Scientific Research Communications

Review Article

Sci. Res. Comm. (2023)
Volume 3, Issue 2
doi: 10.52460/src.2023.009

An Overview of Impact of Agrochemicals on Human Health and Natural Environment

Mohamed Said*

Department of Field Crops, Erciyes University, Kayseri, Türkiye
* Corresponding author: amohamaduu@gmail.com

Received: 25.05.2023 Accepted: 03.08.2023

Abstract

Agrochemicals exposure periods and levels, types of agrochemicals used and various environmental condition of the areas are factors for acute and chronic poisoning on human health and environment. Although agrochemicals are the result of modern technology that depends on inorganic fertilizers and pesticides, their continuous use against agricultural pest and disease vectors poses serious threats upon both human health and environment. Overuse of these chemicals have severe effects on human and environment that may lead to immediate and long-term effects. In developing countries, it is very difficult to find out the impact on the environment due to lack of awareness, training, and adequate knowledge for using agrochemicals. Investigating farmer's awareness of agrochemicals residues and their behaviors regarding application is important in order to reduce human factors that negatively affect environmental safety. This review focuses on a summary of both national and international studies regarding the impact of pesticide and chemical fertilizer residues on nature, both human and environment. The review has revealed the hazardous effects like cancer, neural disorders, and other health related problems and environmental risks associated with agrochemicals exposure.

Keywords: Agrochemicals, human health, environmental impact

1. Introduction

Despite being an expensive input, agrochemicals (pesticides and fertilizers) are viewed as a means of advancing crop production technology. Increased crop production is ensured by balanced use, optimum doses, proper technique, and appropriate timing of pesticide applications. The requirement for fertilizers and pesticides for crops differ according to soil and meteorology (Bhandari, 2014). The developing world makes extensive use of agrochemicals, and the need for pesticides is rising as a result of the current crop production system, which places a premium on high agricultural yields. Pesticides, which are composed of chemicals that can control pests or influence plant growth, have given poor nations one method to raise yields. Many farmers in underdeveloped nations believe that using pesticides is the best way to safeguard their crops against pests, which tend to pose their biggest threat and this year have spread to portions of Africa. As such, pesticides can provide the only form of crop insurance available (Sarkar et al., 2021). Pesticides are substances, tools, or organisms that have been chemically synthesized and are frequently used in agriculture to control,

eliminate, combat, or repel pests, diseases, and parasites. Based on their chemical makeup, pesticides—which contain both organic and inorganic moieties—can be divided into many classes. These pesticides include organochlorines, organophosphates, carbamates, formamidines, thiocyanates, organotin, dinitrophenols, synthetic pyrethroids and antibiotics (Bohmont, 1990). Due to the fact that farmers frequently lack proper personal protective equipment (PPE) and frequently lack the ability to read labels, which are typically the primary source of safety instructions, health risks related to the handling and use of pesticides are more prevalent in developing nations. On these subjects, farmers rarely have access to in-person training. When residential areas are close by, pesticide use issues may go beyond the farming region. Children are especially vulnerable to the dangers of pesticides due to their use and storage in homes. Statistics reveal that a sizable number of suicides occur each year as a result of pesticides. According to the Network of African Science Academies, 2019 the market for neonicotinoid insecticides is expanding at the quickest rate. These pesticides have a lower human toxicity than earlier classes of pesticide, but still pose problems for pollinators and aquatic organisms and are partially banned in the EU. Over the longer term, neonicotinoid use could have serious implications for biodiversity and the environment (Sarkar et al., 2021).

