Socio-Economic Effects of Chemical Pollution on Agricultural Production in Mineral Mining Communities of South- East Nigeria

Samuel .E. Esheya[1], C.U. Okoye[2], N.J. Nweze[3]

[1] Department of Agricultural Education, Ebonyi State College of Education Ikwo.
[2] Department of Agricultural Economics, University of Nigeria, Nsukka,
[3] Department of Agricultural Economics, University of Nigeria, Nsukka
Corresponding Author's E-mail : samuelesheya@gmail.com

ABSTRACT

This study investigated the socio-economic effects of chemical pollution on agricultural production in mineral mining communities of South-East Nigeria. It was carried out in three (3) states namely: Abia, Ebonyi and Imo states. The study was guided by three research questions and one null hypothesis. Multi-stage and purposive simple random sampling techniques were employed for selecting the respondents. Data were obtained from primary sources from a sample of 400 respondents by the use of structured questionnaire. Data collected were analysed using percentage, frequency, mean, and multiple regression analysis. Results indicate that explosives, sulphuric acid, pesticides, persistent organic pollutants, acetylene, nitric acid, radioactive chemicals, fumigants and volatile organic compounds were the commonly used chemicals by mineral mining companies in the study area. Contamination of air, water and land with resultant death of soil micro- organisms, reduction in farmland and soil fertility, poor growth and pre-mature death of crops; poor crop yield and frequent outbreak of civil crises were among the severe socio-economic effects of chemical pollution in mineral mining communities of South- East Nigeria. Based on the results of the multiple regression analysis, the independent variables in the three regression models significantly influence the yield of yam, cassava and rice respectively. This study recommends that it would be necessary to improve the socio-economic status of the farmers and strengthen cooperation between various parties to solve chemical pollution and related problems facing the mineral mining host communities to achieve the twin goals of food security and environmental safety in mineral mining host communities of South- East Nigeria.

Key Words : *Agriculture, Mineral, Mining, Productivity, Pollution.*

Chemicals bring many benefits to societies and represent a vital element of human development. However, without good management and disposal practices, chemical substances as well as wastes have the potential to pose significant risks to human health and the environment, with the poorest members of the global community, particularly women and children most vulnerable to their negative effects.

Mineral mining involves a lot of chemical synthesis in the process of converting the natural products in the environment into other forms convenient for man's consumption (Bowen, 2009). In the process of creating products, man also creates problems either consciously or unconsciously vis-à-vis pollution. Chemicals have created life threatening ecological hazards and deterioration of health and social fabrics of the inhabitants of the mineral mining communities (ATSDR, 2003).

The challenge facing all industries throughout the world is sustainable development, which requires balancing the protection of human health and safety and the natural environment with the need for both sustained economic activity and growth. In the mining industry, waste products are generated in larger volumes than other industries, and mine wastes are primarily disposed of on land. These pose significant health and environmental risks (Steffen, Robertson & Kirsten, 1991).

The fundamental role of chemicals in society, and their processes and products is indisputable. Current trends in the chemicals industry and associated sectors confirm this is true throughout the world- and increasingly so in developing countries where the chemicals industry is rapidly growing in parallel to economic and social development. When improperly managed however, some chemicals can have dire and far-reaching consequences on human health and the environment. Managing and reducing the risks of chemicals in a sound manner is therefore an essential part of sustainable development (Buccini, 2004).

Research Problem

The mineral rich areas of the South- Eastern region of Nigeria are a sensitive and fragile ecosystem. Despite its vast resources endowment and immense potential for socio-economic growth and contributions to the overall development of Nigeria, the area remains under threat from rapidly deteriorating economic and environmental conditions as well as social tension. The production of yam, cassava and rice among other staple food crops which is the major means of rural livelihood is adversely affected chemical pollution and related damages arising from the activities of mineral mining companies. This calls for proactive roles by mining companies in setting standards of operation and practice that maintain international standing and reputation.

However, evidence indicates that even though the Nigerian government and the mining companies are aware of these negative socio-economic and environmental effects of mineral exploitation, they have not made any concerted effort to control the adverse effects of chemicals in mineral extraction, production and distribution activities on the environment of the host communities. Some critics suggest that the situation has worsened in recent years (Gberesu, 1995).

