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Health Risk Associated With Environmental Exposure To Agrochemicals

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Abstract

Agrochemicals are broad range of chemical substances used in agriculture to enhance crop production, protect plants from pests and diseases, and improve soil fertility. They play a crucial role in modern agriculture by increasing crop yields and ensuring food security. Agrochemicals can be classified into fertilizer, pesticides, herbicide, fungicides (for controlling fungal diseases), and rodenticides. Despite the relevance of agrochemical in fostering agricultural production, the health risks associated with it's exposure tends to be enormous and dangerous if left unaddressed. This discourse is geared at exploring the route of exposure to agrochemicals with the aim of identifying health risks associated with such exposure as well as making recommendations to mitigating the associated risks. The study adopted a systematic literature review approach. It was found that all agro-chemicals have the potential to be harmful to humans, animals, other living organisms, and the environment if used incorrectly. Furthermore, it discovered that the prevalent environmental impacts of agro-chemicals exposures are due to inadequate knowledge and skills, poor regulations and poor

	health management systems. It was recommended among others that farmers when using agro-chemicals should always limit their exposure by wearing Personal Protection Equipment and use a low-toxicity agro-chemical when available and users of agro-chemicals should read the label and practicing safe work habits to minimize hazards from the use of agro-chemicals.

Introduction

Agriculture is one of the most important and prevalent types of employment in the world. Agriculture is the practice of cultivating plants and rearing animals for food, fiber, medicinal plants, and other products used to sustain and enhance human life. Agricultural development policies in many developing countries encourage the use of external inputs as means of increasing food production. This situation has led to increased use of agro-chemicals and hence a substitution for natural processes and resources (Ndayambaje *et al.,* 2019).

Agrochemicals, also known as agricultural chemicals or agrichemicals, refer to a broad range of chemical substances used in agriculture to enhance crop production, protect plants from pests and diseases, and improve soil fertility (Oduwaiye *et al*., 2015). They play a crucial role in modern agriculture by increasing crop yields and ensuring food security. Agrochemicals can be classified into fertilizer, pesticides, plant growth regulators and soil amendments. Fertilizers are substances added to the soil or plants to provide essential nutrients that are necessary for optimal plant growth and development. Fertilizers can be organic (derived from natural sources like compost or manure) or inorganic (synthetic chemicals). Pesticides are substances used to control or eliminate pests that can damage crops or transmit diseases. Pesticides include insecticides (for controlling insects), herbicides (for controlling weeds), fungicides (for controlling fungal diseases), and rodenticides (for controlling rodents). Plant growth regulators are chemicals used to modify the growth, development, or physiological processes of plants. They can be used to promote growth, enhance flowering or fruiting, delay senescence, or regulate plant height. Soil amendments are substances added to the soil to improve its physical properties, structure, fertility, or water-holding capacity. Soil amendments include lime, gypsum, organic matter (compost, manure), and biochar (Odunaiya, 2021).

While the use of agrochemicals has significantly increased agricultural productivity and efficiency, their utilization should be done judiciously and with proper consideration for environmental and human health. Agro-chemicals classified as being extremely or highly hazardous by FAO and WHO are used in developing countries causing 3.5 to 5 million acute poisonings a year (WHO, 2020). Excessive or improper use of agrochemicals can have adverse effects, such as soil degradation, water pollution, the development of pesticide resistance in pests, and negative impacts on non-target organisms like beneficial insects and pollinators.

Fenner *et al.* (2013) acknowledged that agro-chemicals can be destructive to agricultural land, waterways, biodiversity, and beneficial predators which can indirectly contribute to the deterioration of human health and productivity outcomes.

According to WHO (2020), developing countries use about twenty-five percent of the agro-chemicals in the world, and the use is in increasing trend. Some of the agro-chemicals used in farms include DDT, chlordane among others. This essentially dangerous technology is being promoted in a setting without technical and human resources to control it properly. Agrochemicals pose a further hazard for the residents of rural areas or surrounding communities for example air pollution, soil pollution when there is soil erosion from the farms and water contamination especially where water resources are shared with the communities.

