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REVIEW

Health and Environmental Implications of Rural Female Entrepreneurship Practices in Osun State Nigeria

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Abstract In rural Nigeria, food processing is mostly engaged in by women and children. Most of these processes are done using outdated technologies that make use of traditional woodstoves. This article presents the health and environmental implications of the rural female entrepreneurs involved in food processing and proffer means of bettering the lot of these women to handle these hazards. A partially structured questionnaire and focus group discussion was used to capture data from respondents. The study revealed that about 73 % of women involved in direct production of garri and palm oil processing could be at risk of early death or disability-adjusted life years from the mentioned diseases. The article concludes that the rural female entrepreneur needs to be better positioned to handle these hazards, for her health, that of her children, as well as for the environment.

Keywords Health · Environment · Rural · Female entrepreneurship · Food processing · Disability-adjusted life years

INTRODUCTION

Rural areas in Nigeria constitute the food basket of the country. The total land area of the country is about 92.4 million ha, with 65 million ha being arable land (FOS 1989). Seeing that the country has a predominantly rural economy, the challenge of economic growth and development would be that of raising productivity and real income in agriculture. The importance of developing the rural economy is put more into perspective seeing that as at 2007, 48 % of the populace lives in the rural areas, with females making up over 35 million persons of the total population of about 72 million inhabitants. Generally, women in the villages are responsible for the processing and sale of farm produce. Thus, food processing in rural areas constitutes the basis for rural female entrepreneurship, and presently depends largely on outdated technologies that in turn operate on traditional woodstoves. We contend in this article that these technologies and the energy means of processing the foods expose the women to various associated health and environmental problems. In this article, our objective was to attempt to present the health and environmental implications of the rural female entrepreneurs involved in food processing, and proffer means of bettering the lot of these women to handle these hazards.

BACKGROUND: NIGERIA AND OSUN STATE

Nigeria comprises 36 states with 774 local government areas. According to the 1999 constitution, its governance structure is a federated republic. Osun State is one of the 36 states in the federation, occupying the 28th position in terms of landmass, and 28th position in terms of population, and by economic positioning based on allocation from the Federal Account, it occupies the 29th position (Federal Ministry of Finance Abuja 2010). Nigeria occupies 910 768 km^2 land mass with Osun State occupying approximately 1 % (8602 km^2) of this. Nigeria's economy is predominantly agrarian and rural. In terms of ecology, the north is a combination of Sudano-Sahelian and prone to high desertification rate; the southwest is forested with a mixture of savannah, with the southeast being dominated by forests. These two ecologies had witnessed deforestation and huge land degradation.

The ecology of Osun State displays a mixture of forest and savannah. Deforestation occasioned by agricultural

activities in the form of intensive grazing and overcultivation is contributing to the changing landscape of the state. Agricultural crops from Osun State include cocoa, rice, palm fruits, cashew, cassava, and yam, among others. Cassava (a woody shrub of the Euphorbiaceae (spurge family) farmed for its edible starchy, tuberous root, and a major source of carbohydrates) is grown in almost all parts of the state, with palm trees growing in Ile-Ife and its environment. The population of the state was estimated to be 3.4 million in 2006 with an average growth rate of 3.4 % per year. The population distribution reflects a near balance, with male being 51 % and female 49 %. Based on the national figure of 48 % rural population, the state has 1.6 million rural dwellers distributed into 0.81 million females and 0.84 million males. Going by the estimated average annual growth rate, the population of Osun State is currently approximately 3.9 million inhabitants.

There is presently an elected civilian government in place with bi-camera assembly at the national level, which comprises the Senate and the House of Representative. The states and local government operate their own houses of assembly. These are responsible for enacting laws that govern activities of the citizenry. Each state is expected to have their respective ministry of environment that oversees environmental issues while the ministry of health is responsible for health issues. Where they exist, ministry of youth and women affairs is concerned with youth and women's affairs. Osun State has all of these ministries at the state level.

STUDY RELEVANCE

One of the greatest challenges in the country presently is to catalyze the economy for growth and development. This has to be done in a sustainable manner, which in this context is as defined by Brundtland Commission, which states that "sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs could be met not only in the present, but also for future generations" (UN 1987). Climate change, which results primarily from energy utilization pattern and environmental degradation, has become topical, and evidence abounds as to its occurrence in the country (BNRCC 2011). The Nigerian economy is predominantly rural and informal, requiring innovative strategies that seek to promote an integrated approach for its development. Female entrepreneurship, particularly in the rural areas of Nigeria, is a formidable resource base that could be accessed to catalyze economic growth and development, as well as be deployed to mitigate and adapt to the impact of climate change in the country. Thus, mobilizing the potential productivity of rural people and particularly of women is indispensable in achieving the resilient economic growth that will pull people above the poverty line. One of the most engaged activities by women is food processing, and this is predominantly done in rural Nigeria. Women involved in this business are exposed to air pollution from the use of solid fuels utilized for energizing there processing technologies. Even though evidence abounds that there are negative impacts from this practice, there had been only limited documentation on this. This article therefore becomes relevant as it attempts to illuminate the health and environmental implications of rural entrepreneurship practices based on processing of garri from cassava and palm oil from palm fruits in Osun State.

METHODOLOGY AND APPROACH

Our study methodology employed both archival and primary sources of data. The archival approach was by reviewing pertinent literature. Primary data were sourced using surveys. The survey was done employing two instruments: a partially structured questionnaire, and a focus group discussion (FGD) approach. Six communities, namely, Ita-Elewa, Eleso, Ooni Ilare I, Ooni Ilare II, Eleweran, and Kajola, were selected purposively based on their production of garri and palm oil. The questionnaire was administered to 265 households and distributed proportionately across all these communities. The respondents were randomly selected from the enumerated households in these selected communities. Descriptive and comparative statistics were used to report study findings.