Suffice it to say that studies cited in this work were methodologically sound and informative; however, they only present a partial picture of the pervasiveness of chemicals in modern society. Thus, there is dearth of economic literature on the socio-economic effects of chemical pollution on agricultural production in mining communities of South- East Nigeria, and this study is meant to close this existing information gap while addressing the under- listed research questions: What are the types of chemicals used by mining companies in the study area? What are the socio-economic effects of chemical pollution on agricultural production in the study area? What are the factors that influence the yield of yam, cassava and rice in the study area?

Objectives

The major objective of this study was to examine the socio-economic effects of chemical pollution on agricultural production in South-East Nigeria. The specific objectives were to: identify the types of chemicals used by mineral mining companies in the zone; describe the socio-economic effects of chemical pollution on agricultural production; and determine the factors which influence the yield of yam, cassava and rice in the mineral mining communities.

Theoretical Framework

Mineral mining has a number of common stages or activities, each of which has potentially-adverse impacts on the natural environment, society and cultural heritage, the health and safety of mine workers, and communities based in close proximity to operations. As indicated by Noronha (2001), the socio-economic and environmental impacts are more pervasive in regions where operations are newly established or are closing-down. Thus, the main theories underlying this study include natural resources conservation theory, sustainability theory and theories of risk-averse.

There are number of resources like air, water, forest, soil, wild animals, minerals etc in nature. These are valuable property of nature for the benefit of human beings. Human beings depend upon them for their different purposes. They also conduct different kinds of activities by using the natural resources. So, the hazards and destructions may run upon the resources. Adverse effects are emerged on the resources which are pollution, and degradation of ecosystem (Thakadu, 2005). Relative conservation theory is used to explain conservation along with consumption approach of property of the earth. According to this approach, the quality and quantity of natural resources are regenerated for future use. There are parallel conservation programmes too. We should use the resources wisely and naturally to sustain the quality and quantity. As a result, it never gets declined from the nature (Twyman, 2000).

Theories of sustainability attempt to prioritize and integrate social response to social, economic and environmental problems. While an economic model looks to sustain natural and financial capital, an ecological model looks at biological diversity and ecological integrity. The theoretical basis of sustainability theory is the form of progress that meets the needs of the present without compromising the ability of the future generations to meet their needs (Shahan, 2009). Sustainability as regards natural resources such as land and its deposits, forests, air and water bodies means a balanced use of these resources over a long period of time without impairing the fundamental ability of the natural resources base to support future generations. An environmentally sustainable system must maintain a stable resource base, avoiding over-exploration of renewable resource systems or environmentally sink functions and depleting non-renewable resources only to the extent that investment is made in adequate substitutes (Okon, 2014).

Risk-Averse (or risk avoiding) is a concept in Psychology, Economics and Finance, based on the behaviour of humans (especially consumers and investors) while exposed to uncertainty to attempt to reduce that uncertainty. Risk aversion is the reluctance of a person to accept a bargain with an uncertain payoff rather than another bargain with more certain, but possibly lower, expected payoff

(Heater, 2003). Ellis (1998) asserted that farm households always operate under risk and uncertainty induced by natural hazards (weather, pests, diseases and natural disasters), market fluctuations and social uncertainty (insecurity associated with control over resources such as land tenure and state interventions and war). These conditions pose risks to farm production and make farmers cautious in their decision making (Walker & Jodha, 1986).

METHODOLOGY

The study area is South-East Nigeria. South-East geopolitical zone of Nigeria is made up of five states: Abia, Anambra, Ebonyi, Enugu and Imo States. Multi-stage simple random sampling and purposive sampling techniques were employed for selecting the respondents. Three out of the five states in the South-East geopolitical zone were purposively selected namely: Abia, Ebonyi and Imo States. Two (2) L.G.As were purposively selected in each state based on intensity of mineral mining and related activities.