Exposure to agro-chemicals is one of the most important occupational risks among farmers in developing countries. Farmers are exposed to agro-chemicals in a variety of ways. Farmers directly involved in the handling are at a high risk of exposure to pesticides through contact with pesticide residues on treated crops, unsafe handling, storage and disposal practices (Fucic *et al*., 2021). Poor maintenance of spraying equipment and the lack of protective equipment or failure to use it properly are another form of exposures. According to Oduwaiye *et al.* (2015), agro-chemical exposure can occur through four routes: Mouth, skin, inhalation into the lungs and the eyes. Inhalation exposure can occur while mixing granular and powder forms of pesticides, spraying of the solvent and during the burning of empty containers. Inhalation exposure provides the fastest route of exposure into the bloodstream (Desalu *et al*., 2014). Workers who perform hand labor tasks in treated areas risk exposure from direct spray, aerial drift, or contact with agro-chemical residues on the crop or soil. Workers who mix, load, or apply agro-chemicals can be exposed to agro-chemicals due to spills, splashes, and defective, missing or inadequate protective equipment.

According to Oduwaiye *et al.* (2015), exposure to toxic environmental chemicals and related health outcomes are inequitably distributed within and between countries; universally, the consequences of exposure are disproportionately borne by people with low incomes, discrimination, other social factors, economic factors, and occupation impact risk of exposure and harm. Agrochemical exposure can have minor to acute negative neurological, respiratory, immunologic, and reproductive effects, and the use of certain types of agro-chemicals is positively related to diagnoses of cancer (Story & Cox, 2001). Njoku *et al*., (2017) noted that extensive use of pesticides have led to an accumulation of a huge amount of residues in the environment, thereby causing a substantial environmental health hazard due to uptake and accumulation of these toxic compounds in the food chain and drinking water. Adesuyi *et al.* (2018) asserted that the risk of exposure is due to lack of knowledge regarding its safe use, proper pesticides handling and practices. Therefore, providing clarity to the health risks associated with the environmental exposure to agrochemicals becomes pertinent in devising protective measures to ensuring sustainable environmental and economic development.

Route of Agrochemical Exposure

People are not only directly exposed to agro-chemicals in occupational, agricultural, and household activities through different application methods, they are also indirectly exposed to agro-chemicals via contaminated environmental media, including air, water, soil, and food (Warembourg *et al.,* 2015). These different types of exposure determine the degree of toxicity of agro-chemicals. The main ways agro-chemicals come into contact with the human body are through the dermal, oral, and respiratory routes.

i. **Dermal exposure** is the most common and effective exposure route for individuals who are exposed to pesticides because of splashing, spillage, or spray drift of pesticides, especially when they use pesticides in agriculture or in household activities.

ii. **Oral Route:** The most common poisoning route is oral exposure, which causes severe health problems. Oral exposure to agro-chemicals can arise when people who produce or use agrochemicals do not wash their hands before eating or smoking and the general populace can be subjected to oral exposure when they consume food that is contaminated with pesticides.

iii. **Respiratory exposure** (via inhalation or breathing) occurs because of the volatile components of pesticides and it is dangerous to workers' health, especially their nose, throat, and lung tissues if they inhale large amounts of pesticides in the environment through air, water, and soil.

Health Risk Associated with Agrochemicals Exposure

Exposure to agrochemicals over an extended period can lead to chronic health effects, which may manifest gradually and persist over time. These effects can vary depending on the type of agrochemical, the level and duration of exposure, and individual susceptibility. Chronic health effects associated with agrochemical exposure may include:

i. Respiratory Risk

The use of agrochemicals can pose respiratory risks to individuals who are exposed to them. Agrochemicals are often applied in the form of sprays or dusts, which can release chemical vapors into the air. When these vapors are inhaled, they can irritate the respiratory system, leading to symptoms such as coughing, wheezing, shortness of breath, and chest tightness. Some agrochemicals, particularly those containing volatile organic compounds (VOCs), can also contribute to the formation of ground-level ozone, a pollutant that can exacerbate respiratory conditions. Certain agrochemicals, such as pesticides, can cause allergic reactions in susceptible individuals. These reactions can manifest as respiratory symptoms, including nasal congestion, sneezing, runny nose, and asthma-like symptoms. Prolonged or repeated exposure to agrochemicals can also lead to sensitization, where the immune system becomes hypersensitive to the chemicals, resulting in respiratory symptoms upon subsequent exposures. Adesuyi, *et al.* (2018) noted that agrochemicals can directly irritate the respiratory system, causing inflammation and irritation of the airways. This can lead to symptoms such as coughing, throat irritation, and difficulty breathing. Some agrochemicals, such as certain herbicides and fumigants, are known to have respiratory irritant properties.

