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Mazlan, Norida; Ahmed, Mohammed; Muharam, Farrah Melissa; Alam, Md. Amirul
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Status of persistent organic pesticide residues in water and food and their effects on environment and farmers: a comprehensive review in Nigeria

Estatus de resíduos de inseticidas persistentes orgânicos em água e alimentos e seus efeitos sobre o ambiente e os agricultores: uma revisão abrangente da Nigéria

Norida Mazlan[1*]; Mohammed Ahmed[1]; Farrah Melissa Muharam[1]; Md. Amirul Alam[2]

Abstract

Pesticide helps to enhance agricultural production, however, it significantly affect both socio and environmental entities of a country. In Nigeria, pesticide is widely used, thus its traces have been detected in water, soil and air. Several studies have already indicated that most of the environmental ecology (air, water, and soil) in Nigeria has been contaminated by persistent organic pesticides like organochlorine and *organophosphate*. Other reasons of high pesticide residues present in Nigeria environment is due to inappropriate dosage applied of pesticides that leaves behind excess. However, its residues are found above safety levels in the air, water, and soil across the nation. Based on previous analysis, it is indicated that 125,000-130,000 metric ton pesticides are being applied annually in Nigeria. Despite banned of some pesticides such as dichlorodiphenyltrichloroethane- and –Hexachlorocyclohexane, they are still being used by farmers in their agricultural production. Many of the Class 1 (high extremely toxic) pesticides are still being used in developing countries like Nigeria. Hence, there is need to sensitize and educate the general public especially the end-users (farmers) particularly on management practices of pesticides. Considering these entire hazardous situations, in this article the history of pesticide used in Nigeria has been reviewed in detail. The article also discussed the effects of pesticide use in Nigerian waters, soil and on crops. The risk of residual pesticide on agricultural workers, pesticide residue risk preventive measures by the Federal Government of Nigeria, banned and restricted pesticides in Nigeria, Nigerian Government and its efforts to eliminate persistent organic pesticides in use are also reviewed in details.

Key words: Organic pesticide. Organochlorine. *Organophosphate. DDT. HCH.* Residue.

Resumo

Inseticidas ajudam a aumentar a produção agrícola, no entanto, afetam significativamente a sociedade e o ambiente do país. Na Nigéria, os inseticidas são amplamente utilizados, assim, seus resíduos foram detectados na água, solo e ar. Vários estudos já indicaram que a maior parte dos aspetos ecológicos ambientais (ar, água e solo) na Nigéria tenham sido contaminados por pesticidas orgânicos persistentes como os organoclorados (OCL) e organofosforados (OP). Outro motivo relacionado com a ocorrência de resíduos elevados de inseticidas presentes no meio ambiente na Nigéria é devido às dosagens inadequadas aplicadas de pesticidas que são aplicados em excesso. No entanto, seus resíduos são

[1] Drs., Department of Agriculture Technology, Faculty of Agriculture, Universiti Putra Malaysia, Universiti Putra Malaysia, 43400 UPM, Selangor, Malaysia. E-mail: noridamz@upm.edu.my; farrahm@upm.edu.my; barmuni17@yahoo.com

[2] Dr., School of Agriculture Science and Biotechnology, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin, Besut Campus, 22200, Terengganu, Malaysia. E-mail: amirulalam@unisza.edu.my

[*] Author for correspondence

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encontrados acima dos níveis de segurança no ar, água e solo em todo o país. Com base em dados anterior, é observado que 125,000-130,000 toneladas métricas de pesticidas são aplicadas por ano na Nigéria. Apesar da proibição de alguns pesticidas como o DDT (Dicloro-difenil-tricloroetano) e HCH (Hexa-cloro- ciclohexano), eles ainda estão sendo usados pelos agricultores para a produção agrícola. Muitos dos Classe 1 pesticidas (extremamente tóxicos) ainda estão sendo usados nos países em desenvolvimento como a Nigéria. Assim, não há necessidade de sensibilizar e educar o público em geral, especialmente os usuários finais (agricultores) em particular sobre as práticas para o manejo dos inseticidas. Considerando estas situações de perigo real, neste artigo o histórico de uso de inseitidas na Nigéria foi estudo em detalhe. O artigo também discute os efeitos da utilização de inseticidas nas águas, no solo e nas culturas. O risco de contaminação para os trabalhadores rurais as medidas preventivas para controlar risco de resíduos adotadas pelo Governo Federal da Nigéria, a proibição e restrição de uso de inseticidas pelo Governo da Nigéria e seus esforços para eliminar resíduos de inseticidas em uso são também discutidos.
Palavras-chave: Inseticidas orgânicos. Organoclorados. Organofosforados. DDT. HCH. Resíduos.

Introduction

Pesticides are commonly used both in domestic and agricultural production to provide crop protection and boost up the yield in agricultural productivity, despite its adverse effects on ecological environment, human and animal's health. Pesticide residues are traces easily detected in our environment, especially in water and on crops. Organochlorines, organophosphates and pyrethroid pesticides have been widely used across Africa continent, it persistence's remain stable for many years after their use which has impact on the environment. Afful et al. (2010) asserted that degradation of dichlorodiphenyltrichloroethane (DDT) in soil ranges from 4-30years while other organophosphate (OPs) may remain stable in soil for many years after their use. William et al. (2008) further stressed that OPs, Hexachlorocyclohexane (HCH) are lipo-soluble compounds and are capable of bio-accumulating in fatty parts of biota like breast milk, blood and fatty tissues of the animals or human which causes serious diseases and also highly toxic to most aquatic life. Persistent organic pesticide residues are widely distributed in Nigerian soil, water, and cultivated crops especially cereals. DDT and HCH have been banned or restricted from used in Nigeria as a results of their severe health hazard associated with, but despite the chemicals are being banned by the Federal Government, many farmers are still using it for their agricultural production and there are few countries beside Nigeria who are still engaged in production, usage and export of y-HCH in a large scale (ABHILASH; SINGH, 2009).

