Environmental and Economic Effects of Abakaliki Rice Mill Company Ltd on Amagu Community-Ebonyi State, Nigeria

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Abstract
Although Rice is the most economically important food crop in the world, its milling is always characterised with environmetal and socio-economic problems.Convinced that Abakaliki Rice Mill was contributing to environmental degradation in Abakaliki Capital City, Ebonyi State Government in 2009, ordered for its relocation.This study, therefore, examined the environmental and the economic effects of Abakaliki Rice Mill Company Ltd on Amagu community using survey and experimental methods. The research employed survey instrument, field measurements and laboratory analysis. A total of 396 questionnaire were administered to residents in Amagu Community. The questionnaire had 2 sub-sections on: the environmental effects, and the economic effects. Hand-held GASMAN Air Pollutants Monitors were used to measure air samples while soil and water samples were subjected to laboratory analysis. The data on the environmental and the economic effects were analysed using Wilcoxon Ranks Signed Tests, while the data on soil properties were analyzed using Mann Whitney tests. Kruskal Wallis Test was used for data on water and air. The results revealed that, whereas the rice mill has no significant negative environmental effect on Amagu Community (p values< 0.05), it rather, has significant positive economic effect (p value>0.05). Hence, the study recommended: entrenchment of waste to wealth ideology, cleaner production practices, treatment of waste water before disposal, tree planting, heat energy conversion to electromechanical energy, advanced integrated agro-technology industry and banning of parboiling of paddy in the residential areas, among others.

Keywords: Rice, Rice Milling, Abakaliki Rice, Amagu-Commuinty, Ebonyi State

Introduction

Milling of rice is an important activity in food chain of the world economies. Rice feeds more than a third of the world's population (Khush, 1997); the predominant staple food in about 33 countries of the world including Nigeria (FAO, 2004). About 85% of the total production of rice is meant for human consumption (Janick, 2002). About 90 - 95% of Nigerians consume rice and this cut across all economic classes where it is eaten in different recipes (Wudiri, 1992).

According to Oguntade (2011), the rice milling industry in Nigeria is capable of contributing significantly to employment generation, economy boosting and food security (IRRI, 2014; World Rice Statistics, 2000). It is an ingredient in medicine; it is used to treat stomach upset, heart-burnt and indigestion, breast cancer and warts.

Few decades ago, rice grains were processed at family level before cooking. Today due to industrialization and global competitive market trend, it has emerged as one of the major industrial activities in various scales to cater for the increasing population of large number of millers engaged in processing. Milling of rice has spread over in some states across the country.

Rice processing operations in rice production include parboiling, drying and milling. All operations except milling are done manually using hand tools (Autrey et al., 1984). The technologies for rice milling

in tiny and small mills are mostly conventional in nature and are not oriented towards minimizing pollution by incorporation of in-plant pollution prevention and control measures. Milling of rice is a crucial post-production step in rice production. The objectives of milling are to get whole grain rice and preserve most of the rice kernels in their original shape and to remove the husk and the bran layers and to produce an edible, white or brown rice kernel free of impurities. In an ideal milling process, this will result in the following fractions: 20% husk, 8-12% bran depending on the milling degree and 68-72% milled rice or white rice depending on the variety. Total milled rice contains whole grains of head rice and brokens. The by-products in rice milling are rice hull, rice germ and bran layers, and the brokens (EPA, 1995; FAO, 2004; IRRI, 2014).

Pollution is particularly high in cleaning of paddy, parboiling of paddy and milling of rice. Primary and secondary cleaning of paddy gives rise to solid waste and fugitive emission in the work environment. The coal and husk generate fly, suspended particulate matter, smoke and oxides of carbon. According to Farouk et al (2006), rice milling may present a significant source of air pollution both on site and the surrounding locality resulting from releases of dust to the atmosphere from processing of the paddy or its by-products and this is a major environmental concern for rice mills. Others according to Farouk et al. (2006), include high internal and external noise levels which may generate health hazards to the local community, odour form soaking reservoirs, as well as unmaintained mechanical devices which cause severe noise and dust levels thereby endangering health of residents.

