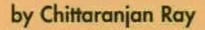
PESTICIDES IN DOMESTIC WELLS











Published by the American Society of Agricultural Engineers in collaboration with the Water Resources Research Center University of Hawaii at Manaa

Contents

| 1 | Introduction | 1 |
|---|---|----|
| | Ground Water as a Resource | 1 |
| | Ground-Water Use | 2 |
| | Pesticides in Ground Water | 5 |
| | Objectives and Approach | 7 |
| | References | 7 |
| 2 | National-Scale and Multistate Studies | 9 |
| | National Pesticide Survey | 9 |
| | Study Design | 10 |
| | Implementation of the survey | 14 |
| | Sample-collection procedure | 15 |
| | Analytical methods | 16 |
| | Results | 19 |
| | National Alachlor Well Water Survey | 22 |
| | Midcontinent Herbicide Initiative | 27 |
| | Ciba Survey of Atrazine and Its Metabolites in Well Water | 34 |
| | Other Multistate Studies | 39 |
| | References | 40 |
| 3 | State-Level Studies | 43 |
| | United States | 43 |
| | California | 43 |
| | Colorado | 44 |
| | Illinois | 46 |
| | Iowa | 54 |
| | Kansas | 61 |
| | Minnesota | 63 |
| | Missouri | 70 |
| | Nebraska | 73 |
| | North Carolina | 76 |

| vi | Contents |
|----|----------|
| | |

| | Texas | 80 |
|---|--|-----|
| | Wisconsin | 83 |
| | Canada | 88 |
| | Ontario | 88 |
| | Prince Edward Island | 90 |
| | References | 91 |
| 4 | Factors Contributing to Pesticide Occurrence in Domestic Wells | 95 |
| | Design of the Study | 95 |
| | Hydrogeologic and Soil Factors | 98 |
| | Land Use and Cultural Factors | 103 |
| | Intensity of Agricultural Activity | 106 |
| | Climatic Factors | 107 |
| | Well Factors | 108 |
| | Sampling and Analytical Factors | 113 |
| | Pesticide Properties and Application Methods | 114 |
| | References | 118 |
| 5 | Toxicological Issues | 127 |
| | Toxicological Considerations | 127 |
| | Pharmacokinetics | 128 |
| | Dose-Response Studies | 130 |
| | Health Advisories | 132 |
| | Noncarcinogenic and Carcinogenic Effects | 133 |
| | Noncarcinogens | 133 |
| | Assessment of noncarcinogenic risk | 134 |
| | Carcinogens | 137 |
| | Assessment of carcinogenic risk | 137 |
| | Models | 139 |
| | Mixed Exposures (synergetic and antagonistic effects) | 139 |
| | Ecotoxicological Issues | 141 |
| | The Issue of Metabolites | 142 |
| | Drinking Water Standard and Health Advisories | 144 |
| | References | 144 |
| 6 | Technological Issues | 149 |
| | Removal Mechanisms at the Point of Treatment | 149 |

| | Damazal Machaniama at the Daint of Line | 150 |
|-----|---|-----|
| | Removal Mechanisms at the Point of Use | 150 |
| | Design Considerations | 152 |
| | Reverse Osmosis | 152 |
| | Activated Carbon Filters | 153 |
| | Implications of Using Removal Units at the Point of Consumption | 157 |
| | References | 157 |
| 7 | Sustainability Issues and Modification in Agricultural Practices | 159 |
| | Relationship Between Pesticide Use and Chemical Detection in Surface/Ground Waters | 159 |
| | Pesticide Application and Yield | 160 |
| | Application Methods | 160 |
| | Pre-emergent versus post-emergent application | 160 |
| | Split versus single application | 161 |
| | Incorporation versus placement | 162 |
| | Formulation Effects | 163 |
| | Delivery Method | 164 |
| | Rate of Application | 164 |
| | Farming Methods to Reduce Potential Loss of Pesticides to Ground Water | 164 |
| | Structural and Nonstructual Measures at the Farm Scale to Reduce Water Quality Problems | 165 |
| | References | 166 |
| 8 | Legislative Issues and Updates | 169 |
| | Legislation on the Use of Highly Leachable Compounds | 169 |
| | Basis for Compound Selection | 170 |
| | Chemical Properties and Use | 170 |
| | Risk Assessment | 171 |
| | State Management Plan Components | 173 |
| | Overviews of Selected State SMPs | 175 |
| | Major Issues | 177 |
| | Legislation on the Health-Based Tolerance Limits for Pesticides | 178 |
| | References | 180 |
| 9 | Future Directions | 181 |
| Ind | l _o x | 185 |