ii. Reproductive Risk

Occupational and environmental contaminants have been linked, among other causes, to the loss in reproductive potential that has been observed around the world, but especially in the so-called infertile belt of sub-Saharan Africa (Fucic *et al.,* 2021). Agrochemicals include a wide range of substances such as pesticides, herbicides, insecticides, fungicides, and fertilizers. While these chemicals are designed to enhance crop production and protect against pests and diseases, they can have unintended consequences on reproductive health.

Male infertility is becoming more common, but the precise causes despite the fact that they are multifactorial are still unknown. Exposure to certain agrochemicals can adversely affect sperm quality in males, leading to decreased sperm count, motility, and morphology, which can contribute to infertility. Agrochemicals can disrupt the delicate balance of hormones in the body, leading to irregularities in the menstrual cycle, reduced fertility, and other reproductive health issues. Abdallah *et al.* (2017) opined that exposure to these chemicals can disrupt the reproductive system, leading to infertility, menstrual disorders, and reproductive organ abnormalities. Also, some agrochemicals, particularly certain pesticides, have been linked to an increased risk of birth defects in humans and animals.

Fucic *et al.* (2021) noted that some pesticides and their resulting metabolites can cross the placenta and can also impact development of the fetus; strong evidence links pre- and post-natal exposures to pesticides to congenital disorders, including physical and/or mental disabilities, fetal death and altered fetal growth. Perhaps the more widely known health effect of pesticides is the elevated rate of birth defects in areas in Vietnam sprayed with defoliant or Agent Orange, a 50:50 mixture of 2,4,5-T and 2,4-D, which has been associated with bad health and genetic effects in Malaya and Vietnam (Chen *et al.,* 2015).

iii. Gastrointestinal Risk

Gastrointestinal complications refer to a range of disorders and conditions that affect the digestive system, which includes the esophagus, stomach, intestines, liver, gallbladder, and pancreas. These complications can vary in severity and may arise from various causes, such as infections, inflammation, structural abnormalities, dietary factors, medication side effects, or underlying medical conditions. American Dietetic Association (2018) identified some common gastrointestinal complications to include: Gastroesophageal Reflux Disease (GERD), Inflammatory Bowel Disease (IBD), Irritable Bowel Syndrome (IBS), Irritable Bowel Syndrome (IBS), Gallstones, Pancreatitis, Gastrointestinal Bleeding and Gastrointestinal Infections. Gastroesophageal Reflux Disease (GERD) occurs when stomach acid flows back into the esophagus, leading to heartburn, chest pain, and regurgitation. Chronic GERD can cause inflammation, esophageal ulcers, and strictures. Stenson (2019) opined that peptic ulcers are open sores that develop on the lining of the stomach or the upper part of the small intestine. They can be caused by infection with Helicobacter pylori bacteria or prolonged use of nonsteroidal anti-inflammatory drugs (NSAIDs).

iv. Cardiovascular Risk

Cardiovascular infections refer to infections that affect the cardiovascular system, which includes the heart, blood vessels, and other components involved in the circulation of blood throughout the body. These infections can have various causes, including bacterial, viral, fungal, or parasitic agents. Though its clinical manifestation is often seen in adulthood, its risk factors develop during adolescence, hence the need for urgent intervention among this sub-population. World Health Organization (2020) outlined some cardiovascular infections to include:

a. Endocarditis: This is an infection of the inner lining of the heart chambers and heart valves. It is usually caused by bacteria, but can also be caused by fungi. Endocarditis typically occurs when bacteria enter the bloodstream and attach to damaged areas of the heart.
b. Myocarditis: Myocarditis is an inflammation of the heart muscle, often caused by viral infections such as enteroviruses, adenoviruses, or herpesviruses. It can lead to heart failure, abnormal heart rhythms, and other complications.
c. Pericarditis: Pericarditis is the inflammation of the pericardium, which is the sac-like membrane surrounding the heart. It can be caused by infections, such as viral or bacterial infections, or it can be non-infectious, resulting from autoimmune disorders or certain medications.
d. Infective endarteritis: This is an infection that affects the inner lining of blood vessels, particularly the arteries. Bacteria or fungi can enter the bloodstream and adhere to damaged areas of the arterial wall, leading to inflammation and the formation of blood clots.
e. Vascular infections: Infections can also affect the blood vessels directly, such as septic thrombophlebitis, which is the inflammation of a vein associated with a blood clot and infection. Additionally, certain parasitic infections, like schistosomiasis, can affect the blood vessels and cause cardiovascular complications.

