*General Article*_____ *Chapter –15*

FARM FAMILIES' EXPOSURE TO TOXIC PESTICIDES: WAYS OF PREVENTION

Yudhishther Singh Bagal

Abstract

As a preventative measure against pests that may destroy crops or cause product damage, farmers often employ synthetic pesticides. Pesticides may have harmful impacts on human health and the environment because of their high biological activity and long-term persistence in the environment. Generally, farmers are exposed to significantly higher concentrations of pesticides than consumers. It is largely during the preparation and application of pesticide spray solutions and the cleaning up of spraying equipment. Due to accidental spills or splashes, direct spray contact, or even drift, farmers who mix, pack, and spray pesticides may be exposed to these chemicals. However, even when not actively involved in pesticide application, farmers might be exposed to pesticides. Farm workers who work in pesticide-treated regions may be exposed to high levels of pesticide residues by direct spraying, drift from nearby fields, or contact with pesticide residues on the crop or soil during their work. This kind of contact is often neglected by the general public. Farmers are most often exposed to pesticides via the skin and the lungs. For normal pesticide handling, exposure to pesticides occurs in regions of the body that remain unprotected, including the face and hands. Farmers' exposure to pesticides may be decreased by limiting the use of pesticides and by using the necessary personal protective equipment at all phases of pesticide application.

Key words: Direct contact, Farmers' exposure, protective equipment, toxic pesticides.

School of Agriculture, Lovely Professional University, Phagwara, Punjab
Corresponding email: ysbagal@gmail.com

Introduction

The presence of potentially dangerous substances in the environment has sparked a lot of discussion in the last several decades (Bao et al. 2015). Toxic pollutants in the air and pesticides and other foreign chemicals in food and water represent an immediate hazard to human health (Gavrilescu et al. 2015). Other contaminants, on the other hand, accumulate over time in the environment and the person, causing illness long after first exposure. While many pesticides have been shown to accumulate in living organisms, it is difficult to establish the link between exposure and disease outcomes because of the many variables that must be considered, such as lifestyle, occupation, diet preferences, and smoking. These variables must all be taken into account when establishing a disease-exposure relationship in epidemiological studies (Colosio et al. 2013). Using chemicals incorrectly and indiscriminately may have severe effects on human health and the environment, even if they are essential for a country's attempts to achieve economic growth and meet its development goals (Moser and Dondi 2015). To put it another way, chemicals may have a positive or detrimental effect depending on a variety of variables, such as how much of them are exposed to in a certain length of time and space (Damalas 2009). A wide range of undesirable living creatures may be eradicated by pesticides, which are common chemicals used widely, notably in agriculture. Crop protection and vector-borne disease management are two of their most common applications in public health and agriculture. Pesticides have the potential to damage both humans and the environment due to their strong biological activity and, in certain circumstances, their extended persistence in the environment (Maroni et al 2006). In rare circumstances, long-term, low-level exposures may potentially have detrimental health impacts if handled incorrectly (Woodruff et al 1994). The extensive use of pesticides means that many people are at risk of pesticide exposure as a consequence of their job. People from various demographics, with varying exposure patterns and levels, are at risk of negative health impacts. Exposure to pesticides at work is most common among those who make and use pesticides, as well as those who work in public health (e.g., exterminators of house pests). The majority of pesticide exposure occurs among farmers and pesticide applicators in the agricultural sector (Woodruff et al 1994/ Maroni et al 1999/ Ye et al 2013/ Glass and Machera 2009). Pesticide residues in food and drinking water may be found on a daily basis in the general population, as well as pesticide drift in the vicinity of spraying regions (Ecobichon 2001).

Acute health concerns and environmental pollution are a result of the widespread usage of outdated, non-patented, more poisonous, ecologically persistent, and affordable chemicals in developing countries (Aktar et al 2009/ Zhang et al 2015/Andersen et al 2002). Pesticides are more likely to be inhaled by farmers and farm workers because of this, and they make up a large portion of the workforce who are often exposed to pesticides. When it comes to pesticides and how often and how they're applied, various types of farms and types of crops typically need different approaches. One of the many jobs conducted by farmers is pesticide application, which is seasonal and sporadic. As a result, farmers have lower exposure rates and shorter exposure times than their counterparts in other sectors. In the agricultural industry, pesticide applicators are more often exposed to pesticides, even though they may have less experience with pesticides.

