



## Chapter 1

# An introduction to contaminants in agriculture and environment

Vinod Kumar, Pankaj Kumar\* and Jogendra Singh

---

### Chapter contents

Introduction .....	2
21st century and agricultural technology .....	3
Contaminants in agriculture and environment .....	4
Contaminant transmission pathways in the agriculture food chain .....	5
Conclusion .....	6
Acknowledgement .....	7
References .....	7

### Abstract

Recent advances in chemical applications in the agricultural sector have been contributed to disruptive contamination of crop and environment. Besides the contribution in improving conventional farming, the development of new methods has also contributed to polluting agriculture as well as environments. The deposition of several contaminants in agricultural products, soil, water, air and even into the higher trophic levels of the food chain has disturbed the well-functioning of the earth ecosystem. The present chapter focused on the primary information of the book regarding how the contaminants in agriculture are introduced with possible ways to mitigate their impacts.

**Keywords:** Agricultural pollution, Contaminants, Development, Sources, Twenty-first century, Urbanization

**Agricultural contaminant definition:** “An unwanted sediment or chemical present in the agriculture and their products which makes it unfit for consumption and survival of living beings”.

---

✉ Pankaj Kumar, Email: kumarpankajkv@gmail.com

Agro-ecology and Pollution Research Laboratory, Department of Zoology and Environmental Science, Gurukula Kangri Vishwavidyalaya, Haridwar-249404 (Uttarakhand), INDIA

## Introduction

The production of foodstuffs related to meet the animal food requirements by growing and harvesting plants and their products is known as agriculture (Nagendran, 2011). Despite global agricultural and economic revolution during recent past 50 years, human beings have transformed the natural ecosystems according to their selfish necessities. This is due to increased demand of foodstuffs due to overexploitation of natural resources, uncontrolled increase in the global population, and use of chemical substances to promote the crop productivity and plant protection (Bergstrom and Randall, 2016). Besides the contribution in improving conventional farming, the development of new methods has also contributed to polluting agriculture as well as environments (Altieri, 2018).

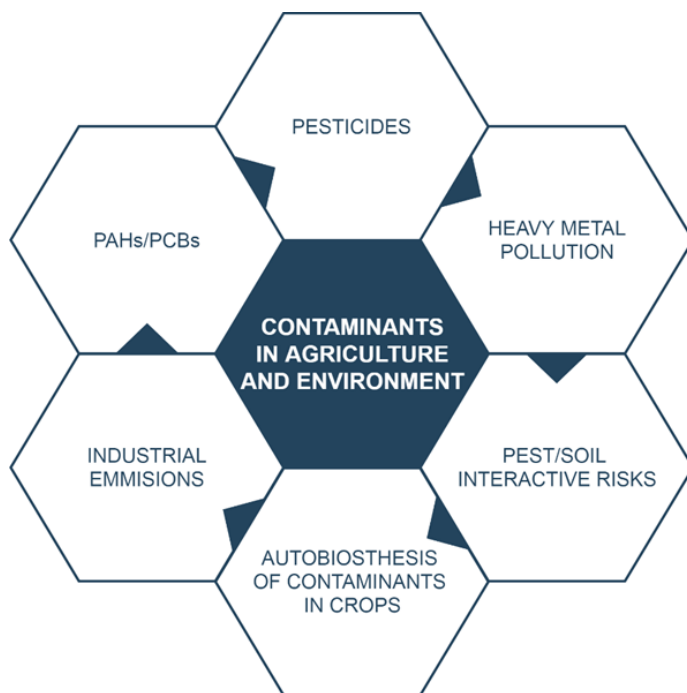
The deposition of several contaminants in agricultural products, soil, water, air and even into the higher trophic levels of the food chain has disturbed the well-functioning of the earth ecosystem. Pollution has tended to cause anxiety among all living beings from small-sized microorganisms to big sized elephant (Pavlidis and Tsihrintzis, 2018). The recent advancements in the agriculture sector have been contributing to degrading the quality of the environment. Agricultural pollution is a complex combination of rehearses due to its wide range of contributing factors. For this, it has several negative consequences on biotic communities in terms of air, water, and soil pollution (Yang *et al.*, 2018). Moreover, the liquid runoffs from urbanized cities, industries, and agricultural fields contains highly noxious elements like long persisting heavy metals, polyaromatic hydrocarbons (PAH), plastics and polymers, pesticides, chemical and reagents, atmospheric depositions, bio-aerosols, pollen grains, microorganisms, biodegradable residues, which creates serious environmental and health issues in the living beings (Nilsen *et al.*, 2019). Recent reports have shown that the long term deposition of such elements caused serious health impacts on both animals as well as plants.

