Available online at www.worldnewsnaturalsciences.com

World News of Natural Sciences

An International Scientific Journal

WNOFNS 23 (2019) 182-199 EISSN 2543-5426

Economics of Environmental Pollution on Cassava-Based Farmers' Health and Production Efficiency within Lafarge Cement Concession Area in Mfamosing, Cross River State, Nigeria

E. O. Edet[1,*], P. O. Udoe[1], I. A. Isong[2], N. E. Abiam[1]

[1]Department of Agricultural Economics (Environmental Economics Unit), Faculty of Agriculture, Forestry & Wildlife Resources Management, University of Calabar, Calabar, Nigeria

[2]Department of Soil Science, Faculty of Agriculture, Forestry & Wildlife Resources Management, University of Calabar, Calabar, Nigeria

*E-mail address: eyoorok53@yahoo.com

ABSTRACT

The paper undertakes an assessment of the economics of environmental pollution on cassava-based farmers' health and production efficiency within the Lafarge cement concession area in Mfamosing, Akamkpa Local Government Area, Cross River State. Data for the study were sourced from 60 cassava-based farmers drawn from neighbourhood and non-neighbourhood locations and analyzed using descriptive statistics and stochastic production frontier techniques. The result showed that farming activities in the area have been dominated by females with an average age of 43 and 35 years of age and household size between 4 and 6 persons. Clearly, the results indicate that cement plant activities have reduced farm productivity over the last 5 years, and has affected the livelihood of the farmers. The study also averred that respiratory diseases, diarrhea, skin rashes, heart disease, asthma, coughs and skin cancer have been the various health challenges suffered by the farmers. According to the study results, farmers lost 44 days due to heart disease, 33 days due to respiratory diseases, and 7 days due to diarrhea. The result of the maximum likelihood estimates (MLEs) of the stochastic frontier production function indicate that hired labour, quantity of fertilizer used and quantity of cassava stem cuttings were the significant variables that influenced cassava yield. The estimated technical efficiency (TE) ranged from 0.45 - 0.99, with a mean index of 0.67 (target group) and 0.57 – 0.99, with a mean of 0.82 (control group). The number of days lost due to illness was the most significant variable influencing inefficiency levels in the study area. It was, therefore, recommended that policies aimed at increasing efficiency should focus on improving health care services in the farming communities, while encouraging efficient level of pollution control by the prescribed cement factory, *ab initio*.

(Received 30 January 2019; Accepted 19 February 2019; Date of Publication 20 February 2019)

***Keywords*:** Lafarge, Cement Pollution, Stochastic Frontier, cassava-based farmers, Mfamosing

1. INTRODUCTION

Lafarge, a cement manufacturing company (formerly United Cement Company, UNICEM), situated in Mfamosing, Akamkpa Local Government Area, Cross River State is known for cement production. Cement production has been adjudged to play a pivotal role in the nation's development process besides being a culprit in the pollution of the environment. Apart from being the physical surrounding for natural habitats, the environment provide the basis for human exploits for agricultural, industrial, commercial, technological and tourism development of a society (Ityavyar and Thomas, 2010). For this and several other reasons, environmental issues now occupy a centre stage in academic discourse and other public fora both at the national and international levels. One of the solutions to the problems impeding development in the developing countries is the emphasis on industrial enterprises (Adekunle, Ashaolu and Obinka, 2015). It is on the basis of this that various government of the world encourages establishment of industries in order to diversified the economy that could propel the achievement of sustainable development (SD), since agricultural sector alone which is the main economic activity especially in Sub-Saharan African countries of which Nigeria is one cannot provide the much needed employment and income to the ever increasing population.

In Nigeria, there are several cement producing companies such as Dangote Group, Eastern Bulkcem Company Limited, Lafarge Cement, WAPCO Nigeria PLC, Reagent Cement Company Nigeria LTD, Ashaka Cement Plc (Wale, 2011). Lafarge is the leading Cement industry in Cross River State. This cement factory is surrounded by residential areas which are mostly rural dwellers whose main occupation is agrarian. Many years after the factory was established in Mfamosing, Cross River State, the residents and farmers in the area complained of the deleterious effect of cement dust on their health, surface water bodies, and buildings with the concomitant impact on their health vis-à-vis livelihood. Hence, household residents are calling on the factory to reduce the dust emission if possible to zero level. Cement industry is one of the 17 most polluting industries listed by the Central Pollution Control Board (CPCB) (Mehraj, Bhat, Balkhi and Gul, 2013).

Studies have shown that pollution including those from cement factories affect agricultural productivity in at least three ways. First, Marshall, Mike and Fiona (1997) were of the view that air pollutants have a sizeable negative effect on crop yields. Second, pollution generates acid rain that deteriorates soil quality, by changing its chemistry or reducing the concentration of important plant nutrients. These effects are cumulative and long-lived (Araga and Rud, 2014). Finally, recent studies find evidence of a negative impact of air pollution on labour supply and productivity (Graffzivin and Neidell, 2012; Hanna and Oliva, 2011), mostly due to its effect on human health.

There is an upward increase in emissions of pollutants particularly dust from cement factories in Nigeria. Nevertheless, most literatures have focused little attention on the effects of pollution on farmers' health. However, bearing in mind the roles of increased efficiency vis-a-vis productivity of cassava and/ or tuber crops farm in Nigeria economy (Abang *et al.*, 2004; Orewa and Izekor, 2012; Adewuyi *et al.*, 2013), this study seeks to examine how cement factory activities affect farmers' health and cassava production efficiency in Mfamosing community in

Akamkpa, Cross River State. Thus, this paper sought to describe the socio-economic characteristics of farmers, examine the effects of cement production on farmers' livelihood, determine the health challenges suffered by farmers and the number of farming days lost due to health challenges and assess the impact of cement production on the level of efficiency of cassava-based farmers in Lafarge cement concession area and compare it with the control area.