Farm workers who are qualified pesticide applicators have been the primary focus of several researches on pesticide exposures. However, there is enough data to suggest that not all agricultural employees are exposed to pesticides, and that a large percentage of farmers may not be directly exposed.

Organometallic compounds and many earlier organochlorine pesticides are among these pesticides, which are both poisonous and long-lasting. Since these substances were outlawed in many nations in the 1970s and 1980s, people have been exposed to lower levels of exposure. However, these compounds are very long-lasting and remain in the environment in minute concentrations. Further study is needed to determine the optimum management strategy due to the ambiguity around the amount of a chemical needed to produce an effect. As a result of the usage of other pesticides including organophosphates, carbamates and triazines that are less toxic and less persistent than organochlorines, many are now verified or suspected to behave as endocrine disruptive substances (Welshons et al 2003). There are endocrine disrupting pesticides whose toxicity worsens with decreasing dosages, until they reach hazardous levels of parts per trillion or even less at extremely low doses (Frank and Ottoboni et al 2011).

Scientists need regular summaries of relevant literature because of the enormous number of articles that are released each year. They may lead to new synthetic discoveries and are often read by the scientific community. This editorial's goal was to present the most basic information available on the pesticide exposure of farmers.

Risk and Toxic Effect of Pesticides

Materials that have an intrinsic poisonous potential are said to be toxic. Toxicology labs determine a substance's toxicity in quantitative measures, such as the LD50 or LC50. Toxic materials are simply one factor in determining risk (or hazard); another is the potential for exposure that comes with their usage. Toxicity is the ability of a drug to cause sickness or death, while risk (hazard) is the result of exposure and toxicity working together in concert. As a result, the danger posed by a particular pesticide is dependent on its toxicity, the dosage, and the method of exposure.

An understanding of both toxicity and exposure is necessary to estimate risk. Pesticides with a high toxicity level have a larger potential for harming people than pesticides with a lower toxicity level (Sarwar 2015). However, additional parameters such as the pesticide's concentration in a formulation, the duration of exposure, and the route of entry into the human body all play a role in poisoning (Klaassen 2013). Toxicology is clearly out of the hands of pesticide applicators, however substantial control over dangers associated with using this herbicide is possible. There is minimal danger until the seal is broken, such as a bottle of very lethal pesticide. When the container is opened, the danger is low, unless the person is not wearing protective gear. However, the danger may be substantial if the container is damaged or leaks, or if the appropriate protective gear is not worn.

Humans may be poisoned or injured by pesticides. Toxic pesticides may induce organ or system damage inside the body, while irritating pesticides can injure the outside of the body. Several pesticides are very hazardous to humans, and even little doses may have a devastating impact. Overexposure to less hazardous active components may still be harmful. Pesticide exposure may cause symptoms as modest as minor skin irritation or

other allergic reactions, or as severe as a severe headache, dizziness, or nausea as a result of its toxicity. Organophosphate insecticides, for example, have the potential to produce life-threatening symptoms, such as convulsions, coma, and even death. Toxicities of pesticides to humans may be classified according to the kind of exposure, the route of exposure, or the affected organ system. It's safe to assume that inhalation and absorption by the skin are both more dangerous than either consumption or ingestion when it comes to poisoning (dermal exposure). Due to the fact that pesticides' harmful effects are fast reversible and do not cause severe or permanent damage, some of these effects are transient. However, the complete recovery may take a long time for certain chemicals. The effects of certain poisons, even if they are not lethal, may be long-lasting and difficult to reverse.