In Nigerian society a quest to increase agricultural production means an increase in the use of pesticides, herbicides, rodenticides and fungicides. These persistent organic chemicals have become integral part of Nigerian society. It has been used for diverse reasons ranging from protecting crops from pests, weeds, rodents and fungal diseases to animal husbandry and also for public health application(CHOPRA; SHARMA, 2010). Though, the synthetic pesticides are not permitted to be used in organic crop production especially cereal crops. Drift from different non-organic farms and by un-lawful use of synthetic pesticides leads to sporadic presence of their residues in environment. Thus, it is necessary to re-assure the consumers that food products are free from undesired pesticide residues. However, with all these significant economic and health benefits, the pollutants are not target-specific and may eventually cause diseases which may be chronic to non-target organisms since most of these pesticides are very persistent and remain for a long period of time due to their stability in structure and lipo-philic character such as OCPs (Organochlorine *pesticides*). These pesticides tend to bio-concentrate and bio-magnify in food chain particularly those foods associated with fatty tissues that is leading to vertebrates and non-vertebrates

toxicity in all those non-target organisms and even on humans (OKOYA et al., 2013; MASIA et al., 2013; IZE-IYAMU; ASIA, 2007). There are many studies conducted and provided evidences on presence of pesticides contamination in Nigerian fresh water bodies from pesticides and other pollutants which have been prevailing toxicity even at trace levels (UPADHI; WOKOMA, 2012; WILLIAMS, 2013; EZEMANYE et al., 2008; EZEMONYE et al., 2009; IZE-IYAMU; ASIA, 2007; ADEBOYEJO et al., 2011; OKENIYIA et al., 2009; ADEYEMI et al., 2011) are the few studies that provided those evidences of pesticides (pollution) contamination in our various environmental compartments. BEMPAH et al. (2011)with almost the entire population depending on rural agricultural activities for subsistence. To increase agricultural produce, various forms of pesticides are normally used in fruits and vegetable farming. The consequence is that several cases of pesticide poisoning have been observed. In this preliminary study, a field survey was carried out to assess the knowledge, attitudes, and peoples' perception concerning the use of pesticides by farmers in fruit production. The residual concentrations of selected pesticides in pawpaw, imported apples and tomato samples and the potential health risks associated with the exposure to these pesticides were also assessed. The field survey data indicated that more than 70% of the participants reported one or more poisoning upon fruits consumption resulting in pesticide-related illnesses. Pesticide residues in the various environmental samples were determined by gas chromatography with electron capture detector (GC-ECD and Konradsen et al. (2003) emphasised that increase in pesticide misuse in various sectors of agricultural productivity is often associated with environmental pollution and health hazards. Misuse of highly toxic pesticides with a weak or total absent of legislature framework is one of the major reasons for high incidences of pesticide poisoning especially in developing countries like Nigeria (SOARES et al., 2003).

Anzene et al. (2014) in their findings attested that the amount of organochlorine pesticide residues detected in some cereal crops from Nasarawa state in Nigeria detected exceeded the MRLs (maximum residue levels) recommendations. The level of MRLs exceeded may pose a danger to human health and equally polluting environmental in Nigeria. Akoto et al. (2013) also found out in their study that, the degree of pesticides residue contamination in maize and cowpea sampled in Ejura town exceeded the European Union MRLs. Their findings however show that, maize was highly contaminated with total of $0.087 mgkg^{-1}$ and $0.075 mgkg^{-1}$for organochlorine, organophosphates and pyrethroid pesticides, respectively. Furthermore, in their analysis it was revealed that heptachlor, Aldrin, dieldrin, endrin, y-chlordane and chlorfenninphos in maize and heptachlor and p,p-DDD in cowpea had great potential for systemic toxicity to the consumers.

History of pesticide use in Nigeria

Ikemefuna (1998) and (Asogwa, E.U. and Dongo, 2009) emphasised that pesticide usage in Nigeria has been on increase ever since its introduction in early 1950s in order to boost agricultural production to meet up the demand of ever increasing population of the nation. Nigeria indicated that thousands of metric tons of pesticides annually are being used comprising about 135 pesticide chemicals marketed locally under 200 different produce brands and formulation which were imported during 1983-1990. Thus, making Nigeria one of the largest pesticide users in Sub-Saharan Africa (OSIBANJO, 2002). About125,000-130,000 metric tons of pesticides were applied annually in Nigeria (ASOGWA; DONGO, 2009)efforts are now intensified to seek measures towards its reduction. The Cocoa Research Institute of Nigeria (CRIN. Nigeria still imbibed on utilization of synthetic fertilizers and pesticides to increase productivity as to attain acceptable levels of "food security". However,

despite the banned of some pesticides that is found critical which have detrimental effects on human health by NAFDAC (*National Agency for Food and Drug Administration and Control*); some farmers still procure and use them. World Bank-West Africa Agricultural Productivity Program (World Bank-WAAPP, 2013) reported that about 72% of farmers in Nigeria procured their inputs from open markets which have high chance of adulteration and fake input products. It has been reported that 2.2 million people in Nigerian state are at risk due to exposure from various agricultural inputs such as pesticides and other related chemicals (*ERHUNMWUNSE et al.,* 2012). This may poses high risk of increase in causing chronic diseases of Non-Communicable Diseases (NCDs) such as diabetes, cancer and other diseases. However, Erhunmwunse et al. (2012) also enumerated the risk and implications of pesticide usage by the farmers in Nigeria.

The most common pesticides used in agricultural production is indicated that are dangerous to human health, some are carcinogenic in nature, and others with permanent and temporal damages on either tissues, organs or the entire systems of human pathology as shown in Table 1.

Pesticide poisoning at either international or occupational level is an important health issue because of its usage in large number by agro-allied and agricultural industries in Nigeria, putting many categories of workers at risks, (ERHUNMWUNSE et al., 2012). The chance of pesticide exposure through occupational sources is greater in Nigeria than any other country in Africa, because most of the workforce is under low-level protection despite availability of regulatory policies which are not usually enforced due to inadequate resources and infrastructure. It was reported that 43% of pesticide applications were done by the farmers while 30% and 26% of the applications were made by hired applicators and farmer's family member's respectively using knapsack sprayer. These exposes workers at high risk of pesticide exposure and also other factors like inadequate of protective equipment's, improper application conditions and practices such as lack of suitable washing facilities, routinely application of highly toxic pesticides by un-trained workers at lengthy hours. Also, unsafe storage and disposal facilities, poor managerial skills and so on. Use of faulty equipment's by the workers, inadequate health centres, medical facilities and lack of trained health personnel may be the main contributing factor of exposing the workers to health hazard, (COSTA, 2006; ANGLEARN, 2001).