No segment of the population of developing countries like Bangladesh is completely protected against exposure to agrochemicals (pesticides) and the potentially serious health effects. Despite their popularity and extensive use, there is serious concern about health risks arising from the exposure of farmers when mixing and applying pesticides or working in treated fields (Biswas et al., 2014). Although the effects of pesticide use are frequently not noticed, there is evidence that farmers, their families, and those who live close to farmed areas may face long-term health problems (Larsen et al., 2017). In developing countries, incidents involving handlers of pesticides occur more often and the health impacts may be more immediate, given a frequent lack of PPE and minimal education about the correct way to spray chemicals. Approximately 20% of the 800,000 persons who commit suicide each year die from pesticide ingestion. The negative health effects associated with pesticide use include respiratory, integumentary, cardiovascular, gastrointestinal, and neurological problems. In Morocco, there were over 2000 different causes of acute pesticide poisoning between 2008 and 2014; 50 % of the pesticides involved were classes I (extremely or highly hazardous) and II (moderately hazardous) according to WHO classifications (World Health Organization, 2021). Cancer is one of the longer-term impacts that is hardest to precisely link to pesticide use. Consuming food that has residues beyond legal limits can have negative effects on one's health (Joko et al., 2020). However, in West Africa, episodic studies by local scholars, students, donor projects and public health agencies allow three cautious generalizations. First, dichlorodiphenyltrichloroethane (DDT, a type of pesticide) residues from spraying programs can linger for decades in the food chain, with milk, meat, fish, and even human breast milk affected. It is difficult to emphasize the harm that pesticides cause to children. Pesticides stored inside homes are also common causes of childhood poisoning (Sarkar et al., 2021). The extension initiatives, particularly the plant protection department, have vanished in Somalia. This situation led lack of awareness of the proper use of pesticide, lack of plant quarantine and pesticide regulations and this encouraged import of international banned synthetic chemicals to Somalia, for example DDT, Aldrin, Aldicarb, and Nicotine sulphate which have high risk of poisoning. Organophosphorus, carbamates, and organochlorines can act as endocrine disruptors and alter hormone function in addition to their primary function as pesticides by blocking, mimicking, replacing, or acting to subvert the roles that hormones naturally play in living species. In this survey (Sarkar et al., 2021), it is observed that the majority of farm workers apply pesticides without protective gear, use empty containers of pesticides as utensils, agro-dealers sell pesticide products together with food items in same places, also ignore of considering the right dose, time and direction of the wind. If this situation continues

for some decades, it may cause chronic diseases to humans, environment, animals, and agroecosystem areas degradation at large (Dayib, 2019).

The aim of this study is to discuss the multifaceted relationship between the use of agrochemicals (pesticides and fertilizers) in agriculture and its effects on crop production, human health, the environment, and ecosystems. The text highlights the potential benefits and risks associated with agrochemicals, addressing various dimensions such as agricultural productivity, pesticide usage, health implications, environmental impact, regulatory frameworks, and potential alternative solutions. It emphasizes the need for responsible and informed practices in agrochemical use, considering factors like proper application techniques, risk assessment, regulatory compliance, and the exploration of more sustainable approaches to ensure a balance between agricultural advancement and the protection of human health and the environment.

2. Human Health Hazard

The links between agrochemicals and human health were suspected as early as the 1960s and 1970s. In locations with significant pesticide use, US epidemiologists noticed an extraordinary increase in Non-Hodgkin's Lymphoma cases (Gupta, 2012). Agrochemicals have an impact on more than just the environment and nonhuman biota. Humans can be exposed to agrochemicals directly by unintentional, deliberate, or occupational reasons as well as indirectly through residues in food and the environment. Infant and kid exposure to harmful pesticides is a serious problem, especially in crowded urban tenements and slums. Several more recent studies and reviews bring to light some critical health implications of agrochemical exposure. These can be classified as acute and chronic illnesses.

2.1. Acute Illness

The typical symptoms of acute pesticide poisoning in humans are fatigue, headaches and body aches, skin discomfort, skin rashes, poor concentration, feelings of weakness, circulatory problems, dizziness, nausea, vomiting, excessive sweating, impaired vision, tremors, panic attacks, cramps, etc., and in severe cases coma and death (Bödeker & Dümmler, 1993). Diagnosis of acute pesticide poisoning generally occurs when one or more of these symptoms, which appear in a short time after contact with pesticides, are detected. 16% of respondents cited eye discomfort, 21% headaches, 6% dizziness, 5% skin irritation, and 7% vomiting after handling pesticides as the survey's most noticeable health issues. The interviews further revealed that 30% of the respondents experienced multiple health effects, with the duration of ailment also being quite significant. Traders indicated an average duration of 7 hours in terms of eye irritation, 13 hours for headaches and 21 hours for dizziness (Dasgupta et al., 2005).

2.2. Chronic Illness

Besides causing acute poisoning, pesticides can also cause chronic illnesses if they are incorporated over a longer period, even though the amounts taken up are relatively small. The workers in agrochemical production centers, as well as across other stages of the supply chain, retailers, and pesticide applicators are directly exposed. People who live near agricultural fields or are present there are also affected. There are cases of inadvertent consumption (homicides), as well as the planned consumption of chemicals as a method of suicide. Several studies show multiple health problems due to exposure, such as birth defects, cancer, and neurological disorders. However, a person's health situation and mitigating behaviors will decide how much of an impact this has on them. Bioconcentration is the process in which the accumulation of the chemical in an organism occurs from the surrounding air or water. For

instance, DDT, for example, is fat-soluble and accumulates in fish or human fatty tissue (lipids). Other chemicals, such as glyphosate, are digested and eliminated from the body.