This exposure to a human being above the threshold may be fatal due to the destruction of body immunity and or organ failure (Liao *et al.*, 2018). Thus, the effective mitigation of such deposition is a challenging approach for the whole world. The effects of harmful toxicants on living cells may be brought either by alteration in the cellular enzyme activities or by chemical and physical modifications in the cell structure (Brunk *et al.*, 2018). These changes might be responsible for the serious health problems like cancer, kidney diseases, weak immunity, bacterial, viral, and fungal diseases, embryonic disorders, hormonal disturbances, organ failure, skin problems and much more (Deng *et al.*, 2018).

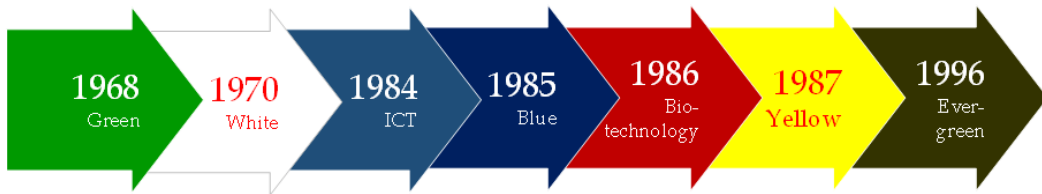
This book chapter emphasized an introduction to the contaminants in agriculture and environment and their possible consequences related to interacting biotic communities. The pollution which has been caused or being caused by various activities affecting the quality of agricultural products is well discussed. The necessity of this article was to spread the supplementary information among the global consumers to aware of them how the contaminants in agriculture arise and the possible ways to mitigate their impacts.

## 21<sup>st</sup> century and agricultural technology

It is obvious that the agricultural method today is quite different and advanced from the methods used in the year 1950. Today, the researchable association between agriculture and environment has received more attention due to the devastating impacts of contaminants on both biotic and abiotic components. These changes are brought by the recent revolutions in the agriculture sector in India. The modern agricultural practices involving the fertilizer, pesticide, machinery applications, raw foodstuff processing, transportation, preservation, and consumption are quite different from the traditional ways used by our ancestors (Tubiello *et al.*, 2015; Baker *et al.*, 2017). The advancements in the techniques of tillage, plowing, fertilizing, manure spreading, pesticide application, feedlots, and animal corrals utilization, irrigation, and clear-cutting has been revived the net profit and income of farmers (Nagendran, 2011). The integration of the industrial sector with agriculture is the most reason for this. Figure 1.1. It is well known that India has received many technological revolutions during the past 100 years (Figure 1.2). The major revolutions includes, green revolution for agricultural development, white revolution for milk production, blue revolution for fish and fisheries, grey revolutions for fertilizer developments, red revolution for meat production, sky revolution for the information and technological technologies, and finally the evergreen revolution which was meant for revolution of overall agriculture sector and production growth (Goldman and Smith, 1995; Breen, 2017).



**Figure 1.1.** Integrated framework of routes of contaminants in agriculture and environment.



*Figure 1.2. Different revolutions in the history which acted as milestone for agriculture of India.*

## Contaminants in agriculture and environment

Whether the contaminants in agriculture arise from the farming and industrial practices or by natural pollutant deposition, they all are considered as agricultural contaminants as they all have negative impacts on the survivability of the living beings (Figure 1.3). Such renowned methods have contributed to contamination of both grounds as well as surface waters with several pathogens like bacteria, viruses, fungi and other microbes (Nagendran, 2011). The agricultural and industrial runoffs contribute to accumulating different salts into agricultural lands, water bodies, surface, and ground waters. The application of chemical fertilizers and pesticides has persisting and long-term effects on the ecological contributors. Besides this, the high concentrations of trace heavy metal and radioactive elements released into the environment can cause serious health issues in animals and plants (Rawlins *et al.*, 1998; Harrison, 2015). Accumulation of different nutrients in water bodies from such runoffs are also. The various agricultural practices like tree cutting, shifting cultivation, forest clearing and overgrazing tend to accelerate the soil erosion rates in the respective regimes which often cause the siltation of the river bottoms and increased turbidity levels (Doula and Sarris, 2016). The altered water quality further affects the flora and fauna of both internal as well as external river systems i.e. riparian zone (Petts, 2018). The intake of contaminated crops by household cattle, birds and rodents creates severe disease which is sometimes fatal. The contaminated fodder when taken by cattle affects the quality of produced milk, and even the residues of heavy metals, pesticides, and other carcinogens have been reported by several researchers (Rawlins *et al.*, 1998). Besides this, among the other environmental impacts, soil erosion is also a major problem caused by agricultural and industrial runoffs.