World Health Organisation (WHO, 2006) reported that pesticide exposure depends on dosage, the route of exposure, how readily the pesticide absorbed, the type of effects of pesticides and its metabolites, accumulation and persistence in the body and the health status of the individual (ERHUNMWUNSE et al., 2012). Poisoning from persistent pesticides can occur through ingestion, eating or drinking contaminated food or drink and dermal contact by drifting into nearby workers (COSTA, 2006; ANGLEARN, 2001). However, exposure of the population in Nigeria could be high due to potential contamination of cereal crops such as maize as a staple food in the majority region of North Eastern Nigeria. The proof of significant contamination of maize and cowpea which was reported in Togo was similarly conducted by Gwary et al. (2011), Ogah et al. (2011); Erhunmwunse et al. (2012) and they postulated that pesticide contamination is on the increase in the country as a result of its usage for different activities. However, little or no data on pesticide's related poison on the population especially Nigerian workers in all agro-allied fields in Nigeria makes it difficult to ascertain the exact effect (s) on human health in the country. Effort should be put towards establishing appropriate medical surveillance and record keeping of workers that are involved with pesticides affliction in Nigeria.

Table 1. Implications of pesticide usage on humans in Nigeria.

Pesticides	Application	Health effects
Chlorotoluron	Post-emergence herbicides	Cholinesterase inhibitor
Cyanazine	Pre and post emergence herbicides	Increase in adenomas and carcinomas of the kidney
1,2 dibromoethane	Fumigant	Increase tumour
Fenoprop	Herbicide	Degeneration and necrosis of hepatocytes and fibroblastic proliferation
Heptachlor and heptachlor epoxide	Broad spectrum insecticide	Kidney tumour
Isoproturon	Systemic herbicide	Marked enzyme induction and liver enlargement
Methyl-parathion	Non-systemic insecticide and acaricide	Decreased diolinesterase activities, sciatic nerve dymyelination, anaemia
Methoxychlor	Broad insecticide	Carcinogic potential in liver and testes
Molinate	Herbicide	Impairment of the reproductive performance
Pyripoxyfen	Broad spectrum insecticide	Increase in liver weight

Source: Ezemonye et al. (2015).

Pesticide residue in water

In every fresh water body (river, lakes and wells) there is likelihood of pesticide residue presence as pollutants which leached out from soil surfaces or through aquifers. In Nigeria, pesticides have been found in surface and underground waters. The residues enters natural water from direct application for control of aquatic weeds, trash fish, aquatic insects, percolation and run-off from agricultural production fields, drift from agro-allied industrial waste water and discharge from waste waters from clean-up equipment's used for pesticide formulation and application (OKENIYIA et al., 2009). Akoto et al. (2013) found in their studies that high level of chlorinated pesticides was as a result of extensive use of Lindane in fishing and Aldrin in cultivated fields close to these lakes, rivers and wells around. Osibanjo (2002) postulated that, the occurrence of OCP in major rivers in Nigeria which serves as a source of drinking water to the vast majority of population in the country and also for domestic and industrial purposes. The residues of these pesticides that are present in soil and water should not exceed extreme limits as this may cause a threat to human health. The high levels of pesticide toxicants found in the country are 240-650 $\mu g/m^3$ (1040 $\mu g/m^3$) for endosulfans and hexachlorobenzene from 120 to 2890 µg/m3 (mean 790 $\mu g/m^3$). However, at southern Nigeria, it reported lower level of Chlordane and endosulfans (AKOTO et al., 2013). In places such as in Lake-Gerio and River Benue (In Adamawa state, Nigeria) where insecticides never been used

for control of vectors, even surface water samples contained pesticide toxicant. In Lake Gerio, DDT was found at 6.054-31.336 µg/l within the range of 0.58µg/l, while DDT level is 3.86µg/l (OKENIYIA, et al., 2009). In (DHOLE, et al.. 2012) sampled water from a commercial water production field and were found various pesticide metabolites in the sample with a pesticide concentration standard of 100ppb by dilution from a commercial EPA 508 (United States Environmental Protection Agency) pesticide residue mix as shown in Table 2a below.

Table 2a. Pesticide residue detected from the commercial production field in Nigeria.

Components Name	Concentration (PPb)
Alpha BHC	0.087
Beta BHC	0.095
Gamma BHC	0.096
Delta BHC	0.095
Heptachlor	0.101
Aldrin	0.094
Heptachlor epoxide	0.096
Endosulphan A	0.101
4,4'-DDE	0.156
Dieldrin	0.169
Endrin	0.110
4,4'-DDD	0.093
Endosulphan B	0.080
4,4'-DDT	0.081
Endrin aldehyde	0.098
Endosulphan sulphate	0.095

Source: Dhole and Madhuli (2012).

Pesticide residue in crop

Pesticide is any substance or mixture of substance intended for prevention, destroy, or controlling any pest, including vectors of human or animal diseases, unwanted plants or animals causing harm during, or otherwise interfering with the production, processing, storage, transport, or marketing of food (ERHUNMWUNSE et al., 2012).Overall mean concentration (µg/kg) of organochlorine residue in Nigerian foodstuff, many samples of food have been analysed by Etonihu et al. (2011) for the presence of pesticide in Nigeria which include analysis on maize grains, white beans and sorghum. The sampled were procured randomly from open markets both in Nasarawa and Plateau states, respectively. The results indicated that 5 pesticides represented in these foods items. Ingestion of contaminated foods to these pesticides generally is the main source of human exposure as it indicated on Table 2b (OSIBANJO, 2002).

Table 2b. Pesticide residue in crops detected in Nigeria.

Metabolites	MRL (maximum residue limit)	Fruits	Vegetable	Tuber	Cereals
DDT	100-5000	6.9	28.3	30.4	81
Aldrin	20-200	1.9	2.1	8.0	80
Dieldrin	-	-	-	32	312
Heptachlor	200	ND	ND	ND	ND
DDE	-	5.8	12	12	106

Source: Osibanjo (2002).