The following sections present a review of the relevant literature and results from field survey. Two kinds of products processed from cassava and palm fruits, namely, garri and palm oil, were examined. Following this section is an analysis of the reviewed literature and field results before conclusion and recommendations are presented at the end of the article.

STATE OF THE ART ON THE SUBJECT MATTER

People living in the rural peripheries (and especially women) shoulder the burden of the world's poverty, particularly in the least developed countries (LDCs) and sub-Saharan Africa (UNIDO 2003). The report also stated that rural dwellers have been deprived for too long from participating in the opportunities and benefits of economic growth and globalization. With women and girls constituting three-fifths of the world's poor, their poverty level is worse than that of men, as clear gender disparities in education, employment opportunities, and decision-making power exist (UNIDO 2003). Going further, the UNIDO (2003) report states that in

most of the developing countries, particularly in Africa, women constitute 70–80 % of the total agricultural labor force and they account for over 80 % of food production, and are also involved in food processing.

PROCESSING IMPACT OF CASSAVA

Some risks and benefits associated with cassava had been documented in Oyegbami et al. (2010). In terms of benefits, cassava is a great giant that fights hunger, providing earnings for the farmer, and thus provides food security. However, the product and its processing techniques can be hazardous to the environment, the processors, and even the consumers. The enlarged roots of cassava contain a huge amount of cyanogenic glucosides (linamarin and lotaustralin) in the outer covering and in the thicker leathery parenchymatous inner covering (Oyewole 2002). The glucosides are not the direct agent of toxicity in cassava, but its hydrolytic product, hydrocyanic acid, can be poisonous to humans and animals when eaten in large quantities (Oyewole 2002). The two major wastes generated during cassava processing, namely peels and the effluents, had been identified to cause costly economic damage to vegetation and structures (Oboh 2004). These also bring about infestation of insects, which, can later lead to disease infection in both humans and animals. The traditional method of cassava processing is known to have led to various pathologies ranging from general body aches, pains and fatigue, and high body temperature due to inhaling the smoke in the roasting environment (Oyegbami et al. 2010). Oyegbami et al. (2010) indicates that the majority of people (69 %) involved in cassava processing are women; however, the study reports uncertainty of awareness of what level of health and environmental hazards are involved in the processing, but mentioned that the associated occupational/health hazards include cuts/bruises, aches and pains, fatigue, dermatitis/skin irritation, and eye irritation; and environmental hazards as damage to buildings by effluents, stench from heap of peels/effluents, possible insect and disease infestation, and health hazard that result from burning cassava peels. For the constraints to cassava processing, which involved three levels, examined issues include: lack of water, a lack of an effective channel for cassava effluent, a lack of an effective disposal method of the cassava peels, a lack of labor, and an unstable price of cassava products, especially garri. The study concludes that this aspect (occupational/health and environmental hazards) of Nigeria's agricultural system has been neglected to the detriment of the society at large in terms of good health, profit margin, and quality of product. Oyegbami et al. (2010) further stated that the adoption of an integrated system of waste disposal (peels and effluent) is ideal, and a much desired control management of hazards associated with cassava processing.

PROCESSING IMPACT OF PALM FRUITS

For oil processing, the IFC (2007) reports that the environmental issues associated with the operational phase of vegetable oil (palm kernel) processing primarily include: solid waste and by-products, wastewater, emissions to air, water and energy consumption, and hazardous materials. Aside from these universal environmental issues, Akinbami (2008) also reported that most of the places visited where palm-kernel processing is done have no organized drainage system. This makes waste water disposal from palm oil processing a major pollutant to the surrounding areas. Furthermore, traditional technologies expose the processors to various weather and other operational hazards. From the IFC (2007), it is reported that health hazards associated with the processing include high body temperature, fatigue, aches, and pains.

AIR POLLUTION, FOOD PROCESSING, AND HUMAN HEALTH

Air pollutants and their major indoor sources have been well documented in Zhang and Smith (2003) and are presented in Table 1. According to Anyon (2009), hundreds of pollutants have the potential to damage human health, but six pollutants have been identified and referred to as "criteria pollutants" as being of the highest priority and concern. The pollutants are particulate matter (PM), nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), sulfur oxides (SOx), ground-level ozone (O_3), and lead (Pb). Furthermore, many dangerous compounds classed as "air toxics" are categorized as VOCs also often referred to simply as HC and are also under pollutants that are regulated through various legislation in Nigeria (ELRI 2011).

As essential and invaluable as energy is for human existence, such as in energizing food processing, its consumption can generate harmful pollutants, which affect the air we breathe, waterways, and soil (Anyon 2009). Man-made urban air pollution is a complex mixture with many toxic components. This mixture had been indexed in terms of particulate matter (PM), a component that has been linked consistently with serious health effects, and, importantly, levels of which can be estimated worldwide (Cohen et al. 2004). Exposure to PM has been associated with a wide range of effects on health, but the effects on mortality are arguably the most important, and are also most amenable to global assessment. Fine particulate

Table 1 Major toxic pollutants of indoor air

Pollutant	Major indoor sources
Fine particles	Fuel/tobacco combustion, cleaning, fumes from food being cooked, e.g., from cooking oil
CO	Fuel/tobacco combustion
PAHs	Fuel/tobacco combustion, fumes from food being cooked, e.g., from cooking oil
NOxs	Fuel combustion
SOxs	Coal combustion
Arsenic and fluorine	Coal combustion
Volatile and semivolatile organic compounds	Fuel/tobacco combustion, consumer products, furnishings, construction materials, fumes from food being cooked, e.g., from cooking oil
Aldehydes	Furnishing, construction materials, cooking
Pesticides	Consumer products, dust from outside
Asbestos	Remodeling/demolition of construction materials
Lead[a]	Remodeling/demolition of painted surfaces
Biological pollutants	Moist areas, ventilation systems, furnishings
Free radicals and other short-lived, highly reactive compounds	Indoor chemistry
Radon	Soil under building, construction materials

Source Zhang and Smith (2003)

[a] Lead-containing dust from deteriorating paint is an important indoor pollutant for occupants of many households, but the most critical exposure pathways are not usually through the air

matter is known to be one of the most dangerous pollutants from combustion sources, which can penetrate deep into human lungs, causing respiratory illnesses, heart disease, and neurological problems. Reducing exposure to PM is the highest air-quality priority for most countries in both developed and developing regions. A recently completed study by the Harvard School of Public Health and Brigham Young University (Pope 2009) emphasizes that:

> "…for every decrease of 10 micrograms per cubic meter of particulate pollution in a city, its residents' average life expectancy increased by more than seven months."