Four (4) villages (two mineral mining and two non-mineral mining areas) were selected from each of the Local Government Areas while eight (8) mineral mining companies were purposively selected for the study because of the preponderance of pollution in the areas due to mining activities. Fifty (50) farmers were randomly selected in each L.G.A while twelve (12) workers were randomly selected in each mineral mining company. Thus, a sample size of four hundred (400) respondents was selected for this study.

Data were obtained mainly from primary sources using a set of structured questionnaires. Data collected for this study were analysed with the aid of descriptive and inferential statistics. Objectives (i) and (ii) were realised using descriptive statistics such as percentage, frequency, mean and a 4-point rating scale while bjective (iii) was achieved using a multiple regression analysis.

The implicit form of the regression model is:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, \varepsilon)$$

Where :

Y = Crop yield (yam, cassava & rice in kg/ha)

X_1 = Farm size (hectares)

X_2 = Labour cost (N)

X_3 = Occurrence of communal crisis (Dummy: Crisis = 1, no crisis = 0)

X_4 = proximity to mine site (Distance in kilometres)

X_5 = Extension awareness (Awareness = 1, Otherwise = 0)

X_6 = Farming experience (years)

X_7 = Age of farmer (years)

X_8 = Educational qualification of farmer (years of formal education)

X_9 = Occurrence of chemical pollution (Dummy: chemical pollution = 1, no chemical pollution during the cropping season = 0)

ε = Error term

RESULTS AND DISCUSSION

Types of chemicals used by mineral mining companies

Table 1 shows the types of chemicals used by mineral mining companies in the mineral mining communities of South- East Nigeria. From the results, it was observed that cyanides are the only chemical that is not in popular use in the study area as it accounted for 49.0%. Explosives, Sulphuric acid, Pesticides, Persistent Organic Pollutants, Acetylene, Nitric acids and Petrochemicals have percentages of 89.6%, 63.5%, 96.9%, 78.1%, 58.3%, 90.6% and 93.8% respectively indicating very high usage. Others include: radioactive chemicals (88.5%), Fumigants (82.3%), Volatile Organic Compounds (97.9%). Agency for Toxic Substances and Disease Registry (ATSDR) (2003) has shown that mineral mining involves a lot of chemical synthesis in the process of converting the natural products in the environment into other forms convenient for man's consumption. In the process of creating products, man also creates problems either consciously or unconsciously vis-à-vis chemical pollution.

Table 1
Percentage distribution of respondents by types of chemicals used by mining companies

Sr. No.	Variable	Mining workers frequency (N-96)	Percentage	Farmers frequency (N-252)	Percentage
1.	Explosives	86	89.6	73	24.3
2.	Cyanides	47	49.0	28	9.3
3.	Sulphuric Acids	61	63.5	14	5.6

4.	Pesticides	93	96.9	127	50.4
5.	Persistent Organic Pollutants (POP)	75	78.1	11	4.4
6.	Acetylene	56	58.3	--	--
7.	Nitric Acid	87	90.6	34	13.5
8.	Petrochemicals such as Methanol, Propylene, Xylene, Hydrocarbons Etc.	90	93.8	58	23.0
9.	Radioactive Chemicals such as Uranium, Promethium, Astatine etc.	85	88.5	--	--
10.	Fumigants / other additives	79	82.3	26	10.3
11.	Volatile Organic Compounds (VOCs) such as formaldehyde, toluene, methylene chloride etc.	84	97.9	41	16.3

***Multiple responses were recorded.**
Source: Field Survey, 2014.

Socio-Economic effects of chemical pollution

Results in table 2 indicate that contamination of air, water and land were the fundamental and most severe socio-economic effects of chemical pollution in mineral mining communities .death of soil micro-organisms and reduction in soil fertility (3.6), poor growth, yield and death of crops (3.7), and permanent displacement of farmers (4.2) are among the severe socio-economic effects of chemical pollution in mineral mining communities of South- East Nigeria. Agricultural crops can be injured when exposed to high concentrations of various soil and air pollutants. These attack ranges from visible markings on the foliage, to reduced growth and yield, to premature death of the crops.