Types of Toxicity

Acute exposure occurs when a farmer receives a single dosage of a pesticide, and acute toxicity is the result (Berthet 2014). A pesticide's acute toxicity measures how harmful it is to a living creature following just a single, brief exposure. It is termed acute dermal toxicity when exposure occurs as a result of skin contact and is referred to as an acute dermal exposure event. If you take a single dosage of a pesticide by mouth, it's called an acute oral exposure, and an acute inhalation exposure is the same thing. Acute toxicity is defined as a toxic impact that manifests during a day or two (24 hrs) of exposure. Even a very little dose of an active component with a high acute toxicity may be deadly. The warnings on a pesticide's label are based on the substance's acute toxicity.

Inhalation, ingestion, and skin contact are the most typical routes for pesticides to enter the human body (MacFarlane et al 2013). Pesticide penetration into the body is influenced by the chemical's condition, which might be solid, liquid, or gaseous. Solids, on the other hand, have a far smaller possibility of entering the body via the lungs than liquid or gas products. Pesticides may penetrate into the body in the same manner as liquids and gases can, if the pesticide particles are tiny enough or if they stay on the skin long enough. Skin absorption is the most prevalent route of pesticide exposure in the general public (Baldi et al 2006). When pesticides are handled (mixed, loaded, or disposed of), splashes and spills may result in dermal absorption. Dermal absorption may occur to a small degree when a large load of residues is exposed (Struik and Kropff 2003). Toxicology, exposure time, pesticide formulation, and the contaminated body part all have a role in how dangerous dermal absorption may be. In comparison to liquid formulations, powders, dusts, and granular insecticides are less readily absorbed via the skin and other body tissues. In contrast, oil-based pesticides and solvent-based liquid pesticides (e.g. organic solvents) are generally absorbed faster than dry pesticides. Emulsified concentrates, for example, are quickly absorbed by the skin because they contain a high proportion of the hazardous ingredient in a little quantity of solvent. Pesticides are more likely to be absorbed by some parts of the body than others.

Oral exposure to pesticides may result in life-threatening disease, severe harm, or even death (Klaassen 2013). These items may be ingested accidentally or purposefully by those who want to do damage to themselves. Not washing hands thoroughly before eating or smoking might potentially lead to oral contamination. Furthermore, pesticides might be accidentally ingested if food containers are not thoroughly sanitized. The small intestine

has been shown to be the primary absorption location for several substances that are consumed orally. Once they've been absorbed, they're transported to the bloodstream and may then be distributed throughout the body. Pesticides that have been transferred from their original labeled container to an unmarked bottle or food container are among the most common sources of unintentional oral exposure. Drinking pesticides or water that was kept in pesticide-contaminated bottles has poisoned numerous individuals. In rural parts of developing countries, pesticide poisoning is a major factor in the suicide rate, especially in rural communities.

Through the nose, throat, and the lungs, pesticides may injure and even kill tissue. Respiratory toxicity is increased due to pesticides' fast absorption via this particular pathway. Vapors and very small particles of the spray solution provide the highest risk of inhalation toxicity. Traditional conventional spraying technology produces greater droplet sizes while applying dilute pesticide sprays. In contrast, when low-volume equipment is used to apply concentrated substance, the risk of respiratory exposure is raised because smaller droplets are generated. Using pesticides in confined spaces (like greenhouses) also increases the risk of inhalation exposure. Exposure to respiratory irritants may be minimized with the use of respirators and gas masks. The eyes are very vulnerable to absorption, and any contact with pesticides may cause harm, blindness, or even death. When working with highly concentrated or dangerous pesticides, wearing goggles is a must. When there's a danger of getting diluted spray or dust in your eyes, be sure to wear eye protection. Additionally, granular pesticides are more hazardous because of the size and weight of the individual granules. Particles may bounce off plants and injure or poison an applicator if they hit sensitive body parts when applied with power tools (i.e., the eyes). Pesticides may come into contact with the eyes, thus goggles should be used whenever possible.

