AESS Interdisciplinary Environmental Studies and Sciences Series

Martha Richmond

Cancer Hazards: Parathion, Malathion, Diazinon, Tetrachlorvinphos and Glyphosate

The 2015 IARC Classifications: Implications for Regulation, Environmental Justice, and Global Health

AESS
Association for Environmental Studies and Sciences

Springer

AESS Interdisciplinary Environmental Studies and Sciences Series

Series Editor

Wil Burns, Forum for Climate Engineering Assessment, School of International Service, American University, Washington, DC, USA

Environmental professionals and scholars need resources that can help them to resolve interdisciplinary issues intrinsic to environmental management, governance, and research. The AESS branded book series draws upon a range of disciplinary fields pertinent to addressing environmental issues, including the physical and biological sciences, social sciences, engineering, economics, sustainability planning, and public policy. The rising importance of the interdisciplinary approach is evident in the growth of interdisciplinary academic environmental programs, such Environmental Studies and Sciences (ES&S), and related 'sustainability studies.'

The growth of interdisciplinary environmental education and professions, however, has yet to be accompanied by the complementary development of a vigorous and relevant interdisciplinary environmental literature. This series addresses this by publishing books and monographs grounded in interdisciplinary approaches to issues. It supports teaching and experiential learning in ES&S and sustainability studies programs, as well as those engaged in professional environmental occupations in both public and private sectors.

The series is designed to foster development of publications with clear and creative integration of the physical and biological sciences with other disciplines in the quest to address serious environmental problems. We will seek to subject submitted manuscripts to rigorous peer review by academics and professionals who share our interdisciplinary perspectives. The series will also be managed by an Editorial board of national and internationally recognized environmental academics and practitioners from a broad array of environmentally relevant disciplines who also embrace an interdisciplinary orientation.

More information about this series at https://link.springer.com/bookseries/13637

Martha Richmond

Cancer Hazards: Parathion, Malathion, Diazinon, Tetrachlorvinphos and Glyphosate

The 2015 IARC Classifications: Implications for Regulation, Environmental Justice, and Global Health

AESS
Association for Environmental Studies and Sciences

Springer

Martha Richmond
Suffolk University
Boston, MA, USA

ISSN 2509-9787 ISSN 2509-9795 (electronic)
AESS Interdisciplinary Environmental Studies and Sciences Series
ISBN 978-3-030-81952-1 ISBN 978-3-030-81953-8 (eBook)
https://doi.org/10.1007/978-3-030-81953-8

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Acknowledgments

I would like to first acknowledge the help of Melinda (Lindy) Paul of Springer-Nature who expressed interest and supported me as I was preparing a proposal for this book. I also want to thank my editors with Springer-Nature for their guidance, and, at times, patience during the time that I was preparing my manuscript. Finally, I would be remiss if I did not thank Walter A. Rosenberg, Former Editor-in-Chief of the Journal of Environmental Sciences and Studies for his interest and encouragement.

To colleagues and friends who gave their time to be interviewed, who provided instructions and suggestions, or who, in other ways, enhanced my knowledge of the material that has gone into the book, I would also like to express my gratitude. I thank Scott Lussier of Suffolk University and Mary Margaret Minnis of Pace University for their excellent instruction in ArcGIS and their suggestions about the ArcMaps that are included in the book. While the maps are only for pesticide and herbicide use in California, given that California is a state with extensive agricultural activity and is also a state maintaining complete annual records on pesticide and herbicide use, they provide an excellent visual representation of how extensively some of the substances discussed in the book are used. To Geoffrey Sunshine, a former colleague who is now associated with Tufts University Medical School, I owe a special thanks. His suggestions and critical comments on the chapter discussing the 2015 IARC evaluations helped me to develop a stronger and more clearly written chapter. Jeannie Economos of the Farmworker Association of Florida provided invaluable information about working conditions for farm, nursery, and landscape workers in Florida. She also identified contacts in California that I might interview. I was fortunate to speak with Anne Katten, Pesticide and Work Safety Project Director of the California Rural Legal Assistance Foundation who provided additional information on environmental justice and advocacy groups in several states. I am particularly grateful that both Jeannie and Anne were available to talk during a time when the COVID pandemic was an issue of great concern, and when time became a highly valued commodity. Finally, I want to thank Emily Bradford Gallup, Information Systems Analyst, for her excellent assistance and suggestions in developing index terms.