PM_{10} and $PM_{2.5}$ are selected as the indicators of exposure to urban air pollution from combustion sources (where PM_{10} includes particles of a diameter between 2.5 and 10 μm, while $PM_{2.5}$ includes small particles of a size less than 2.5 μm in diameter). This is because, as noted earlier, PM is a ubiquitous component of the mixtures emitted into, and formed in, the ambient environment by combustion processes, and indicates the presence of these mixtures in outdoor air. Most importantly, these measures of particulate air pollution have been used in many epidemiological studies from around the world, of both mortality and morbidity of air pollution, and so provide the best overall indicator of exposure for our purposes. PM has been linked to serious effects on health after both short-term exposure (days to weeks), and more prolonged exposure (years), although there remains some uncertainty as to the distribution of induction times with regard to mortality (Cohen et al. 2004). The annual average concentration(s) of PM is chosen as the exposure metric because it corresponds to the time scales of a priori interest for estimates of attributable and avoidable burden in the Global Burden of Disease (GBD) project. This has been used to estimate the effects of exposure to PM in the key epidemiological study that provides estimates of the concentration–response function (Cohen et al. 2004).

To put this into context, Paris, France has an ambient PM concentration of around 15 $\mu g/m^3$. In some Asian cities, this level can rise to above 100 $\mu g/m^3$, and in a dwelling where indoor wood-fire cooking takes place, the level can be an order of magnitude higher again (Anyon 2009). Efe (2008) reports an average ambient PM of 123.6 $\mu g/m^3$ for 17 cities in Nigeria compared to the WHO standard of 20 $\mu g/m^3$.

Air pollution, which is derived largely from combustion sources (simply when something is burned), causes a spectrum of health effects ranging from eye irritation to death (Cohen et al. 2004). Combustion sources most prone to producing air pollutants are solid fuels; 79 % of households make use of solid fuels in Nigeria for cooking (Smith et al. 2004; Momodu et al. 2010); more than 80 % of commercial activities in the country involving food processing and cooking are done with solid fuels. Recent assessments suggest that the impacts on public health from exposures to pollutants from these fuels may be considerable. Cohen et al. (2004) reported that this evidence has increasingly been used by national and international agencies to inform environmental policies, and quantification of the impact of air pollution on public health has gradually become a critical component in policy discussions as governments weigh options for the control of pollution. However, to quantify the magnitude of these health impacts in cities worldwide would present considerable challenges owing to the limited availability of information on both effects on health and on exposures to air pollution in many parts of the world, particularly in a developing country like Nigeria.

Currently, most epidemiological evidence and data on air quality that could be used for such estimates come from developed countries. For developing countries, assumptions have to be therefore made concerning factors such as

the transferability of risk functions, and exposure of the population and their underlying vulnerability to air pollution, while trying to ensure that these assumptions are transparent and that the uncertainty associated with them is assessed through appropriate sensitivity analyses. Estimates of the burden of disease were based on the contributions of three health outcomes: mortality from cardiopulmonary disease (CPD) in adults, mortality from lung cancer, and mortality from acute respiratory infections (ARI) in children aged 0–4 years. Numbers of attributable deaths and years of life lost (YLL) for adults and children (aged 0–4 years) were estimated using risk coefficients from a large cohort study of adults in the United States of America (Pope et al. 2002) and a meta-analytical summary of five time-series studies of mortality in children, respectively (Cohen et al. 2005).

Cohen et al. (2005) stated that base-case estimates were calculated assuming that the risk of death increases linearly over a range of annual average concentrations of $PM_{2.5}$, between a counterfactual (or referent) concentration of 7.5 mg/m^3 and a maximum of 50 mg/m^3. The results indicate that the impact of urban air pollution on the burden of disease in the cities of the world is large, but this is likely to be an underestimate of the actual burden, on the basis of an assessment of sources of uncertainty. There is also considerable variation in estimates among 14 sub-regions, with the greatest burden occurring in the more polluted and rapidly growing cities of developing countries. Furthermore, the study (Cohen et al. 2005) estimated that air pollution in urban areas worldwide, in terms of concentrations of PM, causes about 3 % of mortality attributable to CPD in adults, about 5 % of mortality attributable to cancers of the trachea, bronchus, and lung, and about 1 % of mortality attributable to ARI in children. This amounts to about 0.80 million premature deaths (1.4 % of the global total) and 6.4 million YLL (0.7 % of the global total). Cohen et al. (2005) then stated that this burden occurs predominantly in developing countries, with 39 % of attributable YLL occurring in the WHO's Western Pacific Region—low child, low adult (WPR-B) and 20 % in the WHO's South-East Asia Region—high child, high adult (SEAR-D). The highest proportions of the total burden occurred in the WPR-B and WHO European Region—low child, low adult (EUR-B), where urban air pollution caused 0.7–1.0 % of the burden of disease.