1. 1. Some theoretical issues

The theories relevant to this study are the theories of production, efficiency, externalities and ecological perspective of change and development. According to the theory of externalities, analysis of market mechanisms brought neo-classical theory to two discoveries of cardinal importance for the development of environmental economics: externalities and market failures. Alfred Marshall (1842-1924) observed that the results of an activity often do not limit themselves to what is deliberately intended. They are accompanied by external effects or externalities. An important feature of an externality is that neither corresponding costs nor benefits are borne or received by the agent causing the externality.

In economics, an externality is the cost or benefit that affects a party who did not choose to incur that cost or benefit. Jhingan (2000) view externalities as market imperfections where the market offers no price for service or disservice. These externalities lead to misallocation of resources and cause consumption and production to fall short of *Pareto Optimality*. Pollution is termed an externality because it imposes costs on people who are *"external"* to the producer and consumer of the polluting product. Many negative externalities are related to the environmental consequences of production.

In a closed economy, the problem is to maximize utility subject to the production possibility frontier (PPF).

Along an indifference curve:

$$\frac{\Delta u}{\Delta y_1}\Delta y_1 + \frac{\Delta u}{\Delta y_2}\Delta y_2 = 0 \quad (1)$$

Alternatively,

$$\frac{\partial y_2}{\partial y_1} = -\frac{MU_1}{MU_2} = (\text{MRS}) \quad (2)$$

where, MRS = marginal rate of substitution; MU_1 and MU_2 = marginal utilities; y_1,y_2 = output of y_1, and y_2

Along the production possibility frontier (PPF), cost is given thus:

$$wL + rK = \overline{C} \quad (3)$$

where: L = labour; K = capital; w = wage rate ; r = cost of capital; C = total cost constraint (the bar on top of c means that the firm has a given amount of money to spend on both factors of production)

Thus, along the PPF,

$$\frac{\Delta C}{\Delta y_1}\Delta y_1 + \frac{\Delta C}{\Delta y_2}\Delta y_2 = 0 \qquad (4)$$

Alternatively,

$$\frac{\partial y_2}{\partial y_1} = -\frac{MC_1}{MC_2} = (\text{MRT}) \qquad (5)$$

where: MRT = marginal rate of transformation; MC_1 and MC_2 = Marginal costs. Maximization of utility subject to the budget constraint implies that at an optimal solution on the PPF, MRS = MRT. That is, it is a tangency point, like point A in Figure 1, between the highest indifference curve and the PPF. Equilibrium price ratio is the slope of the line tangent to both the indifference curve and the PPF. Here, MRT is the ratio of marginal costs incurred by the society as a whole, not private cost. That is, at point A, output price ratio is equal to the ratio of social marginal costs (MSC), i.e.

$$\frac{P_1}{P_2} = MRT = \frac{MSC_1}{MSC_2} \qquad (6)$$

This would be the end of the story, if there were no externalities. However, the presence of external costs or benefits disturbs the equilibrium and introduces a distortion in a market economy. At point B, marginal social cost deviates from marginal private costs (MPC). Line (3) reflects the ratio of social marginal costs,

$$\frac{MSC_1}{MSC_2} \qquad (7)$$

However, the private sector faces a different price ratio,

$$\frac{P_1}{P_2} = \frac{MPC_1}{MPC_2} \qquad (8)$$

In the presence of external costs in the sector or industry,

$$MPC_1 < MSC_1 \qquad (9)$$

Thus,

$$\frac{P_1}{P_2} = \frac{MPC_1}{MPC_2} < \frac{MSC_1}{MSC_2} = \frac{MPC_1 + \beta}{MPC_2} \qquad (10)$$

where: β is the additional pollution cost the society bears. In the absence of regulation, an equilibrium occurs at a point B, where the above inequality holds for consumers (line 2 is flatter line 3).

As a result, excessive production of the pollution intensive industry, y_1 (⇑) Insufficient production of the clean industry, y_2 (⇓).

It should be noted that while ignoring the externality causes and inefficient allocation of resources, it does not mean that complete elimination of pollution is optimal. The optimal output mix occurs at point A, not either end of the PPF as presented in Figure 1.

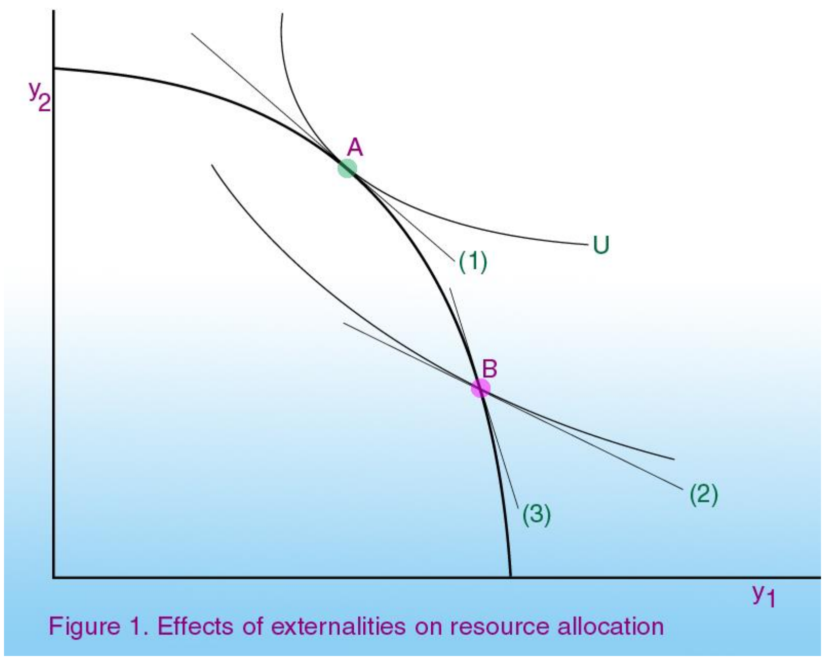

Figure 1. Effects of externalities on resource allocation

Source: Adapted from Kwan (2009)

2. METHODOLOGY

2. 1. Description of study area

Lafarge cement factory is situated in Mfamosing, which is located in Akampa, Cross River State. It lies between latitudes 5º7'0"N and Longitudes 8º31'0"E. The site is 200 m close to west of Mbebui village at coordinates 05.04493ºN, 008.298995ºE, 500m south to Abifan community at 05.07591ºN, 008.52192ºE and 200 m east to Mfamosing community and 100 m east to the main quarry site at coordinates 05.06993ºN, 008.53908ºE (Fig. 2) (Lameed and Ayodele, 2008).