Prolonged exposure to certain pesticides, such as organochlorines and organophosphates, has been associated with neurological disorders. These may include Parkinson's disease, cognitive impairments, and motor dysfunction. Chronic exposure to certain agrochemicals may weaken the immune system, making individuals more susceptible to infections and autoimmune diseases (Odunaiya, 2021).

Reasons for Prevalence of Health Risk Associated with Exposure to Agrochemicals

The serious health problems related to pesticide exposure in developing countries occur because of insufficiently qualified institutions governing and evaluating their production and sales. Moreover, developing countries lack strict laws and regulations that properly regulate pesticide exports and imports. Furthermore, some highly toxic pesticides banned in developed countries are still being used there in developing countries.

Intense usage by farmers, unsafe practices, and insufficient education about the use of pesticides are the main reasons for the general health problems in developing countries

(Akinola *et al.,* 2020). In addition, owing to large populations, farmers in developing countries are under increasing pressure to use pesticides to maintain their subsistence livelihoods. Furthermore, farmers in developing countries do not have enough opportunities for education and training, hence they do not fully understand the chemical toxicity and the methods for the safe application of chemicals used in agricultural and household activities to control pests and diseases. They also do not have enough power to control external forces, including market and trade liberalization and internal policies.

Another important reason for the general health problems in developing countries is that the public health systems of these nations do not have the capacity to adequately tackle pesticide-related health problems. This situation is made worse by many different types of pesticides in use that require different case management protocols (Akinola *et al.,* 2020).

1. **Environmental Impacts of Agrochemicals**

The use of agrochemicals in agriculture can have various environmental impacts, ranging from soil and water contamination to harm to non-target species. Agrochemicals, particularly pesticides and fertilizers, can accumulate in the soil, leading to contamination. This can affect soil health and microbial diversity. Furthermore, runoff from fields treated with agrochemicals can carry these substances into nearby water bodies, contributing to water pollution and impacting aquatic ecosystems. Excessive nutrient runoff, primarily from fertilizers, can lead to eutrophication in water bodies, disrupting aquatic ecosystems. The production and use of certain agrochemicals contribute to greenhouse gas emissions, affecting climate change.

Agrochemicals, especially pesticides, can harm non-target organisms, including beneficial insects and birds, leading to disruptions in local biodiversity. Sometimes, the overuse of pesticides can lead to the development of pesticide-resistant pests, necessitating increased pesticide applications (Bass, 2015). The application of agrochemicals in the form of sprays or dust can release volatile organic compounds (VOCs) into the air, contributing to air pollution (Koh, 2010). The expansion of agriculture, often accompanied by agrochemical use, can result in habitat destruction and deforestation. Agrochemicals, especially nitrates from fertilizers and certain pesticides, can leach into groundwater, affecting drinking water quality (Koh, 2010).

2. **Precautionary Measures against Risk Associated with Agrochemicals**

Exposure to agrochemicals can pose health and environmental risks. To mitigate these respiratory risks associated with agrochemical use, it is important to follow proper safety precautions and guidelines. This includes wearing appropriate protective clothing and respiratory protection, using agrochemicals in well-ventilated areas, following recommended application techniques and dosage, and seeking medical attention if any respiratory symptoms occur after exposure to agrochemicals (Oduwaiye *et al.* 2015). Additionally, implementing integrated pest management strategies, which emphasize non-chemical methods of pest control, can help reduce reliance on agrochemicals and minimize associated risks.