A recent report by the UN Environment Program observes a significant association between occupational and residential exposure to pesticides and adverse health outcomes, including cancers and neurological, immunological, and reproductive effects. Based on clinical research conducted in laboratories, an extensive account of the physiochemical, toxicokinetic, and toxicodynamic features, stages of intoxication, symptoms of poisoning, and treatments relating to commonly used pesticides has been gathered (United Nations Health Program, 2022). Health damage due to pesticide poisoning has been a public health issue ever since the beginning of the widespread use of chemical pesticides in agriculture. Mortality or morbidity (acute or chronic) are consequences.

The Task Force of WHO published the first global assessment on human pesticide poisoning in 1990, which estimated one million cases and a fatality rate of 20,000 per year (Boedeker et al., 2020). Due to its widespread availability, intentional pesticide poisoning as a method of suicide is fairly popular, especially in developing nations. Globally, 110,000–168,000 suicides were reported by this method annually over the 2010–2014 period, which accounts for 14–20% of total suicides.

Under real-world circumstances, exposure from many sources, such as air, water, food, and beverages, is highly frequent. The consumption of agricultural foods and animal products exposes people to a variety of chemical residues. In human systems, this chemical cocktail may have additive effects and be more dangerous than a single molecule. Renal damage is consistent with chronic kidney disease incidence in Sri Lanka and was reported to be linked to the synergistic effects of exposure to glyphosate with other pollutants like paraquat, under stressful physical labor conditions, such as high temperatures in lowland tropical regions (Devi et al., 2022).

3. Impact of Agrochemicals on Environments

3.1. Adverse Effects on Non-Target Animals, Microbial Community, and Non-Target Plants

The bird and other small wild animals are in threat because of the use of pesticides (Biswas et al., 2014). According to the farmers, the most significant environmental effects of pesticides usage were, decline in abundance of pollinating bees (40%) and butterflies (18%), the disappearance of the red-billed oxpecker (20%), and other non-target insects dying (12%) when or after spraying and wildlife mortalities (10%). The birds disappeared when the government subsidized a common facility for livestock in the 1980s. Since then, the birds have only been observed in forest areas. Only 3% of the farmers had seen signs of poisoned birds so the alternative that the birds moved to another habitat for other reasons, such as the lack of ticks and insect parasites on the animals cannot be excluded. The populations of helpful soil microorganisms can decrease when soil is heavily treated with pesticides and other agrochemicals. Overuse of chemical fertilizers and pesticides has effects on the soil organisms that are similar to overuse of antibiotics in humans. Indiscriminate use of chemicals might work for a few years, but after a while, there are not enough beneficial soil organisms to hold on to the nutrients (Biswas et al., 2014).

Weeds are intended to be killed by herbicides. So, it is not surprising that they can injure or kill desirable species if they are applied directly to them. In addition to killing non-target plants outright, Pesticide exposure can kill non-target plants directly in addition to having

sublethal effects on them. Phenoxy herbicides, including 2,4-D, can injure nearby trees and shrubs if they drift onto leaves (Dreistadt, 2016).

Contrary to causing damage, many insects are highly beneficial and serve useful purposes. Bees produce honey and are also important for the pollination of various crops, contributing to a good yield. It may also happen that an insect which at first caused no trouble in the crop becomes a pest after spraying because its natural enemy was removed, even though this was not the intention. This is one more reason for not spraying more frequently than necessary. One could also enquire into alternative control methods, such as those mentioned in the introduction, or consider using pesticides which are selective in their action. If the active ingredient of a pesticide only slowly departs from the environment, it is considered persistent. Persistent compounds can accumulate in the environment, in the soil or the food chain. Eventually, however, they also accumulate in meat, fish, or milk. In this way humans also become exposed to the pesticide. A prime example of a persistent pesticide is DDT. Another effect of excessive spraying is that the harmful organism becomes tolerant (less sensitive) to the pesticide used. More and more pesticide must then be used to obtain the same degree of control, with all the harmful consequences involved for humans and the environment. Moreover, the resistance of the harmful organism simply increases so that it becomes necessary to use a different pesticide to which the pest is not yet resistant (Boland et al., 2004).

Threatened plant species are particularly at risk from this. When soil microbes and beneficial insects are destroyed as a result of pesticide treatment, plants might also experience indirect effects. Herbicide contamination of water could also have devastating effects on aquatic plants. Oxadiazon was reported to significantly lower algal growth in one research (EPA, 1996).

