ENVIRONMENTAL AND OCCUPATIONAL HEALTH SCIENCES
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UIC

Toward the Creation of a Public Health Surveillance System for Pesticide Related Illness/Injury in Illinois

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UIC Illinois Injury Prevention Center

ABOUT THIS REPORT

In the summer of 2016, UIC School of Public Health received a contract from the National Institute for Occupational Safety and Health to report cases of Pesticide Related Illness occurring in Illinois. Under the guidance of Sherry Brandt-Rauf, JD, MPhil, Associate Professor, the students of Environmental and Occupational Health Policy (EOHS 480 and EOHS 580) conducted a policy analysis to inform the establishment of an active, high quality public health surveillance system for Pesticide Related Illness in the State of Illinois. Information was collected from online sources and interviews of key informants across the U.S. who are engaged in PRI surveillance in individual states between August, 2016 and May, 2017. Public health surveillance, specifically in the realm of PRI, is handled differently in each state. The goal of this project was to examine the array of policies and practices across the U.S. as a way to forge a policy initiative on PRI surveillance in Illinois.

Published data sources are listed at the end of each section, comprehensive statewide data was most available for the year 2012. Published one year later, the status of the states may have changed since it was written. Authors take responsibility for any errors or misinformation in this report.

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EXECUTIVE SUMMARY

Pesticide exposure, at work and at home, poses a significant risk to the health of people in Illinois. Every year, there are cases in which people become ill, even die, due to pesticide toxicity. Public Health Surveillance is the capture, analysis and dissemination of health information to focus preventive efforts. In the US, case ascertainment of Pesticide Related Illness/Injury (PRI) differs by state; the program in Illinois is extremely limited. The aim of this project was to investigate practices among the states to inform best practices and to align recommendations for an enhanced PRI Public Health Surveillance program aligned with Illinois statute.

Recommendation

Illinois should implement a PRI reporting system that incorporates the most effective practices of the states that require PRI reporting. Such a system would allow Illinois to target educational, regulatory, enforcement, and preventive services in the most effective and efficient manner, ensuring that the risks of pesticide use are minimized while maximizing the benefits.

Specific recommendations:

- **Create a mandatory, well-publicized, simple mechanism for PRI reporting in Illinois**. A mandatory reporting system that includes health care providers and fosters information sharing across state agencies, already in place in some states, is the most effective mechanism for capturing cases and assembling information that can be used for prevention. At minimum, current Illinois requirements for notification of PRI by applicators should be enforced.

- **Implement educational programming for health care providers so that they can more easily identify cases of PRI.** Recognition, treatment, and appropriate documentation are skills needed by health care providers to prevent the devastating consequences of pesticide poisoning. [Once notified, the Illinois Poison Center, Toxikon, a few health care specialists, and other entities like the National Pesticide Information Center are able to handle acute interventions]. A number of states already have concise and easily accessible teaching modules for health care providers. (see Appendix B)

- **Institute a single portal reporting system for all cases of PRI** whether structural or agricultural, occupational or non-occupational. The IDPH I-NEDSS system could be modified to include PRI reporting by health care providers.

- **Create a gatekeeper position for all pesticide-related inquiries.** The gatekeeper should serve as the primary point of contact for PRI inquiries. The position should be filled by a member of one of the agencies involved in collecting or reporting PRI data. With an expert understanding of how pesticide related issues are handled within the state (who gets what information and where it goes to be aggregated, analyzed, and reported), the gatekeeper would be in a position to refer inquiries to the appropriate department, individual, or program.

- **Ensure that the flow of information within and among departments is seamless and efficient.** The experience of other states reveals that the regulatory system is heavily dependent upon interagency coordination, which could be facilitated by the Illinois Interagency Committee on Pesticides and by the gatekeeper, who could serve as a strategic interagency liaison.

- **Emphasize and strengthen the requirements for reporting PRI in testing and training materials for applicators.** Insure that the penalty structure for failure to report reflects the importance of reporting in cases of illness or injury.

- **Incorporate PRI data into the decision-making process about whether to register or reregister pesticides in Illinois**. With the availability of a more complete PRI database, the Director of the Illinois Department of Agriculture will more easily be able to rely on the data in evaluating the risks of pesticide use in making registration decisions.

- **Strengthen relationships with stakeholders**. Relationships with stakeholders can help with education, outreach and research on PRI and can help advise their constituencies on how, when, and why to report PRI.

- **Fund PRI reporting through licensing fees, product registration fees, fines, and penalties**. Raise fees if necessary so that the cost of pesticide poisoning and its reporting are incorporated in the cost of using pesticides in the state.

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Toward the Creation of a Best-Practices System of Reporting Pesticide-Related Illnesses and Injuries in Illinois

Pesticide related illness and injury (PRI) poses a significant risk of harm to Americans both at work and at home. Every year, there are thousands of events in which people are injured, become ill, or even die because of exposure to a pesticide. For a variety of reasons, data about PRI either are not collected or are collected in a way that is uneven or inaccurate. In some states, collection of PRI data is mandatory. Most states require health care providers to report suspected cases of PRI (Medical Case Profile, n.d.). In other states, reporting of PRI is optional. However, in a minority of states, there is little or no systematic collection of data on PRI. Illinois is one such state. In the absence of PRI data, both the state and the federal government are compromised in their ability to regulate pesticides, conduct public health surveillance, and educate pesticide users and the general public in the safest methods for pesticide usage.

The goal of this project was to investigate the practices of states that already have PRI reporting and to suggest ways in which the best of these practices could be implemented in Illinois. Considering the best practices at different cost points, the project team developed recommendations consistent with State pesticide laws that would allow Illinois to effectively and efficiently capture and use PRI data to prevent exposure and illness among the Illinois public.

I. INTRODUCTION TO PRI REPORTING

Every year, many people are victims of hazardous pesticide exposures in their homes and workplaces. During 2013, of the approximately 2 million exposures reported to US poison control centers (PCCs), around 3% were related to acute pesticide exposures. There were almost 80,000 single substance pesticide exposure calls, reflecting a total of 15,430 cases of PRI, over 90 percent of which were unintentional (Mowry, Spyker, Cantilena, McMillan, & Ford, 2014). There are many groups at heightened risk for exposure. For example, more than 57 out of 100,000 agricultural workers may experience acute PRI each year (Calvert et al., 2008). However, agricultural workers are only one group at risk. Children and their teachers are exposed to pesticides at schools and daycare centers, and many people are exposed in their homes and in office buildings. In part, this is because of extensive pesticide use across the United States. In 2007 for example, 5.1 billion pounds of pesticides were used in the U.S., 17% of which were conventional (insecticides, herbicides, fungicides, and fumigants). However, any exposure that intoxicates workers or bystanders signifies a failure of control measures, which are effective and well established (USEPA, n.d. Pesticides and Public Health).

Unfortunately, there are few accurate data on the incidence and severity of PRI. Many states do not collect these data, and even those that do often have optional or otherwise limited reporting. For example, some states collect data only from calls to PCCs. These data may exclude serious cases that result in hospitalization if hospital personnel already know how to treat the exposure in question and do not call the PCC. Some states collect only occupational data, thereby missing cases of PRI that occur in homes, schools, office buildings, or hospitals caused by drift, home use, or overspraying. In cases of pesticide poisoning, the EPA also accepts reports directly. However, emergencies are referred to either 911 or the local PCC. For nonemergency situations, the EPA recommends contacting the National Pesticide Information Center (NPIC), state agencies, manufacturers, and OSHA ("How to report," 2017). The NPIC, which shares de-identified information on reported incidents with the EPA, recommends that the "state pesticide regulatory agency" should be contacted in the event of occupational pesticide exposure, such as drift or pesticide misapplication which does not result in conditions requiring immediate medical attention ("Where to start," 2017). Therefore, it is unlikely that either the EPA or NPIC is a source of comprehensive PRI data.