AIR QUALITY STUDIES IN NIGERIA

Despite the acknowledged fact that women and children are the most engaged in food processing using outdated technologies energized with solid fuels in our rural areas, little efforts had been made to document the impact of pollutants emitted from these solid fuels, particularly among female entrepreneurs on their quality of life. Most studies in developing countries including Nigeria had rather concentrated on air quality of urban areas with focus on pollutants from vehicular emissions (Efe 2008; Abam and Unachukwu 2009).

Fu (2001) and Goyal (2006) report that traffic emissions contribute about 50–80 % of NO_2 and CO concentration in developing countries. This situation is alarming and is predicated on the poor economic disposition of developing countries. Furthermore, in developing countries the super emitters contribute about 50 % of harmful emissions to the entire average emission (Brunekreef 2005). The increase of traffic-related pollution is based on such factors as low-quality fuel, poor traffic regulation, and lack of an air-quality implementation force. These are clear indices to high levels of traffic-related pollution in developing countries. It has been reported that the world's urban population will increase, reaching 60 % by 2030 (Abam and Unachukwu 2009). This increase will have a back effect in developing countries where 80 % of the urban population will be living in 2030. The rise in the urban population will have a geometrical effect in the increased number of motorized vehicles in cities by 2050, aggravating the hazard even in countries with overall low motorization rates (Abam and Unachukwu 2009). Developing cities in Asia and Africa are at high risk to exposure of this traffic-related pollution. Research conducted in Ethiopia, Mozambique, Kenya, and the Republic of Benin shows that there is a high level of DNA damage in urban residents and a higher prevalence of asthma in urban school children exposed to traffic pollution compared to rural children (Autrup 2006). The African continent may be highly heated if priority is not given in understanding the scale of this problem and its control.

In Nigeria, much attention is given to general industrial pollution and pollution in oil industries, with little reference on damage of pollution caused by mobile transportation sources of air pollution (Faboya 1997; Magbagbeola 2001; Iyoha 2009). The situation of increased pollution from mobile transportation is on the increase in per-capita vehicle ownership, thus resulting in high congestion on Nigeria's city roads and an increase in the concentration of pollutants in the air, consequently, increasing health risks for the human population. Studies conducted in the cities of Kaduna and Abuja show higher values of CO_2 concentration in heavily congested areas: 1840 ppm for Sambo Kaduna, 1780 ppm for the Stadium roundabout, Kaduna, and 1530 ppm for A.Y.A, Abuja, 1160 ppm for Asokoro Abuja (Akpan and Ndoke 1999). A similar study by Abam and Unachukwu (2009) at Minna, a city in Nigeria, shows the maximum value of 5000 ppm for CO_2 in congested areas, which was still lower than the WHO stipulated maximum value of 20 000 ppm. The maximum value for CO emission obtained was 15 ppm, which was still lower

than the baseline of 48 ppm stipulated by the WHO and 20 ppm stipulated by the Federal Environmental Protection Agency of Nigeria (FEPA). The reason for this low emission concentration in Minna is due to low traffic and industrial activities in the city.

A study of the impacts of urban road transportation on ambient air was conducted by Koku and Osuntogun (2007) in three cities of Nigeria: Lagos, Ibadan, and Ado—Ekiti, all in the southwest region of Nigeria. Air-quality indicators, namely CO, SO_2, NO_2, and total suspended particulates (TSP), were determined. The highest levels obtained for the air pollution indicators in Lagos were CO: 233 ppm at Idumota, SO_2: 2.9 ppm at Idumota, NO_2: 1.5 ppm at Iyana–Ipaja, and total particulates 852 cpm at Oshodi bus stop. At Ibadan, the CO and SO_2 levels at 271 and 1.44 ppm were highest at Mokola roundabout while NO_2, at 1.0 ppm was highest at Bere roundabout. In Ado-Ekiti, the highest level obtained were CO: 317 ppm at Oke Isha, NO_2: 0.6 ppm at Ijigbo Junction, and SO_2: 0.8 ppm at Old Garage Junction. The obtained results of CO, SO_2, NO_2, and particulate counts per minute were found by Koku, to be higher than FEPA limits. Limits set also by FEPA are CO: 10 ppm, SO_2: 0.01 ppm, NO_2: 0.04–0.06 ppm. The noise level at all the locations was found to be higher than the FEPA limit of 90 dB and the WHO limit of 70–75 dB (Abam and Unachukwu 2009). Conclusions of this investigation show a growing risk of traffic-related problems in Nigeria cities and demand for serious air-quality measures.

A comparative study of emission figures in Lagos and the Niger Delta (an oil-producing region) area had been reported in Jerome (2000). The results show that the concentrations of TSP, NOx, SO_2, and CO in Lagos and Niger Delta were above the FEPA recommended limit. The concentration of CO emissions for Lagos is quite high, being in the range of 10–250 ppm recorded higher than the ranges of 5.0–61.0 and 1.0–52 ppm recorded for oil communities in the Niger Delta. The TSP concentrations are also high for both cities when compared to WHO's standard. Furthermore, Jerome (2000) indicated that vehicular-related air pollution in Nigeria is on the increase, and poses a potential hazard to the population. It is not out of place to state that the concentration of these pollutants must have increased tremendously in the past 10 years of democratic rule in Nigeria due to the influx of old and fairly used vehicles into the country following changes in government policy.

IMPLICATION OF AGRICULTURAL PRACTICES ON ENVIRONMENT AND HEALTH

Even though land is the most important resource necessary for subsistence, Nigerian land is grossly abused, and this has led to its degradation. Evidence abounds that much of Nigeria's arable land is being sapped insidiously of its productive potential through overuse, inappropriate technologies, and urbanization. Rapid deforestation, resulting from multiple uses of forest resources for human survival (e.g., fuel-wood and energy, housing, etc.) is a major contributing factor to land degradation. The end result of deforestation, which is currently progressing at the rate of 1.36 % per year and other agricultural activities, including intensive grazing and overcultivation, are severe land degradations. Furthermore, there has been a report of biodiversity losses. For instance, it is estimated that about 0.4 % of the plant species are threatened and 8.5 % are endangered, with 0.14 % of the animals and insects threatened and 0.22 % endangered Vision 2020 Report 2009).