However, forested areas show less soil erosion as compared to unprotected areas like fallow lands, which are directly affected by numerous natural as well as anthropogenic activities such as rainfall patterns, river streams, landslides, wind patterns, agricultural practices, overgrazing, deforestation and river bed mining are the major ones and therefore contribute to high soil loss (Jain *et al.*, 2001). Overgrazing is the process by which the fertile soil surfaces attached with

grasses are removed by means of the grazing and walking activities of livestock like sheep, goats, cattle, camels, horses, and others. Like other elements, overgrazing is also an important factor which contributes to the enhanced frequencies of agricultural contamination by means of incorporation of harmful pests, pathogens, and loosing soil strength and quality. The removal rate of soil nutrients is accelerated when the runoff process happened in such soils. Or the contaminants from other sites are transported to the agricultural soils via such liquid discharges.

### Contaminant transmission pathways in the agriculture food chain

The transport mode of an agricultural contaminant in the food chains is strongly regulated by natural and anthropogenic factors. The pollutant retention in a particular trophic level depends on the metabolism and residual dispersion to higher ones (Fowler, 2018). The control of physical and chemical factors is also a determinant of contaminant mass transfer into living cells. Over-application of pesticides and fertilizers have contributed to accumulate their higher

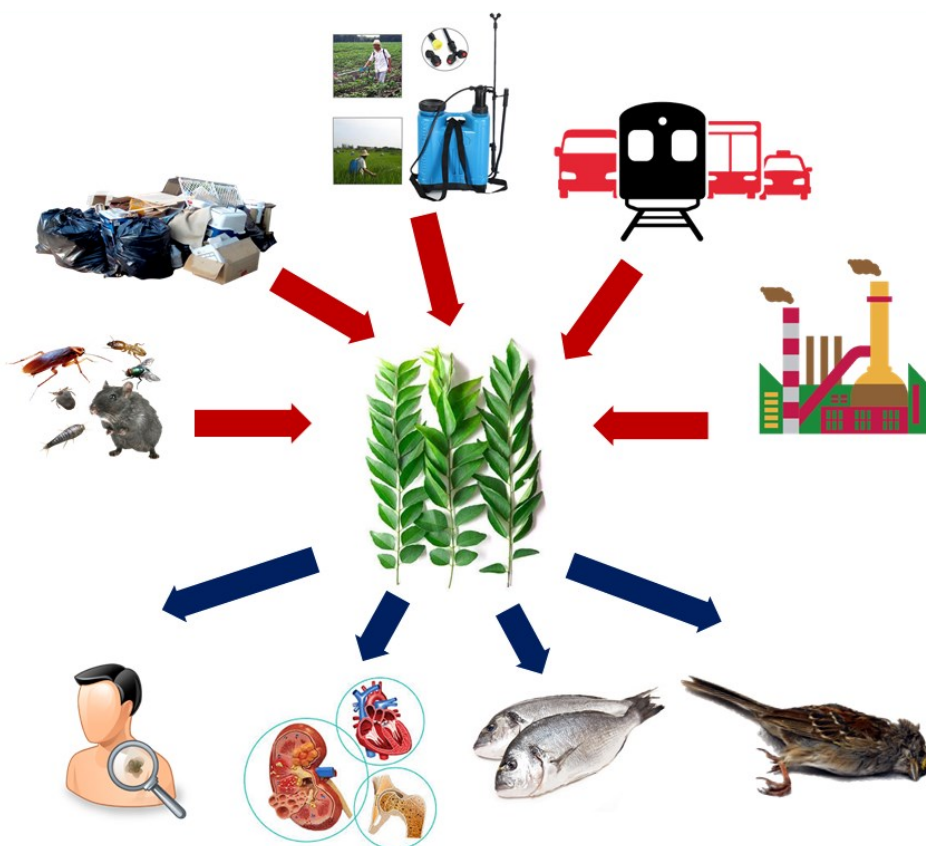


Figure 1.3. Sources of contaminants in agriculture and their health consequences.