Cases may be difficult to identify because the symptoms of PRI often resemble those of other diseases and conditions or because appropriate laboratory tests are either not available or not ordered ("Recognition and management," 2013). Even exposed individuals may not realize that the cause of their symptoms is pesticide toxicity if the symptoms seem generalized or occur later in time, removed from the exposure. In addition, individuals may fail to report the poisoning for social, cultural, economic, or political reasons including lack of fluency in English ("Findings," 2005), fear of losing a job (Stanbury & Rosenman, 2013), lack of transportation or health insurance (Flocks, 2015), or immigration concerns (Shen, 2013). Even in cases that are correctly identified as PRI, identification of the particular pesticide that caused the illness may be virtually impossible where victims have been exposed to many different pesticides over a period of time or the source of exposure is unavailable.

The federally sponsored Sentinel Event Notification System for Occupational Risk (SENSOR) program, which began collecting acute occupational pesticide exposure data in 1998, captures data on PRI from a small number of states (Pesticide Illness and Injury Surveillance, n.d.). These states use different sources, methodologies, timelines, and agencies in collecting their PRI data. But even in these states, the data are incomplete and are believed to under-represent the actual number of individuals harmed by pesticide exposure (Namulanda G., et al., 2016). Notably, only seven states collect data on non-occupational PRI, data do not include chronic health effects, data may exclude significant sources of pesticide poisoning like disinfectants or biological pesticides, there is a restrictive definition of a "case," and SENSOR states suffer from the same difficulties in reporting and identifying PRI as non-SENSOR states. Because reporting is uneven and complex, higher reported rates of PRI in some states may reflect better detection and follow-back rather than more cases.

Accurate PRI data are critical both for effective pesticide regulation and for public health surveillance. Without such data, opportunities to reduce PRI will be missed and the harm caused by pesticides unnecessarily increased.

II. PESTICIDE REGULATION

The federal government, largely through the U.S. Environmental Protection Agency, has a significant, primary responsibility for pesticide regulation and for setting a floor below which states cannot go in regulating pesticides and their application. Pesticides are regulated on the federal level by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. secs. 136 ff, 2012). Under FIFRA, all pesticides, which the statute defines broadly[1], must be registered prior to use. The EPA may register a pesticide if the substance is determined to be effective, is properly labelled, and produces "no unreasonable adverse effects when used in accordance with widespread and generally recognized practice" (FIFRA, sec. 136a(c)(5)(D), 2012). FIFRA defines unnecessary adverse effects as "unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide" (FIFRA, sec. 136(bb), 2012). Thus, registration under FIFRA requires a "cost-benefit analysis that weighs the unreasonable adverse effects of the pesticide to humans or the environment against the beneficial commercial use of the pesticide (Li, 2015). If the EPA finds unreasonable adverse effects on the environment, it may (must) refuse to register a pesticide or may cancel an existing registration (FIFRA, sec. 136d(c)(1), 2012). When manufacturers learn about harms to humans, they are required to inform the EPA (FIFRA, sec. 136d(a)(2), 2012). However, they need not actively seek to generate PRI data after registration, and the requirement of disclosure may actually create a disincentive for them to collect such data. Many states follow a similar procedure and may be more — but not less — strict than the federal EPA in registering pesticides. California, for example, has adopted stricter rules for use of the pesticide chloropicrin than the EPA (Smith, 2015). The EPA is also responsible for implementing the Worker Protection Standard, which has the goal of providing minimum standards to protect agricultural workers from PRI in part through education (Worker Protection Standard, n.d.).

In order to accurately ascertain, measure, and quantify the harm to the human environment associated with use of a particular pesticide, both the EPA and the states must have accurate data on PRI.

1 From FIFRA: "The term "pesticide" means (1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, and (3) any nitrogen stabilizer…" 7 U.S.C. 136(u). The statute goes on the articulate several relatively narrow exceptions to this broad definition.

III. PUBLIC HEALTH SURVEILLANCE

Even if FIFRA did not require accurate PRI data for pesticide regulation, such data would still serve an important role in public health surveillance. According to the World Health Organization, public health surveillance is "the continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice" (WHO, n.d.). In the case of PRI, the collection of surveillance data is necessary in order to allow officials to understand health disparities, design and test interventions, (Stanbury & Rosenman, 2014) monitor disease outbreaks and trends, and identify exposure patterns and research needs ("Pesticide-related illness," 2005; Osorio, 2007). In the absence of an organized data collection effort, cases of PRI stemming from the same worksite or consumer product might never be detected, thereby foreclosing the opportunity to take action to educate users and the general public and to minimize harm. **Accurate data on PRI is a critical element in the process of public health surveillance of the consequences of pesticide use.**

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IV. STATE REPORTS

In an effort to determine how states with PRI reporting collect, store, and disseminate these data, this project looked closely at a number of states. The states were selected based on their different approaches to PRI reporting and their similarities to, or differences from, Illinois. Some of these states participate in the SENSOR program and others do not. Some states require PRI reporting and others make reporting optional. Each section begins with a series of "fast facts" that presents a snapshot of the state, and then describes the state's handling of pesticide regulation, generally, and PRI, in particular. Sources for the fast facts appear in Appendix A.

A. SENSOR States

While operating within the same basic framework, SENSOR states differ with respect to funding, breadth of reporting, and sources of data. Therefore, the project explored several different SENSOR states, focusing on their similarities and differences, as well as their strengths and weaknesses. The first SENSOR state below, Iowa, presents a case study of data analysis and of the general functioning of the SENSOR system. It is therefore discussed in greater depth than subsequent states.

1. Iowa

Iowa is a Midwestern state. It is surrounded by the Mississippi River to the east and the Missouri River and the Big Sioux River on the west. Iowa is bordered by six different states: Wisconsin and Illinois to the east, Missouri to the south, Nebraska and South Dakota to the West, and Minnesota to the north. The 2010 census reports a state population of 3,046,355, which includes a white, non-Hispanic majority (91.3%), Hispanic or Latino (5.0%), Black or African American (2.9%), Asian (1.7%) and two or more races (1.8%) (U.S. Census). More than 67.7% of the population is in the civilian labor force with over 1,649,007 employed (BLS, 2012). Iowa was ranked the 30th most populous state in the United States (2010 United States Census). Its capital and largest city is Des Moines.

Fast Facts

- Exposed workers: 199,361
- State population: 3,046,355
- Major industries: Agriculture and food production, manufacturing, renewable energy and fuels, service industries, and information and communication technology
- State GDP: $148,612 bil
- Major Crops: corn, soybeans, hay, oats, and wheat
- Chemical Expenses in dollars: $ 1,152,179
- Land in Farms in acres: 30,622,731
- Percent Population Urban: 64.02%
- Mandatory PRI reporting; SENSOR State

Iowa's gross state product (GSP) was $173,599 billion in 2012, placing it 30th among all states (U.S. BEA, 2012). Iowa's largest economic share includes agriculture, manufacturing, and services industries. Iowa ranks 26th in terms of the size of its land area (Census 2000 Geography), and it has some of the most fertile and productive soil in the world (National Agriculture in the Classroom, 2016). It is one of the foremost U.S. states in number of farms. Nearly nine-tenths of its land is reserved to agriculture, placing Iowa as one of the leading states in agricultural production (Honey and Salisbury, 2015). Iowa is the second largest agriculture producing state in the U.S. by farm commodities and cash receipts. It ranks 1st in corn and soybean production (NASS, 2016), and is one of the largest exporters of food.

The amount of pesticides used by Iowa farmers has increased over time. According to the USDA, Iowa farmers applied pesticides to 95 percent of all planted corn acres, for a total of more than 30 million pounds of pesticide matter. A recent survey in 2015 showed that 93 percent of soybean acres planted were treated with herbicides, 25 percent with insecticides, and 18 percent with fungicides (USDA, 2015). The state of Iowa issues supplementary reports on PRI.

Iowa has a current labor force of over 1.7 million workers including 110,000 agricultural workers (6%). This includes both owner/operator or traditional family farmers, as well as a growing number of corporate farms and migrant labor employees. Iowa consistently has a high rate of workers with pesticide-related poisonings, with a 11-year average rate of 3.8 cases per 100,000 workers (2004-2014) compared to an average rate of 1.8 per 100,000 workers in the US (2004-2012) (CSTE). Iowa ranks as one of the highest states by rate of pesticide poisonings reported to PCCs, as evaluated by state-based surveillance OHI data (Occupational Health Indicators, n.d.).