In the World over, the industrial sector has been responsible for a "significant percentage" of all environmental damage and pollution. Unlike most other countries such as Indonesia, China, India, and many other countries where rice production is produced on a large scale, the policy frameworks in Nigeria to address these environmental problems have not considerably shifted from the end-of-pipe approach and strong government intervention to cleaner production and market-based actions (EPA, 1995; FAO, 2004; IRRI, 2014).

The first measures by the government of Nigeria to address pollution problems in the 1980s were through the introduction of regulations and control under the program of compulsory environmental sanitation and compliance with environmental laws. This command and control approach had not been successful in raising awareness on environmental management issues. It has rather resulted in a perception that environmental management meant high costs for both capital investments and operations and maintenance (cost centre). Hence, these mandatory measures have not succeeded particularly well in responding to the environmental problems (Geiser, 2001; Nigerian Orient News, 2010).

The policy of cleaner production and market-based action has in most cases, ended up as blueprints in Nigeria. Most times instead of being progressive on environmental matters, Nigerian Government relapse back to the end-of-pipe approach and strong government intervention in environmental protection which are already facing out in the developed countries. For this reason, in the mid 1990s, the Ministry of Environment started to apply mixed policies and instruments which integrate the mandatory approach, partnerships and voluntary programs, and market-based and economic instruments (Daramola, 2005; Nigerian Orient News, 2010).

Abakaliki has the largest indigenous rice mill in Nigeria. The Abakaliki Rice Mill Company Ltd has over 5,000 workers, 2,500 rice milling machines, and a production capacity of more than 11,000 metric tonnes per month. Tonnes and tonnes of rice husks are produced every year as by product of rice processing at Abakaliki rice mills (Cohen, et al., 1998; Nigerian Orient News, 2010).

The by-products include both the solid and liquid waste such as the rice husk, bran, effluents from fuel and used water. The husks are dumped indiscriminately around the rice mills and they accumulate due to the numerous rice milling machines located in the area (Ekwe, 2012; Mba *et al.,* 2009).

Again, noise of different decibels is generated from the rice milling operations and heat of high temperature comes from the parboiling operations. Most of the by-products are abandoned in the husk dumps. They are occasionally set ablaze. Moreover, there is usually smoke emitted from the rice mill continually into the surrounding communities (Njoku *et al.,* 2011).

Despite the magnitude of these wastes generated daily and the possible and adverse effects on the environment, no serious attempts have been made either for their effective utilization or safe disposal. During the rainy seasons, the husk dumps are washed off as waste water into nearby streams and creeks (Mba *et al.,* 2009). Again, due to the presence of the industry, there is usually influx of people from different places within and outside Abakaliki who come to buy the finished rice for consumption and sales.

In line with a policy in 2009, geared towards making Abakaliki one of the cleanest cities in Nigeria by Ebonyi State Government and 2012 policy to boost industrialization in tandem with the 2011 policy of the Federal Government under former President Goodluck Jonathan to boost agriculture, with great emphasis on rice production, the Abakaliki Rice Mill was slated for relocation to the newly established State's Rice Clusters situated at Iboko in Izzi LGA, Onu Igboji in Ikwo LGA, and Oso Edda in Afikpo South LGA selected from the 3 senatorial zones of the State (Adie, 2012, Nigerian Orient News, 2010).

In response to the move for relocation, the rice millers and people of Amagu Community where the mill is located in 2012 rejected the decision for relocation; reasoning that the milling process does not pollute the environment and that it will bring hardship to the people; not just the owners and workers of the Abakaliki Rice Mill but also the generality of the Community and the state capital. This impasse culminated in a court case between the two parties that is the stakeholders of the mill and the Ebonyi State Government. This calls for need to holistically investigate the environmental and economic effects of rice milling using Abakaliki Rice Mill in Amagu Community wherein the Rice Mill is located as a case study.

Materials and Methods

Study Area

The study area-Amagu Community (wherein Abakaliki Rice Mill Company Ltd is sited) as shown in figure 4 is located in Abakaliki Local Government of Ebonyi State. It is bounded to the North, by Ebonyi L.G.A; to the East, by Edda and Okpuitumo communities and Ebonyi River; to the South, by Ezza North L.G.A and to the West, by the Izzi Unuphu (see fig. 3). Abakaliki on the other hand, is located between Latitudes 6^0 10"N and 6^0 20" N and Longitudes 8^0 00''E and 8^0 30'' E in the derived savannah zone of Nigeria; with a landmass of approximately 5,935sq km. Ebonyi state is located in the Southeastern part of Nigeria; within the transitional belt between the rain forest and guinea savanna. It is bounded to the North by Enugu and Benue States; to the East by Cross River State; to the South by Abia State and to the West by Anambra State (see figure 2) (Ugo, 2003).

