

An Evidence-based Causal Perspective of Agrochemical Pollution and Its Impact on Health

Eric Wong, MSc, Julia Hagen*

Department of Public Health, University of Oslo, Problemveien 7, 0315 Oslo, Norway

*: All correspondence should be sent to: Dr. Julia Hagen.

Authors' Contact: Mr. Eric Wong, MSc, E-mail: eric.wong85@gmail.com; Dr. Julia Hagen, PhD, E-mail: julia.hagen@gmail.com

DOI: <https://doi.org/10.15354/si.22.re086>

Funding: No funding source declared.

COI: The authors declare no competing interest.

The extensive use of agrochemicals has had a wide range of impacts on human health. The research progress of the impact of agrochemical use on human health is reviewed, in order to provide some support and protection for taking corresponding measures to minimize or avoid the harm of agrochemicals to human health.

Keywords: Agrochemicals; Pesticides; Pollution; Health; Impact

Science Insights, 2022 October 31; Vol. 41, No. 5, pp.691-695.

© 2022 Insights Publisher. All rights reserved.



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the [Creative Commons Attribution-NonCommercial 4.0 License](https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed by the Insights Publisher.

A GROCHEMICALS refer to chemical compositions or mixtures of several substances and their preparations used to prevent, eliminate or control diseases, insects, grasses and other harmful organisms that harm agriculture and forestry, as well as purposefully regulate the growth of plants and insects. Agrochemicals are all potentially toxic compounds currently managed by humans that are intentionally released into the environment to achieve their value.

There are about 1,500 kinds of agrochemicals registered in various countries, among which more than 300 kinds are commonly used, and with the actual needs of production and the continuous development of the agrochemical industry, new varieties of agrochemicals are increasing every year (1). There are more than 10,000 kinds of insect pests, more than 8,000 kinds of pathogenic bacteria, 1,500 kinds of nematodes, and more than 2,000 kinds of weeds in the world. In agricultural production, if there are no agrochemicals, the yield of crops is only 30%, and 42% is still lost after protection. Among them, weeds lost 13.2%, pests lost 15.6%, and diseases lost 13.3% (2). The use of agrochemicals is an important measure to keep and increase agricul-

tural production, improve the quality of agricultural products and labor productivity. However, the use of agrochemicals has adverse effects on the environment (atmosphere, soil and water resources), food safety and the health of agricultural producers. While human beings gain benefits, there are also risks to human beings and the environment. Among the five major pollutants of food (agrochemicals, chemical fertilizers, wastes from factories, urban waste, and human factors), agrochemicals occupy the first place (3). The pollution is the most extensive, the duration is the long, and the residual agrochemicals are the most harmful to human beings. As the negative effects of agrochemical use become increasingly prominent, experts and scholars in agriculture, environment, medicine and other fields, as well as relevant government departments, have begun to conduct research to seek countermeasures.

So far, the research on the impact of agrochemical use on health has mostly focused on the following aspects: The pollution profile of agrochemicals is caused by the chemical pollution, damage to water, air, soil, and ecology. There have been studies on the adverse effects of agrochemicals on animals, plants, mi-

croorganisms, and agricultural products. Human beings, who dominate the earth, are the producers of agrochemical pollution and the ultimate victims of the pollution. All the harm to the environment caused by agrochemical pollution will eventually converge on human beings. Regarding the harm of agrochemical pollution to human health, the current studies mainly include endocrine disrupting, acute poisoning, productive poisoning, effects on the skin, damage to nerves, damage to the immune system, causing gastrointestinal diseases, damage to male fertility, physical decline caused by chronic poisoning, liver and kidney damage, and various chronic diseases (4).

Causes of Agrochemical Pollution Reasons at the Farmer Level

(i) Farmers have high requirements for quick-acting agrochemicals and are greedy for cheapness, so they specialize in purchasing highly toxic and high-residue agrochemicals. (ii) In order to save money, they often “compound” agrochemicals without authorization, and blindly increase the dosage and frequency of agrochemical use. (iii) Improper selection of agrochemical varieties, and the application method does not correspond to the type of farm chemical. (iv) The spraying equipment is outdated, and the leakage is serious. (v) Some agrochemicals have been stored for a long time, and the labels on the bottles have fallen off. Farmers use them blindly without identifying the agrochemicals. (vi) Ignore the agrochemical safety interval. (vii) Dispensing and flushing applicators in rivers, ponds, wells, and throwing the residues of agrochemical packaging. (viii) Most of them are retail investors with low educational level and lack of overall scientific understanding of pest control.