Pesticide Regulation

Iowa's pesticide regulations generally follow federal regulations promulgated under FIFRA. Iowa has adopted state-specific rules for applicator license and certification requirements, recordkeeping and reporting, and pesticide storage. The Pesticide Bureau, under the authority of the Iowa Department of Agriculture and Land Stewardship (IDALS), administers on-site containment of pesticides, fertilizers and soil conditions rules (IAC Ch. 44); pesticide rules (IAC Ch. 45); pesticide advisory committee (IAC Ch. 48); and the Pesticide Code (IAC Ch. 206) (IDALS, 2015). The Iowa Department of Agriculture and Land Stewardship (IDALS) has an extensive database of registered pesticides utilized in Iowa, which is a great aid in determining product codes, formulations, labeling requirements, and whether the product used is a registered pesticide. Pesticide product registration is based on information submitted by companies that intend to sell their products in Iowa and that have sought approval from the EPA, as well. (Kelly Registration Systems, Inc, 2015). Iowa currently has over 25,000 licensed private pesticide applicators, and over 8,000 commercial pesticide applicators. Iowa State University (ISU) Extension and Outreach, in cooperation with the IDALS, provides training and certification programs for commercial and private pesticide applicators in Iowa. ISU Extension training incorporates examples and updates provided by the IDPH Occupational Health & Safety Surveillance Program (OHSSP) Pesticide Exposure Surveillance Project (PESP).

Reporting PRI

Iowa Administrative Code (IAC) *section 641-1.3*(1) requires pesticide poisoning to be reported to the IDPH. Similar to the broad definition in FIFRA, the Iowa code defines a pesticide as "any substance or mixture of substances intended for preventing, destroying, repelling or mitigating directly or indirectly any insects, rodents, nematodes, fungi, weeds, and other forms of plant life or viruses, except viruses on or in living persons, which the secretary insects, rodents, nematodes, fungi, weeds, microorganisms, or any other form of life declared to be a pest, and any substances intended for use as a plant growth regulator, defoliant, or desiccant." Any form of pest declared by an Administrator of the U.S. Environmental Protection (EPA) and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant are defined as pesticides. This includes herbicides, insecticides, rodenticides, fungicides, disinfectants, wood treatment products, growth regulators, insect repellents, etc (Walker, 2013).

Pesticide poisonings were added to the list of reportable diseases in the Iowa Administrative Code section 641-1.3 (1) due to concern about adverse human health effects from exposure to pesticides (Walker, 2013). The Iowa Pesticide Poisoning Surveillance Program, located within the Division of Environmental Health of the IDPH, monitors, collects, and analyzes pesticide poisoning to determine the extent of exposure among affected populations in Iowa (Walker, 2013). It also maintains a database of information on acute occupational pesticide poisonings occurring throughout the state. The Iowa PESP is an expanded program component of the OHSSP and is operated as a part of the NIOSH Pesticide Illness and Injury Sentinel Event Notification System for Occupational Risk (SENSOR) program. The main objective of the Iowa OHSSP PESP is to prevent PRI throughout the state by conducting exposure surveillance and case investigation, and by executing actions to benefit and preserve the public's health (IDPH OHSSP, 2015). Collected pesticide data is disseminated to government agencies, the public, and healthcare professionals. IDPH is required to report its PRI findings annually to Iowa Department of Agriculture and Land Stewardship (IDALS) for further investigation.

The Division of Acute Disease Prevention, Emergency Response, and Environmental Health (ADPER & EH) provides support, technical assistance, and consultation to local public health agencies, hospitals, emergency medical service programs, and local health care providers regarding infectious diseases, disease prevention and control, and public health and health care emergency response (IDPH, 2017). ADPER makes up three bureaus, the Center for Acute Disease Epidemiology, Bureau of Immunization and TB, and Bureau of Emergency and Trauma Services (IDPH, 2017). The PESP within ADPER & EH monitors, collects, and evaluates pesticide poisonings to determine the degree of exposures among affected populations throughout Iowa. The information gathered by the ADPER & EH is disseminated to governmental agencies, the public, and healthcare professionals. Additionally, the IDPH is instructed to submit its findings annually to the IDALS) (Walker, 2013).

Reporting Requirements

The State of Iowa Code requires the reporting of known or suspected pesticide exposures to the IDPH by medical providers. The Iowa State Poison Control Center (ISPCC) is also required to report pesticide calls to OHSPP PESP, and

case information also comes from IDALS and the media. Using these various sources of data, the OHSSP PESP program attempts to capture as many cases of occupational[2] PRI as possible.

According to the Iowa Law (IAC Public Health [641] Chapter 1, 1.1-1.6) cases regarding persons believed to be experiencing a reportable pesticide poisoning must be immediately reported to the IDPH. Pesticide poisoning is "any acute or subacute systematic, ophthalmologic, or dermatologic illness or injury resulting from a suspected or resulting from inhalation or ingestion of, dermal exposure to, or ocular contact with a pesticide. Laboratory confirmation is not required." (IAC Public Health sec. 641). The reporting requirements extends to health care providers or public, private, or hospital clinical laboratories, school nurses or principals, school officials, and superintendents (where there are no nurses), poison control and poison information centers, medical examiners, and occupational health nurses. Each report must contain: the patient's name, address, date of birth, sex, race/ethnicity, marital status, and telephone number; the name and address of the laboratory; the type of lab test, whether it is a capillary or venous blood sample; the collection date; analytical result; date of the diagnosis; the name and address of the healthcare provider who performed the test; if the patient is female, whether the patient is pregnant; or just in the case of occupational conditions, the name of the patient's employer.

Reports

IDPH receives an average of 3800 reports annually from the Iowa Statewide Poison Control Center (ISPCC) (Walker, 2013). Of these reports around 500 are occupational in nature. Over the last 5 years, Iowa had 331 reports that met the SENSOR case definition for PRI and were therefore reported to the National Institute of Occupational Safety and Health (NIOSH). This averages to approximately 66 cases per year (Walker, 2013).

From 2008 to 2012, IDPH received over 19,000 reports, mainly from the ISPCC (Walker, 2013). The ISPCC receive calls and collects information from various sources (e.g. hospitals, work, homes) then inserts the data into the TOXICALL software database system for report to IDPH. ISPCC started reporting to IDPH using TOXICALL in 2005 (Walker, 2013). The ISPCC downloads and transfers reports for surveillance use. IDPH PESP reviews each report and determines case classification or need for additional information. When cases reflect two or more signs or symptoms the data is manually entered into the Iowa SENSOR Pesticides Incident Data Entry and Reporting software (SPIDER) database for further data analysis. Analyzed data are submitted to NIOSH as part of the grant requirements (Walker, 2013).

Definite: Objective evidence confirms the exposure and illness, and the related illness is consistent with known toxicology.

Probable: Objective evidence of either pesticide exposure or health effects, and the related illness is consistent with known toxicology.

Possible: Only subjective evidence of exposure and illness is available, and the related symptoms are consistent with known toxicology.

Suspicious: Insufficient toxicological information to determine a causal relationship between exposure and health effects.

Unlikely: The relationship between reported exposure and illness is not consistent with known toxicology.

Insufficient Information: Insufficient documentation on exposure or health effects.

Asymptomatic: Exposure reported, but no signs or symptoms.

Unrelated: Determination that health effects were due to other conditions, not pesticides.

[2] Section 641 of the Iowa Code requires reporting of both occupational and non-occupational PRI. However, because of limited funding, the state only enters data on occupational PRI into their SPIDER database for reporting to the NIOSH SENSOR program.

