

Review Article: Impacts of Pesticides on Human Health and Environment: Need for a New Concept in Agriculture

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Abstract: *Increasing demand of food has increased the chemical burden on natural ecosystem. A pesticide is a chemical product used in agriculture to protect crops from pests, weeds and to enhance crop yields. However, these pesticides causes large number of negative health and environmental effects. Now a days their side effects have become an important environmental risk factor. The sustainability of agriculture cropping system is a basic question on which the future of humanity is relying. Several indicators tend to suggest that the current system of agriculture production is reaching its limit and become unsustainable. The urgent need for more sustainable agriculture practice has produced many innovative ideas. This review paper emphasised on how the agricultural reforms and food production implementing sustainable practices will evolve to food sovereignty.*

Keywords: Ecosystem, Pesticides, Agriculture, Sustainable Agriculture

I. INTRODUCTION

A pesticide is a chemical product used in agriculture, to protect crops from pests, weeds and enhance crop yields. Insecticides, fungicides, herbicides, rodenticides, and plant growth regulators are some examples of such chemical products. These products are used in agriculture for preventing, destroying and controlling pests, weeds and diseases. They protect humans from vector borne diseases. Apart from agricultural uses they are also employed for the maintenance of non-agricultural areas like public gardens and sport fields. [1] These chemicals have long been used in agriculture for controlling pests and improving crop yield. About 4,500 years ago Sumerians had employed sulphur compounds to control insects. [4] For more than 2000 Pyrethrum has been applied as an insecticide. For controlling weeds salts or sea water has been used. Until 1940 many inorganic substances and organic compounds were employed in pest control. [3]

In the recent past, increasing demand of food grains and decreasing farmland have increased the pressure on farm yield improvement. [2] Because of this the use of pesticides in agriculture have tremendously increased. But many pesticides have adverse effects on human health and environment. [1] Use of some certain pesticides in agriculture has been banned due to their hazardous effects. Some pesticides can cause harmful impact even when come in contact with skin. [6] The possible health outcome depends on factors like the type of pesticide, the duration and route of exposure, and the individual health status. [9] When the pesticides are ingested or inhaled by a human or animal body, they may be metabolized, stored, or excreted. In some cases they are bioaccumulated in body fat. [10] The pesticides have many negative health effects, some of them are dermatological, neurological, respiratory, gastrointestinal, carcinogenic, reproductive and endocrine effects. In many cases continuous or accidental exposure to these chemical pesticides can cause hospitalization and sometime it even results in death. [15]

Coming to the environmental impacts, many chemicals present in the pesticides are environmentally stable and hence they prone to bioaccumulation. Such toxic chemicals remain in the environment for hundreds of years. They can cause permanent farmland infertility. They also contaminate their surrounding environment like air and water resources. [5] Residues of pesticides have been founded in a great variety of routine foods and beverages. For instance, these harmful substances can be found in cooked meals, water, fruit juices, wine, animal feed and refreshments. [14]

This current review aims at focusing on the urgent need for a new concept in agriculture which involves an abundant reduction in the use of chemical pesticides. Given the fact that human health issues and environmental issues have been extensively discussed in the current literature, this review paper focuses on health and environmental effects that have

been associated with exposure to harmful chemical pesticides. More emphasis is given to the widely used herbicide “glyphosate” and on bio based plant protection product “Stifenia”. The underestimated negative health impacts of such products reveal the urgent need for their proper risk assessment.

II. METHODOLOGY

2.1 Search Criteria

To carry out this study required review of literature materials and documents available from online publications. These materials were obtained from the internet through Google, Google Scholar, ResearchGate, Frontiers and ScienceDirect. The following criteria were used to search for the studies that were used in this paper. Studies that were selected were those that have addressed toxicity of pesticides, effect of pesticides on human health and environment, the need of sustainable practices in agriculture. Also chosen were studies that have emphasized on the underestimated toxic effects of widely used herbicide "Glyphosate" and plant protection product "Stifenia".

A. Terms used in the Search

The terms used in the search were 'Pesticides', 'Pesticides toxicity', 'Impact of pesticides on human health', 'Impact of pesticides on environment', 'Glyphosate toxicity', 'negative impacts of herbicides', 'Inflammatory effect of Stifenia', 'Pesticide Pollution', 'Sustainability in agriculture', 'New concept in agriculture', 'Commercial pesticides', 'Pesticides Exposure', 'Pesticides effect on non-target organisms'.