The quarry site is a large expanse acre of land with characteristics mountain outcrop which is said to be ninety five percent (95%) dominated by limestone. The Mfamosing limestone deposit serves as a major source of raw materials used by Lafarge Cement Manufacturing for the production of Portland Cement (OPC) (Richard, Chinyere, Jermiah, Opera, Henrieta and Ifunanya, 2016). The inhabitants of the area predominantly Ejagham speaking people, amidst other minorities who speaks and understands the *Efik* language. The major occupation of the natives is farming while a few are Lafarge workers.

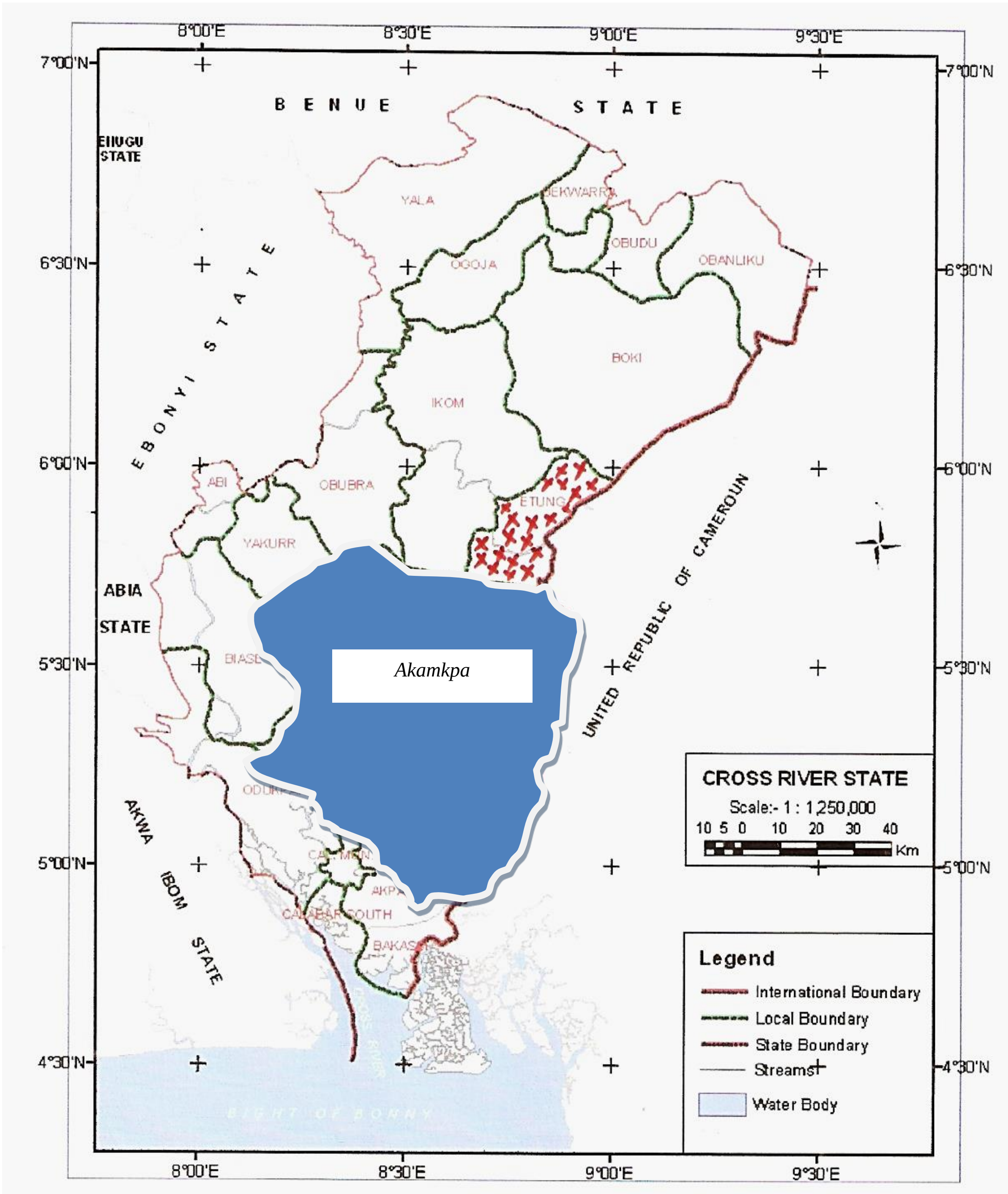

Fig. 2. Map of Cross River State Showing Akamkpa Local Government Area.

2. 2. Data sources and method of collection

Data used for the study were obtained from primary sources through validated structured questionnaires.

2. 3. Sampling procedure and sample size

Multi-stage sampling procedure were used to collect the data in the following stages: In stage 1, the study area were divided into two: Neigbourhood (that is farmers within 1 km radius of Lafarge concession) and Non-Neigbourhood (that is farmers living more li than 1 km radius of Lafarge cement concession) to represent primary selection units which denotes the strata from where the data were collected. Each primary selection unit denotes a stratum. In stage 2, purposive selection of three (3) villages from each stratum was obtained giving a total of six (6) villages in all representing neigbourhood and non-Neigbourhood. The choice of the selection process in this stage was due to the presence of the cement factory. The last stage made use of the simple random selection of 10 respondents in each of the villages giving a total of 60 respondents used for the study.