Risk of residual pesticides in ecosystem

The application of pesticides in our environment as a result of the indiscriminate or intentional use has resulted in its persistence in the environment, thereby affecting the ecosystems and non-target organisms. (FATEMAH et al., 2012) has calculated health risk of commonly detected pesticide in water in Nigeria. They used the measured environmental concentration (MEC) to indicate risk assessment using risk quotient and the findings indicated that Eldrin, Dieldrin and Endosulfan I and II are likely to cause adverse effects to each fish in the study area. Acute and chronic pesticide poisoning usually results from consumption of contaminated food. Risk assessment using risk quotient deterministic method, where MEC was divided by Probable No Effect Concentration (PNEC) is presented in the table 3 below. The results indicated that Endosulfan aldehyde of fish is (RQ≥1). But if it indicates ($0.001 \leq RQ \leq 0.1$) which shows low risk. However, Dieldrin and Endrin that are above Effect Low Range (ERL) indicates potential risk to benthic organisms as a result of exposure to contaminated sediments. Endosulfan Aldehyde, Endrin and Dieldrin are likely to cause adverse effect to fish species (RQ = 1).

However, in a study conducted by Malhat et al. (2015), the samples of honey were screened to monitor residues of organochlorine and pyrethroid pesticides. Their study meant to examine the quality of honey, and to use honey as a bio indicator of environmental contamination. Residue levels were determined by gas chromatography (GC-μECD). Samples were also found having a wide spectrum of organochlorine and synthetic Pyrethroids pesticides, with hexachlorobenzene (HCB) as the most frequently detected organochlorine, followed by permethrin, heptachlor epoxide. Only one sample had a concentration of γ-HCH (Hexachlorocyclohexane) higher than maximum residue limit of honey ($0.01 mgkg^{-1}$). Residues of organochlorines were detected in some fresh supplies, despite the ban imposed on their use. The study confirmed that honey bee and beehive matrices could be used as gauge for monitoring environment contamination. From public health point of view, the observed levels of pesticide residues in honey do not pose a serious health risk to the consumers, but raises questions of the source of organochlorines.

Table 3. Ecological risk assessment of pesticides in water detected in Ogbesse River in Nigeria.

Pesticides	MEC	PNEC	RQ	ERL
Heptachlor epoxide	0.43	0.25	1.72	
Dieldrin	0.14	0.0062	22.85	0.5 (ng/L)
Endrin	0.06	0.0032	18.23	0.02 (ng/L)
4, 4 DDT	0.12	0.087	1.40	
Endosulfan I	0.22	0.0033	66.50	
Endosulfan II	0.08	0.0685	1.22	
Endosulfan aldehyde	0.23	0.15	15.56	
Glyphosate	0.27	0.13	2.09	

Risks of pesticide consumption

Food and Agriculture Organization (FAO) and World Health Organization (WHO) reported that, food contamination monitoring program found the presence of Aldrin, Dieldrin, DDT, Lindane, Heptachlor and Heptachlor epoxide in human breast milk. The WHO and UN environmental program estimated that, each year3 million workers in agricultural production in developing countries like Nigeria experience severe poisoning from pesticides and about 18,000 of who die. According to one study, as many as 25 million workers in developing countries may suffer mild pesticide poisoning yearly (WHO, 2006; BEMPAH et al., 2011). The table 4 below also indicated that the Hazard Quotient (HQ) values were higher suggesting that health risks associated with intake of Endrin, Aldrin, Dieldrin and Heptachlor epoxide is higher, therefore human health risk estimated higher than *Average Daily Intake* (ADI) for 10kg weight group. *Estimated Average Daily Intake* (EADI) for Heptachlor epoxide and Endrin exceeded the ADI for 30kg category, while EADI for Heptachlor epoxide exceeded the ADI for 70kg category.

Conclusively, all pesticides with EADI higher than ADI had their HQ greater than 1 (>1) which indicates high potential health risk through consumption. Hence, the results obtained from this study conforms with the studies of Darko et al. (2008) who reported that, life time consumption of perishable foods like tomatoes and eggplant from Kumasi market (Ghana) could pose some health risk because it has been found that, the HQ greater than 1 (>1).

The table 5 below indicated the different types of pesticides for controlling both the pests and herbs and their various applications with their risks to human health causing both chronic and temporal damages to human physiology.

Table 4. Risks of pesticide consumption.

ADI Pesticides	10 Kg (child)		30 kg (baby)		70 kg (adult)	
	EADI	HQ	EADI	HQ	EADI	HQ
Endrin	0.23	17.31	0.08	6.41	0.03	2.47
Aldrin	0.57	18.90	0.21	7.00	0.08	2.70
Dieldrin	0.48	9.54	0.18	3.53	0.07	1.36
Heptachlor epoxide	0.41	13.50	0.15	5.00	0.06	1.93

Source: Darko et al. (2008).

Table 5. Risks to human health of some pesticides commonly used in Nigeria agriculture.

Pesticides	Application	Health Effects	References
Aldicarb	It is a systemic insecticide effective for the control of aphids, nematodes, flea, thrips, white flies etc.	Inhibitor of cholinesterase	WHO (2006)
Aldrin	Effective against wire worm and to control termites.	Increased D-glutaric acid metabolism	Hunter (1971)
Paraquat	It is used as a plant desiccant effective against grasses	Contact dermatitis, cellular proliferation in the lung. Fetal intoxication, chronic fibrotic changes.	Adams (1983) WHO (1990)
Captafol	It is a protective, wide spectrum foliage an soil fungicide	Contact dermatitis	WHO (1990) Adams (1983)
2-4-D	It is a selective post emergence herbicide used for the control of many annual broadleaf weeds	Contact dermatitis	WHO (1990)
Mancozeb	It is a protective fungicide, effective against a wide range of foliage disease	Contact dermatitis	WHO (1990)
Barban	Herbicides	Skin sensitization, allergic reaction and rash contact dermatitis	Adams (1983)
Benomyl	Eradicant fungicides	Skin sensitization, allergic reaction and rash contact dermatitis	Adams (1983)
DDT	Effective against wide variety of insects, including domestic insects and mosquitoes	Skin sensitization, allergic reaction and rash, carcinogenic	Adams (1983)
Lindane	It is used against sucking and biting insects	Skin sensitization, allergic reaction and rash. Contact dermatitis. Enzyme induction	Adams (1983)
Zineb	Protectant fungicide	Skin sensitization, allergic reaction and rash, Photoallergic reaction	Adams (1983)
Malathion	Wide range insecticides used against aphids, red spider, thrips and leafhoppers.	Skin sensitization, allergic reaction and rash	Adams (1983)
Hexachlorobenzene (HCB)	Acaricide	Photosensitivity, bulbae formation, deep scarring, permanent loss of hair, skin atrophy and chlorance	WHO 1990)
2, 4, 5-T	Herbicides-hormone weed killer	Chlorance	Bainova (1982)
Pentachlorophenol	Molluscicide	Chlorance	Bainova (1982)
Ethylene dibromide	Fumigant nematocide	Mutagenic	IARC (1988)