Table 2
Mean rating of respondents by severity of socio-economic effects of chemical pollution

Sr. No.	Items	Mean	Decision
i.	Chemical pollution causes ecological imbalance	1.5	Not Severe
ii.	Chemical pollution deprives humans the intended use of water	3.5	Severe
iii.	Chemical pollution contaminates the air causing respiratory diseases	3.8	Severe
iv.	Chemical pollution causes poor growth, yield and death of crops	3.7	Severe
v.	Chemical pollution causes permanent displacement of farmers	4.2	Severe
vi.	Chemical pollution causes acid rock drainage	1.8	Not Severe
vii.	Chemical pollution causes loss of agricultural farm land	3.4	Severe
viii.	Chemical pollution kills soil organisms thereby reducing soil fertility	3.6	Severe
ix.	Chemical pollution contaminates water and make it unfit for irrigation	4.2	Severe
x.	Chemical pollution endangers aquatic, wild life and domestic animals	4.7	Severe

*** Multiple responses were recorded; Mean score = 2.50 and above**
Source: Field Survey, 2014.

The results in Table 2 above further indicate that loss of agricultural farm land (3.4), contamination of intended domestic and irrigation water (4.2), outbreak of respiratory diseases (3.8) are also among the severe effects of chemical pollution in the study area. Opinion of the respondents indicated that the mineral mining companies do not provide significant chemical pollution control measures in their areas of operation. This accounts for the high level of air, water, soil, and even noise pollution observable in the host communities. Findings also show that mineral mining companies do not pay adequate compensation to displaced and affected farmers thereby making re-settlement very difficult. This and other inhuman treatments often triggered off civil crises in the mineral mining host communities.

Factors influencing yam, cassava and rice yields

The analysis of OLS results of factors that determine crop yields (yam, cassava and rice) in mineral mining communities of South East Nigeria were presented in Table 3. The R^2 values were 0.5410, 0.8113 and 0.5304 for yam, cassava and rice models respectively. These imply that 54%, 81% and 53% of the variations in the model were explained by the independent variables included in the model. The F-statistics of 44.27 (0.0000), 161.51(0.000), and 42.41 (0.0000) for yam, cassava and rice models respectively were significant at 1 per cent critical value suggesting that all the models were of good fit.

Summarily, the independent variables in the three regression results shown in table 3 influenced the yield of yam, cassava and rice almost similarly. Findings indicate that these nine factors specified influenced crop yields almost similarly across the sampled states. Farm size, farming experience and level of formal education had positive and significant influence on crop yields while occurrence of civil crisis and farm's proximity to mine sites had negative and significant influence on crop yields.

Age of the farmer, extension awareness and labour cost had negative but no significant influence on the yield of crops. However, the occurrence of chemical pollution had negative and significant influence on the yields of cassava and rice while it influenced yam yield negatively but not significantly. This may be attributed to the fact that yam as the king of all crops is not grown everywhere. Thus, rational yam farmers in mineral mining host communities completely avoid areas where this prestigious crop could be prone to chemical pollution and related damages.

Table 3

Estimates of OLS models of factors influencing yam, cassava and rice yields

Dependent Variable Crop Yield (Yam.) Variable	Yam		Cassava		Rice	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Constant	3.528731 (0.477616)	73.88**	4386.328 (827.7318)	5.31**	3.95119 (.1801939)	21.93**
Age	. -.0002776 (.0009146)	-0.30	.0924326 (15.40753)	0.01	-.0859748 (.100088)	-0.86
Fmsize	0069007 (.0010105)	6.83**	6193.488 (186.9721)	33.13**	.402931 (.0547613)	7.36**
Labour	.0002015 (.0001371)	1.47	-.7333306 (2.313477)	-0.32	-.0871808 (.0557234)	1.56
Crisis	-.0333151 (.0192379)	-1.73*	-208.4922 (309.4811)	-0.67	-.0222043 (.0065493)	3.39**
Proximity	023739 (.0180099)	1.29	-171.6103 (303.6985)	-0.57	.0124976 (.0065711)	1.90*
Extaware	-.0121606 (.0184618)	-0.66	-523.3835 (300.6586)	-1.74*	-.0278139 (.0065594)	-4.24**
Fm exp.	.0099226 (.0011511)	8.62**	33.53971 (19.45627)	1.72*	.2370815 (.0537076)	4.41**
Education	.0086969 (.0015502)	5.61**	12.47395 (26.11959)	0.48	.0058038 (.0046994)	1.23
Pollution	-.0197756 (.0226245)	-0.87	-795.4509 (374.9095)	2.12**	-.037354 (.008043)	-4.64**
R2	0.5410		0.8113		0.5304	
Adjusted R2	0.5288		0.8063		0.5178	
F- stat	44.27		161.51		42.41	
No. of observations	400		400		400	

