δ_5	-0.115***	0.025	-4.659
Farming experience (yrs) δ_6	-0.090**	-0.042	-2.14
Educational-levelδ_7	0.365***	0.133	2.740
Sigma-squared σ_2	0.443***	0.051	2.817
Gamma γ	0.899***	0.003	37.23
Log likelihood		6.603	

Source: Computed from data analysis, 2013;
No. of periods = 1; No. of observation = 80; No. of iterations = 25;
Values in the table have been corrected to three significant figures;
* = statistically significant at 10%, ** = 5%, *** = 1%

The effect of ill health on technical efficiency of the vegetable farmers was captured by illness episode and number of days absent from the farm due to ill health in the inefficiency model. The coefficients of both the illness episode and number of days absent from farm work were positive and significant ($p<0.10$). This is in conformity with the *a priori* expectation that ill health impacts negatively on the productivity of farmers. This implies that the higher the numbers of illness episodes, the higher the number of days absent from farm work, the higher the farmers' inefficiency levels. This is similar to the findings of [12] who reported that adverse health impacts negatively on the productivity of farmers in Kainji Lake Basin, North Central Nigeria. This is also in line with the assertion made by [8] that rice farming households' inefficiency in Ogun State increase with number of illness episodes and absenteeism from farm work due to illness.

3.3. Elasticity and Return to Scale

Table 4 shows that the variables specified in the stochastic frontier production model have inelastic effect on vegetable output. A 100% increase in the farm size will increase output of vegetable production in the study area by 34%, while a 100% increase in the quantity of seed planted will increase the output by about 55%. The summation of the elasticity coefficients of the estimated variable equals 1.151. This shows that vegetable production in the study area is carried out in the stage 1 of the production surface. Stage 1 is the stage of increasing positive return to scale. This implies that farmers should intensify their efforts to expand the present scope of vegetable production in the study area, in order to actualize the potential therein. The RTS reported in this study was close to 1.115 reported among mixed-crop farmers in Nigeria by [22].Reference [23] also reported a close value of 1.19 in the efficiency of sweet orange production among small scale farmers in Osun State, Nigeria. A RTS value of 1.209 was also reported by [24] in a study on Ofada rice farming in Ogun State, Nigeria. These showed that the value reported in this study is not an isolated case, thereby further stressing the need to expand the scope of Agricultural production in Nigeria.

Table 4. Elasticities and return to scale (RTS) analysis of the production functions

Variables	Elasticities
Farm size	0.340
Seed	0.548
Labour	0.102
Insecticide	0.098
Fertilizer	0.041
Manure	0.022
Return to scale (RTS)	1.151

Source: Field Survey data, 2013

3.4. Efficiency Analysis for Vegetable Production in the Study Area

Table 5. Estimate of technical efficiency of vegetable farmers

Interval	Frequency	Percentage
0.30-0.39	18	22.5
0.40-0.49	12	15
0.50-0.59	5	6.25
0.60-0.69	0	0
0.70-0.79	0	0
0.80-0.89	18	22.5
0.90-0.99	27	33.75
Total	80	100
Mean	0.707	
Minimum	0.353	
Maximum	0.995	

Source: Computed from field survey data, 2013

Table 5 presents the individual vegetable grower's technical efficiency obtained from the estimated stochastic frontier. The predicted technical efficiency (TE) ranged between 0.353 and 0.995 with a mean TE of 0.707. The wide variation shows possibility for improvement for some farmers. This result implies that if the average farmer in the study area were to achieve the technical efficiency of his most efficient production, then the average farmer could realize a 28.9% cost saving or increase in output (that is, 1-(0.707/0.995). A similar calculation for the most technical inefficient farmer in this study reveals increase in output of 64.5% (that is, 1-(0.353/0.995).

4. Conclusion and Recommendations

This empirical study is on the effect of ill health on technical efficiency of dry season vegetable farmers using stochastic frontier production function. The result of the SFA revealed that basic production variables included in the production function had positive relationship with vegetable output. The production function estimations revealed Return to Scale (RTS) value of 1. 151. This implies that farmers were operating in stage 1 of the production surface. The health variable which was captured by illness episodes and number of days absent from work due to illness were found to reduce the efficiencies of the vegetable farmers. The study therefore concludes that ill health impacts negatively on the technical efficiency of the dry season vegetable farmers in the study area thereby reducing their productivity levels.

Based on the findings of this study, it is recommended that to curb the menace of ill-health, health care services should be improved in the farming communities at subsidized rate in order to facilitate good medical care to the vegetable farmers. Furthermore, health education should form a core of educational or extension service delivery to the farmers to assist them to make proper use of preventive measures so as to reduce illness episodes and number of days lost to illness.

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