amounts in the soils and further their transportation the upper parts of the plants. On the other hand, higher trophic levels of the agricultural system are also affected by agricultural pollution (Liu *et al.*, 2015; Kumar *et al.*, 2018). The process of bio magnification of pesticides and heavy metals in a complex mechanism, where plant enzyme-proteins actively binds with such pollutants and transport them to the edible and non-edible parts of the plant. Later, the herbivores take the energy from those contaminated plants or plant products and help in transferring them to top consumers including human itself.

For example, in India, the case of house sparrow bird deaths was due to extensive pesticide accumulation in rice crop which declined its significant population in both rural and urban areas (Rawat and Agarwal, 2015). The accumulation of harmful pesticides in rice crop tends to increase the toxicity of early rice grains, which are taken by birds. On the other hand, the pesticide application on crop leaves kills the pests which are further fed to infants by mother sparrow. Consequentially, pesticides like Aldrin, DDT, Carbendazim, etc. act as toxic substances in the bird which further cause deaths. As not all insects are harmful to crops, many beneficial pests like a fly predator, lady beetle, moth egg parasite, honey bee, etc. are killed by such pesticide and fertilizer applications. This cause the disturbance in the natural food chain as many of them act as important keystone species to balance the agricultural ecosystems (Wojciechowska *et al.*, 2016). Livestock grazes large quantities of grasses, herbs, and shrubs present in the mountain areas. The walking and grazing activities create terracettes (steeper slopes) on the uppermost soil surfaces, where small contours, nearby 1.6 meters in depth. The formation of these slopes undergoes to make the soil detached from the mail surface layer and results in slow soil erosion (Pandey, 1996). If the process continues for a long time, it becomes a threat to the food chain and well as a risk to the concerning ecosystem caused by a decrease in the net gross productivity. The walking activity of livestock from one agricultural field to another spreads the pathogens easily. The probability of getting the non-disease crop increase when the number of livestock enters having such pests, or pathogen spores.

## Conclusion

In conclusion, after surveying the past and current status of contaminants in agriculture and environment, we found that human revolution has significantly contributed to increasing the health problems by incorporating the harmful substances. Besides this, the development of advanced technologies for gaining more benefits has perceived more attention of farmers for using modern chemical fertilizers and pesticides.

Recent studies revealed that the agricultural and industrial runoffs contribute to accumulating different salts into agricultural lands, water bodies, surface, and ground waters. The high concentrations of trace heavy metal and radioactive elements released into the environment can cause serious health issues in animals and plants. Therefore, the responsive goals for mitigating these contaminants should be taken into account.

## Acknowledgements

The author is thankful to the Department of Zoology and Environmental Science, Gurukula Kangri Vishwavidyalaya and Agriculture and Environmental Science Academy for valuable suggestions in formulating this chapter.