Following the SENSOR protocol, collected reports from the Iowa Statewide Poison Control Center and other sources are classified based on three criteria: documentation of pesticide exposure; documentation of adverse health effects; and evidence supporting a causal relationship between exposure and health effects. The measurement scale is represented by numerical scores of 1 through 4, one functioning as the highest level of information and four being for cases with insufficient information and data (Walker, 2013). Adverse health effects are classified by severity: fatal, high, moderate, or low. Evidence of causality is likewise scaled based on the nature and quantity of the evidence, with cases being labelled as:

Iowa has averaged approximately 61 cases of occupational pesticide poisonings per year with the exception of 2011, which had a total of 88 cases (Walker, 2013). The cause of the spike is uncertain, as the cases appear comparable to those of previous years. One possible cause is due to increased activity by the Occupational Health Program, which conducted outreach and education to providers in collaboration with ISPCC in 2011 (Walker, 2013). Throughout the period of 2008-2012, IDPH received a total of 19,171 reports from the ISPCC (Walker, 2013). On average, the ISPCC received over 50,000 calls per year. The IDPH data were just a fraction of the overall volume of the ISPCC system; this was due to the continual refinement of the query procedures from the ISPCC to provide IDPH with the best data possible, without including cases from exposures unrelated to pesticides (Walker, 2013).

Occupational pesticide exposures in Iowa occurs in a wide variety of industries and positions. Common sectors include agriculture, manufacturing, retail trade, healthcare, and social assistance, accommodation and food services, and administrative support to buildings and dwellings. Almost any worker in any occupation or industry can be exposed to pesticides in the workplace. Many of the past exposures involved cleaning products used by untrained workers who mixed incompatible products, used products inappropriately, or failed to use required or recommended personal protective equipment (PPE).

Over half of all pesticide exposures reported to IDPH happened in the months of May through August, accounting for 53% of annual cases. (Walker, 2013). Sixty-three percent of victims were male (Walker, 2013). Pesticide application is gender heavy towards male. However, many women are in jobs in which they are exposed to disinfectants or cleaning chemicals (Walker, 2013). In one analysis of 327 cases reported in 2008-2012, the age groups of 20-29 and 30-39 made up about half of exposures. About 30% of the exposures occurred among the 20-29 age group had the highest pesticide exposure, the next age group of 30-39 had the second highest workplace exposure with 20%, followed by 40-49 with 18% of workplace exposures (Walker, 2013). Of all exposures, 65% were "targeted," meaning that the exposure involved a pesticide that was released at the target site and not carried away by air (Walker, 2013). Eleven percent of the exposures were from indoor air, leaks and/or spills; 7% of were from surface exposure; and 17% were from drift and other exposures (Walker, 2013). Applying, mixing, transporting and disposing of pesticides were the most frequent activities during the exposure, and in 60% of cases, there was a contributing factor of the victim not having access to, or not wearing, appropriate personal protective equipment. About 109 of these cases had contributing factors such as improper or no eye protection (29% of reports) absence of gloves (8%), inadequate or no respirator (17%) and improper PPE (7%). These deficits were implicated in 60% of cases (Walker, 2013).

Almost half (47%) of the victims went to the emergency room for evaluation and another 39% only used poison control center advice as medical treatment. Disinfectants made up over 60% of the PRI cases reported to IDPH. An exposure that caused some type of health reaction to the skin, eye or respiratory tract but resolved without medical treatment made up 82% of the cases. Twenty-six percent of reports had signs or symptoms of the eyes, followed by 22% for the skin and 23% for the respiratory system (Walker, 2013).

Analysis and Future Prospects

Problems and limitations of PRI data may result from the incompleteness and lack of details in the initial report. The lack of comprehensive follow-up investigation and case review limit the usefulness of surveillance findings. Possible causes for deficits in reports may include desire for anonymity among workers, and the fact that most calls are from healthcare providers and not from the patients, which may result in missing contact information in ISPCC reports. Migrant workers or temporary workers in particular may not want or be able to report fully because of communication ability, fear of deportation, stigma, fear of losing employment due to time seeking care, lack of transportation, incomplete insurance benefits to cover healthcare costs, and/ or lack of knowledge of the health care system (Hacker, et al. 2015).

In 2014-2015, the Iowa PSPP established project capacity activities by employing paid temporary workers and unpaid interns as staffing extenders for the year. Technical capacity development was also introduced--the Iowa PESP personnel participated in coding exercises, teleconferences, webinars, and training events coordinated by NIOSH pesticide surveillance program (IDPH, 2015). Skills in the 2014 NIOSH Industry & Occupation Computerized Coding System (NIOCCS) training were exercised and taught to interns and temp workers (IDPH, 2017). A new trauma registry database was implemented in Spring of 2015 that collects data elements designated in a 2014 OHSSP project to enable better case capture by the Iowa PESP (IDPH, 2015). It is predicted that this will increase the number of pesticide exposure cases picked up by Trauma and Emergency Medical Services (EMS) data for SENSOR reporting (IDPH, 2015).

Collaborations and Stakeholder Participation

The Iowa PESP cooperates with the IDALS on cases with label violations, overspraying, or other public health concerns for human exposure. The PESP regularly contacts the Iowa State University Extension service about new or innovative pesticide information so it can be applied in their development of pesticide applicator training. Gathered information on pesticides is also disseminated to additional stakeholders including AgriSafe Network, the National Educational Center for Agricultural Safety, the National Educational Center for Agriculture Safety, and the Great Plains Center for Agricultural Health, all of these organizations provide worker and occupational health training across the U.S (IDPH, 2015). It is a priority of the Iowa PESP to cooperate with NIOSH and other state-based pesticide surveillance organizations. Iowa PESP not only represents the concerns of Iowa workers, but also represents the needs of other states with several owners/operators, or family agricultural operations and businesses (IDPH, 2015). Iowa PSPP also participates on various national workgroups and assist the NIOSH program when necessary. Staff of the Iowa OHSSP PESP are also members of the Agricultural Health Study (AHS) Iowa advisory group which meets regularly (IDPH, 2015). The PESP standard operating processes and strategic plan were scheduled to be reevaluated with feedback from stakeholders during the 2015-2020 project period, but the loss of federal funding specific to Iowa pesticide exposure surveillance resulted in cuts that ultimately ended active surveillance at IDPH. The IDPH OHSSP continues to assist the IDALS Pesticide Bureau on a case by case basis.

Strengths of the Iowa PRI surveillance program:	**Challenges of the Iowa PRI surveillance program:**
– Well-established administrative process with clear distribution of roles and responsibilities among state agencies and departments and avid communication among them – Mandated laws and regulations that require reporting by many different individuals who are likely to handle cases of PRI – Comprehensive system for reporting and collection of data from multiple data sources	– Loss of funding has eliminated the ability to conduct active surveillance going forward – The lack of and/or inconsistent funding causes abrupt changes in capabilities – Incomplete PRI data due to underreporting, the focus on occupational PRI, and social structural factors

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2. Michigan

The state of Michigan is a Midwestern state with almost 10 million residents in 2016 (United States Census Bureau). It is bordered by Wisconsin, Indiana, and Ohio and four of the five Great Lakes. Its population is predominantly white non-Hispanics (75.2%) followed by African Americans (14.1%), Hispanics/Latinos (5.1%), and Asian Americans (3.2%). Michigan's GDP ranks 13th among the 50 states. Its median household income was slightly under $5,000 according to the United States Census Bureau in 2015, falling short of the national average by almost $5,000. Michigan has been and continues to be an automotive and technology leader. A significant agricultural state, its main products are corn, soybeans, hay, wheat, oats, sugar beets, maple syrup, cucumbers, tomatoes, and potatoes. According to the USDA State Agriculture Overview, the total value of production from these product is over 650 million dollars. About 95% of the over 52,000 farms that produce these items are single family operated. Even many of those that are incorporated have been family-owned for generations.