The outcome of this is the poor global rating of Nigeria in global environmental performance. The country's large population of 150 million persons and its rapid growth rate of 2.8 % are indicted as being culprits contributing to the country's environmental degradation. Despite its relatively low level of industrialization, Nigeria continues to rank very low in terms of its environmental performance. In 2008, the country's environmental performance index (EPI) was 56.2, ranking it number 126 out of 149 countries surveyed in the world. The low EPI figure puts the country behind many other African countries like Mauritius (78.1), Egypt (76.3), Ghana (70.8), Kenya (69.0), Mauritius (78.1), South Africa (69.0), and Cameroon (63.8) (Nigerian Vision 2020 Program 2009).

All of these have resulted in climate change phenomenon manifesting in many respects apart from the rising sea level and inundation of coastal lands by sea water. These include increased frequencies of extreme climatic events like strong storms, floods, and above-average daily minimum and maximum temperatures.

SURVEY RESULTS

Sociodemographic characteristics of respondents show that women in the age bracket of 21–50 totaled 69 %, with married women constituting over 85 % of the respondents, while 56 % belong to monogamous homes. However, to accentuate the level of poverty in the society, the survey revealed that about 19 % of the respondents are well above 61 years old, an age at which they should have retired from such physically involving work. This becomes more worrisome when the tedious nature of food processing, particularly based on the fact that most technologies used are outdated.

To put the economic significance of products examined in the study into perspective, we examine the demand situation from the respondents in the six communities.

Table 2 Demand situation for garri and palm oil in study areas

Demand level	Ita-Elewa		Eleso		Ooni Ilare I		Ooni Ilare II		Eleweran		Kajola		Total	
	F	%	*F*	%	*F*	%	*F*	%	*F*	%	*F*	%	*F*	%
Low	3	6	2	5	2	5	4	5	1	6	2	4	15	6
High	11	23	10	25	10	25	18	24	4	24	11	24	64	24
Very high	32	68	27	68	27	68	52	68	11	65	31	69	180	68
Not filled	1	2	1	3	1	3	1	1	1	6	1	2	6	2
Total	47	100	40	100	40	100	76	100	17	100	45	100	265	100

Data indicates that demand for both products for domestic consumption within Nigeria market and for export is quite high. The outcome is not farfetched, as garri processed from cassava is one of the staple foods consumed in almost all the regions of the country, while palm oil (a multipurpose product) is in high demand because of its economic importance as a high-yielding source of edible and technical oils. The survey outcome from the six communities on the demand situation is presented in Table 2.

Figures 1 and 2, respectively, show photographs of the processing environment of the female entrepreneurs in making palm oil from palm fruits, and garri from cassava. In our administration of the questionnaire and FGD conducted at the study communities, it was observed that recognition of the dangers involved in food processing influenced the cultural beliefs in what women are allowed to partake in. For instance, one major issue the researcher raised among the respondents is that of businesses which women are forbidden to partake in. Data from the structured questionnaire revealed that some small-scale businesses that women are forbidden to partake in include hunting, timber tree cutting, climbing and felling of palm fruits, as well as the clearing of farmland.

Of the total responses indicating that women are forbidden to be involved in one form of small-scale business or the other, about 18 % are from Ita-Elewa, about 15 % are from both Eleso and Abule Ooni Ilare I, while 29, 6, and 17 % are from Ooni Ilare II, Eleweran, and Kajola, respectively. Ooni Ilare II with 22 % among its respondents had the highest number of women that indicated that women are not allowed to hunt. The community similarly had the highest response among the entire communities with 29 % response from the total of 48 that indicated that women are forbidden to hunt. Felling of trees and the clearing of farmland elicited the least level of activities that women are forbidden to partake in, in the various communities.

The responses revealed that most of the activities women are forbidden to participate in appear to be due more to their nature rather than any cultural taboo inclination; reasons being that these businesses are too tedious and hazardous for women. During the FGD exercise, however, it was revealed in two of the communities (Abule Ooni Ilare I and Ooni Ilare II) that it is a taboo for women to be involved in climbing and felling of palm fruit from palm trees. In Ooni Ilare II, however, it was added that this practice (the taboo) did not originate from the community itself but was instead "imported" by other women from other ethnic groups engaged in food processing. The activities mostly carried on in the communities are agrarian in nature, which clearly demonstrates that the level of development in these communities still leaves much to be desired.

INVOLVEMENT OF WOMEN IN PRODUCTION PROCESSES

Generally, women in the villages are responsible for the processing and sale of farm produce, as is the case in the six communities where this study was conducted. Regarding the processing of palm oil and garri in the various communities visited, some questions were used to capture the responses of the level of the involvement of women. The processes identified include extraction of fruit, cooking, extraction of oil, buying finished product for palm oil production, and harvesting (which does not cut across all the communities), peeling (which actually includes grating and sieving), and frying for garri processing. For palm oil-making, the survey shows that 43 % of the women that responded to the questionnaire (and as clarified through FGD) indicated that they were not involved in palm oil-making. There were 3.5 % that responded that they were involved in palm fruit extraction, 3 % in cooking, and extraction of oil about 7 %. Those that buy just the finished products totaled 5 %; 15 % indicated involvement in palm fruit extraction, cooking oil extraction, while 24 % stated that they are involved in all the processes.

Those not involved in garri processing, based on the responses of the women to the questionnaire and clarified at FGD, were 21.3 % of the total. Those involved in all aspects of the garri-making production process were 31.3 % of the respondents; 6 and 19 %, respectively, were involved in just either peeling or frying. Only 3.4 % indicated involvement in harvesting cassava from farms at the communities of Kajola and Eleweran.