Pesticide residue risk preventive measures by Federal Government of Nigeria

Many policies and programs are being promulgated by different government which lead to implementation of some appropriate preventive measures assisted in minimizing cases of pesticide poisoning and other related health risk. The Government of Nigeria is concerned about the health risks related to pesticides and has implemented various measures which include

integrated pest management (IPM), prohibition of highly hazardous pesticides, restriction of the use of toxic (compounds) chemicals, and also the development of a national implementation plan and strategic projects. However, the outbreak of secondary pests and the presence of pesticide residues in food, herbages, soil, air and water which ultimately leads to human health hazards and ecological imbalance. Considering the severe side-effects of chemical pesticides, the Nigerian government introduced, incorporated and adopted an IPM approach strengthening and modernizing IPM approaches through Green Revolution which began in 1960s signalled the beginning of a new era in agricultural productivity. High yield crop varieties were developed from various research centres and Universities and equally distributed along with policies to promote agricultural and horticultural productivity and stimulate and sustained poverty reducing growth.

The new Nigerian agricultural policy

The global pesticide residue limits and mycotoxin standards of the Codex Alimentarius Commission, EU and USDA are applied by National Agency for Food and Drugs Administration and Control (NAFDAC) in its assessment of food safety and also to ensure increase in production capacity in order to meet up the demand of highly increasing population in the country. All food products must have a certificate of analysis, which can demonstrates to NAFDAC's satisfaction that the item is free of radioactive contents in addition to other quality parameters which can assist in ensuring quality standard in all agro allied products. There is a maximum residue limit for approval of pesticides, however, NAFDAC in Nigeria reserves the right to subject any domestic or imported agro allied product(s) to its own analysis to determine wholesomeness of safety for all food products. NAFDAC officials routinely subject any imported foods to inspection and analysis at the port of entry, retail level and also perform laboratory analysis. Contaminated products are quarantine and be subjected to seizure and destruction by NAFDAC and possible prosecution (SMITH, 2009).

According to Hussaini (2013) the new policies cover issues on (i) agricultural production resources (land, labour, capital, seeds, fertilizer, etc.) whose supply and prices affect the productivity and profitability of agricultural business, (ii) crops, livestock, fisheries and agro-forestry production, (iii) pest control, (iv) mechanization, (v) water resources and irrigation, (vi) rural infrastructure, (vii) agricultural extension and technology transfer, (viii) research and development (R&D), (ix) agricultural commodity storage, processing and marketing, (x) credit supply, (xi) insurance, (xii) agricultural cooperatives, (xiii) training and manpower development, and (xiv) agricultural statistics and information management.

The successful implementation of the agricultural production policy is, however, contingent upon the existence of appropriate macroeconomic policies that provide the enabling environment for agricultural productivity to grow in equilibrium with other sectors. They affect profitability of agricultural enterprises and the welfare of farmers through their effects on the flow of credit and investment funds, taxes, tariffs, subsidies, budgetary allocation, etc., this will enable food security for the country and ensure socio economic and technological development of any developing nation especially Nigeria.

The previous agricultural policies were completed in 1988 and were supposed to remain functional until the year 2000. Hence, in year 2001, new policy was enacted. The new policy bears most of the features of the old one, but with more focused and better articulation. However, the objectives of the new agricultural policies are very similar to those of the old one. These includes; (i) the achievement of self-sufficiency in food production and basic food supply and the attainment of food security, (ii) increased production of agricultural raw materials for industries, (iii) increased production and processing

of export crops, using improved production and processing technologies, (iv) generating gainful employment, (v) rational utilization of agricultural resources, improved protection of agricultural land resources from drought, desert encroachment, soil erosion and flood, and the general preservation of the environment for the sustainability of agricultural production, (vi) promotion of the increased application of modern technology to agricultural production such as fertilizers, pesticides and other vital inputs for productivity and, (vii) improvement in the quality of life of rural dwellers which will go a long way in boosting the interest of the local farmers and ensure increase in their output.

Characteristics of the new policy

The key features of the new policy are as follows

Evolution of strategies that will ensure self-sufficiency and improvement in the level of technical and economic efficiency in food production. This is to be achieved through (i) the introduction and adoption of improved seeds and seed stock, (ii) adoption of improved husbandry and appropriate machinery and equipment, (iii) efficient utilization of resources, (iv) encouragement of ecological specialization, and (v) recognition of the roles and potentials of small –scale farmers as the major producers of food in the country. Reduction of risks and uncertainties in agriculture to be achieved through the introduction of a more comprehensive agricultural insurance scheme to reduce the natural hazard factor militating against agricultural production and security of investment. Nationwide, unified and all-inclusive extension delivery systems under the Agricultural Development Programs (ADPs). Active promotions of agro-allied industry to strengthen the linkage effect of agriculture on the economy. Provision of such facilities and incentives as rural infrastructure, rural banking, primary health care, cottage industries etc., to encourage agricultural and rural development and attract youths (including school leavers) to go back to the land.