Reasons at the Level of Chemical Manufacturers and Distributors

(i) There are too many agrochemical manufacturers, and the product quality is uneven. (ii) Quality The problems of untrustworthiness are quite prominent: shoddy products, fake products, illegal operation, etc. (iii) Most of the agrochemical operators have a low level of education, and they have great blindness when purchasing agrochemicals, lack the ability to identify the quality of agrochemicals, and even do not know the fake and inferior agrochemicals they have purchased.

Reasons at the Government Level

The access of agrochemical operators is not strict. After the agrochemical market was liberalized, the original agricultural technology department and the core business of the supply and marketing cooperatives became able to sell to anyone, and the market was relatively chaotic, and the operators did not have agrochemical business licenses.

Reasons at the Social Level

Modern society has a fast pace of life, and there is a large demand for various products, and the objective requirements are to supply quickly and well. Traditional organic planting technology is far from meeting the needs. Money-centered values prevail in society, and the pursuit of economic interests has become the primary or even the only goal of most individuals or organizations. The market system is still not standardized, and the legal

system is not sound enough, resulting in a disordered market and serious fake and shoddy phenomenon, which seriously dampens the enthusiasm of organizations and individuals committed to promoting green and safe food.

Countermeasures to Improve Pollution of Agrochemicals

At The Farmer Level

Improve the knowledge level of the overall prevention and control of pests and diseases. Use advanced applicator equipment and application techniques. Use agrochemicals scientifically, mix agrochemicals scientifically and rationally, and harvest them in strict accordance with the safe use interval of agrochemicals stipulated by the state.

Agrochemical Manufacturers and Distributors Level

Prohibition of highly toxic agrochemicals at the level of agrochemical manufacturers and distributors, and actively research and develop modern chemicals (such as amide, pyrimidine, thiazole and antibiotic fungicides; pyridine and pyrimidine, amide, and pyrazole herbicides; heterocyclic and new pyrethroid agrochemicals, etc.), photoactivated agrochemicals, biological agrochemicals, green agrochemicals, and water-based agrochemicals (5). Strengthen the integrity of the agrochemical industry and improve the sense of social responsibility. Actively publicize and popularize scientific agrochemical knowledge to the public to increase their understanding of agrochemicals and strengthen the training of farmers on safe drug use knowledge. Actively promote the merger and reorganization of advantageous agrochemical enterprises. Vigorously develop agrochemical chain operations and strengthen the training of agrochemical operators.

Government Level

Increase investment in agriculture. Improve industry legislation, strengthen supervision and management, enhance the safety awareness of the agrochemical industry, and improve the legal quality of the agrochemical industry. Continuously improve the level of scientific evaluation, incorporate agrochemical re-evaluation into the registration management process and gradually improve it. Carry out agrochemical safety risk assessment. Improve welfare and encourage research and development by scientific research units. Encourage the development of organic agriculture, actively promote green prevention and control technologies, such as: insecticidal lamp application technology and sticky shellac application technology, use the chemotaxis of insects, and protect and utilize natural enemies. Organize a special campaign against counterfeiting agricultural materials. Protect agrochemical intellectual property rights. Actively carry out publicity and popularization of knowledge about diseases, insect pests and agrochemicals, popularize new agrochemical application machinery and advanced agrochemical application technology (such as ultra-low-volume fertilization and application technology), and vigorously develop specialized unified prevention and control of diseases and insect pests (6). Establish a macro guidance mechanism to guide the promotion and use of biological agrochemicals and green agrochemicals.

Social Level

Through social media and public opinion, make people understand relevant knowledge and information, and enhance people's awareness of environmental protection and safety. Actively establish relevant associations or organizations, such as Friends of the Earth Japan (FoE Japan) (7).