Fig. 1 A typical processing environment for palm oil-making including: **a** the boiling of palm fruits, **b** dehusking of the palm fruits, **c** boiling of the dehusked product from palm fruits, **d** cooling and settling of palm oil from the water, **e** separating oil from the water, and finally **f** kernel crushing

ASSOCIATED HAZARDS OF FOOD PROCESSING

The processing of cassava tubers into the various forms (garri, *fufu*, and *lafun*) is not without a lot of hazards both to the environment and the processors. Visits to processing sites revealed some of these hazards. For garri-making, it was observed that the two major wastes generated during cassava processing, namely the cassava peels and the effluents, could cause a lot of damage to vegetation, houses, and could also bring about infections, which was also observed in Oyegbami et al. (2010). Furthermore, from the collation of responses from the questionnaire (Table 3) and during FGD, we observed that the women reported that the traditional processing method they presently adopt usually causes a general increase in body temperature. This increased body temperature was attributed to smoke inhalation from the frying pan by the women, which they also indicted as leading to fatigue, aches, and pains. For palm oil production, the researchers observed that there was no organized drainage system at the processing centers. Waste water is allowed to just drain off into the surrounding bushes. Thus, the use of traditional technologies for this food processing exposed the processors to the vagaries of the weather and other operational hazards.

Table 3 gives further information from the women on the implication of their exposure during food processing. These women and children are usually exposed to firewood burning burnt through open fires or traditional stoves for upwards of 6 h daily. Furthermore, those involved in garri processing could be intensively exposed to open fires for close to 250 days (1,500 h) or more in any given year while

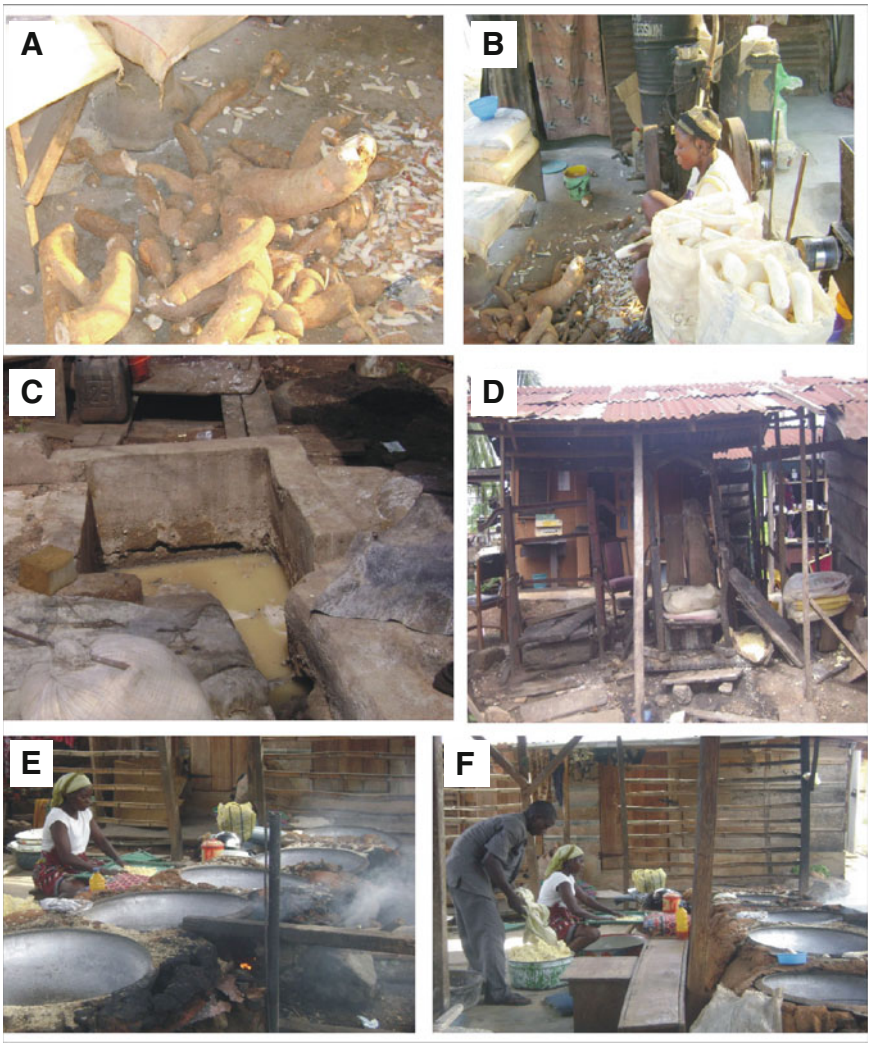

Fig. 2 A typical processing environment for garri-making: **a** Cassava tubers, **b** Peeling of cassava tubers, **c** Waste water from dewatering of grated cassava, **d** Dewatering grated cassava, **e** Frying of sieved and dewatered cassava, **f** Sieving of grated cassava

Table 3 Hazards associated with the production processes of garri and palm oil in the study areas

Health problem	Ita-Elewa		Eleso		Abule Ooni Ilare I		Ooni Ilare II		Eleweran		Kajola		Total	
	F	%	*F*	%	*F*	%	*F*	%	*F*	%	*F*	%	*F*	%
Low productivity	19	40	16	40	16	40	32	42	7	41	19	42	109	41
Harmed leg	8	17	7	18	7	18	13	17	3	18	8	18	46	17
Weakness of the body	13	28	11	28	11	28	21	28	4	24	12	27	72	27
I do not know	3	6	2	5	2	5	5	7	1	6	3	7	16	6
Not filled	4	9	3	8	3	8	6	8	2	12	4	9	23	9
Total	47	100	40	100	40	100	76	100	17	100	45	100	265	100

those involved in palm oil processing have seasonal intensive exposure that may last for upwards of 90 days (540 h). Available health services and monitoring agencies (where there are any around the rural female entrepreneurs) are usually ill-equipped to handle some of these exposures. Some studies (Chay and Greenstone 2003; Currie and Neidell 2005; Smith et al. 2005; Benjamin 2006) have documented that women and children exposed to pollutants from firewood burning for cooking have strong correlations with incidences of infant deaths and disability-adjusted life years (DALY) from ARI, chronic obstructive pulmonary disease (COPD), tuberculosis, asthma, lung cancer, ischemic heart disease, and blindness.