Fast Facts:

- Exposed workers: 309,668 (3%)
- State population: 9,883,640
- Major industries: manufacturing, tourism, agriculture
- State GDP: $398 billion
- Major Crops: corn, soybeans, wheat, hay, sugar beets
- Chemical Expenses: $362,470
- Land in Farms in acres: 9,948,564
- Percent Population Urban: 74.57%
- PRI mandatory reporting and a SENSOR state

As with many states, Michigan has a number of pesticide laws covering different situations and contingencies. These include the Natural Resources and Environmental Protection Act, Act 451, P.A. 1994, Part 83, Pesticide Control; Regulation 636, Pesticide Applicators; Regulation 637, Pesticide Use; and the Michigan Occupational Safety and Health Act (MIOSHA). In order to protect the health of Michigan's citizens and the state's unique environmental resources, Michigan instituted pesticide regulations that went beyond the requirements of FIFRA. In Michigan, applicators must be state-certified in most situations to apply pesticides for a commercial purpose, in the course of employment, or when applying pesticides for hire. Those involved in producing agricultural commodities require certification only for application of Restricted Use Pesticides, which matches FIFRA requirements. Although the Michigan Department of Agriculture & Rural Development administers the certification exams, study materials are provided by Michigan State University Extension. Depending on the type of applicators (private or commercial) different information is stressed but all must take and pass exams and obtain continuing education credits on pesticide use, safety, and regulations. Study manuals for test preparation focus on pesticides and the methods for applying them, state and federal laws and regulations, labeling, environmental and human health effects, personal protective equipment, and safe handling measures.

Michigan major sources for PRI are: 1) Michigan's Poison Control Center that covers the whole state; Medical records with ICD codes (T60* (Pesticide poisoning excluding T60.0X2*, T60.1X2*, T60.2X2*, T60.3X2*, T60.4X2*, T60.8X2* and T60.92* (intentional self-harm), Z57.4 (Occupational exposure to toxic agents in agriculture) from all hospitals and emergency departments in the state; and 3) individual health care practitioners all of whom who are required to report known or suspected work-related disease including pesticide poisoning. This activity is accomplished as part of the state's participation in the NIOSH SENSOR system. NIOSH funds Michigan State University as the bona fide agent of both the Michigan Department of Health and Human Services (MDHHS) and the Michigan OSHA program to conduct pesticide surveillance in Michigan. Michigan uses PRI data to:

- Identify groups at risk for pesticide-related illnesses
- Identify clusters/outbreaks of pesticide-related illnesses
- Detect trends
- Identify high-risk active ingredients
- Identify illnesses that occur even when the pesticide is used correctly;
- Identify and refer cases to regulatory agencies (MDARD and MIOSHA) for interventions
- Provide information for planning and evaluating intervention programs

Michigan law requires employers, health providers, clinics and hospitals to report all known or suspected cases of occupational PRI to the Michigan Department of Licensing and Regulatory Affairs (MDLRA). (Michigan Public Health Code Sec. 333.5601). The Michigan Public Health Code details defines an occupational disease as:

"(1) … an illness of the human body arising out of and in the course of an individual's employment and having 1 or more of the following characteristics:

(a) It is caused by a frequently repeated or continuous exposure to a hazardous substance or agent or to a specific industrial practice which is hazardous and which has continued over an extended period of time.

(b) It is caused by an acute exposure to a hazardous substance or agent.

(c) It presents symptoms characteristic of an occupational disease known to have resulted in other cases from the same type of specific exposure……"

Cases of suspected or known occupational diseases (but not injuries) or aggravation of an occupational disease or health condition by a workplace exposure by email, fax, or mail within 10 days. Forms go to the Michigan Dept. of Licensing and Regulatory Affairs. Pesticide poisoning is also a reportable condition under the Michigan Public Health Code, which requires health care providers and employers to report identifiable information about actual or suspected cases of pesticide poisoning to the state. (Michigan Public Health Code). This includes occupational cases and, since 2006, non-occupational cases, as well. Michigan's poison control center also is required to report inquiries related to PRI exposures both occupational and non-occupational. Cases also come from private citizens, co-workers, and advocates. In addition, some cases are reported to the Pesticide and Plant Pest Management Division of Michigan Department of Agriculture and Rural Development (MDARD), which also receives complaints about health effects caused by pesticide misuse, and which investigates violations of pesticide law.

Cases are classified using the SENSOR classification criteria. Although the state collects both occupational and non-occupational data, owing to limited resources only occupational cases receive follow-up. In addition to enforcement interventions online fact sheets about pesticide-related illness are developed for individual citizens, workers and health care providers. Although many departments are involved with the collection and use of PRI data, one of the strengths of the Michigan system is that there is a contact person at the MDHHS who serves as a gatekeeper for all pesticide related matters.

The annual reports of pesticide poisoning surveillance data are public information and can be obtained on the Michigan State University and Michigan Department of Health and Human Services websites. Annual reports have been developed since 2001. The most recent report, Pesticide Illness and Injury Surveillance in Michigan 2014, which was released in 2016, includes data on occupational and non-occupational pesticide illness and injuries, outreach, education, prevention activities, and discussions. It was prepared by the Division of Environmental Health of the Michigan Department of Health and Human Services and Michigan State University. (Division of Environmental Health 2016).

According to this report, a total of 59 occupationally related incidents were identified in 2014 stemming from 50 different events. In 32 cases, the poisoned individual was female, and 27 cases involved males. The most common occupation was Building and Grounds/ Cleaning and Maintenance, which represented almost a third of cases (12 cleaning personnel and 7 pest control operators). The next largest category was Protective Service (18.6%), which represented 11 lifeguards (10 from a single event). Although there was no case follow-up for non-occupational cases, the same criteria and data sources were used for these cases. The report indicates 155 confirmed non-occupational cases from 152 different events (79 women/76 men). In both occupational and non-occupational cases, when the victim's activities were known, the most common was involvement in pesticide application. About 75% of confirmed occupational cases and 60% of the non-occupational cases came from PCC reports. Just one example of the utility of these PRI data; the Michigan report indicates that half of the confirmed cases deal with disinfectants. It notes that in many cases, PRI could have been avoided by educating the public and employers to limit disinfectant use to situations in which it is indicated. Although the report acknowledges that cases are likely to be undercounted, in the past 5 years there has been a steady decrease in cases.

Strengths of the Michigan PRI surveillance program:	Challenges of the Michigan PRI surveillance program:
– An academic center (Michigan State University), coordinates the activity of the three state agencies; each entity has a clearly defined role in the surveillance system and there is regular communication among the entities – There is mandatory reporting of all occupational illnesses and injuries as well as mandated reporting of PRI by hospitals, emergency departments and health care providers – Workers' Compensation contributes data on PRI claims – Annual reporting is comprehensive, high quality and accessible to the public – Despite involvement of numerous departments, an identifiable gatekeeper serves as the person of contact for PRI related items – Agencies have a relationship with an academic center (MSU), which can provide medical input, additional rigor and contribute to dissemination for multiple audiences – In addition to the state's own intervention strategies, reports are shared with EPA for enforcement purposes – There is a clear definition of Occupational Cases – The PCC allows the most accurate and detailed reports	– Not clear how workers themselves are supposed to report – Cases are undercounted due to complicated coding, lack of personnel, and potential cases not seeing a doctor (similar to other states) – No follow-back is done on non-occupational cases

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3. Washington

Washington is the third largest agricultural exporter in the nation with more than 15 million acres of farmland producing around 300 commercial crops and livestock products (NASDA, 2017). Primary crops are apples (148,000 harvested acres), wheat (2,225,000 harvested acres) and potatoes (170,000 harvested acres). Washington leads in minor crops like hops, mint, and berries.

A notable reduction in land dedicated to agriculture has occurred over the past few decades. Today there are 37,249 farms and 14,748,107 acres dedicated to farmland. Between 2007 and 2012, the number of farms decreased from 39,284 to 37,249 (a loss of 2,035 farms) and farming land decreased from 14,972,789 to 14,748,107 acres (a loss of 224,682 acres), a trend that is continuing (USDA Economic Research Service, 2017). The rising cost of land and the increase in the percentage of land managed by older farmers together explain much of the state's lost agricultural land (American Farm Trust, 2017).