The study population is 33,284; 15835 males and 17449 females (NPC, 2006) which is the population of Amagu Community and 100 Rice Mill workers. These were sampled. The vegetative cover of Abakaliki by classification is of Guinea-Savanah, and tropical rain forest recording both the dry season and the rainy season with the heat of the tropical sun, without rainfall and the severe North-East trade winds between December and April. Water in this period of the year is most often contaminated and breeds guinea worm

(Ugo, 2003). The climatic phenomena result in common crops and grasses as well as short trees, herbs and shrubs found scattered in the study area (Anikwe, 2000).

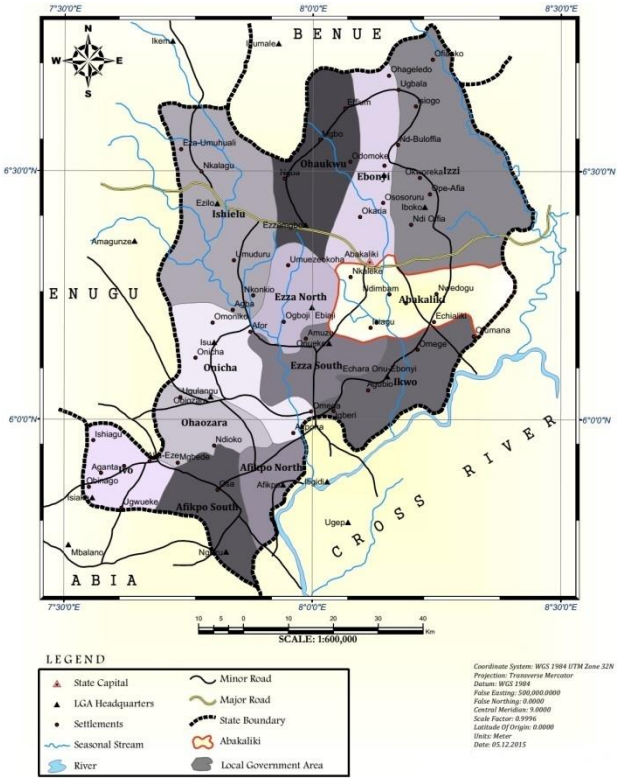


Fig. 2: Map of Ebonyi State, Nigeria showing Abakaliki.**Source**: GIS LAB, Geo-Planning Dept, KSU, Anyigba and

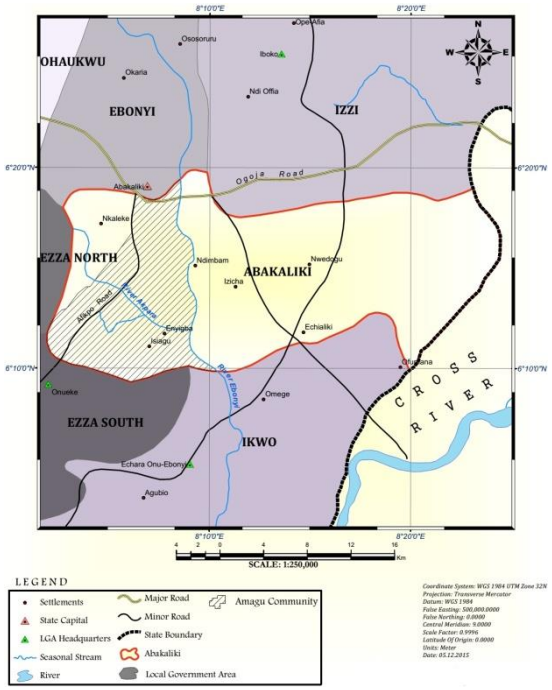


Fig. 3: Map of Abakaliki Local Govt. Area showing Amagu Community. **Source**: GIS LAB, Geo-Planning Dept, KSU, Anyigba and Federal Surveys, Nigeria (1967).