2.2 Screened Publications

The total number of publications screened was seventeen. Among the studies identified four publications reported on the toxic effect of pesticides on human health and environment. Nine publications focused on how some pesticides adversely affect the human as well as environmental health. Two publications reported on water pollution effect of pesticides. Two publications reported on the need of sustainable practices in agriculture.

III. LITERATURES REVIEW

Robin Mesnage and Gilles-Eric in 2018 conducted a research on toxicity of pesticides on health and environment. The study was done from multi-disciplinary point of view. The study revealed that toxicity of pesticides is underestimated. For instance, pesticides are always commercialized as mixtures of different ingredients but only one declared of these ingredients is tested for human health effects. Ingredients such as surfactants are poorly tested although they can be the most toxic ingredients in a pesticide formulation. The research confirms that new ways to evaluate effects of pesticides on human health and environment are urgently needed.

In 2017, Leny Teyssier, Julie Colussi, Stephanie Delemasure, Johanna Chluba, David Wendehenne, Olivier Lamotte and Jean-Louis Connat conducted research on effects of the plant protection product Stifenia on vertebrates. Stifenia is a plant protection product composed of crushed fenugreek seeds. It is thought to be a safer alternative to classical plant protection products. But the study revealed unexpected effects of Stifenia on human and animal health. In case of humans it have very harmful effect on peripheral blood mononuclear cells. This leads to a conclusion that although bio-based pesticides are natural in origin but their impact on human health and environment need to be carefully studied.

Polyxeni Nicolopoulou-Stamati, Sotirios Maipas, Chrysanthi Kotampasi, Panagiotis Stamatis and Luc Hens in 2016 conducted a review on effects of pesticides on human health. The study emphasized on the need of new concept in agriculture. The study focuses on harmful effects of organochlorines, organophosphorus and carbamates pesticides on human health. The study revealed that Current agricultural practices include the wide production and extensive use of chemicals known for their ability to cause negative health effects in humans and wildlife and to degrade the natural environment. Therefore, an urgent strategic approach is needed for a reduction in the use of agrochemicals and for the implementation of sustainable practices. This leads to a conclusion that alternative procedures to the current model of food production should be implemented in new agricultural policies targeting sustainable development and protection of the consumers' health.

In 2010, Anju Agrawal, Ravi S. Pandey, Bechan Sharma conducted a review on the impacts of pesticides contamination in water bodies and drinking water. The study revealed that although use of pesticides have enhanced the crop yield and

reduced the vector borne diseases but their unregulated and indiscriminate application have raised serious concerns about the environment. Further, the study shows that even at low concentrations, the pesticides present in environment may exert several adverse effects. Pesticide contamination causes great harm to the environment and non target organisms like beneficial soil microorganisms, insects, plants, fish, and birds. The study leads to a conclusion that best way to avoid pesticide contamination is to use safer, non chemical pest control methods.

In 2015, Isra Mahmood, Sameen Ruqia Imadi, Kanwal Shazadi, Alvina Gul and Khalid Rehman Hakeem conducted a study on effects of pesticides on environment. Detailed study have done on pesticides, their types, usefulness and the environmental concerns related to them. This article has discussed about the methods for eradication of use of pesticides. Further, future outcomes after complete pesticides eradication have also discussed. The study emphasized on how excessive use of pesticides leads to destruction of biodiversity. The study revealed that in future chemical pesticides can be used in combination with natural treatments and remedies which result in more sustainable elimination of pests and insects. This combination will surely help to attain environmental sustainability. Also it has diverse applications in controlling urban pests and invasive species.

Lauren Brzozowski and Michael Mazourek in 2018 conducted a review on how agro ecological pest management will lead to sustainable agricultural future. The harmful impacts of using pesticides in pest management have discussed. The study focuses on ways to develop agro ecological management strategies. The main aspect of sustainable agricultural system consist of meeting food demands in a economical viable manner, while improving environmental health and individual and societal well being. Therefore, there is a need to invest in the agricultural systems that will give us sufficient yield to fulfil food grain demand while minimizing environmental impacts.

In 2016, Marek Cuhra, Thomas Bohn and Petr Cuhra conducted a review study on glyphosate. Glyphosate is a herbicide which is considered as less toxic in comparison to other products of the same class. But many new research evidences increases controversy about glyphosate toxicity. The study revealed that glyphosate is having more toxicological effects than assumed from previous assessment. One more finding of this review paper is that the biological and chemical degradation process of glyphosate are insufficiently documented. There is a need of more regulated risk assessment of glyphosate and glyphosate based herbicides (GBHs). The study leads to a conclusion that use of glyphosate and glyphosate based herbicides (GBHs) should be restricted on account of their recognized higher toxicity and stronger potential to cause harmful effect on human health and environment. But in reality in spite of so much of evidences regulatory authorities are allowing more sources of glyphosate in the food supply chain.