National food safety policy

Tijani (2006)dangers associated with their use and established regulatory incentive (if any asserted that a co-ordinated approach to food control could be achieved by establishing a national food safety policy that will amongst other things assign roles and responsibilities to all stakeholders and co-ordinate all food safety activities. This would reduce the lack of co-ordination and co-operation at national levels and conflict arising from the overlap of functions of the food regulatory bodies which results in ineffective control and inefficient performance. The National Policy on Food Safety is intended to assign roles and responsibilities and provide official guidelines on the minimum food safety practices which must be adhered to and also assure consumers about the safety of food and food products meant for human consumption in Nigeria. It is an integral part of the Nigerian National Health Policy. The National Food Safety Policy provides for the establishment of a National Committee on Food Safety which shall draw its membership from the public and private sectors relevant to the production, storage, processing/ preparation, distribution, transportation, and sale of food intended for consumption.

Development of IPM approach in Nigeria was initially introduced in cereal crops such as maize, rice, wheat, millet and other cash crops like cocoa, rubber, and leguminous crops (SP-IPM, 2008). Since 1960s the Nigerian Governments has developed IPM as a dominant principle of plant protection through biological, cultural, strategic and genetically based control in order to reduce or minimize the dependency on chemical control. The Commonwealth Agricultural Bureau International (CABI) in United Kingdom supported the IPM regional program in food and cash crops since 1993. A significant government investment in cereal crops in Nigeria was made through Green Revolution (1967-1973), Operation Feed the Nation (1976-1980); Go back to land (in 1980s); War against Indiscipline and Agricultural Development

Programs in the year 2001 by various government. Nigerian government has implemented number of IPM regional program in different phases. In the first phase, it emphasised on authentication of the IPM technology and its expansion with farmers. The second phase deals with human resource development and introduction of full-time farmers training program as in FADAMA. This approach has proven to be popular among Nigerian farmers. The third phase involves the institutionalization of IPM into government structures through agricultural development projects. In Nigeria, about 11 IPM centres are in operation for various tasks as monitoring of pests and diseases, production and release of bio-control agents and bio-pesticides, it also imparts training to agriculture/ horticulture extension officers and farmers alike at grass root level through organization of workshops, seminars on pests and diseases management in major cereal crops like rice, maize, sorghum, millet, wheat and cocoa, rubber etc. In all Nigeria states especially in Northern Nigeria where vast majority of farmers cultivate cereal crops as staple food. Also Nigerian government in various occasion provided grants to state government for ecological disaster.

Banned and restricted pesticides

Blacklisted under the Stockholm Convention on Persistent Organic Pollutants, or POPs, the chemicals' use and production must be restricted in 152 countries among which Nigeria is not excluded. Though, the United States has not ratified the treaty. HOPSKINS (2008) reported that NAFDAC has banned the sale and supply of 30 agrochemical products, according to the Nigeria-based Vanguard news service. NAFDAC Director-General, Dora Akunyili, said that the ban became necessary when it was discovered that the pesticides were causing food poisoning that had resulted in multiple deaths after consumers had eaten food crops with high levels chemicals, "We got report that many people in Bekwarra LGA of Cross River State suffered from food poisoning due to ingestion of moi-moi and beans. A total of 112 people were hospitalized and the deaths of two children were recorded," Akunyili said. The moi-moi and beans from the homes of the victims and from open markets in Taraba and Benue states in Nigeria were collected for laboratory analysis. The laboratory report revealed outrageously high levels of organophosphates, carbamates, fenithrothion, and chloropyrifos, that are highly toxic pesticides, she further asserted on the report that over 120 students of Government Girls Secondary School, Doma, Gombe were rushed to Gombe Specialist Hospital after consuming a meal of beans suspected to have been preserved with poisonous chemicals, she said. Samples were again taken to our laboratory and it was discovered that the foodstuffs contained outrageously high levels of Lindane, and organochlorinated pesticide commonly called Gammallin that affects the nervous system, producing a range of symptoms from nausea, vomiting, headaches, dizziness to seizure, convulsion, and death. (HLPSKINS, 2008).

However, Nigerian Government banned the production and importation of more than twenty pesticides because of their risks to both human and animal's health and also for their ecological menace. Some of the banned pesticides are Aldrin, binapacryl, Captafol, chlordane, chlordimeform, DDT, dieldrin, dinoseb, ethylene dichloride, heptachlor, Lindane, parathion, phosphamidon, monocroptophos, methamidophos, chlorobenzilate, toxaphene, endrin, merix Endosulfan, delta HCH, and ethylene oxide (INALEGWU, 2008).

Nigerian government and its efforts to eliminate persistent organic pesticides (POPS)

The concern of international community about the health risks associated with persistent pesticides have been great sought for mutual cooperation and action from all nations to reduce and or eliminate the production, use, and release of those persistent organic pesticides. However, about more than

six international legal bindings, instruments have been negotiated and concluded while Nigeria has signed and ratified three of them, as a result of this, the usage and production of pesticide increases the food production and supply for the nation and reduce pesticide risks to crops and consumers hence moving towards food security. The ratified conventions were as follows in Table 6.

Table 6. International Convention on POPs and Nigeria status.

International instrument	Parties	Rationale	Nigeria status	Ratified
Based Convention on trans boundary movement of hazardous waste and the subsequent 1995 Band Amendment (Basel ban)	163 nations	Import and Export of hazardous waste	Signed and ratified	1991-1992
Rotterdam Convention on the prior informed consent (pic) procedure for certain hazardous chemicals and pesticides in international trade and	United States, Along with 71 other countries	Import and Export of hazardous waste	Signed and ratified	2001-2004
Stockholm Convention on persistent organic pollutant.	149 countries	Production, use and disposal of persistent organic pollutants	Signed and ratified	1992-1994