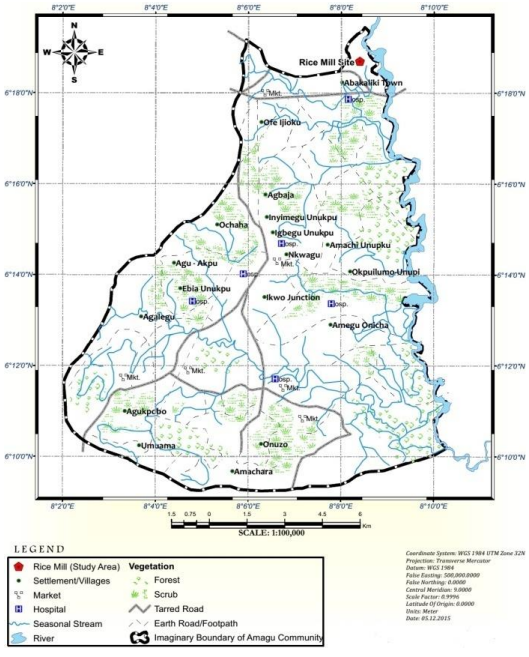


Fig. 4: Map of Amagu Community showing the Mill. **Source**: GIS LAB, Geo-Planning Dept, KSU, Anyigba and

The second season is the rainy season which starts from May to October. The annual rainfall is between 185 and 200 centimeters; mean annual temperature of about 24^{0}C and relative humidity of 60-80%. The rainfall pattern is bimodal; April-July and September-November with a short spell in August. Most of the agricultural activities are carried out then (Ofomata, 1975, Ugo, 2003).

The most outstanding of the water bodies is Ebonyi River with sandy deposits. The major water supply sources are wells, bore holes. The vegetation characterized by the usual mixed rainforest and guinea savanna species of flora (Ofomata, 1975). The main economic activity of Amagu community is rice cultivation and petty trading. Moreover, due to its proximity to the administrative base of the State and Ebonyi State University, Abakaliki, civil service is amongst the economic activities (Ugo, 2003).

Conceptual Framework

This work is based on the concept of sustainable development because it is the development that meets the needs of the present without compromising the ability of the future generation to meet their own needs. The concept stands on social, economic and environmental sustainability.

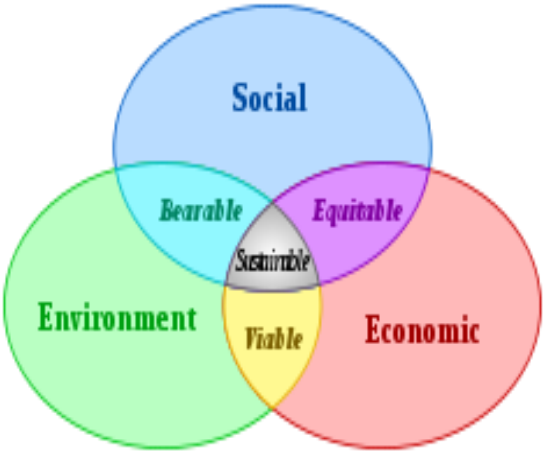


Figure 4: Scheme of sustainable development at the confluence of three constituent parts
Source: Adams (2006)

The widely accepted definition of sustainability or sustainable development was given by the World Commission on Environment and Development in 1987. It defined sustainable development as "forms of progress that meets the needs of the present without compromising the ability of future generations to meet their needs." Sustainability encompasses is the long-term maintenance of environmental, economic and social dimensions of responsibility and encompasses the concept of stewardship (Adams, 2006).

Sustainability is important because all the choices we pursue and all the actions that we make today will affect everything in the future. We need to make sound decisions at present in order to avoid limiting the choices of generations to come. For instance, if clean water and good soil become scarce enough, all life on Earth can become extinct. Keep in mind that this does not just apply to soil and water but all elements of nature that are crucial to sustaining the Earth's equilibrium (Adams, 2006).

The definition of sustainable development requires that one should see the World, the environment and its resources as a system which connects space; and a system that connects time. Perceiving the World as a system over space, one may understand for example that air pollution from an area may

affect air quality of another area and thinking of the world as a system over time can make one realize that farmland practices used years back can affect agricultural practice today; and the environmental policies we approve of today may have an impact on the environment in the future.