IV. RESULTS AND DISCUSSION

4.1 Effects on Human Health

Pesticides have many adverse effects on human health. The common classes of pesticides i.e., organochloride, organophosphate, pyrethroids, carbamates, triazine and neonicotinoids contain detrimental pesticides that have human endocrine disrupting potential. Many of them have carcinogenic actions. [18] The endocrine disrupting compounds have adverse effects on human reproductive system which causes breast, testicular and ovarian cancer. [14] They can also cause metabolic disruption leading to metabolic diseases such as obesity or diabetes. There are concerns about prenatal exposure and health effects in children due to pesticides as their residues have been detected in human breast milk samples. [21] Many bio-based pesticides are considered safe as they are of natural origin. But an important study investigated the inflammatory effects of one of the bio-based plant protection product Stifenina [FEN 560] on human peripheral blood mononuclear cells. Although this plant protection product is of natural origin [made from crushed fenugreek], direct toxicity of it to human health can be observed. Thus bio-based pesticides must be studied carefully to avoid their negative health effects on human health. [22]

Since 1970, glyphosate based herbicides are being used in agriculture. [2] Many scientists and researchers have revealed that glyphosate is responsible for increased rates of human infertility and birth defects. [13] This is because they are metal chelator and sperm motility is dependent on Mn. Recent researches have concluded that due the metal chelating properties of glyphosate they may be responsible for Alzheimer's disease, Parkinson's disease, anxiety disorder, osteoporosis, inflammatory bowel disease, renal lithiasis, osteomalacia, cholestasis, thyroid dysfunction, and infertility. [6]

4.2 Pesticide Effects on Environment

Pesticides have many hazardous effects on the environment. Some pesticides are used to kill fungi, unwanted herbs and insects from the farmland. This reduces the biodiversity of that landscape to only one edible crop. The lack of biodiversity directly affects the soil resilience. [3]

The bioactive pesticides interact with biomass and water systems. The widely used herbicide glyphosate residues have been detected in soil and ground water. [4] Many environmentally stable toxic pesticides get bioaccumulated into the environment and remain there for hundreds of years. These pesticides may be present in different organisms like birds, fish and insects and thus there are possibilities that they may reach the non target organisms. [1]

The large scale use of organophosphorous pesticides causes their accumulation in soil, from where they get into the ground water and rivers. A recent study has demonstrated the long range transfer of organothiophosphate insecticide chlorpyrifos as its residues have been detected in air and sea water of Arctic. [10]

A research done by David B. Donald and colleagues investigated the presence of residues of 45 Pesticides in the drinking water of reservoirs of northern Great Plains of North America. This increases concerns about the non-target effects of Pesticides. [23]

A huge amount of pesticides exists in environment. There are many chemicals which are present in low concentration and do not cause acute detectable effects in organisms, but they may cause other types of harms like genetic disorders and physiological alteration that, in long run, reduces the organisms life span. [4]

V. CONCLUSION

We need to invest in agricultural systems that will give us sufficient yields to nourish humanity while minimizing environmental impacts. The great yields from conventional agriculture today are inextricable from hidden cost to the environment through the detrimental effect of pesticides. While scaling organic agriculture to feed the world is still maturing, organic agroecological approaches hold the potential to provide for our world population sustainably by driving research and development of these pesticide alternatives. Our responsibility as agricultural scientists is not to maintain the status quo, but rather to continue path of innovations of previous generations for securing the productivity that currently supports our population. Indeed, agriculture is a human invention that has been in flux for millennia as new crops became available, growing techniques were developed, pest and environmental challenges emerged, new lands opened to cultivation, and markets expanded. Importantly, our knowledge of the effects of synthetic agricultural pesticide use has also shifted since their widespread introduction in the 20th century. How will we change our management techniques in response to improve the sustainability of our agricultural production? Can we move to more complex and multi-pronged strategies that are resilient and responsive to the living agroecosystems? By reframing the yield gap between conventional and organic agriculture as an investment gap, we can focus on the questions we need to answer toward the use of organic agroecological approaches in plant breeding and crop management for organic agricultural systems.

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