Ways to Reduce Exposure

Alternative agricultural systems that are less reliant on pesticides are vital for achieving the desired aim of minimizing pesticide exposure. An ecological approach to crop protection based on currently known ecological information may help achieve this goal. Agronomists have just recently begun to apply cutting-edge ecological principles to their work. It is the goal of this method to strengthen agricultural systems' ability to trigger natural pest regulatory mechanisms while also helping improve agricultural output. Preventing pests, diseases, and weeds, as well as making informed decisions, should be the foundation of any long-term approach (Ratnadass et al 2012). Natural processes in the cropping system may be maximized for prevention, hazardous species suppressed via the development of antagonists, system diversity maximized, and internal resource recycling stimulated (Coffman et al 2009). It is possible to achieve this goal through variety methods such as the following: 1) maintaining a clean seed or planting material on the farm, and 2) using both synergistic and antagonistic effects in the cropping system, such as the suppression of disease and pests through the use of non-chemical preventive methods like cultivating carob trees, cultivating plants that are more resistant to weeds and diseases, such as blights.

Many varieties of PPE are available for use in pesticide handling to reduce the risk of cutaneous exposure. In terms of Personal Protective Equipment (PPE), gloves, boots,

caps and long-sleeve shirts are among the most prevalent. The kind of PPE employed by farmers is influenced by a variety of factors, including the pesticide's toxicity, the conditions of exposure, and the preferences of the workers themselves. Most pesticides require the use of gloves and boots as the minimal level of PPE. To minimize exposure to extremely harmful pesticides, workers should wear a variety of personal protective equipment (PPE). Complementary degrees of protection against cutaneous exposure are provided by various PPE. Wearing gloves was determined to be the most efficient technique of protecting Danish greenhouse workers from pesticide exposure, and lowered cutaneous exposure among US citrus producers by 27%. It was shown that using both gloves and coveralls significantly decreased cutaneous exposure among US citrus producers by 65 percent.

Depending on the PPE, the method of application of pesticides, and the amount of accurate fitting and maintenance, the level of protection provided by the PPE might vary. Depending on the fabric type, including thickness and weight, most common protective apparel offers some level of protection from the elements (Aprea et al 2004). Waterproof polypropylene materials outperformed cotton in terms of dermal protection, although both types of fabrics reduced exposure to the skin (Vitali et al 2009). Cotton clothing had a penetration rate ranging from 11.2% to 26.8%, while synthetic clothing had a penetration rate of less than 2.4% (Fenske et al 2002). It was discovered that among US citrus producers that there was no significant difference between synthetic and woven materials (Keifer 2000). The application technique is said to alter the efficacy of personal protective equipment (PPE) in terms of pesticide penetration through clothes, however studies on this problem have been conflicting (Driver et al 2007/ Nigg et al 1993/ Stewart et al 1999). Low-pressure backpack spraying has been linked to more pesticide penetration than high-pressure spraying, however other study shows that low-pressure backpack spraying has poorer pesticide penetration than high-pressure hand lance spraying (Fenske et al 2002/ Keifer 2000/ Driver et al 2007/ Nigg et al 1993/ Stewart et al 1999/ Machera et al 1993).

One of the most overlooked factors in determining a PPE's efficacy is how it's actually put to use. Moving and sweating of farmers during pesticide application might reduce the PPE fabric's resistance to penetration. This is especially true in hot conditions where pesticides are applied (Stewart et al 1999). A polyethylene coverall had a better penetration rate, taking into consideration the mobility of farmers (Ekstrom and Ekbom 2011). Any PPE's effectiveness to protect its wearer relies on how it is used. There is a higher risk of cutaneous exposure for farmers who often pull their sleeves up or remove their gloves during pesticide use (Machera et al 1993). Personal protective equipment (PPE) may be ineffective if it is inadequate, wrongly fitted, unmaintained, or misused. PPE is seldom used to its theoretical maximum protection levels, making it impossible to gauge the actual amount of personal protection provided.

Conclusion

Modern agriculture relies heavily on pesticides, thus it is critical to devise ways to minimize their influence (Dent 2005). Minimizing pesticide use can be accomplished by using accurate diagnosis and advanced knowledge of pest problems, optimizing intervention timing for maximum long-term efficacy, selecting a pesticide product with minimal impact on non-target organisms and the operator, as well as better applying the

selected product to maximize dose transfer to the biological target. All pesticide handling procedures must be improved in order to meet public concerns about pesticide residues in food and drinking water, while adhering to all rules. As a result, farmers' exposure to pesticides may be minimized by using spraying equipment that is in good working order and taking the appropriate safety procedures throughout the pesticide handling process.