As someone with a background in public health, especially environmental health, I have long been interested in the impact of toxins on communities, especially underserved communities. The hazards posed by pesticide use, especially its extensive use in developed and less developed countries, are clearly an area of concern. I was quite fortunate to visit twice and to be sponsored by the University of the Free State in South Africa to visit as a guest lecturer. I was able to meet with several faculty from the QwaQwa campus as well as the main campus in Bloemfontein. Special thanks go to Hennie Claassen of the QwaQwa campus who sponsored my second visit, made the necessary arrangements, and who also spent many hours taking me to visit emerging farms, speak with farmers, and learn more about the issues and challenges regarding farming as well as pesticide and herbicide use in South Africa. Hennie also provided me with opportunities to become better acquainted with the presence of agroindustry in farming communities.

I am fortunate to have had access to the Sawyer Library at Suffolk University, both to locate reference materials in the library collection and also acquire those not available through Suffolk University. This was an especially valuable resource during the COVID pandemic when in-person visits were not possible. I want to thank all the staff members who helped me.

I want to thank my family. Particular thanks go to my immediate family members, including Andrea and Kevin Shurtleff, Jack Shurtleff, Thomas Shurtleff, and Nicole Richmond. Their interest in and excitement about the book and their often-probing questions provided needed guidance for effective framing of issues.

I was very grateful for the constant companionship of our late dog Allegra who sat at my feet during much of the time I spent writing and researching the book manuscript. Her warmth and kindness were critical during these times. And, finally but hardly least, it is impossible to overstate my gratitude for the constant encouragement, interest, and love that my husband, John Berg provided. Writing a book is frequently challenging. Having his enduring support at such times has been important beyond measure. I love him very much and am very fortunate that he is part of my life.

Introduction

From the time that plant cultivation became established, unwanted pests—insects, plants, and molds—have threatened crops, frequently leading to poor yields or even complete losses. To combat pests and minimize loss, farmers throughout history have developed a number of "pesticides." With the exception of a few organic chemicals extracted from natural sources, historically most pesticides were inorganic substances, including some highly toxic compounds such as those containing mercury and arsenic. Many were "home-grown" and used in small amounts rather than produced in large volumes; or they came from natural sources such as pyrethrum, extracted from chrysanthemums. However, with the growth of modern chemical methods in the late nineteenth and twentieth centuries, the development of compounds more targeted to pests and, theoretically, less harmful to humans and farm animals became a possibility. Additionally, these compounds were generally produced by industrial organizations and were more readily available. This development became an incentive for the growth of the large agrochemical industry.

Whatever their etiology, pesticides and herbicides are intended to be acute toxins to the targeted species: to quickly kill unwanted pests or plants, while, in theory, not posing a significant danger to larger populations. This includes the larger ecosystem; farm animals; people working in agricultural, pest removal, or landscape applications; those living in close proximity to such activities; or members of the general public who might consume food or be exposed to fibers from agricultural products treated with the pesticides. Quantitatively, this means that for the target species, acute toxicity, generally measured as LD_{50} or mean lethal dose, is orders of magnitude smaller than the LD_{50} of humans and related species.

A large number of what might be considered the "first generation" of pesticides were chlorinated hydrocarbons. This included substances such as the pesticides dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethylene (DDE), dieldrin and endrin, or herbicides such as dichlorophenoxyacetic acid (2,4-D) or trichlorophenoxyacetic acid (2,4,5-T), all of which are deemed to post significant dangers, not only to those working directly with them but to the general population and the larger environment. A distinct disadvantage of these substances is that, because they are lipid-soluble, they bioaccumulate, both in individuals who come

into contact with them and also because they concentrate through the food chain. Today, all are deemed to pose significant dangers, not only to those working directly with them but also to the general population and the larger environment.