Washington's population in 2016 was 7,288,000 with a majority being white, not Hispanic or Latino (69.8%), Hispanic or Latino (12.4%), Asian (8.4%), African American (4.1%), and Native American/Alaska Native (1.8%) (U.S.Census, 2017). More than 63% of the population is in the labor force with over 110,000 employed outside of agriculture but in fields in which pesticide exposure is likely.

Fast Facts:

- Exposed workers: 406,729 (5.4%)
- State population: 7.4 million
- Major industries: aerospace, agriculture, clean technology, information and communication technology, forest products
- State GDP: $370 billion
- Major Crops: apples, wheat, and potatoes
- Chemical Expenses: $498,212
- Land in Farms in acres: 14,700,000
- Percent Population Urban: 84.05
- SENSOR state; PRI reporting mandatory

Pesticide regulation

Washington State statute (Title 70, Chapter 70.104, Section 70.104.030) authorizes the Department of Health to investigate all suspected human cases of pesticide poisoning and to establish response time periods, by rule, from immediate to forty-eight hours to investigate a suspected case. Further, the Department of Health is authorized to collect tissue samples and other relevant information pertaining to determination of the nature and cause of any pesticide poisoning. Results are to be communicated to the state Department of Agriculture and Department of Labor and Statistics and others if appropriate.

The Washington Pesticide Control Act (15.58 RCW) establishes that businesses involved in all aspects of the pesticide manufacturing process, from formulation through disposal, are a matter of public interest. It further establishes the state's police powers to protect public health and welfare in this area. Specifically:

> The formulation, distribution, storage, transportation, and disposal of any pesticide and the dissemination of accurate scientific information as to the proper use, or nonuse, of any pesticide, is important and vital to the maintenance of a high level of public health and welfare both immediate and future, and is hereby declared to be a business affected with the public interest. The provisions of this chapter are enacted in the exercise of the police powers of the state for the purpose of protecting the immediate and future health and welfare of the people of the state.

The Washington Pesticide Application Act (17.21 RCW) establishes that activities associated with pesticide application, including the licensing of pesticide applicators, are of public interest. As a result, the Act utilizes the police power to authorize activities for the protection of public health.

Specifically:

> The application and the control of the use of various pesticides is important and vital to the maintenance of a high level of public health and welfare both immediate and future, and is hereby declared to be affected with the public interest. The provisions of this chapter are enacted in the exercise of the police power of the state for the purpose of protecting the immediate and future health and welfare of the people of the state.

General Pesticide Rules (WAC 16-228) establish specific designations regarding registration and licensing of pesticide chemical compounds, restrictions on various pesticide compounds, storage and labeling requirements, and penalties for violation.

The Washington Worker Protection Standard (WAC 16-233) outlines requirements to protect workers from injuries caused by exposure to pesticides during the course of performing their work-related duties. Specifically:

> This chapter contains standards designed to reduce the risks of illness or injury resulting from workers' and handlers' occupational exposures to pesticides used in the production of agricultural plants on farms or in nurseries, greenhouses, and forests and also to reduce the accidental exposure of workers and other persons to such pesticides. It requires workplace practices designed to reduce or eliminate exposure to pesticides and establishes procedures for responding to exposure-related emergencies.

State law requires employers to train pesticide applicator employees on safe application techniques as well as the risks of exposure and how to obtain emergency medical care. The law does not have a requirement to include information about the reporting process.

The Cholinesterase Monitoring rule (WAC 296-307-148) requires agricultural employers to provide medical monitoring for workers who handle organophosphate or N-methyl-carbamate cholinesterase-inhibiting pesticides in Categories I or II. The rule requires the employer to obtain a written recommendation from the health care provider for each employee test (including baseline tests) and evaluation and ensures that the employee receives a copy. The updated rule has been in effect since February 1, 2006.

Reporting requirements

Reporting of suspected pesticide exposure-related illness is mandatory in Washington. Health care providers, health care facilities, laboratories, veterinarians, food service establishments, child day care facilities, and schools are legally required by WAC 246-101-105 to notify public health authorities in their local health jurisdiction of suspected or confirmed cases of selected diseases or conditions referred to as 'notifiable conditions' (discussed further below). Pesticide Poisoning falls within this category (Washington Department of Health, 2017). RCW 70.104.055 (Pesticide poisonings - Reports) defines a suspected case of pesticide poisoning as "a case in which the diagnosis is thought more likely than not to be pesticide poisoning".

Chapter 246-101 WAC, 'Notifiable Conditions', outlines numerous provisions of which a handful directly apply to PRI. Duties of the health care provider, department of health, the means and content of notifications, as well as the handling of case reports and medical information set specific requirements related to pesticide exposure. WAC 246-101-010 defines pesticide poisoning as "the disturbance of function, damage to structure, or illness in humans resulting from the inhalation, absorption, ingestion of, or contact with any pesticide."

Health care providers, either primary care or other specialties (under WAC 246-101-105), "shall notify the State Department of Health pesticide poisoning that is fatal, causes hospitalization or occurs in a cluster- immediately and for all other cases, within 3 business days". 'Immediately' is defined as "the time of diagnosis or suspected diagnosis" and, further, the law states that this requirement "applies twenty-four hours a day, seven days a week". WAC 246-101-105 dictates that the health care providers notify public health authorities when a pesticide exposure "is fatal, causes hospitalization or occurs in a cluster." Finally, patient confidentiality is addressed in WAC 246-101-120 'Handling of case reports and medical information'. Among rules to ensure patient privacy, (3)(ii) dictates that a system be in place "to remind referring health care providers of their reporting obligations under this chapter."

Reporting

The Washington State Department of Health (DOH) became a part of the National Institute for Occupational Safety and Health (NIOSH) Sentinel Event Notification System for Occupational Risk (SENSOR) Pesticide Incident Data & Reporting (SPIDER) system in 2010. The SENSOR database stores information gathered from occupational pesticide-related illness and injury cases submitted by the SENSOR-pesticides states. Washington is one of the 8 out of 12 SENSOR states that receives EPA funding and technical support, though this stopped in 2015, with an additional one-year contract. In addition, Chapter 70.104 RCW adds *non-occupational* pesticide related illness to the DOH's scope of responsibility, charging it with investigating both worker and non-worker pesticide related illnesses.

Reports of suspected and confirmed pesticide exposures are collected via various routes. The major source of occupational data comes from workers' compensation claims, which are forwarded to the Washington Department of Health (WDOH) by the Washington Department of Labor and Industries (WDLI). Health care providers are mandated to report cases as well, and may do so through calls to the Washington Poison Center (WAPC), through filing workers' compensation reports or directly to the Washington Department of Health (WDOH). The WAPC forwards both occupational and non-occupational cases to the WDOH on a daily basis, and the WDOH decides which cases to investigate. Cholinesterase testing is mandated for pesticide applicators using certain chemicals and laboratories analyzing these specimens are required to report to WDOH. A small number of cases are reported to WDOH from the Washington Department of Agriculture (WDA). Often all of the desired data elements (especially name of product, EPA number, chemical name, and date of birth of the worker/patient) are not provided and require further investigation by WDOH—e.g., review of medical records, interview of the patient, review of application records--in order to provide adequate data to NIOSH, to make a determination of the probability of PRI, and to inform enforcement and prevention activities (J. Prado, personal communication, March 14, 2017).

In 2013, the most recent year for which these data are currently available on the WAPC website, pesticides were among the top ten human exposure categories, as were household cleaning substances, which often contain disinfectants, classified under FIFRA as pesticides (WAPC, n.d.). Household cleaning substances were also one of the top ten exposure categories for children under the age of six. Both categories appear in the top ten list for adults for that year, with household cleaning substances at number five and pesticides at number eight. For adults, these exposures were both occupational and non-occupational. As is true of all poison control data, they only represent those pesticide exposures that were reported by workers and community members or healthcare providers that care for them.

The Department of Agriculture may, according to the Administrative Procedures Act RCW 34.05, issue a Notice of Intent (NOI), enabling the Department to assess civil penalties, and/or suspend, deny or revoke the violator's license. The Washington State Department of Agriculture (WSDA), under the Washington Administrative Code, can assess a maximum penalty of $7,500 per violation and/or suspend, deny or revoke a license (WSDA, 2017). Less formal actions include a verbal warning, advisory letter or Notice of Correction.