Conflict of Interest

The author declares no conflict of interest.

References

Aktar, M. W., Sengupta, D., and Chowdhury, A., (2009). Impact of pesticides use in agriculture: Their benefits and hazards. *Interdisciplinary Toxicology,* 2(1), 1-12.

Andersen, H. R., Cook, S. J., and Waldbillig, D., (2002). Effects of currently used pesticides in assays for estrogenicity, androgenicity, and aromatase activity in vitro. *Toxicology and Applied Pharmacology,* 179(1), 1-12.

Aprea, C., Terenzoni, B., Angelis, V. De, Sciarra, G., Lunghini, L., Borzacchi, G., Vasconi, D., Fani, D., Quercia, A., Salvan, A., and Settimi, L., (2004). Evaluation of skin and respiratory doses and urinary excretion of alkylphosphates in workers exposed to dimethoate during treatment of olive trees. *Archives of Environmental Contamination and Toxicology,* 48(1), 127–134.

Baldi, I., Lebailly, P., Jean, S., Rougetet, L., Dulaurent, S., and Marquet, P., (2006). Pesticide contamination of workers in vineyards in France. *Journal of Exposure Science & Environmental Epidemiology*, 16(2), 115–124.

Bao, L. J., Wei, Y. L., Yao, Y., Ruan, Q. Q., and Zeng, E. Y. (2015). Global trends of research on emerging contaminants in the environment and humans: A literature assimilation. *Environmental Science and Pollution Research*, 22(3), 1635–1643.

Berthet, A., Hopf, N. B., Miles, A., Spring, P., Charrière, N., Garrigou, A., Baldi, I., and Vernez, D., (2014). Human skin *in vitro* permeation of bentazon and isoproturon formulations with or without protective clothing suit. *Archives of Toxicology,* 88(1), 77-88.

Coffman, C. W., Stone, J., Slocum, A. C., Landers, A. J., Schwab, C. V., Olsen, L. G., and Lee, S., (2009). Use of engineering controls and personal protective equipment by certified pesticide applicators. *Journal of Agricultural Safety and Health,* 15(4), 311–326.

Colosio, C., Alegakis, A. K., and Tsatsakis, A. M. (2013). Emerging health issues from chronic pesticide exposure: Innovative methodologies and effects on molecular cell and tissue level. *Toxicology,* 307, 1–2.

Damalas, C. A., (2009). Understanding benefits and risks of pesticide use. *Scientific Research and Essays*, 4(10), 945–949.

Dent, D., (2005). Overview of agrobiologicals and alternatives to synthetic pesticides. In J. Pretty, (Ed.), *The Pesticide Detox: Towards a More Sustainable Agriculture,* (pp 70-82). London, UK: Earthscan.

Driver, J., Ross, J., Mihlan, G., Lunchick, C., and Landenberger, B., (2007). Derivation of single layer clothing penetration factors from the pesticide handlers exposure database. *Regulatory Toxicology and Pharmacology,* 49(2), 125–137.

Ecobichon, D. J., (2001). Pesticide use in developing countries. *Toxicology,* 160(1-3), 27-33.

Ekström, G., and Ekbom, B., (2011). Pest control in agro-ecosystems: An ecological approach. *Critical Reviews in Plant Sciences,* 30(1-2), 74–94.

Fenske, R. A., Birnbaum, S. G., Methner, M. M., Lu, C., and Nigg, H. N., (2002). Fluorescent tracer evaluation of chemical protective clothing during pesticide applications in central Florida citrus groves. *Journal of Agricultural Safety and Health,* 8(3), 319–331.

Frank, P., and Ottoboni, M.A., (2011). *The Dose Makes the Poison: A Plain-Language Guide to Toxicology* (3rd ed.). Hoboken, NJ, USA.: Wiley.

Gavrilescu, M., Demnerová, K., Aamand, J., Agathos, S., and Fava, F. (2015). Emerging pollutants in the environment: Present and future challenges in biomonitoring, ecological risks and bioremediation. *New Biotechnol,* 32(1), 147–156.