How to Control the Negative Impact of Agrochemical Use on Health?

There are obstacles in the detection of residues of agrochemicals. Most of the agricultural products are directly marketed without testing after picking, and the agrochemical residues are serious; accumulation in the food chain; poor health and safety awareness, lack of or improper protection during occupational exposure; agrochemicals lack of identification knowledge; better availability of agrochemicals.

How to control the impact of agrochemical use on health, we can start from the following aspects.

- i. Eliminate agrochemical pollution from the root cause: Improve and perfect the regulations and standards for the use, supervision and management of agrochemicals. Agricultural production must strictly follow the standards for the safe use of agrochemical and promote the use of low-toxicity and high-efficiency agrochemicals.
- ii. Control of agrochemical residues: Research and formulate the safety interval for each farm chemical. Establish and improve agrochemical residue standards in food. Use scientific and reasonable processing methods. Actively promote pollution-free vegetables.
- iii. Degradation of agrochemical residues: The methods that have been studied to eliminate agrochemical residues mainly include chemical degradation, photochemical degradation, ultrasonic degradation, detergents, ionizing radiation and biodegradation. Photodegradation, ultrasonic wave, supercritical water oxidation, and Fenton method are mainly used for the treatment of agrochemical wastewater. Among them, the treatment technology of photocatalytic degradation and the combination of photodegradation and chemical oxidation degradation has a good development prospect. Ozone method, hydrogen peroxide method, and ionizing radiation are mainly used for the removal of agrochemical residues in fruits, vegetables and food, among which detergents have good application prospects. Microbial degradation is mainly used in field crops and soil. In recent years, the use of TiO₂ to degrade agrochemical residues in the environment has become an important approach and has become one of the research hotspots. The research of nano-TiO₂ as a photocatalyst to degrade agrochemical pollutants has attracted the attention of various countries.
- iv. Food safety management should change as soon as possible from the current post-event management mode of "sampling in the market, media exposure, and post-event strikes" to a pre-event management mode of "full-process control, product traceability, integrity assurance, risk assessment, hazard early warning and emergency response".
- v. Consumers should fully understand which vegetables and fruits in the basic recipes are sprayed with more agro-

chemicals and purchase them scientifically. At the same time, buy fresh vegetables and fruits in season, and apply scientific methods to remove agrochemical residues, such as alkaline water immersion method, thermal decomposition method, storage transformation method, detoxification, sterilization and washing method, use of multifunctional oxygen machine. The outer skin holding agrochemical residues can be removed with a knife, and only the fleshy part is eaten.

- vi. In case of occupational contact, take personal protection.
- vii. Improve the emergency network for agrochemical poisoning, do a decent job in the treatment of agrochemical poisoning, and improve the medical level of agrochemical poisoning treatment at the grassroots level. Provide timely and orderly health education to agrochemical poisoning patients and their families to increase their understanding of disease knowledge.
- viii. Prevention of non-productive poisoning: Strictly implement the agrochemical registration system, strictly implement the agrochemical production license system, strictly implement the agrochemical management system, strictly implement the restrictions on the scope of use of agrochemicals, especially the use of highly toxic and highly toxic agrochemicals and encourage high efficiency and low toxicity. The development and development, promotion and use of agrochemicals, to avoid the loss, proliferation and random purchase of agrochemicals; to carry out a colorful amateur cultural life, to cultivate a healthy, civilized and scientific lifestyle, and to continuously improve the psychological quality and cultural accomplishment of the masses; to actively carry out Mental health consultation, timely intervention of various mental diseases; actively carry out the popularization of agrochemical knowledge.
- ix. Focus on dietary matching: research has shown that dietary protein has a significant effect on agrochemical toxicity. When protein in the human body is sufficient, it can increase the activity of liver microsomal enzymes and accelerate the catabolism of agrochemicals. Carbohydrates can function as indirect detoxification by altering the availability of proteins and preventing them from being broken down as energy. In addition, vitamin C can improve the detoxification ability of the liver, and vitamin B1, vitamin B2, niacin, methionine and folic acid also play a role in preventing or reducing the toxicity of agrochemicals.