## References

- Altieri, M.A. (2018). *Agroecology: the science of sustainable agriculture*. CRC Press. pp. 140-155.
- Baker, S., Volova, T., Prudnikova, S.V., Satish, S. and Prasad, N. (2017). Nanoagroparticles emerging trends and future prospect in modern agriculture system. *Environmental Toxicology and Pharmacology*, 53: 10-17.
- Bergstrom, J.C. and Randall, A. (2016). *Resource economics: an economic approach to natural resource and environmental policy*. Edward Elgar Publishing. pp. 34-40.
- Breen, T.H. (2017). "Baubles of Britain": the American and consumer revolutions of the eighteenth century. In *Colonial America and the Early Republic*, Routledge, pp. 197-228.
- Brunk, E., Chang, R.L., Xia, J., Hefzi, H., Yurkovich, J.T., Kim, D. and Palsson, B.O. (2018). Characterizing posttranslational modifications in prokaryotic metabolism using a multiscale workflow. *Proceedings of the National Academy of Sciences*, 115 (43): 11096-11101.
- Deng, Y., Song, L., Nie, X., Shou, W. and Li, X. (2018). Prenatal inflammation exposure-programmed cardiovascular diseases and potential prevention. *Pharmacology & Therapeutics*, 1-11.
- Doula, M.K. and Sarris, A. (2016). Soil Environment. In *Environment and Development*, Elsevier, pp. 213-286.
- Fowler, S.W. (2018). Biological transfer and transport processes. In *Pollutant transfer and transport in the sea*, CRC Press, pp. 1-65.
- Goldman, A. and Smith, J. (1995). Agricultural transformations in India and Northern Nigeria: exploring the nature of green revolutions. *World Development*, 23(2): 243-263.
- Harrison, R.M. (2015). *Pollution: causes, effects and control*. Royal Society of Chemistry. pp. 150-156.
- IPCC (2014). Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. The Intergovernmental Panel on Climate Change. Retrieved from <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data> on 01 February, 2019.
- Jain, S.K., Kumar, S. and Varghese, J. (2001). Estimation of Soil Erosion for a Himalayan Watershed Using GIS Technique. *Water Resources Management*, 15: 41-54.
- Kumar, V., Chauhan, R.K., Srivastava, S., Singh, J. and Kumar, P. (2018). Contamination, enrichment and translocation of heavy metals in certain leafy vegetables grown in composite effluent irrigated soil. *Archives of Agriculture and Environmental Science*, 3(3): 252-260.
- Liao, C., Kim, U.J. and Kannan, K. (2018). A review of environmental occurrence, fate, exposure, and toxicity of benzothiazoles. *Environmental Science & Technology*, 52(9): 5007-5026.
- Liu, J., Mooney, H., Hull, V., Davis, S. J., Gaskell, J., Hertel, T. and Li, S. (2015). Systems integration for global sustainability. *Science*, 347(6225): 1258832.
- Nagendran, R. (2011). *Agricultural waste and pollution*. In *Waste*, Published by Academic Press. pp. 341-355. <https://doi.org/10.1016/B978-0-12-381475-3.10024-5>
- Nilsen, E., Smalling, K.L., Ahrens, L., Gros, M., Miglioranza, K.S., Pico, Y. and Schoenfuss, H.L. (2019). Critical review: Grand challenges in assessing the adverse effects of contaminants of emerging concern on aquatic food webs. *Environmental Toxicology and Chemistry*, 38(1): 46-60.
- Pandey, B.W. (1996). *Geoenvironmental Hazards in Himalaya: Assessing and Mapping (the upper Beas)*, pp. 109-110.
- Pavlidis, G. and Tsihrintzis, V.A. (2018). Environmental benefits and control of pollution to surface water and groundwater by agroforestry systems: a review. *Water Resources Management*, 32(1): 1-29.
- Pettis, G. E. (2018). Perspectives for ecological management of regulated rivers. In *Alternatives in regulated river management*, CRC press, pp. 13-34.

- Rawat, U.S. and Agarwal, N.K. (2015). Biodiversity: concept, threats and conservation. *Environment Conservation Journal*, 16(3): 19-28.
- Rawlins, B.G., Ferguson, A.J., Chilton, P.J., Arthurton, R.S., Rees, J.G. and Baldock, J.W. (1998). Review of agricultural pollution in the Caribbean with particular emphasis on small island developing states. *Marine Pollution Bulletin*, 36(9): 658-668.
- Tubiello, F.N., Salvatore, M., Ferrara, A.F., House, J., Federici, S., Rossi, S. and Prosperi, P. (2015). The contribution of agriculture, forestry and other land use activities to global warming, 1990–2012. *Global Change Biology*, 21(7): 2655–2660.
- Wojciechowska, M., Stepnowski, P. and Gołębiowski, M. (2016). The use of insecticides to control insect pests. *Invertebrate Survival Journal*, 13(1): 210-220.
- Yang, Q., Li, Z., Lu, X., Duan, Q., Huang, L. and Bi, J. (2018). A review of soil heavy metal pollution from industrial and agricultural regions in China: Pollution and risk assessment. *Science of the Total Environment*, 642: 690-700.

\*\*\*\*\*

**Cite this chapter as:** Kumar, V., Kumar, P. and Singh, J. (2019). An introduction to contaminants in agriculture and environment. In: Kumar, V., Kumar, R., Singh, J. and Kumar, P. (eds) *Contaminants in Agriculture and Environment: Health Risks and Remediation*, Volume 1, Agro Environ Media, Haridwar, India, pp. 1-8, <https://doi.org/10.26832/AESA-2019-CAE-0159-01>