2. 4. Analytical technique

Data obtained were analyzed using descriptive statistics and stochastic production frontier. Objectives 1, 2 and 3 were analyzed using descriptive statistics such as means, frequency tables, likert scale and percentages. Objective 4 was analyzed using stochastic production function estimation approach. Thus, stochastic production function estimation approach was used to specify the impact of the cement pollution on technical efficiency of the farmers. It was presented in terms of a Cobb-Douglas production function as follows:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + (V_i - U_i) \quad (11)$$

where:

ln = Natural Logarithm

Y = Cassava yield (tonnes/hectare)

$\beta_0 - \beta_4$ = the parameters to be estimated

X_1 = Farm size (ha) ($\beta_1 > 0$)

X_2 = Cassava cuttings (kg) ($\beta_2 > 0$)

X_3 = Hired labour (Man-days) ($\beta_3 > 0$)

X_4 = Fertilizer (kg) ($\beta_4 > 0$)

V_i = Random error assumed to be identical, normally distributed with zero means and constant $N(0, S_V^2)$.

U_i = Random variable of the technical inefficiency.

The inefficiency effects model was formulated and estimated jointly with the Cobb-Douglas Stochastic Frontier Model in a single stage maximum likelihood estimation procedure using the computer software Frontier Version 4.1 (Coelli, 1996). It was assumed that the technical inefficiency effects are independently distributed and Ui arises by truncation (at zero) of the normal distribution with mean, Ui and variance δ^2, where Ui is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + w_i \quad (12)$$

where:

U_i = Technical inefficiency of the i^{th} farmer

$\delta_0 - \delta_8$ = Coefficient to be estimated

Z_1 = age (Years) (δ_1 > <0)

Z_2 = gender (dummy variable: 1 if male, 2 = female) (δ_2 > < 0)

Z_3 = marital status (married = 1, others = 0) (δ_3 > < 0)

Z_4 = household size (No. of persons) (δ_4 > 0)

Z_5 = educational level (Years) (δ_5 > 0)

Z_6 = farming experience (Years) (δ_6 > 0)

Z_7 = extension service (1 = contact, 0 = non-contact) (δ_7 > 0)

Z_8 = number of days loss due to illness (days of forgone production) (δ_8 < 0)

Wi = random error

3. RESULTS AND DISCUSSION

3. 1. Socio - economic characteristics of respondents

Table 1 shows the socio-economic characteristics of respondents in the study area. The results revealed that farmers in the target and control areas were mostly females representing 56.7% and 76.7% respectively. Thus, there were more females than their male counterparts in the study area. An average age of 43 and 35years was obtained for both the target and control respondents. This suggests that energetic men and women abound in the area to do farm work. However, 73.3% and 60% were married with mean household size of 4 and 6 persons respectively. Also, 73.3% of the target respondents had formal education while 83.3% for that of control. The literacy level in the target area was lower as compared to the control area. This implies high literacy level in both the cement production target audience and the control area. In spite of the high literacy level, there was low level of awareness among the natives on the dangers of cement dust pollution and its deleterious impact in the area (Okojie, 2014). Tijani, Ajobo and Akinola (2004) obtained similar results and concluded that the level of educational attainment by the farmers in the control area may indicate better chances for more productive agriculture and better farm organization and operation. T

The result also showed that 63.3% of the respondents had access to capital in the target area and 53.3% for the control. Majority of the respondents (66.7%) in the target area belong to association (including farmers association), while 36.7% were also members of associations in the control area. However, the average farming experience for both target and control areas was 6years, with majority of the respondents having less than 6years farming experience in both areas. This implies that there was no significant difference in the average years of farming experience between farmers in the target and control areas. Both target and control farmers have several plots scattered over different locations. Farmers' in the target area had farm size less than 3.0 hectares with a mean of 4hectares while that for the control farmers varied from 3.0 to 6.0 hectares with a mean of 3.0 hectares. The survey revealed that less than 3.0 hectares of farmland were used for cassava cultivation in both areas. Finally, 60% of the farmers in the target areas have between 1-2 extension contacts (frequency of extension agent visits) and their sources of capital were from family and friends (30%), while that of control area had 3-5 extension contact and their capital source were from personal savings. The low number of extension contacts in the target area could be one reason why they are more exposed to the hazards of cement production owing to lack of counsel, which would have been mitigated if there were frequent extension contact visits.

Table 1. Socio-economic characteristics of respondents.

Variable	Target		Control	
	Frequency	Percentage	Frequency	Percentage
Gender:				
Male	13	43.30	7	23.30
Female	17	56.70	23	76.70
Total	**30**	**100**	**30**	**100**
Age(years):				
< 25	-	-	1	3.30
25 - 35	8	26.70	16	53.30
36 - 45	10	33.30	9	30
46 - 55	6	20	4	13.30
> 55	6	20	-	-
Total	**30**	**100**	**30**	**100**
Mean	42.9		35.30	
Marital Status:				
Single	6	20	6	20
Married	22	73.30	18	60
Divorced	-	-	4	13.30
Widowed	2	6.70	2	6.70
Total	**30**	**100**	**30**	**100**
Level of Education:				
No Formal Education	8	26.70	5	16.70
Primary	4	13.30	6	53.30
Secondary	4	13.30	8	26.70
NCE	11	36.70	1	3.30
HND	3	10	-	-
Total	**30**	**100**	**30**	**100**
Household Size				
1-3	14	46.70	10	33.30
4-6	10	33.30	14	46.70
>6	6	20	6	20
Total	**30**	**100**	**30**	**100**
Mean	4.43		4.57	
Credit				
Yes	19	63.30	17	56.70
No	11	36.70	13	43.30
Total	**30**	**100**	**30**	**100**
Membership to association				