Beginning in the 1970s, with cost-benefit analyses of agrochemical use, studies on farmers' suboptimal choice behavior began to emerge, interpreting farmers' suboptimal choice behavior as farmers' cognitive dissonance and underestimation of health risks. Since then, there has been an increasing amount of research on the effects of agrochemical use, especially on the effects of agrochemicals on agricultural producers. The research focuses on the following two aspects:

- i. Health damage caused by agrochemical use: acute poisoning and productive poisoning (8); non-productive poisoning (suicide, etc.) (9); effects on the skin (10); damage to the immune system (11); cause gastrointestinal disease

(12); effects on the cardiovascular system and blood system (13); multiple cancers (14); genetics, damage to offspring (15); damage to male fertility (16); risk rheumatoid arthritis and systemic lupus erythematosus (17); endocrine disrupting (18); physical decline, liver and kidney damage caused by chronic poisoning (19).

- ii. Prevention and control of health damage: exploring methods for safe pest control (20); developing organic food (21); using lockable boxes to store agrochemicals to pre-

vent suicide and accidental poisoning (22); and exploring treatment methods for poisoning (23). In addition, the ethical dilemma involved in agrochemical exposure experiments on volunteers in experiments on the effects of agrochemicals on health has also been discussed (24, 25).

Agricultural development requires the use of agrochemicals, but the influence of these chemicals on human health should be extensively evaluated and analyzed. ■

References

1. Tudi M, Daniel Ruan H, Wang L, Lyu J, Sadler R, Connell D, Chu C, Phung DT. Agriculture development, pesticide application and its impact on the environment. *Int J Environ Res Public Health* 2021; 18(3):1112. DOI: <https://doi.org/10.3390/ijerph18031112>
2. Best Food Facts. Sustainability: What if farmers did not use pesticides? Last access: October 20, 2022. Available at: <https://www.bestfoodfacts.org/sustainability-what-if-farmers-did-not-use-pesticides/>
3. Abdel-Shafy HI, Mansour MSM. Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egypt J Petrol* 2018; 27(4):1275-1290. DOI: <https://doi.org/10.1016/j.ejpe.2018.07.003>
4. Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P, Hens L. Chemical pesticides and human health: The urgent need for a new concept in agriculture. *Front Public Health* 2016; 4:148. DOI: <https://doi.org/10.3389/fpubh.2016.00148>
5. Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P, Hens L. Chemical pesticides and human health: The urgent need for a new concept in agriculture. *Front Public Health* 2016; 4:148. DOI: <https://doi.org/10.3389/fpubh.2016.00148>
6. Damalas CA, Eleftherohorinos IG. Pesticide exposure, safety issues, and risk assessment indicators. *Int J Environ Res Public Health* 2011; 8(5):1402-1419. DOI: <https://doi.org/10.3390/ijerph8051402>
7. FoE Japan. For a peaceful and sustainable society where all life coexists. Last access: October 24, 2022. Available at: <https://foejapan.org/en/>
8. Damalas CA, Koutroubas SD. Farmers' exposure to pesticides: Toxicity types and ways of prevention. *Toxics* 2016; 4(1):1. DOI: <https://doi.org/10.3390/toxics4010001>
9. Gunnell D, Eddleston M. Suicide by intentional ingestion of pesticides: A continuing tragedy in developing countries. *Int J Epidemiol* 2003; 32(6):902-909. DOI: <https://doi.org/10.1093/ije/dyg307>. Erratum in: *Int J Epidemiol* 2004; 33(4):920.
10. Spiewak R. Pesticides as a cause of occupational skin diseases in farmers. *Ann Agric Environ Med* 2001; 8(1):1-5.
11. Christin MS, Ménard L, Gendron AD, Ruby S, Cyr D, Marcogliese DJ, Rollins-Smith L, Fournier M. Effects of agricultural pesticides on the immune system of *Xenopus laevis* and *Rana pipiens*. *Aquat Toxicol* 2004; 67(1):33-43. DOI: <https://doi.org/10.1016/j.aquatox.2003.11.007>
12. Giambò F, Teodoro M, Costa C, Fenga C. toxicology and microbiota: How do pesticides influence gut microbiota? A review. *Int J Environ Res Public Health* 2021; 18(11):5510. DOI: <https://doi.org/10.3390/ijerph18115510>
13. Sekhatha MM, Monyeki KD, Sibuyi ME. Exposure to Agrochemicals and Cardiovascular Disease: A Review. *Int J Environ Res Public Health* 2016; 13(2):229. DOI: <https://doi.org/10.3390/ijerph13020229>
14. Parent ME, Déry M, Siemiatycki J. Does exposure to agricultural chemicals increase the risk of prostate cancer among farmers? *McGill J Med* 2009; 12(1):70-77.
15. Marcelino AF, Wachtel CC, Ghisi NC. Are our farm workers in danger? Genetic damage in farmers exposed to pesticides. *Int J Environ Res Public Health* 2019; 16(3):358. DOI: <https://doi.org/10.3390/ijerph16030358>
16. Lwin TZ, Than AA, Min AZ, Robson MG, Siriwong W. Effects of pesticide exposure on reproductivity of male groundnut farmers in Kyauk Kan village, Nyaung-U, Mandalay region, Myanmar. *Risk Manag Healthc Policy* 2018; 11:235-241. DOI: <https://doi.org/10.2147/RMHP.S175230>
17. Parks CG, Walitt BT, Pettinger M, Chen JC, de Roos AJ, Hunt J, Sarto G, Howard BV. Insecticide use and risk of rheumatoid arthritis and systemic lupus erythematosus in the Women's Health Initiative Observational Study. *Arthritis Care Res (Hoboken)* 2011; 63(2):184-194. DOI: <https://doi.org/10.1002/acr.20335>
18. Mnif W, Hassine AI, Bouaziz A, Bartegi A, Thomas O, Roig B. Effect of endocrine disruptor pesticides: A re-