Furthermore, breathing of air containing wood smoke causes serious health challenges. According to the New Hampshire Department of Environmental Services (2009),

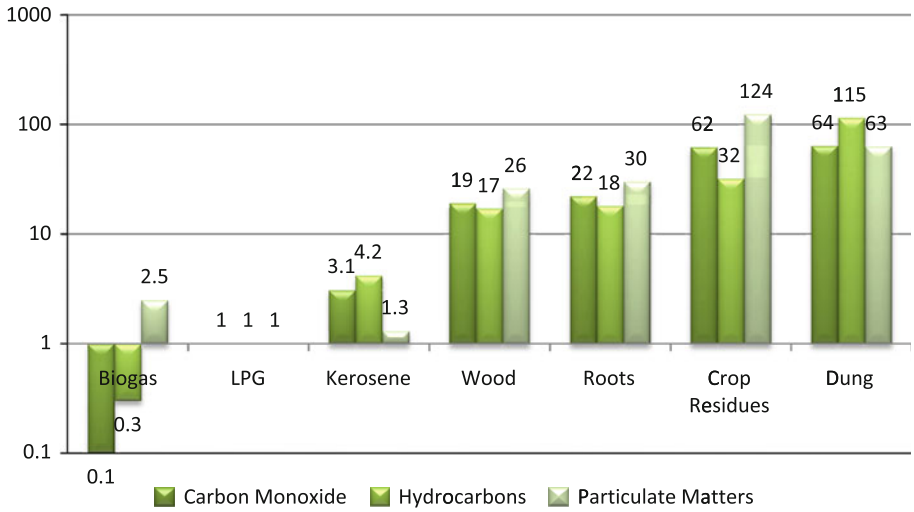

Fig. 3 Pollutant emissions per meal by cooking fuel, relative to LPG (1.0 on the scale) (measured in India; note log scale) (Source Smith et al. 2005)

Table 4 Major toxic pollutants the women involved in garri processing are exposed to and the likely health impact

Pollutant	Likely impact on women from garri processing
Fine particles	Cardiovascular problems
CO	Blindness
PAHs	Fatigue
NOxs	Disability
Volatile and semivolatile organic compounds	ARIs
	Chronic obstructive pulmonary disease

Sources Adapted from Zhang and Smith (2003) and Pope et al. (2002)

breathing air containing wood smoke can cause a number of serious respiratory and cardiovascular health problems. So the women making garri in the areas visited are at great health risks from wood smoke. Those most vulnerable are infants, children, pregnant women, the elderly, and those suffering from allergies, asthma, bronchitis, emphysema, pneumonia, or any other heart or lung disease. Fine PM, the very small particles that make up smoke and soot, may be the most insidious component of wood smoke pollution. The most harmful particles are those 10 μm or less in diameter (a human hair is approximately 70 μm in diameter). These particles can easily be inhaled deep into the lungs, collecting in the tiny air sacs (called alveoli) where oxygen enters the blood, causing breathing difficulties and sometimes permanent lung damage. The particles are also often composed of harmful substances, such as polycyclic aromatic hydrocarbons (PAHs) (which can originate from certain home-cooking practices), which are regarded as potentially genotoxic and carcinogenic to humans (EFSA Panel on Contaminants in the Food Chain 2008), sulfate, which is acidic, and toxic trace metals like lead and cadmium. Inhalation of fine PM can increase cardiovascular problems, irritate the lungs and eyes, trigger headaches and allergic reactions, and worsen respiratory diseases such as asthma, emphysema, and bronchitis, resulting in premature deaths. In Fig. 3, pollutant emissions meal by cooking is shown. The heavy pollutants relative to LPG are wood, roots, crop residues, and dung; these fuel types are the most used in food processing in the study area (Smith et al. 2005). From these evidences, inference of the likely impact of pollutants from fuel wood burning during the processing of garri and oil processing are as presented in Table 4.

The study also detected that continuity of food processing is in jeopardy, even though the reason is not connected to pollutants from food processing. The study collated the responses from the women entrepreneurs in the various communities to the possibility of continuing their businesses with the present prevailing conditions. Coupled with the FGD, it was revealed that practically all the women would not be interested in continuing with the businesses if present prevailing circumstances are not improved upon. However, close to 45 % responded that they will continue if there is improvement, particularly in finances and technology as against the present situation. They indicate that they will also be glad to be able to utilize the wastes (or by-products) rather than constitute hazards as they presently are. On the issue of awareness, 80 % of respondents indicate that they are aware of the environmental and health hazards caused by their food processing, but are, however, handicapped in not being able to solve the associated environmental- and health-related problems.

QUALITY CONTROL OF THE PROCESSED FOOD PRODUCTS

According to the law, establishing the National Agency for Food and Drug Administration and Control (NAFDAC), commercial production of food and drugs in Nigeria for public consumption are supposed to be under its regulation. For instance, water production has standard quality parameters, which also goes for all other regulated NAFDAC products. In the case of water produced either in sachet or bottled in Nigeria, the standard quality parameters usually expected to be met by producers for human consumption include its pH, taste, color, and odor, among others. For garri, however, a staple food eaten in almost all parts of Nigeria, particularly the eastern, western, and southern parts, there is no known standard applied to and enforced in its production. Studies have shown that the moisture content of garri is affected by the kind of packaging material used for its storage (Ibeh et al. 1991; Ogiehor et al. 2007; Ogugbue and Obi 2011). It is also reported by Amadi and Adebola (2008) that the storability of garri is affected by the level of moisture content in it. Thus, despite these evidences, there is no known quality-control regulation through NAFDAC on these to the women involved in processing this food product.