Yes	20	66.70	11	36.70
No	10	33.30	19	63.30
Total	**30**	**100**	**30**	**100**
Farming Experience				
< 6	18	60	16	53.30
6 - 10	7	23.30	7	23.30
11-15	4	13.30	7	23.30
> 15	1	3.3	-	-
Total	**30**	**100**	**30**	**100**
Mean	6.03		6.43	
Farm Size				
<3	14	46.70	15	50
3-6	13	43.30	15	50
7-10	2	6.70	-	-
>10	1	3.30	-	-
Total	**30**	**100**	**30**	**100**
Mean	3.80		2.74	
Extension service				
1-2	18	60	10	33.33
3-5	9	30	13	43.33
≥ 6	3	10	7	23.33
Total	**30**	**100**	**30**	**100**
Mean	1.50		2.23	
Sources of Capital:				
Personal	6	20	14	46.70
Co-operative	7	23.30	2	6.70
Credit/loan	8	26.70	10	33.30
Family/friends	9	30	4	13.30
Total	**30**	**100**	**30**	**100**
Output of cassava:				
< 3	21	70	26	86.70
3 - 5	8	26.70	4	13.30
> 5	1	3.30	-	-
Total	**30**	**100**	**30**	**100**
Mean	1.96		1.48	

A dash (-) means no response
Source: Field Survey Data (2017)

3. 2. Effects of cement production activities on farmers' livelihood

The result of the perceived effects of cement production on farm household's livelihood is presented in Table 2. A weighted mean value of 4.10 was using to determine how serious the perceive effect was on farm households livelihood. The result revealed that the most perceived effects of cement production on farm household livelihood by the respondents in the target area are pollutants from cement plants are causing harmful effects on human health and environment (4.87), skin itches more than it used to over the last 5 years (4.40), cement plant activities causes coughing (4.20), farm productivity has decreased over the last 5 years due to cement production (4.17). The less severe effects are that the youth are no longer staying to cultivate land because of effect of pollution (4.07), income generated from selling bush meat are no longer coming because of noise (4.07), the risk of health and crop failure is increasing by the day (3.90), Health hazards posed by cement activities result in rural dwellers spending more to maintain their health (3.77) and emissions have local and global environmental impact resulting in global warming, ozone depletion, acid rain, biodiversity loss, reduced crop productivity (3.50). A similar study by Adekunle, Ashaolu and Obinka (2015) showed that majority (68% with a mean of 1.44) of the respondents in the target area strongly agreed that pollutants from cement plants have caused harmful effects on human health and environment. Also, 78% of the sampled farmers strongly agreed that cement plant activities caused cough while about 54% agreed that the risk of farmers' health and crop failure had increased by the day.

Table 2. Effects of cement production activities on farmers' livelihood.

Perceptional Statement	**SA**	**A**	**UD**	**SD**	**D**	**Cum**	**Mean**	**rank**
Pollutants from cement plants are causing harmful effects on human health and environment	27(135)	2(8)	1(3)	-	-	146	4.87**	1st
Farm productivity has decreased over the last 5 years due to cement production	6(30)	23(92)	1(3)	-	-	125	4.17**	4th
Skin itches more than it used to over the last 5 years	14(70)	14(56)	2(6)	-	-	132	4.40**	2nd
Income generated from selling bush meat are no longer coming because of noise	9(45)	15(60)	5(15)	1(2)	-	122	4.07	5th
Youth are no longer staying to cultivate land because of effect of pollution	12(60)	11(44)	5(15)	1(2)	1	122	4.07	5th
Health hazards posed by cement activities result in rural dwellers spending more to maintain their health	7(35)	14(56)	5(15)	3(6)	1	113	3.77	7th
Emissions have local and global environmental impact resulting in global warming, ozone depletion, acid rain, biodiversity loss, reduced crop productivity	7(35)	10(40)	8(24)	1(2)	4	105	3.50	8th
The risk of health and crop failure is increasing by the day	6(30)	19(76)	2(6)	2(4)	1	117	3.90	6th
Cement plant activities causes coughing	12(60)	13(52)	4(12)	1(2)	-	126	4.20**	3rd

Source: Field Survey Data (2017)
Note: weighted mean = 4.11, (X ≥4.11 = have serious effect, X<4.11 = less effect), ** serious perceived effect; SA = Strongly Agree, A = Agree, UD = undecided, SD = strongly disagree, D = Disagree

3. 3. Health challenges suffered by farmers and the number of farming days lost due to those health challenges

The various health challenges suffered by farmers and number of farming days lost due to those health challenges are presented in Table 3. Out of the 30 people sampled in the target location for each disease, 10 (33.3%) reported prevalence of respiratory diseases, 4 (13.3%) reported Diarrhea, 20 (66.7%) were due to skin rashes, 5 (16.7%) reported heart disease, 2 (6.7%) reported asthma, 25 (83.3%) and 4 (13.3%) were due to cough and skin cancer respectively. However, much of the days lost was on heart diseases (44) and respiratory diseases (33), with diarrhea (7) accounting for the least days lost by sick persons and caregiver. This result is consistent with that of Afolabi, Francis and Adejompo (2012). In their studies, diarrhea (9) accounted for the least diseases faced by farmers close to cement factory. Also, Adekunle *et al.* (2015) concluded that diseases associated with cement factory are respiratory diseases (78), skin rashes (36), diarrhea (11) and heart diseases (1). In their studies, they alluded that respiratory diseases recorded the highest number of days lost to sick farmer followed by skin rashes.

Table 3. Health challenges suffered by farmers and the number of farming days lost due to those health challenges.