Conclusions

Most of the review studies suggested that residue levels of pesticides in Nigeria soils, air, and water are usually high despite present low consumption rate, because most of the chemicals used before were banned by National Agency of Food and Drugs Control (NAFDAC). Furthermore, there is absolutely needed for urgent new policy development at Federal, State and Local Government levels by the legislators in order to curtail if not minimize the usage of these inorganic chemicals. However, correct dosage and appropriate spraying machines and tools would address and minimize wastage economically on the part of farmers. Farmers through adequate training, education programs can enhance their efficiency and effectiveness in handling and maintaining machineries and tools for pesticides application. The introduction of courses on persistent organic pesticides in school curriculum in Nigerian colleges, polytechnics and universities should be incorporated. Environmentally friendly approaches such as integrated pest management (IPM) should be adopted and encouraged to the farmers while information in regards to correct application of pesticides and the use of advance technologies as well as intensive training on selective application of recommended pests should be inculcated or disseminated to the farmers for effective and efficient practice. Plant health clinics should be established so as to offer guidance to farmers. Medical surveillance program for management practices and exposure to pesticides poisoning should be developed to enhance reduction of health risks from persistent organic pesticides in all 36 States of the Federation in Nigeria. Finally, policies should be developed by legislatures to back-up the new concepts above. Nigerian government should be responsible for training specialist in the field of occupational health and safety management and establish research centre's to carryout epidemiological and metabolic studies of the affected person's. Manufactures should develop less toxic or hazardous pesticides increase the awareness of pesticides usage and set up modalities to develop specific mechanism to obtain data from health centre and create basic national

exposure-assessment data of pesticides produced in order to know the nature of damage caused by such pesticide(s).

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References

ABHILASH, P. C.; SINGH, N. Pesticide use and application: an Indian scenario. *Journal of Hazardous Materials*, v. 165, n. 1-3, p. 1-12, 2009.

ADAMS, R. M. Occupational skin disease. Grune and Strattion. *Incorporation,* New York, v. 72, n. 6, p. 5-736, 1983.

ADEBOYEJO, O. A.; CLARKE, E. O.; Olarinmoye, M. O. Organochlorine pesticides residues in water, sediments, fin and shell-fish samples from Lagos Lagoon complex, Nigeria. *Researcher*, v. 3, n. 3, p. 38-45, 2011.

ADEYEMI, D.; ANYAKORA, C.; UKPO, G.; ADEDAYO, A. D. G. Evaluation of the levels of Organochlorine pesticide residues in Water samples of Lagos Lagoon using solid phase extraction method. *Journal of Environmental Chemistry and Ecotoxicology,* v. 3, n. 6, p. 160-166, 2011.

AFFUL, S.; ANIM, A.; SERFOR-ARMAH, Y. Spectrum of organochlorine pesticide residues in fish samples from the Densu Basin. *Research Journal of Environmental and Earth Sciences,* v. 2, n. 3. p. 133-138, 2010.

AKOTO, O.; ANDOH, H.; DARKO, G.; ESHUN, K.; OSEI-FOSU, P. Health risk assessment of pesticides residue in maize and cowpea from Ejura, Ghana. *Chemosphere*, v. 92, n. 1, p. 67-73, 2013.

ANGLEARN. Network for sustainable agriculture. New York: Organophosphate Aglearn-Net, 2001. p. 3-4.

ANZENE, J. S.; TYOHEMBA, R. L.; AHILE, U. J.; EMEZI, K. S. A. Organochlorine pesticide residues analysis of postharvest cereal grains in Nasarawa State, Nigeria. *International Journal of Agronomy and Agricultural Research (IJAAR),* v. 5, n. 5. p. 59-64, 2014.

ASOGWA, E. U.; DONGO, L. N. Problems associated with pesticide usage and application in Nigerian cocoa production: a review. *African Journal of Agricultural Research,* v. 4, n. 8, p. 675-683, 2009.

BAINOVA, A. *Dermal absorption of pesticides, toxicology of pesticides* (*Tech. Rep.).* Geneva: World Health Organization, 1982. p. 41-53.

BEMPAH, C. K.; DONKOR, A.; YEBOAH, P. O.; DUBEY, B.; OSEI-FOSU, P. A preliminary assessment of consumer's exposure to organochlorine pesticides in fruits and vegetables and the potential health risk in Accra Metropolis, Ghana. *Food Chemistry*, v. 128, n. 4, p. 1058-1065, 2011.

CHOPRA, A. K.; SHARMA, M. K. Bioaccumulation of Organochlorine pesticides in aquatic system-an overview. *Environmental Monitoring and Assessment*, v. 173, n. 1, p. 905-916, 2010.

COSTA, I. Current issue in organophosphate toxicity. *Clinica Chimica Acta*, v. 366, n. 1-2, p. 1-13, apr.2006,

DARKO, G. A. O. Dietary intake of Organophosphorus pesticide residues through vegetables from Kumasi, Ghana. *Food Chemical Toxicology*, v. 46, 12, p. 3703-3706, 2008.

DHOLE, V.; MADHULI, N. Analysis of organochlorine pesticide residues in water using GCMs. *Thermoflasher Scientific*, 2012. Available at: <http://tools.thermofisher.com/content/sfs/brochures/AN-10350-GC-OC-Pesticide%20Residues-TRACE-1110-AN10350-EN.pdf>. Access at: 27 apr. 2017.

ERHUNMWUNSE, N. O.; DIRISU, A.; OLOMUKORO, J. O. Implications of pesticide usage in Nigeria. *Tropical Freshwater Biology*, v. 21, n. 1, p. 15-25, 2012.

ETONIHU, A. C.; AMINU, B. A.; AMBO, A. I.; ETONIHU, K. I. Iodine content and pesticide residues of some Nigerian food grains. *Continental Journal of Agricultural Science,* v. 5, n. 1, p. 26-32, 2011.

EZEMONYE, L. I. N.; IKPETSU, T.; ILECHIE, I. Distribution of Diazinon in water, sediment and fish from Warri River, Niger Delta, Nigeria. *Jordan Journal of Biological Sciences*, v. 1, n. 2, p. 77-83, 2008.

EZEMONYE, L.; IKPETSU, T.; TONGO, I. Distribution of propoxurin in water, sediment and fish from Warri river, Niger Delta, Nigeria. *Turkish Journal of Biochemistry-Turk J Biochem*, v. 34, n. 3, p. 121-127, 2009.

EZEMONYE, L. I.; OGBEIDE, O. S.; TONGO, I.; ENUNEK, A. A.; OGBOMIDA, E. Pesticide contaminants in *Clarias gariepinus* and *Tilapia zilli* from three rivers in Edo State, Nigeria; implications for human exposure. *International Journal of food Contamination*, v. 1, n. 3, p. 1-8, 2015.