3.2. Water Contamination

Agriculture development is closely related to the use of pesticides. The use of pesticides has helped in preventing the losses caused by pest attacks and has improved the production potential of crops, but these excess quantities are leaching down to groundwater and causing pollution (Khanna & Gupta, 2018). Although the agricultural soil is the primary recipient of agrochemicals, water bodies that are adjacent to agricultural areas are usually the ultimate recipient of agrochemicals residues. There is a suspicion that agrochemical residues are common in surface water systems, especially in irrigation drains, which ultimately pollute the pond and river water, and can harm the aquatic environment (Biswas et al., 2014). On farms, agrochemicals are used to either increase soil fertility, eradicate weeds, or combat pests and diseases—actions designed to boost agricultural output and meet human demand for food. Gravity causes water that falls on the earth's surface to continue to seep in until a saturation zone is achieved. Thus, the relative rate of percolation and degradation within the soil profile, which processes are regulated by climate, soil characteristics, chemical characteristics, application rate, aquifer depth, and farming practices, determines the risk of contamination. Due to the higher capacity of sand for infiltration than clay, agrochemical use on sandy soil has a higher potential to leach to groundwater. If the parent compound's degradation rate is greater than its rate of percolation through the soil profile, groundwater contamination is also less likely to happen. Adsorption describes how firmly a particular agrochemical sticks to the soil while traveling down with water. The length of time a chemical remains in its original form in the soil is known as persistence. Groundwater vulnerability or susceptibility, which is independent of the kind of pollution, is the result of the contributions of these variables. In regions with high rainfall, agrochemicals like nitrogen-based fertilizers and herbicides left unused by plants may leak to contaminate groundwater. After the chemicals have been utilized, this contamination may not occur for several days or even months. Some common compounds that are mobile and difficult to attenuate in the subsoil make up the most prevalent

pollutant. The use of agrochemicals such as fertilizers and pesticides constitute an important aspect of modern agriculture as they are needed to control various pests and improve soil fertility. The benefits are increased supplies of food, but problems arise when significant amounts of agrochemicals accumulate as residue in soils and percolate into groundwater. (Adeoye et al., 2013)

4. Conclusions

Global production, consumption, and export of chemical pesticides often follow unscientific practices, augmented by aggressive marketing. As a result, even substances that are prohibited in one nation may be exported to another. Additionally, the importing nations, which are mainly developing nations, have either lax rules or little enforcement of existing regulations. This is made worse by technical developments that call for greater use of these chemicals, such as the ability to tolerate herbicides through genetic engineering. Agrochemicals on the other hand are considered a quick, easy, and inexpensive solution for controlling weeds and insect pests and increasing yield in agricultural landscapes. However, the use of pesticides comes at a significant cost. Almost every aspect of our environment has been poisoned by pesticides. The long-term effect of low-level exposure to one agrochemical is highly influenced by concomitant exposure to other agrochemicals. Most of the farmers are not capable of taking decisions on pest management and pesticide application. Often, they apply pesticides when there is no real need, or they use the wrong chemicals at the wrong doses, methods, and times. As a result, they kill the beneficial organisms easily and create pest resistance causing greater problems and crop losses.

Pesticides should be strictly handled according to the regulations which contribute to reduction of the adverse effects of pesticides on human health and environment. However, existing regulatory and management protocols are based on assessment frameworks that suffer from methodological drawbacks. As a result, the usage of agrochemicals judged safe by these frameworks has steadily increased worldwide. The impact of pesticide mixtures and synergistic long-term ecological repercussions are not taken into account by the present assessment frameworks. The assessment frequently fails to take into account the interconnectedness of the sinks and the complex nature of the agrochemicals' environmental impact. This leads to the legal usage of various agrochemicals that have the potential to have long-term negative effects on the environment and human health. For green environment and reducing chronic effect biological solution can play effective role. Biofertilizer is a super alternative to chemical fertilizers. Biopesticide also becomes an alternative solution for pest control. IPM and using several natural products and biological agents also give us hope to minimize the adverse effect of agrochemicals.

With the aim of offering explicit and definitive guidance, designed to provide clear and actionable recommendations:

- Global production, consumption, and export of chemical pesticides often involve unscientific practices and aggressive marketing, leading to cross-border export of prohibited substances and lax enforcement of regulations in importing developing nations.
- Technical advancements, like genetic engineering for herbicide tolerance, exacerbate the reliance on agrochemicals, which are seen as quick and inexpensive solutions for boosting agricultural yield.