In contrast, the organophosphate pesticides as well as the herbicide glyphosate, because they are water-soluble, were seen as having a distinct advantage. They were generally metabolized to easily excreted products, or, in some cases, eliminated without metabolic transformations. Thus, while a number of chlorinated hydrocarbon pesticides and herbicides have been banned or highly restricted for use through regulatory processes, especially in developed countries, the use of organophosphate substances has grown dramatically. However, coupled with the development of GM seeds in the 1980s and 1990s, this large growth has led to significant environmental persistence. This was a consideration by the International Agency for Research on Cancer (IARC), in choosing to evaluate four organophosphate pesticides as well as the organophosphate herbicide glyphosate in 2015. Results of their findings were published in a 2017 Monograph entitled, "Some Organophosphate Insecticides and Herbicides." IARC, an agency of the World Health Organization, has published a series of monographs, beginning in 1972. Each publication provides findings and conclusions of expert panels who have examined evidence from peer-reviewed publications and government data to assess the carcinogenic hazards of a variety of materials. The 2017 Monograph details findings from the review panels that concluded tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate pose a carcinogenic hazard.

The reaction to the 2017 Monograph has been strong and frequently polarized. Commercial entities and other organizations allied with or speaking for these groups have challenged the IARC designations in a number of ways: attacking the scientific basis of findings; claiming bias of those participating in the IARC reviews; and stating that the need for food security mandates pesticide and herbicide use. This has been especially true with respect to glyphosate, in part because of the development of Roundup Ready™ genetically modified seed, marketed by Monsanto. Negative responses to the glyphosate classification include publications in the lay press, congressional hearings in the US, extensive scientific publications challenging methods used in IARC assessments, and administrative changes in industries that synthesize and distribute glyphosate-containing products for use in agriculture or landscaping, presumably to lessen potential liability. In contrast, environmental and health advocacy groups have supported the IARC findings: defending the scientific basis of designations, questioning the strength of arguments for food security, and pointing out concerns about environmental spread and persistence.

Often buried in the controversies is the distinction between hazard identification and risk assessment. Hazard identification, the purpose of IARC's review process, derives from a careful examination of vetted scientific data. The goal is to identify substances that can pose a carcinogenic risk under potential exposure conditions. In contrast, risk assessment takes information on hazard identification and applies this information to various models used to develop estimates of risk for various constituencies. The constituencies include the general public, or, within the occupational sector, those who work in agricultural and landscaping industries, and who may

require exposure protection. Risk assessment generally incorporates hazard identification into various exposure models to develop quantitative information regarding safe levels of exposure and potential intake.

It is important to note that IARC's hazard assessments are intended to address potential outcomes on a global basis, which in many cases involves conditions where exposures are unknown, or, if known, are not well-regulated. This leads to questions of environmental justice. Those exposed to toxic substances through poor working conditions and lax environmental regulations and who are not adequately protected are far more likely to respond adversely. This can include both short-term reactions and long-term responses, including the development of chronic diseases such as cancer. For various reasons, these responses are often either underreported or not reported at all to the appropriate agencies. Many of those experiencing adverse reactions are members of underserved communities or live and work in underdeveloped/poorly developed geographic constituencies. They are afforded little or no protection and, furthermore, lack strong advocacy groups.

While it can be acknowledged that issues of environmental justice are often specific to given agricultural sites or specific agricultural operations, food and flower production have also become increasingly global. It is unclear how, in the production-export process, agribusiness is regulated. Hence, the potential for adverse effects of pesticide and herbicide use becomes an issue of growing complexity.

The following book focuses on the four pesticides and the herbicide assessed by IARC in 2015. It first provides a historical perspective for the introduction of each compound into agriculture and landscaping uses, documents the spread in use and the environmental impact of each, and critiques data on health effects. Particular focus will be given to chronic diseases, especially cancer or pre-cancerous conditions. The second part of the book looks specifically at the IARC review process, both in terms of its development, its general approach, and then on specific issues of the 2017 IARC Monograph. The next chapters detail and critically examine the responses to the IARC designations and implications of these responses. The final sections will discuss the larger issues of environmental justice, both in specific environments or industries as well as the global community.

Contents

Part I
Overview of Parathion, Malathion, Diazinon, Tetrachlorvinphos and Glyphosate