FATEMAH, K.; MOATTAR, F.; FARSHCHI, P.; SAVARI, A. ERA Suitable method for estimation of ecological effects of pesticide contamination on aquatic Species (marine science). *Journal of the Persian Gulf,* v. 3, n. 8, p. 67-73, 2012.

GWARY, O. M.; HATI, S. S.; DIMARI, G. A.; OGUGBUAJA, V. Pesticide residues in beans samples from Northeastern Nigeria. *ARPN Journal of Science and Technology*, v. 2, n. 2, p. 79-84, 2011.

HUNTER, W. M. In *Radioimmunoassay methods*. In: KIRKHAM, K. E.; HUNTER, W. M. (Ed.). *European workshop*. Churchill Livingstone, Edinburgh and London, 1971. p. 3-23.

HUSSAINI, A. M. Mycotoxin and food safety in developing countries. [S.l.: s.n.], 2013. 280 p.

IKEMEFUNA, P. N. Agrochemicals and the environment. *NOVARTIS Newsletter*, v. 4, n. 1, p. 2, 1998.

INALEGWU, S. *30 agrochemical products banned in Nigeria after deaths.* Vanguard Nigeria, may 2008. p. 1, 14

INCORPORATING INTEGRATED PEST MANAGEMENT INTO NATIONAL POLICIES – SP-IPM. IPM Research Brief No. 6. SP-IPM Secretariat, International Institute of Tropical Agriculture (IITA). Ibadan: IITA, Carolyn House, 26 Ding-wall Road, Croydon, CR9 3EE, UK, 2008.

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER – IARC. IARC monographs on the evaluation of carcinogenic risks to humans: alcohol drinking. Lyon: IARC, 1988. v. 44.

IZE-IYAMU, O. K.; ASIA, I. O. Concentrations of residues from organochlorine pesticide in water and fish from some rivers in Edo State. *International Journal of Physical Sciences,* v. 2, n. 9, p. 237-241, 2007.

KONRADSEN, F.; VAN DER HOEK, W.; COLE, D. C.; HUTCHINSON, G.; DAISLEY, H.; SINGH, S.; EDDLESTON, M. Reducing acute poisoning in developing countries-options for restricting the availability of pesticides. *Toxicology*, v. 192, n. 2-3, p. 249-261, 2003.

MALHAT, F. M.; HAGGAG, M. N.; LATFY, M. N.; OSMAN, M. A. M.; AHMED, M. T. Residue of organochlorine and synthetic pyrethroid pesticide in honey an indicator of ambient environment, a pilot study pesticide residue and environmental pollution department. *Central Agricultural Pesticide Laboratory, Agricultural Research*, Dokki, v. 20, n. 2015, p. 457-461, 2015.

MASIA, A.; IBANEZ, M.; BLASCO, C.; SANCHO, J. V.; PICO, Y. H. F. Combined use of liquid Chromatography quadrupole time-of-flight mass spectrometry in systemic screening of pesticides and other contaminants of water sample. *Analytica Chimica Acta*, v. 761, n. 2013, p. 117-127, 2013.

HOPKINS, M. Nigeria Bans 30 Pesticides after Deaths. Agribusiness global. Available at: <www. agribusinessglobal.com/tag/nigeria>. Accessed at: 25 apr. 2017.

OGAH, C. O.; COKER, H. B.; ADEPOJU-BELLO, A. Organophosphate and carbamates pesticide residues in Beans from Market in Lagos State, Nigeria. *Journal of Innovative Research in Engineering and Science.* v. 2, n. 1, p. 50-61, 2011.

OKENIYIA, S. O.; EGWIKHIDE, P. A.; AKPORHONORE, E. E.; OBAZEE, I. Distribuion of Organochlorine and polychlorinated pesticides residue in water bodies of some rivers in northern Nigeria. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, v. 8, n, 11, p. 1269-1289, 2009.

OKOYA, A. A.; OGUNFOWOKAN, A. O.; ASUBIOJO, O. I. *Organochlorine pesticide residues in sediments and waters from cocoa producing areas of Ondo state, South Western Nigeria*. International Scholarly Research Network (ISRN) and Soil Science, 2013. 12 p.

OSIBANJO, O. Organochlorines in Nigeria and Africa. *The Handbook of Environmental Chemistry*, v. 30, n. 12, p. 321-354, 2002.

SMITH, M. *Russian Federation food and agricultural import regulations and standards-Narrative*. FAIRS Country Report, 2009. p. s. 1-37.

SOARES, W.; ALMEIDA, R. M.; MORO, S. Rural work and risk factors associated with pesticide use in Minas Gerais, Brazil. *Cadernos de Saúde Pública*, v. 19, n. 4, p. 1117-27, 2003.

TIJANI, A. A. Pesticide use practices and safety issues: the case of cocoa farmers in Ondo State, Nigeria. *Journal of Human Ecology*, v. 19, n. 3, p. 183-190, 2006.

UPADHI, F.; WOKOMA, O. A. F. Examination of some pesticide residues in surface water, sediment and fish tissue of Elechi Creek, Niger Delta, *Nigeria. Research Journal of Environmental and Earth Science*, v. 4, n. 11, p. 939-944, 2012.

WORLD BANK, GHANA-WEST AFRICA AGRICULTURAL PRODUCTIVITY PROGRAM – WAAPP. Project Procurement Plan, *Washington DC: World Bank,* v. 1, p. 1-35, 2013.

WILLIAM, J.; TAGOE, L.; DRECHSEL, P.; KELDERMAN, P.; GIJZEN, H.; NYARKO, E. Accumulation of persistence organochlorine contaminants in milk and serum of farmers from Ghana. *Environmental Research*, v. 106, n. 1, p. 17-26, 2008.

WILLIAMS, B. A. Levels and distribution of Chlorinated pesticide residues in water and sediments of Tarkwa Bay, Lagos Lagoon. *Research Journal of Environmental Sciences. Toxicology,* v. 2, n. 1, p. 1-8, 2013.

WORLD HEALTH ORGANISATION – WHO. Gives indoor use of DDT a clean bill of health for controlling Malaria. Division of Environmental Health, WHO, 1211. Geneva: Media Centre, 2006.

WHO IRIS: public health impact of pesticides used in agriculture. WHO library cataloguing in publication data. Geneva: World Health Organization. 1990.