Sustainable development is based on environmental and economic objectives and there is need to conserve environment resources, biodiversity, and the same time uses the resources judiciously to achieve certain economic goals ((Adams, 2006). Sustainable development is therefore very vital in rice milling system. Herein, resources are utilized and processes are carried out. The resources in the context of this study are the human and natural vis-à-vis, the soil, water and air components, the human beings, the rice, the machines, the money to and fro the business of rice milling.

The government as well as the Rice Millers owes to the environment the responsibility of managing the environmental resources in such a way as to satisfy the needs of today without compromising the needs of future generation. When both parties play their parts as pointed out in the course of managing the development, it will be said that the management and development are sustainable.

Data Collection

The materials employed in this research were questionnaire, books, tape, pen and statistical tables as well as the hand held GASMAN Air Pollutant Monitors for air samples. For the water samples; clean polythene bottles with caps, thermometer, masking, permanent marker, gloves, cotton wool and cooler with ice packs while for the soil samples; shovel, cutlass, trowel, nose mask, hand gloves, measuring tape and ruler, sample bags, a pen and jotting pad.

Method of Analysis

The research methodology adopted for this work is the survey and experimental method. A control site was also adopted to compare results collected from laboratories. A total of 396 questionnaires were distributed to the 9 villages that make up Amagu Community using clustered systematic sampling technique on the households. Systematic random sampling method was adopted in eliciting information from 100 Rice Mill workers/operators. The questionnaire contained two major sections. Section A on personal data of the respondents while section B contained variables Environmental and Economic effects of the rice mill on the residents of Amagu Community.

The air samples were collected for 1 to 12 hours during the working and off-working periods in three different points in each of the clusters, according to National Ambient Air Quality Standard (NAAQS) and California Standard. Three instruments were used namely: hand-held GASMAN Nitrogen dioxide (NO_2) Gas Monitor, hand-held GASMAN Carbon dioxide (CO_2) Gas Monitor, hand-held GASMAN Sulphur dioxide (SO_2) Gas Monitor to measure the Nitrogen dioxide (NO_2), Carbon dioxide (CO_2) and Sulphur dioxide (SO_2) respectively.

Four water samples were collected at 4 different source-points from Ebonyi River, preserved at a temperature of 4 ^{0}C and afterwards analysed. WHO standard was used to check the allowable limit. The physical parameters determined were temperature, color, conductivity and turbidity. The chemical parameters were total dissolved solid (TDS), total hardness, chloride, Nitrate, Calcium and Magnesium. The biological properties determined were dissolved Oxygen (DO) chemical Oxygen demand (COD), and E-Coli.

The soil samples were collected horizontally at depths 0-15cm, 15-30cm and 30-45cm using soil auger and shovel. Whereas the questionnaire data was analyzed using Wilcoxon Signed Ranks Test; the soil samples were analyzed using Mann-Whitney test while the water and air data were analyzed using Kruskal-Wallis test.

Results and Discussion

Table 1 shows the respondents' opinion on the negative environmental effects of rice milling on Amagu Community. As regards the total negative environmental effects, 46% agreed, 31.4% disagreed while 22.6% were not decided. This means that greater number of the respondents (very close to half of the sampled population) was of the view that the Abakaliki Rice Mill had negative effects on Amagu Community.

The result from table 2 shows that in terms of texture, the soil samples were as follows: site A: clayey sandy soil (%sand: %clay =44.0: 28.6) site B was sandy silt soil (%sand: %silt=34.0: 36.4), Site C was clayey sandy soil (%sand: % clay=63:21.6% while the control site was also clayey sand (% sand: clay=44.0:36.6).