Glass, C. R., and Machera, K., (2009). Evaluating the risks of occupational pesticide exposure, *Hellenic Plant Protection Journal*, 2, 1-9.

Keifer, M. C., (2000). Effectiveness of interventions in reducing pesticide overexposure and poisonings. *American Journal of Preventive Medicine,* 18(4), 80–89.

Klaassen, C. D., (2013). *Casarett & Doull's Toxicology: The Basic Science of Poisons,* (8th ed.). Columbus, OH, USA.: McGraw-Hill Education.

MacFarlane, E., Carey, R., Keegel, T., El-Zaemay, S., and Fritschi, L., (2013). Dermal exposure associated with occupational end use of pesticides and the role of protective measures. *Safety and Health at Work,* 4(3), 136–141.

Machera, K., Goumenou, M., Kapetanakis, E., Kalamarakis, A., and Glass, C. R., (2003). Determination of potential dermal and inhalation operator exposure to malathion in greenhouses with the whole body dosimetry method, *Annals of Occupational Hygiene,* 47(1), 61–70.

Maroni, M., Fait, A., and Colosio, C., (1999). Risk assessment and management of occupational exposure to pesticides, *Toxicology Letters,* 107(1-3), 145–153.

Maroni, M., Fanetti, A. C., and Metruccio, F., (2006). Risk assessment and management of occupational exposure to pesticides in agriculture. *Med. Lav,* 97(2), 430–437.

Moser, F., and Dondi, F. (2015). Environmental protection between chemical practice and applied ethics: A critical review. *Toxicological and Environmental Chemistry,* 98(9), 1-17.

Nigg, H. N., Stamper, J. H., Easter, E., and DeJonge, J. O., (1993). Protection afforded greenhouse pesticide applicators by coveralls: A field test, *Archives of Environmental Contamination and Toxicology,* 25, 529–533.

Ratnadass, A., Fernandes, P., Avelino, J., and Habib, R., (2012). Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: A review. *Agronomy for Sustainable Development,* 32, 273–303.

Sarwar, M., (2015). The dangers of pesticides associated with public health and preventing of the risks. *International Journal of Bioinformatics and Biomedical Engineering,* 1(3), 130–136.

Stewart, P. A., Fears, T., Kross, B., Ogilvie, L., and Blair, A., (1999). Exposure of farmers to phosmet, a swine insecticide, *Scandinavian Journal of Work, Environment & Health,* 25(1), 33–38.

Struik, P. C., and Kropff, M. J., (2003). An agricultural vision. In Hond, F. den, Groenewegen, P., and Straalen, N. van, (Eds.), *Pesticides: Problems, Improvements, Alternatives,* (pp. 16-30). UK Oxford: Blackwell Science.

Vitali, M., Protano, C., Del Monte, A., Ensabella, F., and Guidotti, M., (2009). Operative modalities and exposure to pesticides during open field treatments among a group of agricultural subcontractors. *Archives of Environmental Contamination and Toxicology,* 57(1), 193–202.

Welshons, W. V., Thayer, K. A., Judy, B. M., Taylor, J. A., Curran, E. M., and vom Saal, F. S., (2003). Large effects from small exposures. I. Mechanisms for endocrine-disrupting chemicals with estrogenic activity. *Environmental Health Perspectives,* 111(8), 994–1006.

Woodruff, T. J., Kyle, A. D., and Bois, F. Y., (1994). Evaluating health risks from occupational exposure to pesticides and the regulatory response. *Environmental Health Perspectives,* 102(2), 1088–1096.

Ye, M., Beach, J., Martin, J. W., and Senthilselvan, A., (2013). Occupational pesticide exposure and respiratory health. *International Journal of Environmental Research and Public Health,* 10(12), 6442–6471.

Zhang, C., Hu, R., Shi, G., Jin, Y., Robson, M. G., and Huang, X., (2015). Overuse or underuse? An observation of pesticide use in China. *Science of the Total Environment,* 538, 1-6.