Disease	Frequency	Percentage	*Days lost by sick farmer	*Days lost by caregiver	Total days lost
Respiratory	10	33.30	23	10	33
Diarrhea	4	13.30	5	2	7
Skin rashes	20	66.70	8	2	10
Heart disease	5	16.70	33	11	44
Asthma	2	6.70	8	4	12
Cough/catarrh	25	83.30	8	2	10
Skin cancer	4	13.30	3	17	20

Source: Computed from Field Survey Data (2017)
Note: * = mean value, frequency and percentages values are for targets that tick yes

3. 4. Maximum likelihood estimates of stochastic production frontier function for cassava farmers in Mfamosing

The maximum likelihood estimates of the stochastic frontier production function parameters of the sampled cassava farmers are presented in Table 4. Maximum-likelihood estimates of the parameters of the stochastic frontier model revealed that hired labour was positive and statistically significant at the 1% level for both target and control group. These results was in line with the *a priori* expectation and imply that the yield of cassava in both the target and the control group farmers in the study area were expected to increase with the increasing use of labour. Amaza, Kwaghe and Ojo (2005), Bamidele, Babatunde and Rasheed (2008) and Ebong, Okoro and Effiong (2009) also reported a positive and significant relationship between labour and technical efficiency in Nigeria. In the target group area, the cassava cuttings and farm size used did not have any significant effect on cassava yield produced as indicated by their t-ratio values. This implies that increasing the quantity of cassava cuttings and farm size used will not increase cassava yield in this study area, *ceteris paribus*. Conversely, the coefficient of the quantity of cassava stem cuttings was positive and significant at the 10% level in the control group area. The positive coefficient of the quantity of cassava stem cuttings used implied that cassava output increases with increased in this variable. Therefore, a 10% increase in quantity of cassava stem cuttings used by the farmers will increase cassava yield by 0.4137E-4 tonnes/ha.

The coefficient of fertilizer in target group was negative (-0.2075E-4) and is statistically significant at the 5% level. This means that fertilizer is an important factor for increased yield in the study area, but the interference with cement dust and gaseous substances released from the cement factory leads to a reduction in the level of yield of cassava produced. The determinant of technical inefficiency of cassava production in Mfamosing as presented in Table 4 indicates that the sources of inefficiency examined for target and control of cassava farmers were: age, gender, marital status, household size, educational qualification, farming experience, extension services and numbers of days lost to illness. However, only number of days lost due to illness was significant in both the target and control group areas. The coefficients of number of illness episode (i.e number of days lost due to illness) were negative and significant at the 1% and 5% levels for target and control groups respectively. This result is indicative that the higher the number of days lost due to illness, the higher the farmers' inefficiency levels.

The result obtained in this study was not consistent with that of Adekunle *et al.* (2015), who obtained a positive and significant coefficient of number of days lost due to illness with output of cassava. Therefore, the implication of the result of this study is that, if there is a 1% increase in the number of days lost due to illness by farmers in the target group area, the quantity of cassava output produced will decreased by 0.54%. Conversely, in the control group location, if there is a 5% increase in the number of days lost due to illness by farmers, the quantity of cassava output produced will decreased by 0.091%.

However, the cassava farmers in the target locations were less efficient when compared with their counterpart in the control location. Although in the control group; the gender, educational level, farming experience were not statistically significant at any level, but were in line with the *a priori* expectations. This suggests that the male headed households, more educated and more experienced cassava farmers were more efficient than the female, less educated and less experienced cassava farmers. That is, as the farmers' educational level and farming experience increased in the study area, inefficiency in the resource use decreased and technical efficiency increased.

3. 5. Distribution of technical efficiency among the respondents

The distribution of farm-specific resource-use efficiency scores among the two groups of farmers are presented in Table 5. The resource use efficiency of the sampled farmers in both farms is less than unity (i.e.100%), indicating that all the farmers are producing below the maximum efficiency frontier. The efficiency indices in the target group of farmers ranged from 0.45 - 0.99 with a mean index of 0.67 while in the control group location, the efficiency ranged from 0.57 – 0.99 with a mean of 0.82. The picture that emerges from the analysis is one of generally high resource-use efficiency in cassava production in the study area as most of the farmers (90% of target group and 100% of control group) produced above 0.50 efficiency index. However, 43.3% of the target group farmers and 60.00% of control group farmers produced above the estimated average technical efficiency index of 0.67 and 0.82 respectively. The distribution of the resource-use efficiency suggests that potential gain among the sampled farmers is not much. Thus, in the short-run, there is a scope of increasing cassava production in the target group by 33% and in the control group by 18% by adopting the technology and technique used by the best-practice farmer. On the whole, control group farmers are more efficient in the use of available farm resources in cassava production compared to their target group counterparts.

Table 4. Maximum Likelihood Estimates of the Parameters of the Stochastic Frontier Production Function

Variable	Parameter	Target group			Control group		
		Coefficient	Std. error	t-ratio	Coefficient	Std. error	t-ratio
Production Factors							
Constant	b_0	0.1754	0.1927	0.9102	0.8738	0.05429	16.09***
Farm size (X_1)	b_1	0.001991	0.04565	0.4359	-0.003991	0.03690	-0.1082
Cassava cuttings (X_2)	b_2	0.1046E-4	0.2545E-4	0.4111	0.4137E-4	0.229E-4	1.806*
Hired labour (X_3)	b_3	0.1295E-3	0.7736E-5	16.74***	0.1376E-3	0.3743E-4	3.676***
Fertilizer (X_4)	b_4	-0.2075E-4	0.9555E-5	-2.171**	-0.4554E-5	0.5674E-5	-0.8027
Inefficiency effects							
Constant	δ_0	0.4081	0.4184	0.9754	0.2279	0.6089	0.3745
Age (Z_1)	δ_1	-0.01055	0.00669	-0.1577	0.01737	0.01774	0.9793
Gender (Z_2)	δ_2	0.08867	0.1128	0.7860	-0.1401	0.1452	-0.9642
Marital status (Z_3)	δ_3	0.1444	0.1601	0.9019	-0.01294	0.09056	-0.1429
Household size (Z_4)	δ_4	-0.04634	0.03352	-1.3825	-0.02772	0.04898	-0.5658
Educational level (Z_5)	δ_5	0.05609	0.04475	1.253	-0.004638	0.09968	-0.04653
Farming experience (Z_6)	δ_6	0.02057	0.02035	1.0108	-0.01359	0.02416	-0.5625
Extension service (Z_7)	δ_7	0.005975	0.08429	0.07089	0.005096	0.08157	0.06252
Number of days lost due to illness (Z_8)	δ_8	-0.05406	0.008307	-6.507***	-0.02145	0.00906	-2.368**
Diagnostic statistics:							
Sigma –squared(δ^2)		0.02834	0.8295E-4	0.3417***	0.03138	0.01191	2.634**
Gamma(γ)		0.9999	0.4116E-4	24294***	0.999	0.2728E-4	36650***
LR test		13.25			12.75		
Likelihood function(λ)		11.52			22.51		
Sample size		30			30		