Table 1: Data on Environmental Effects of Abakaliki Rice Mill Company Ltd on Amagu Community

Item	Description	Agreed	Disagreed	Unsure
1	Dust/smokes/odour from Rice Mill disturb you	164(41.4%)	214(54%)	18(4.5%)
2	Abakaliki Rice Mill makes your village dirty.	54(13.6%)	140(35.4)	202(51%)
3	Wastes from the mill flow into Ebonyi River	218 (55%)	122(30.8%)	56 (14.1)
4	Waste from the mill improve the soil nutrients	181(46%)	103(26%)	112(28%)
5	Dumped husks block your water channels	89 (22.5%)	201(50.8%)	106(26.8%)
6	Air within Abakaliki Rice Mill is always dusty	311 (78.5%)	41 (18.4%)	44 (11.1%)
7	Surrounding bushes always catch fire	214(54.1%)	72(18.2%)	110(27.7%)
8	Noise from Abakaliki Rice Mill disturb you	224 (56.6%)	103 (26%)	69 (17.4%)
	Total	**1455**	**996**	**717**

Source: Author's Field survey; 2015.

The result from table shows that the soil of Amagu are greatly of sand parent material implying that it is of good economic importance, absorbs water easily, hence, could reduce flooding. What this implies is that it has a low tendency of breeding less mosquitoes and low chances of promoting malaria epidemics. On its own part, the mean values of Amagu's soil chemical properties show that the soil is acidic, unsuitable for dumpsites, decreased in acid-alkaline exchange capacity, easily exchangeable in acidity and alkalinity which gives rise to heavy metal concentration in the soil, low in plant yield support except in Site A, as well as partially high and low base saturation which encourages dispersion and micro-nutrient solubility mobility and leaching as well as heavy metals concentration in the soil.

Table 2: Soil Samples Laboratory Results

		SAMPLE BATCHES IN CLUSTERS			
	Parameters	A	B	C	Control site
PHYSICAL PROPERTIES	% SAND	44.00	34.00	63.00	44.00
	% SILT	27.4	36.4	15.40	19.40
	% CLAY	28.60	29.60	21.60	36.60
CHEMICAL PROPERTIES	pH (H_20); 1:2.5	CL	CL	CL	CL
		5.90	6.10	5.10	5.20
	P(Cmol/kg)	39.00	25.80	20.00	27.20

	% N	0.042	0.056	0.028	0.063
	% OC	1.66	0.57	0.24	0.16
	% OM	2.86	1.00	0.42	0.32
	Mg(Cmol/kg)	5.60	4.00	1.60	3.20
	K (Cmol/kg)	0.047	0.055	0.056	0.082
	NA(Cmol/kg)	0.101	0.110	0.114	0.123
	EA(Cmol/kg)	0.64	0.16	16.32	20.40
	ECEC(Cmol/kg	18.388	9.925	22.09	27.805
	% BS	97	98	26	27

Source: Author's Field work; Analyzed by Dept. of Soil Science and Environmental Mgt. Lab, EBSU, Abakaliki.

Note: *SITE A=Unagboke Inyimagu (Very close to the Rice Mill; cluster A)*

SITE B=Obegu Agbaja (Close to the Rice Mill; cluster B)

SITE C=Amagu Unuphu (Relatively far from the Rice Mill; cluster C.

The analysis on table 3 shows that out of the 18 parameters studied, 12 were within the W.H.O acceptable standard or permissible limit while 5 parameters did not satisfy. 1 parameter- Cu was not present and as such not analyzed (Havsar, 2001 Morrison, et al., (2001).

Table 3: Data on Physical and Chemical Properties of Water

Parameters	A_1	A_2	A_3	A_4	W.H.O STD.	Remarks w.r.t W.H.O
Temperature(^{0}c)	27.60^{0}C	27.70^{0}C	28.30^{0}C	26.80^{0}C	20-30^{0}C	Within std.
PH	7.50	6.85	6.90	8.75	6.50-9.50	Within std.
Odour	D.S	D.S	D.S	D.S	Odourless	Below std.
Color(%transmittance	CL	CL	CL	CL	Colorless	Within std.
Conductivity(us/c)	1180.00	1175.00	1183.00	1182.00	1200us/m	Within std.
Turbidity (NTU)	9.35	8.45	9.40	10.20	5.00NTU	Far below std.
Zn (mg/l)	0.17	0.16	0.18	0.17	3.0mg/l	Within std.
N(mg/l)	0.026	0.024	0.021	0.033	50mg/l	Within std.
Ca (mg/l)	90.70	91.40	89.50	91.20	200mg/l	Within std.
Pb (mg/l)	0.056	0.053	0.057	0.060	0.01mg/l	Below std.
Cl (mg/l)	227.20	228.00	227.10	226.50	250mg/l	Within std.
Mg (mg/l)	103.20	101.50	104.00	104.10	150mg/l	Within std.
Fe (mg/l)	0.025	0.024	0.026	0.025	3.0mg/l	Within std.
Cu (mg/l)	None	None	None	None	2.0mg/l	N.A
Manganese (mg/l)	0.60	0.70	0.55	0.55	0.4mg/l	Below std.
TH	119.63	118.8	119.50	120.59	500mg/l	Within std.
TS (mg/l)	35.67	36.40	35.80	34.81	500mg/l	Within std.
TSS (mg/l)	59.85	58.90	59.00	61.65	50mg/l	Below std.