Added to this is the fact that garri and palm oil producers are not required to indicate the shelf life of their products to consumers as enforced for some other NAFDAC-regulated products. Studies have also shown that the same goes for palm oil production (Udensi and Iroegbu 2007; Okonkwo and Ogbuneke 2010). It may be argued that this is because they are small-scale producers the government wants to encourage, but this needs to be balanced carefully against enforcement of public health standards.

MEANS OF MAKING THE WOMEN BETTER HANDLE ENVIRONMENTAL AND HEALTH IMPLICATIONS OF FOOD PROCESSING

Two issues become very prominent in the analysis of data obtained from the survey. The first is that associated with environmental and health issues, and the second involves providing alternative technology as well as the needed energy source for the processing of these food products. It needs be quickly stated here that even though Smith et al. (2005) show liquefied petroleum gas (LPG) to be a relatively cleaner energy source for food production by the women, it needs to be borne in mind that where a better alternative presents itself, in terms of availability, affordability, and accessibility, this should be encouraged.

There are quite a number of documented studies on the utilization of wastes from both cassava and oil palm processing. Oboh (2005) reported that waste from cassava could be a good source to be explored in the industrial sector, as a source of industrial amylase. This quality derives from the fact that amylases from fermented cassava waste water are active at wide temperature and pH ranges. In another study, Ofoefule et al. (2011) report that cassava waste-water processing could not lead to flammable gas on its own, but when mixed at the appropriate proportion with other biogas sources could be made flammable. So processing the waste water from cassava could also become a good energy source for frying the processed cassava into granules and flour called garri. The use of this energy source could be more beneficial from a climate-change perspective and at the same time generate additional income for the rural entrepreneur. This could also help in reducing the environmental and health hazards of this by-product from cassava processing. It needs to be mentioned that cassava peels serve as a food source for domestic animals such as goats, sheep, and cattle. The cassava peel could also be useful. For example, a report from Okafor (1998) showed that cassava wastewater generated from garri production was inoculated with microorganisms to produce microbial biomass. This biomass was then mixed with ground cassava peels to formulate feed for pigs. From palm oil processing, Ofoefule et al. (2011) report that even though palm oil sludge could not produce quantifiable gas, however, when combined with other agro-based wastes [brewery spent grain (SG), carbonated soft drink sludge (SL) and cassava waste water], reasonable quantities of biogas were produced, which flamed after some lag.

Thus, we opine that taking these steps on by-products from cassava and palm oil processing would lead to a reduction in environmental pollution and bring about new demands for agricultural products arising from increased biomass usage. This in turn would impact the social–economic life of the women especially. In addition, this could also serve as a means of addressing social issues particularly in the rural areas such as employment generation and poverty reduction. Further gains could include the fact that the conversion of these biodegradable waste waters (both domestic and industrial) into biogas would result in cleaner air as well as an efficient waste management system and improvement in the environment in which these women operate.

CONCLUSIONS AND RECOMMENDATIONS

Without doubt, the health of the citizenry and protection of the environment of any nation is the primary responsibility of the government. In this study, we pointed out that in Nigeria, the nearest to taking care of the health of the citizens (particularly women and children in the rural areas, and also protecting the environment) had been to examine

indoor air pollution, air quality of urban areas with focus on pollutants from vehicular emissions, and making advocacy on reducing deforestation or planting of trees. There has been no recourse to study and/or legislation focused on the ambient air quality that the female entrepreneurs in the rural areas operate.

From the foregoing it can therefore be deduced that rural entrepreneurship as being practiced is tedious, injurious, and highly unprofitable to these women. It is even more alarming when the exposure that the female entrepreneur had to go through in processing food for the economy (average of 1500 h/person/year for garri-making and 540 h/person/year for palm oil-making). Garri and palm oil are high-demand products in Nigeria's economy particularly, and in a global market as well. Garri is one of the staple foods in the country, while palm oil (a multipurpose product) is in high demand because of its economic importance as a high-yielding source of edible and technical oils. These two products are of high economic value. Despite this fact, however, it is quite unfortunate that ambient air quality, which these women operate in in their respective locations, is not adequately monitored. This is evidenced from the fact that there are no concerted efforts at quantifying the magnitude of environmental and health implications of their food processing engagement. There is currently no policy or regulation or regulatory body responsible for looking out for the women's welfare. The outcome of this neglect is that there is no informed environmental and health policies targeting the quantification of the impact of air pollution on public health as it relates to food processing in the rural areas.

Based on this conclusion, we therefore recommend the following:

1. There is an urgent need to address the issue of air quality policy in the country, particularly targeting women and children who are most vulnerable to exposure from the burning of solid fuels either in cooking or food processing;
2. A regulatory framework for monitoring ambient air quality is long overdue; rural female entrepreneurs need to be protected through such regulatory bodies in the country;
3. The NAFDAC was set up in response to a need; the function of the NAFDAC in conjunction with the states' ministries of health as well those handling women and youth affairs should be extended to also cover quality of food produced from these rural female entrepreneurs as well as their state of health;
4. Training of the women to become aware of the implication of the use of solid fuels to their health as well as how to handle by-products from their processing cassava and palm fruits;
5. Ultimately, it would be extremely beneficial to change the outdated technology that depends on solid fuels for energy to less polluting fuels such as LPG or even biogas from the wastes generated through the processing of the food. This is likely going to be a useful means of reducing particulate pollution and improving the ambient air quality.

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