Pesticide Investigations following reports of potential exposure

According to the Pesticide Data Report (Washington State, 2013), the Health Department investigated 300 complaints of pesticide exposure from 2010 to 2011- 162 in 2010 and 138 in 2011. Aerial drift accounted for 9 incidents of human exposure, ground drift for 33, and reentry to a treated field prior to expiration for 7. One-hundred seventeen involved agricultural drift with 49 involved possible human exposure, 14 of which resulted in action. These actions included civil penalties ($24,450 in 2010) with 58 Notices of Correction (NOC) issued, resulting in a total of 96 days' license suspension. A breakdown of penalties for 2011 is not available but a summary report on WSDA pesticide enforcement actions (WSDA, 2013) indicates that $6,400 in civil penalties, 21 total days of license suspension and 1 instance of mandated, additional, WSDA-provided training to employees were assessed.

Two hundred ten of the 300 complaints resulted in violations. A larger proportion of complaints involved exposure to herbicides than pesticides. Sixty percent of all complaints in 2010 and 45% in 2011 involved herbicides with 2, 4-D and glyphosate being the two active ingredients most reported.

Activities that resulted in violations for the 2 years combined are broken down into five categories: 77 (37 %) commercial/industrial; 42 (20 %) agricultural, l, 40 (19 %) pest/wood destroying organism control, 29 (14 %) right-of way (public land), and 22 (10 %), residential activities.

Outreach

Partnerships and key relationships play an important role in pesticide regulation in Washington. The WDOH collaborates with the WDLI and the WAPC with respect to data collection and management and also in preventing pesticide exposure. Land grant colleges and the University of Washington's Division of Environmental and Public Health also provide support with respect to research and knowledge transfer. The WDOH also works closely with community centers, regional migrant health centers, rural communities and pesticide applicator company owners. This cross-agency collaboration is essential to informing and educating the public (in particular, those most vulnerable to exposure) about PRI.

Strengths of the Washington PRI surveillance program:	**Challenges of the Washington PRI surveillance program:**
– Established administrative process, well defined roles and responsibilities among agencies – Comprehensive and crosscutting laws and regulations that address pesticide exposures across multiple fronts, from training to reporting – Cooperative relationships with community organizations – Mandatory cholinesterase testing for pesticide handlers with mandatory reporting	– Inconsistent funding – Multiple pathways for reporting: reports of potential pesticide related illness are accepted by different agencies (WAPC, DOH) and laboratories (cholinesterase), although the regulation stipulates that reports be made to the DOH – Incomplete data due to under or inadequate capture, especially by WAPC

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4. Nebraska

Nebraska is a Plains state with a climate similar to Northern Illinois. Illinois is roughly 8 times more populous. However, with respect to agriculture, both states grow very similar field-based crops. Agriculture in both states is heavily mechanized, with a limited number of workers involved. Nebraska's pesticide use laws and regulations closely track FIFRA, with all restricted use pesticides requiring a license to sell, purchase or apply. Nebraska is a NIOSH SENSOR state, with mandated PRI reporting by doctors, hospitals and clinics, and laboratories. PRI cases also come to the Nebraska Poison Control Center (NPCC) through provider and individual inquiries. Nebraska receives technical assistance from NIOSH, but receives no funding from NIOSH.

Fast Facts:

- Exposed workers: 124,214
- State population: 1,826,341
- Major industries: agriculture, manufacturing, mining, and service
- State GDP: $95 billion
- Major Crops: cattle, corn, soybeans, hogs, wheat
- Chemical Expenses: $757,437
- # of Farms in acres: 45,331,783
- Percent Population Urban: 73.1%
- PRI reporting mandatory; SENSOR state

When there is a suspected PRI incident, if medical treatment is sought, health care providers are required to report confirmed or suspected PRI within 7 days. These reports go to a local health department or may be made directly to the NDHHS. The Department investigates high priority incidents to determine if there was, in fact, pesticide poisoning and may make referrals to appropriate agencies with authority to further investigate or take action on licenses, if warranted; it publishes an internal report of its findings. Data surrounding each incident are entered into the NIOSH SENSOR program if the PRI is determined to be occupational.

If the victim does not seek medical treatment, a report of the incident may still be generated if someone calls NPCC. These data are collected by NDHHS, however, reports are often incomplete or difficult to verify. Occupational cases are entered into the SENSOR database.

According to the Nebraska Pesticide Act, enacted in 1993, the Nebraska Department of Agriculture (NDA) is primarily responsible for pesticide regulation. In particular, the NDA is in charge of regulating restricted use pesticides. Anyone who buys, sells, applies, or transports a restricted use pesticide must be licensed by the NDA. The only exceptions are that the Nebraska Department of Environmental Quality regulates pesticide use if a pesticide is being manufactured, mixed, loaded or stored in Nebraska, or is being applied by the addition to irrigation water (known as chemirrigation). Applicator training is largely under the auspices of the University of Nebraska Lincoln Extension. There are three applicator license levels in Nebraska. Private Applicator licenses are for those who will be using restricted use pesticides on their own property. A private use applicator license holder may apply pesticides to someone else's property, but cannot be paid to do so. An exchange of services is allowable, so long as there is no other compensation. Private license holders need not take an examination. Training for a private use license may be completed by attending classes, completing a self-study course, or completing an exam provided by the NDA. A $25 fee is collected, and a 3-year license is issued. Resources for applying for a private applicator license are available at http://pested.unl.edu/ .

Commercial use licenses are for individuals who apply restricted use pesticides on a for-hire basis. In addition, anyone who applies structural pesticides, whether restricted use or general use, on a for-hire basis must have a commercial use license. These licenses are divided into 14 categories, with another 4 sub-categories. Each category is specific to a common pesticide class and usage, such as agricultural plant pesticides, livestock pesticides, and structural pesticides. The full list can be found at http://www.nda.nebraska.gov/pesticide/cert2.html . In order to receive a commercial use license in one of these categories, an individual must pass two tests. The first test is a general pesticide use test common to all categories. The second is specific to each category and is tailored to the practices and hazards specific to each. The licensing fee is $90 and the licensing period is three years.

Non-commercial use licenses are for individuals who apply restricted use pesticides for an employer but not on a for-hire basis. This category also includes persons performing outdoor vector control pesticide applications for communities or municipalities. The licensing tests and categories are identical to the commercial use licenses, however there is no fee for a non-commercial license.

Strengths of the Nebraska PRI surveillance program:	Challenges of the Nebraska PRI surveillance program:
– Nebraska has a clear, single pathway for reporting. – One state agency is responsible for collecting and investigating reports – SENSOR data is easily comparable to other SENSOR states – Data is relatively easily accessible online	– Nebraska has a relatively new program without much historical data – Unclear how much outreach to NGOs and other interested entities is happening – NDHHS has limited funding, which prevents appropriate staffing levels, given new responsibilities. – Poison control data, the major source of PRI cases, is often missing important data elements (DOB, EPA registration number) – No indication that non-occupational PRI is adequately captured; relatively low numbers of occupational PRI may indicate a failure to capture all occupational PR

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5. Florida

Florida is a Southern state with an extensive coastline. Florida borders the states of Georgia and Alabama. The 2010 census reports a state population of 18,801,310 with majority being white (57.9%) and the second largest group being Hispanic or Latino at 22.5 %, followed by Black or African American at 16% (U.S. Census Bureau, n.d.). Around 63.5% of the population is in the civilian labor force with about 8,990,221 employed (U.S. Census Bureau, n.d.). Florida has the 4th highest population in the United States (U.S. Census Bureau, n.d.). The state capital is Tallahassee.

Florida's GDP was $749,751 billion in 2012 placing it fourth among the states (Baumgardner, Brooks, & Cao, 2012). Florida's major industries include tourism, agriculture, international trade, and life sciences. Florida is the number one producer in the United states of oranges and sugarcane as well as a top five contributor in vegetables harvested (Florida, 2017).