- However, pesticide use has significant environmental costs, polluting various aspects of the environment and causing long-term impacts due to interactions between different agrochemicals.
- Farmers often lack the expertise to make informed decisions on pest management and pesticide application, leading to misuse and resistance development in pests.
- Strict adherence to regulations is vital to mitigate the adverse effects of pesticides on human health and the environment, but existing assessment frameworks have methodological limitations, resulting in the continued use of supposedly safe agrochemicals.
- The complexity of agrochemical interactions and environmental impact is often not adequately considered in assessments, leading to the legal use of potentially harmful chemicals.
- Biological solutions, such as biofertilizers, biopesticides, integrated pest management (IPM), and natural products, offer promising ways to reduce the negative effects of agrochemicals and promote a greener environment.

Author Statement

The author confirms sole responsibility for the whole paper.

Conflict of Interest

The author declares no conflict of interest.

References

Adeoye, P. A., Kazaure, A. S., & Adeolu, A. R. (2013). Effect of Agrochemicals on Groundwater Quality: A Review. *Scientia Agriculturae, 1*(1), 1-7.

Bhandari, G. (2014). An Overview of Agrochemicals and Their Effects on Environment in Nepal. *Applied Ecology and Environmental Sciences, 2*(2), 66–73.

Boedeker, W., Watss, M., Clausing, P., & Marquea, E. (2020). The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. BMC Public Health, 20:1875, 19 pp.

Bohmont, B. L. (1990). *The Standard Pesticide User's Guide*. Upper Saddle River (NJ): Prentice Hall.

Boland, J., Koomen, I., de Jeude, J. vL. & Oudejans, J. (2004). *Pesticides: Compounds, Use and Hazards*. Wageningen: Agromisa Foundation.

Bödeker, W., & Dümmler, C. (1993). *Pestizide und Gesundheit : Vorkommen, Bedeutung und Prävention von Pestizidvergiftungen*. Karlsruhe: Müller.

Dasgupta, S., Meisner, C., & Mamingi, N. (2005). Pesticide Traders' Perception of Health Risks: Evidence from Bangladesh. *Policy Research Working Paper*; No. 3777. Washington, DC World Bank Publications.

Dayib Abubakar, M. (2019). *Effect of Pesticides on the Agro Ecosystem in Somalia*. Report number: 2. Mogadishu: Somali Natural Resources Research Center.

Devi, P. I., Manjula, M., & Bhavani, R. V. (2022). Agrochemicals, Environment, and Human Health. *Annual Review of Environment and Resources, 47*, 399-421.

Dreistadt. S.H. (2016). *Pests of Landscape Trees and Shrubs, Third Edition: An Integrated Pest Management Guide*. University of California Division of Agriculture and Natural Resources: UCANR Publications.

EPA, Environmental Protection Agency (1996). Reregistration Eligibility Decision (RED): Trifluralin. Office of Prevention, Pesticides, and Toxic Substances.

Gupta, A. (2012). Pesticide Use in South and South-East Asia: Environmental Public Health and Legal Concerns. *American Journal of Environmental Sciences, 8*(2), 152-157.

Joko, T., Dewanti, N.A.Y., & Dangiran, H. L. (2020). Pesticide Poisoning and the Use of Personal Protective Equipment (PPE) in Indonesian Farmers. Journal of Environmental and Public Health, Vol. 2020, Article ID 5379619.

Khanna, R., & Gupta, S. (2018). Agrochemicals as a Potential Cause of Ground Water Pollution: A Review. *International Journal of Chemical Studies, 6*(3), 985-990.

Biswas, S. K. Rahman, S., Kobir, S. M. A., Ferdous, T., & Banu, N. A. (2014). A Review on Impact of Agrochemicals on Human Health and Environment: Bangladesh Perspective. *Plant Environment Development, 3*(2), 31-35.

Larsen, A. E., Gaines, S. D., & Deschenes, O. (2017). Agricultural Pesticide Use and Adverse Birth Outcomes in the San Joaquin Valley of California. Nature Communications, 8:302, 1-9.

Sarkar, S., Dias Bernardes Gil, J., Keeley, J., Möhring, N., & Jansen, K. (2021). The Use of Pesticides in Developing Countries and Their Impact on Health and the Right to Food. Policy Department for External Relations. Belgium.

United Nations Health Program. (2022). *Environmental and health impacts of pesticides and fertilizers and ways of minimizing them*. Summary for Policymakers, Envisioning a Chemical-Safe World.

World Health Organization. (2021). *Suicide Worldwide in 2019*, Global Health Estimates.