view. *Int J Environ Res Public Health* 2011; 8(6):2265-2303. DOI: <https://doi.org/10.3390/ijerph8062265>

19. Manfo FPT, Mboe SA, Nantia EA, Ngoula F, Telefo PB, Moundipa PF, Cho-Ngwa F. Evaluation of the effects of agro pesticides use on liver and kidney function in farmers from Buea, Cameroon. *J Toxicol* 2020; 2020:2305764. DOI: <https://doi.org/10.1155/2020/2305764>
20. Jampílek J, Kráľová K. 3 - Nanopesticides: preparation, targeting, and controlled release. Editor(s): Alexandru Mihai Grumezescu. *New Pesticides and Soil Sensors*, Academic Press. ISBN 9780128042991. 2017, pp.81-127. DOI: <https://doi.org/10.1016/B978-0-12-804299-1.00004-7>
21. Mie A, Andersen HR, Gunnarsson S, Kahl J, Kesse-Guyot E, Rembiałkowska E, Quaglio G, Grandjean P. Human health implications of organic food and organic agriculture: A comprehensive review. *Environ Health* 2017; 16(1):111. DOI: <https://doi.org/10.1186/s12940-017-0315-4>
22. Hawton K, Ratnayake L, Simkin S, Harriss L, Scott V. Evaluation of acceptability and use of lockable storage devices for pesticides in Sri Lanka that might assist in prevention of self-poisoning. *BMC Public Health* 2009; 9:69. DOI: <https://doi.org/10.1186/1471-2458-9-69>
23. Emergency management of poisoning. Haddad and Winchester's *Clinical Management of Poisoning and Drug Overdose*. 2007; 2007:13-61. DOI: <https://doi.org/10.1016/B978-0-7216-0693-4.50007-4>
24. Resnik DB, Portier C. Pesticide testing on human subjects: Weighing benefits and risks. *Environ Health Perspect* 2005; 113(7):813-817. DOI: <https://doi.org/10.1289/ehp.7720>
25. London L, Coggon D, Moretto A, Westerholm P, Wilks MF, Colosio C. The ethics of human volunteer studies involving experimental exposure to pesticides: Unanswered dilemmas. *Environ Health* 2010; 9:50. DOI: <https://doi.org/10.1186/1476-069X-9-50>

Received: July 19, 2022 | Revised: August 27, 2022 | Accepted: September 12, 2022