Figures in parenthesas are standard errors. **, * indicate significance at 1% & 5% respectively.

Source: Field Survey, 2014.

CONCLUSION

The risk posed to the means of livelihood and health of the farm households in mineral mining communities by chemical pollution is real. Since little documented research has quantified the level of the threat, and little attention had been paid to reducing the risks, households continue to be exposed to toxic levels of chemical pollution. Mineral mining can bring broader benefits to a country at the expense of localized costs such as loss of agricultural output, some of them born by already poor disadvantaged group. This redistribution should be considered to better understand local opposition to mineral mining projects and demands for better compensation. Failure to recognize these social costs would grossly overestimate the net contribution of mineral mining to an economy.

Recommendations

i. Government must ensure that environmental impact assessment is carried out for any new mineral mining industry before its establishment

ii. Local communities must be involved in the running and oversight of the industries directly impacting their communities.

iii. Mineral mining companies must install appropriate equipment for preventing or minimizing chemical pollution.

Received : October 6, 2017
Accepted : December 2, 2017

REFERENCES

1. *Agency for Toxic Substances and Disease Registry (ATSDR) (2003). Public health assessment: Evaluation of Leviathan mine site, Markleeville, Alphine County, California. May 7, 2003.*
2. *Bowen, B. 2009. Mining, development and social impact on communities. Accessible at: www.unep.org.*
3. *Buccini, J. 2004. The global pursuit of the sound management of chemicals. World bank, Washington, D. C.*
4. *Ellis, F. 1998. Household strategies and rural livelihood diversification. Journal of development studies. 35 (1), 1-38.*
5. *Gberesu, D. A. 1995. Oil Spillage. A man made hazard in Rivers State, Nigeria. In proceedings of the international workshops on natural and manmade hazards in Africa. NMGS Publication.*
6. *Heater, G. 2003. Impacts of air pollution and acid rain on farmland. Assessed 12th June 2014 from http//www.amazon.co.uk.*
7. *Noronha, L.2001. Designing tools to track health and wellbeing in mining regions of India. Natural Resources Forum. 25, 53-65.*
8. *Okon, U. E. 2014. An Assessment of Income generating activities among urban farm households in South-South Nigeria. An Unpublished Ph.D Thesis submitted to the Department of Agricultural Economics, University of Nigeria, Nsukka.*
9. *Shaham, Z. 2009. What is sustainability? The practice makes the ideal. The critical 4th component. Retrieved July 8, 2013 from http//www.blog.sustainability.org.*
10. *Stephen R. and Kirsten, N. 1991. In association with Maxime Wiber, Toronto, Actrex partners Limited. Toronto and staff of the Ministry of North Development and Mines. Report 89702, Draft of mine closure plan guidelines, prepared for 0nterio Ministry of Northern Development and Mines. 121-163.*
11. *Thakadu, O. T. 2005. Success factors in community based natural resources management in Northern Botswana. Lessons for practice. Natural resources forum. 29 (13), 199-212.*
12. *Twyman, C. 2000. Participatory consumption: Community based natural resources management in Botswana. The Geogrpahical Journal. 166(4), 323-335.*
13. *Walker, T. and Jodha, N. 1986. How small farmers adapt to risk. In P. Hazell; C. P. Mareda; and Valdez, eds. Crop insurance for agricultural development. Baltimore: John Hopkins University Press.*
14. *Word Bank 2008. Rural finance in Nigeria: Integrating New Approaches. Report No. 44741. The World Bank Press.*