*** (P < 0.01); ** (P<0.05) * (P<0.10);

Table 5. Distribution of farm-specific resource-use efficiency scores in both farming groups.

Efficiency scores	Target group		Control group	
	Frequency	Percent	Frequency	Percent
0.41-0.50	3	10	-	-
0.51-0.60	11	36.70	1	3.30
0.61-0.70	6	20	6	20
0.71-0.80	4	13.30	5	16.70
0.81-0.90	3	10	9	30
0.91-1.0	3	10	9	30
Mean efficiency	0.67		0.82	
Minimum efficiency	0.45		0.57	
Maximum efficiency	0.99		0.99	

Source: Computed from Field Survey Data (2017)

3. 6. Generalized Likelihood Ratio (LR) Hypothesis test for inefficiency

The results in Table 6 showed the hypotheses test for inefficiency. The first hypothesis Ho: $\gamma = \delta 0 = \delta 1 = \delta 2 = \delta 3 = \delta 4 = \ldots = \delta 9 = 0$ specify that there is no technical inefficiency effects in the model. When this restriction was imposed on the model, the value of the generalized likelihood ratio (LLR) test statistic was 10.87 (control) and 13.25 (target), which is larger than the critical value of 2.706. Thus, we reject the null hypothesis and conclude that there is a technical inefficiency effect, given the specifications of the stochastic frontier and inefficiency effect model. The second null hypothesis, Ho: $\gamma = 0$, specifies that technical inefficiency effects are not stochastic. If the parameter γ is zero, then the variance of the technical inefficiency effect is zero and so the model reduces to the traditional OLS. When this restriction was imposed on the model, the value of the generalized likelihood ratio test statistic of 12.75 (control) and 13.24 (target), which is larger than the critical value of 2.708. Thus, the null hypothesis that the technical inefficiency effects are not stochastic is rejected. This indicates that the traditional average (OLS) function is not an adequate representation for the result. The third hypothesis, Ho: $\delta 0 = \delta 1 = \delta 2 = \delta 3 = \delta 4 = \ldots = \delta 9 = 0$, specifies that farmers' socio-economic characteristics considered in the inefficiency model have no significant influence on technical inefficiency. When this restriction was imposed on the model, the value of the likelihood ratio test statistic of 11.89 (control) and 13.25 (target) was obtained, which is larger than the critical value of 5.138. Thus, the null hypothesis that farmers' socio-economic characteristics considered in the inefficiency model have no significant influence on technical inefficiency associated with the cassava farmers' inefficiency is also rejected. These findings suggested that traditional response function of estimating ordinary least square (OLS) could not have been an adequate representation of the data and this conforms to the findings of Oluwatosin (2011).

Table 6. Hypothesis test for inefficiency.

Null hypothesis	Loglikelihood Value	LR	Critical Value	Decision
Control group				
$H_0 =: \gamma = \delta_0 = \delta_1 = ...\delta_9 = 0$	17.08	10.87	2.706	Ho Rejected
$H_0 : \gamma = 0$	22.513	12.75	2.708	Ho Rejected
Ho: δ0 = δ1 = δ2 = δ3 = … = δ9 = 0	16.579	11.89	5.138	Ho Rejected
Target group				
$H_0 =: \gamma = \delta_0 = \delta_1 = ...\delta_9 = 0$	4.9	13.25	2.706	Ho Rejected
$H_0 : \gamma = 0$	11.52	13.24	2.708	Ho Rejected
Ho: δ0 = δ1 = δ2 = δ3 = … = δ9 = 0	4.9	13.25	5.138	Ho Rejected

Source: Derived from diagnostic test/MLE/ Field Survey (2017)

4. CONCLUSION AND POLICY RECOMMENDATIONS

The respondents in farming livelihood in the target and control areas were mainly of the female gender with the mean ages of 43 and 35 years respectively and they were mostly married. The literacy level was low in the target as compared to the control area. The result of the SFA revealed that hired labour, fertilizer and cassava cuttings were the significant variables that had a relationship with cassava yield. The externalities/pollution variable which was captured by number of days lost due to illness was found to reduce the efficiencies of the cassava farmers. The study, therefore, concludes that cement externalities impact negatively on the technical efficiency of the cassava farmers in the study area, thereby reducing their productivity levels and technical efficiency among small-medium scale cassava-based farmers in Lafarge cement concession area and control area. Based on the findings, the following policy recommendations were made:

1) Policy aimed at increasing efficiency should focus on improving health care services in the farming communities and encouraging efficient level of pollution control by the factory.
2) Government should mandate Lafarge to administer free annual medical check up to farmers around Mfamosing community for the singular purpose of addressing health problems due to cement factory pollutants.
3) Communities closed to the factory should be educated on the dangers to health of exposure to particles emanating from cement production. Again, residents, especially

farmers should be advised to distant their farming activities away from the factory as required by the enabling national and international Mining extant laws, of which Nigeria is a signatory. The enforcement of the extant laws would help to curtail issues that may lead to noise, vibrations, dust and hazards associated with heavy vehicular movement *ab initio*.