Source: Author's Field work 2015; Analyzed by Pymotech Lab., Enugu and WHO Drinking water standard, 2012.

Note: *TS=Total Solid, TSS=Total Suspended Solid, THD=Total Hardness, Cl=Chlorine, N=Nitrate, Mg=Magnesium, Ca=Calcium, Mn=Manganese, Fe=Iron, Lead=Pb, Zn=Zinc, Cu=Copper, CFU= Coli form count, DO= Dissolved Oxygen, CL=Colourless D.S=Decaying smell.*

Table 4: Air Qualities during Working Period of Abakaliki Rice Mill

Sampling site	Pollutant	R_1(ppm)	R_2(ppm)	R_3(ppm)	R_4(ppm)	AV.HR
CLUSTER A= A_1+A_2+A_3 (Unagboke, Divine Academy EBSU Farm; Inyimagu,)	CO	2.54	2.54	2.47	2.56	90mins
	NO_2	0.63	0.53	0.58	0.69	90mins
	SO_2	0.30	0.24	0.29	0.37	90mins
CLUSTERB=B1+B_2+B_3 (Obegu,OchudoCity, Azuiyiokwu Agbaja)	CO	2.5	2.5	2.49	2.51	90mins
	NO_2	0.10	0.09	0.10	0.11	90mins
	SO_2	0.10	0.10	0.10	0.10	90mins
CLUSTERC_1+C_2+C_3(Amagu Okwuitumo, Ndi Nwamini, Ndi Ogbakuru Unuphu)	CO	2.54	2.53	2.55	2.54	90mins
	NO_2	0.30	0.30	0.40	0.20	90mins
	SO_2	0.30	0.29	0.31	0.30	90mins

Table 5: Sampled Air Results during Off-Work Period of Abakaliki Rice Mill

Sampling site	Pollutant	R_1(ppm)	R_2(ppm)	R_3(ppm)	R_4(ppm)	AV. HR
CLUSTER A= A_1+A_2+A_3 (Unagboke, Divine Academy EBSU Farm; Inyimagu,)	CO	2.44	2.43	2.45	2.42	90mins
	NO_2	1.03	0.22	0.29	0.28	90mins
	SO_2	0.70	0.20	0.23	0.23	90mins
CLUSTERB=B1+B_2+B_3 (Obegu,OchudoCity, Azuiyiokwu Agbaja)	CO	2.41	2.39	2.40	2.44	90mins
	NO_2	0.10	0.12	0.07	0.11	90mins
	SO_2	0.10	0.08	0.09	0.13	90mins
CLUSTERC_1+C_2+C_3(Amagu Okwuitumo, Ndi Nwamini, Ndi Ogbakuru Unuphu)	CO	2.41	2.40	2.42	2.41	90mins
	NO_2	0.20	0.27	0.20	0.20	90mins
	SO_2	0.20	0.20	0.20	0.20	90mins

Source: Author's Field work as captured from gas monitors of Dept. of Soil Science and Environmental Mgt. Lab, EBSU, Abakaliki.

National Ambient Air Quality Standard (NAAQS) (1995) specifies the permissible standards of 9ppm to 35ppm for CO, 0.1ppm for NO_2 and 0.14ppm for SO_2. From tables 4 and 5, the highest concentrations of CO (2.56ppm), NO_2 (0.69ppm) and SO_2 (0.37ppm) at 270 average hours which were recorded during the work period in cluster A were still within the NAAQS 1995 standard. This is suggestive of the fact that Abakaliki Rice Mill emissions raise the level of the isolated gases in Amagu Community.