Damalas and Koutroubas (2016) outlined are some precautions individuals could take to minimize the risk associated with agrochemical exposure:

i. Read and follow instructions: Always carefully read and understand the instructions provided on agrochemical labels, including safety precautions, recommended dosage, and handling procedures. Follow them strictly to minimize the risks.
ii. Wear protective clothing: When handling agrochemicals, wear appropriate personal protective equipment (PPE) such as gloves, goggles, face masks, and coveralls to protect your skin, eyes, and respiratory system from direct contact or inhalation.
iii. Store safely: Store agrochemicals in a secure location away from children, animals, and food products. Follow the manufacturer's guidelines for proper storage conditions, such as temperature and humidity requirements. Ensure containers are tightly sealed to prevent leakage or spills.
iv. Mix and apply safely: Follow proper mixing and application techniques to minimize exposure. Avoid direct contact with the agrochemicals during mixing and use mechanical aids like measuring devices, funnels, and sprayers to reduce spills and splashes.
v. Choose the right equipment: Use appropriate application equipment such as sprayers or spreaders to ensure precise and controlled application. Calibrate and maintain equipment regularly to ensure accurate dosage and minimize drift.
vi. Be cautious during windy conditions: Avoid spraying or applying agrochemicals during windy conditions as it can cause drift and increase the risk of unintended exposure to nearby areas, water bodies, or individuals.
vii. Wash hands and clothing: After handling agrochemicals, wash your hands thoroughly with soap and water. Remove and wash contaminated clothing separately from other laundry items to prevent cross-contamination.
viii. Maintain good hygiene practices: Avoid eating, drinking, or smoking while handling agrochemicals. Wash fruits and vegetables thoroughly before consumption to remove any residual agrochemicals.
ix. Dispose of waste properly: Follow local regulations for the safe disposal of agrochemical containers, unused products, and rinse water. Do not dispose of them in regular trash or pour them down drains, sewers, or water bodies.
x. Educate and train: Provide proper training and education to farmers, workers, and anyone involved in agrochemical handling, emphasizing the importance of safety measures, risks associated with exposure, and appropriate emergency response procedures.

Mastewal *et al.* (2021) opined that it is essential to consult and adhere to local regulations, guidelines, and safety recommendations provided by agricultural authorities and relevant health agencies to ensure effective precautionary measures against agrochemical exposure. However, occupational risks associated with exposure to agrochemicals are not standalone; they often interact and influence each other. By managing these factors through lifestyle modifications, such as adopting a healthy diet, exercising regularly, avoiding smoking, maintaining a healthy weight, and controlling blood pressure and cholesterol levels, individuals

can significantly reduce their cardiovascular risk and improve overall heart health (WHO, 2021). Regular check-ups with healthcare professionals are essential for assessing and monitoring individual risk factors and developing personalized prevention strategies.

Conclusion/Matters Arising

All agro-chemicals have the potential to be harmful to humans, animals, other living organisms, and the environment if used incorrectly. When agro-chemicals are applied to target plants, applicators and communities are directly or indirectly exposed to agro-chemical through environmental contamination via oral, ingestion, and inhalation exposure routes, leading to acute toxic effects and chronic diseases. Prevalent environmental impact of agro-chemicals exposures is due to inadequate knowledge and skills, poor regulations and poor health management systems. Health risk associated with exposure to agrochemicals cannot be overemphasized thus, corporate effort must be geared towards mitigating these impacts.

Health risks associated with agrochemical exposure has several implications and has raised pertinent concerns of stakeholders in area of health, agriculture and policy making. Tackling the outlined health risk would require effective collaboration to provide educational, health and support for protection for sustainable agricultural production and environmental protection.

Recommendations

On the basis of the outcome of this discourse the following are recommended;

1. Farmers when using agro-chemicals should always limit their exposure by wearing Personal Protection Equipment and use a low-toxicity agro-chemical when available.
2. Users of agro-chemicals should read the label and practicing safe work habits to minimize hazards from the use of agro-chemicals.
3. Policy makers should formulate health policies to regulate the use of highly toxic agro-chemicals among populace to avoid contaminating and reducing environment health.
4. Government at all level should invest in health care system development to improve the quality of healthcare services to patients exposed to toxic agro-chemicals.
5. Ministry of Health in collaboration with Ministry of Agriculture should organize regular training, conferences and workshop to enhance the knowledge and competencies in agro-chemical handling and usage.

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