References

[1] Abang, S. O. & Agom, D. I. (2004). Resource use efficiency of small holder farmers: The case of cassava producers in Cross River State, Nigeria. *Journal of Food, Agriculture and Environment,* 2(3&4), 87-90.

[2] Adekunle, C. P., Ashaolu, O. F. & Obinka, C. A. (2015). Effect of industrial externalities on technical efficiency among cassava-based farming households in Ewekoro Local Government Area, Ogun State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment,* 11(4), 82-89.

[3] Adewuyi, S. A., Agbonlahor, M. U. & Oke, A.T. (2013). Technical Efficiency Analysis of cassava farmers in Ogun State, Nigeria. *International Journal of Agriculture and Food Science,* 4(1&2), 515-522.

[4] Afolabi, A., Francis, F.A., & Adejompo, F. (2012). Assessment of Health and Environmental Challenges of Cement Factory on Ewekoro Community Residents, Ogun State, Nigeria. *American Journal of Human Ecology,* 1(2), 51-57.

[5] Amaza, P.S., Kwaghe, P.V., & Ojo, N. (2005). Determinants of wheat production and technical efficiency in the Chad basin development area, Nigeria. *Nigerian Journal of Agriculture, Food and Environment*, 2, 1- 6.

[6] Araga, F. M., & Rud, J. P. (2014). Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana.

[7] Bamidele, F. S., Babatunde, R.O. & Rasheed, R. (2008). Productivity Analysis of Cassava-based Production Systems in the Guinea Savannah: Case study of Kwara State, Nigeria. *American-Eurasian Journal of Scientific Research,* 3(1), 33-39.

[8] Coelli, T. (1996). Frontier version 4.1: A computer program for stochastic frontier production and cost function estimation. Working paper 96/7, center for efficiency and productivity analysis, department of econometrics, University of New England, Armidale, Australia.

[9] Ebong, V, O., Okoro, U. S., & Effiong, E.O. (2008). Determinants of Technical Efficiency of Urban Farming in Uyo Metropolis of Akwa Ibom State, Nigeria. *International Journal of Agriculture and Social Sciences,* 5, 89-92.

[10] Emberson, L. D., Ashmore, M. R., Murray, F., Kuylenstierna, J. C. I.., Percy, K. E., Izuta, T., Zheng, Y., Shimizu, H., Sheu, B. H., Liu, C. P., Agrawal, M., Wahid, A., Abdel-Latif, N. M.. van Tienhoven, M., de Bauer, L. I. and Domingos, M. (2001). Impacts of Air Pollutants on Vegetation in Developing Countries, *Water, Air, & Soil Pollution,* 130, 107-118.

[11] GraffZivin, J. S., & Neidell, M. J. (2012). The Impact of Pollution on Worker Productivity. *American Economic Review*, 102(7), 3652-3673.

[12] Hanna, R., & Oliva, P. (2011). The Effect of Pollution on Labor Supply: Evidence from a Natural Experiment in Mexico City, NBER Working Paper No. 17302.

[13] Ityavyar, E. M., & Thomas, T. T. (2010). Environmental pollution in Nigeria: the need for awareness creation for sustainable development. *Journal of Research in Forestry, Wildlife and Environment*, 4 (2), 1-14

[14] Jhigan M. I. (2000). Microeconomic Theory (5th Ed.) India: Vrinda Publications.

[15] Lameed, G.A., & Ayodele, A.E. (2008). Environmental impact assessment of cement factory production on biodiversity: A case study of UNICEM, Calabar Nigeria. *World Journal of Biological Research*, 1, 1-7.

[16] Marshall, F., Mike A., & Fiona, H. (1997). A hidden threat to food production: Air pollution and agriculture in the Developing World, Gatekeeper Series SA73, International Institute for Environment and Development (IIED).

[17] Mehraj, S.S., Bhat, G.A., Balkhi, H.M., & Gul, T. (2013). Health risks for population living in the neighborhood of a cement factory. *African Journal of Environmental Science and Technology*, 7(12), 1044-1052.

[18] Okojie, L. O. (2014). Cement Production and Sustainable Rural Farming Livelihood in Nigeria: Striking a Sensible Balance through Environmental Legislation and Enforcement. *European Journal of Sustainable Development*, 3(3), 251-262.

[19] Oluwatosin, F.M. (2011). Measuring Technical efficiency of yam farmers in Nigeria: A Stochastic Parametric Approach. *Agricultural Journal*, 5(2), 40- 46.

[20] Orewa, S. I. & Izekor, O. B. (2012). Technical efficiency analysis of yam production in Edo State: A Stochastic frontier approach. *International Journal of Development and Sustainability*, 1(2), 516-526

[21] Egbe Edmund Richard, Nsonwu-Anyanwu Augusta Chinyere, Offor Sunday Jeremaiah, Usoro Chinyere Adanna Opara, Etukudo Maise Henrieta, and Egbe Deborah Ifunanya. Cement Dust Exposure and Perturbations in Some Elements and Lung and Liver Functions of Cement Factory Workers. *Journal of Toxicology* Volume 2016, Article ID 6104719, 7 pages. http://dx.doi.org/10.1155/2016/6104719

[22] Tijani, A. A. Ajobo, O., & Akinola, A. A. (2005). Cement Production Externalities and Profitability of Crop Enterprises in Two Local Government Areas of Ogun State. *Journal of Social Sciences*, 11(1), 43-48.

[23] Wale, A. (2011). Nigeria Cement Industry. *Pan African Capital Industry Reports*, pp 2-16.