Table 6: Data on Economic Effects of Abakaliki Rice Mill on Amagu Community

Description	Agreed	Disagreed	Unsure
Abakaliki Rice is the major type of Rice in Amagu	379(95.7%)	9(2.3)	8(2.0)

Abakaliki Rice Mill creates job opportunities	378(95.5%)	3(0.76)	15(3.8)
Rice husks from the Rice Mill improves crop yield	338(85.6%)	13(3.0)	45(11.4)
Rice Husks are used as fowl feeds	301(76%)	32(8.0)	63(16.0)
Rice husks is used as an alternative source of energy	328(83%)	55 (13.7)	13(3.3)
Abakaliki Rice Mill is a source of your revenue	350(88.4%)	12(3.0	37(9.3)
Abakaliki Rice Mill boosts development	356(88.9%)	6(1.5)	37(9.3)
Abakaliki Rice Mill boosts your rice farming	346(87.4%)	20(5.0)	30(7.6)
Total	2776	150	248

Source: Author's Field survey 2015.

Out of the 8 items hypothetically posed in table 6 amounting to 3168 responses to obtain the economic effects of Abakaliki Rice Mill on Amagu Community, the total number that agreed to the hypotheses were 2776 (87.6%), 150 (4.7%) disagreed while 248(7.8%) were not decided or unsure. This implies that almost all the respondents (i.e. more than 5/6 of the sampled population), were of the opinion that Abakaliki Rice Mill had positive effects on Amagu Community.

To ensure that the conclusions are not based on mere observations, opinions and comparative analyses, the data was subjected to series of statistics analytical tools such as Mann Whitney Test and Kruskal-Wallis and Wilcoxon Signed Rank Tests to test the two hypotheses formulated. Whereas Mann Whitney was used on the soil data, Kruskal wallis test was used on both the water and air data, while Wilcoxon Signed Ranks Test was used on the questionnaire data on both the respondent's opinion on environmental and economic effects.

The test of hypotheses revealed that there is no significant environmental effect of the Rice Mill on the host community. It was also revealed that there was no significant change seen in the physical and chemical properties of the soils and water within the period of study. However, it was revealed that there is a significant difference between the air samples during and after the working hours suggesting that the Rice mill is capable of negatively impacting on the community. The second test of hypotheses also revealed that Abakaliki Rice Mill has a significant economic effect on the host community, Amagu.

Summary and Conclusion

This study investigated the environmental and economic effects of Abakaliki Rice Mill Company Ltd on Amagu Community, Ebonyi State Nigeria. Water, soil and air samples were collected from the field. Questionnaire method was used to elicit respondent's opinion. The test revealed that there was no significant change in the physical and chemical properties of the soil and water. There was no significant difference in the physical and chemical properties of water samples. However, there was a significant difference between the air qualities within Amagu Community during and after work in the Rice Mill though at levels within the WHO permissible limit. It is therefore concluded that Abakaliki Rice Mill Company Ltd. has no significant environmental effect on Amagu community. On the respondent view, the result revealed that 86.7% of the respondents agreed to the positive statements on the economic effects of Abakaliki Rice Mill suggesting that Abakaliki Rice Mill Company Ltd has a significant economic effect on Amagu Community. The research discovered that the economic benefits were the strong basis upon which the greater number of the residents accepted the current location.

Recommendations

Sequel to the findings made, the following recommendations were made:

1. Cleaner production technology should be pursued to tackle solid waste and fugitive emissions; treatment of waste water from the Rice Mill before disposal should be adopted, tree planting to improve on imagery and ambient temperature of the community; banning

of parboiling of rice within the residential areas

2. The rice husks should be employed in agriculture, alternative energy generation; waste to wealth ideology should be entrenched through mass sensitization and Government legislation; integrated waste market for the rice husks, waste treatment plants and Rice husk energy-generating plant.
3. There should be Government-private partnership to make easier the purchase of expensive modern milling machines for a cleaner production technology.
4. Mechanized and less dehumanizing method of husk disposal should be adopted. This will create more job opportunities and improve on the financial status of the workers.
5. A new model should be developed in rice milling industries that will improve the value chain of rice production up to advanced agro-based business using an integrated agro-technology outfit all within the Rice Milling Industry.

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