Fast Facts:

- Exposed workers: 500,468
- State population: 18,801,310
- Major Industries: Tourism, Agriculture, International Trade, Life Sciences
- State GDP: $750 billion
- Major Crops: Oranges, Sugar cane, tomatoes
- Chemical Expenses in $: 1,110,995
- Farm land in acres: 9,548,342
- Percent Population Urban: 91.2
- PRI reporting mandatory; SENSOR state

Pesticide Regulation

The Florida Department of Agriculture and Consumer Services (FDACS) has a primary role in the regulation of pesticides. Through their Bureau of Compliance, they handle cases of drift and overspray as well as occupational exposures. Their Bureau of Entomology and Pest Control handles cases of household pesticide exposure as well as investigating cases that involve a licensed pest control operator (Pesticide Poisoning, n.d.).

The FDACS continuously updates product brand registration status and information. In addition, together with the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS), it administers the training and certification program (including re-certification) for pesticide applicators. ("Pesticide Applicator Certification," 2015) Certification, which is covered for agricultural, industrial, and outdoor pesticide use by the Florida Pesticide Act, is required for most restricted use pesticide applications as well as certain applications of general use pesticides (for example, by aerial spraying) (Florida Statutes, chapter 487 part 1). Licenses may be private, public, or commercial. Licensing for indoor pesticide application, which is required for any general- or restricted-use pesticides (other than in one's own home) is covered by the Structural Pesticide Control Act (Florida Statutes, chapter 482), which is also administered by the FDACS, Bureau of Licensing and Enforcement. A variety of licenses and certifications are available. There is also a separate category for public health pest control. Training, either in person or by the use of manuals, is provided by the UF/IFAS. In all cases, training and exams cover pesticide use and safety as well as specifics pertaining to the particular license sought.

The FDACS, Bureau of Licensing and Enforcement also maintains a Registry for Pesticide Sensitive Persons, for those who have been identified as pesticide sensitive by a physician. They are to be notified before lawn care pesticides are applied in a property adjacent to their own.

While FDACS administers the education and testing program for applicators, the Florida Department of Health (FDOH) provides a significant range of educational materials on its website geared toward individuals (Pesticide Poisoning, n.d.).

PRI Reporting

Although Florida and Illinois are not very similar with respect to climate or crops, Florida has a PRI reporting system in place that makes it useful as an analytical comparison. Florida is a NIOSH SENSOR state, with mandated PRI reporting. The goal of Florida's PRI surveillance program is to "document and monitor pesticide exposures in the state to identify trends in pesticide exposures and prevent additional exposures where possible" ("Surveillance," n.d.).

Although individuals who believe they have been exposed to pesticides may use the reporting system, health care providers, including physicians, hospitals, and laboratories, must report cases of PRI by the next business day. (Florida

Statutes, Section 381.0031, Rule 64D-3, Florida Administrative Code (F.A.C)). Florida makes a significant effort to educate healthcare personnel in the presentation and symptomatology of PRI. (Appendix B) In addition to this mandatory reporting, reports are accepted from others, including "exposed person(s), witnesses, legal services, farmworker advocacy groups, other state agencies, media, and others willing to report" ("Surveillance," n.d.). A report may be made to either the local county health department or by telephone to the Department of Health Pesticide Exposure Surveillance section or to the Pesticide Hotline during business hours. In this regard, the FDOH works directly with the primary agency in charge of pesticides, which is the FDACS as well as with the local county health departments. Investigations of reported cases are conducted by the FDOH in conjunction with the FDACS, particularly if it appears that there may have been a pesticide use violation. Although the FDOH does not have its own laboratory for use in these investigations, it will accept lab reports from accredited laboratories within the state. These investigations may involve interviews, a medical records review, and a review of field and lab findings.

Surveillance of PRI in Florida is done by the FDOH under the auspices of its Chemical Disease Surveillance Program (CDSP). "The primary purpose of the surveillance program is to identify the magnitude and distribution of acute pesticide-related illness and injury and to implement prevention and intervention activities aimed at reducing the occurrence of pesticide poisonings" ("Surveillance," n.d.). The CDSP relies on mandatory and voluntary case reports as well as information from the Florida Poison Information Center Network (FPICN) and emergency rooms. It uses the standard SENSOR protocol for classifying cases as to the likelihood that the symptoms reported are related to a pesticide exposure (described in Iowa section, above). Ultimately the FDOH uses the data to determine prevention and intervention activities, including education and outreach. The data are reported annually to NIOSH and compared to that of the other states in the NIOSH/SENSOR program. The data are then shared with other federal agencies such as the EPA and National Center for Environmental Health (NCEH) at the CDC.

FDOH reports pesticide exposure rates on its website as part of its Environmental Public Health Tracking system (Pesticides, n.d.). The most recent year for which data are available online is 2014. These data are derived from calls to the FPICN plus follow-up. They include pesticide exposure per 100,000 (24.66 statewide in 2011), pesticide exposure with a health effect per 100,000 (5.44), and pesticide exposure with a health effect where case was treated in a health care facility (2.15). These data are also divided by county but are not categorized by any other demographic attributes.

Strengths of the Florida PRI surveillance program:	**Challenges of the Florida PRI surveillance program:**
– Mandatory reporting of all PRI cases, occupational and non-occupational – Clear pathways for reporting – Some data are available online – High quality educational materials for healthcare professionals (see Appendix C) and individuals – Cooperation between state agencies is well worked out	– PRI data only include acute illnesses which occur between 24-48 hours after pesticide exposure – Not all cases of pesticide related illness are reported to FDOH (general problem with "passive" surveillance systems) – FDOH staff may not be able to locate a seasonal or migrant farm worker for interview – Limited data available on FDOH website

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6. California

California is located on the west coast of the United States. It is surrounded by the Pacific Ocean to the west, the states of Oregon to the north and Nevada and Arizona to the east, and the country of Mexico to the South. The 2010 Census reported a total state population of over 37 million people, of whom 40.1% of people identified as white; 37.6% identified as Hispanic or Latino; 13.1% identified as Asian or Pacific Islander; and 5.8% identified as Black or African American (U.S. Census Bureau, 2011). As of 2016, California had a GDP of over 2.6 trillion U.S. dollars and an unemployment rate of 5.2%.

California has been ranked as the sixth largest economy in the world (Taylor, Sisney, Kuhn, Simbol, & Newton, 2016) and, in addition to other industries, has a prominent agricultural component to its economy. Although the California Department of Employment Development reports only about 440,000 farm workers (about 1.2% of the population), farming takes up 25,550,000 acres of land (about 25% of the state's area) (CDPR, 2011). The state generates an abundance of produce, including grains, citrus, nuts, leafy greens, vegetables, fruit, and other crops.

Fast Facts:

- Exposed workers: 1,259,492
- State population: 37,253,956
- GDP: $2.3 trillion
- Major industries: Computers and Electronics; Vehicles and Machinery; Agriculture, Food and Beverages; and Chemicals and Pharmaceuticals (Taylor, Sisney, Kuhn, Simbol, & Newton, 2016)
- Major crops: Almonds, Grapes, Lettuce, Strawberries, and Tomatoes (Ca. Dept. Food & Agric., 2015)
- Chemical expenses: $2,190,674
- Farmland (acres): 25,569,001
- Urban population: 94.95%
- Mandatory PRI; SENSOR State

Most growers in California rely on pesticide use to deter insects, rodents, fungi, and competing plant life. In 2010, reported pesticide use in California totaled 173 million pounds, increasing by 15 million pounds from 2009 (CDPR 2011). Although pesticides can improve yield and quality of produce, they can also be an occupational hazard for farmworkers and an environmental hazard for those living near farm operations or downstream or downwind of agriculture. To improve the safety of those working and living around agriculture, California regulates pesticide use and monitors pesticide exposure.

Pesticide Regulation

The California Department of Pesticide Regulation (DPR), which operates under the umbrella of the California Environmental Protection Agency (CalEPA), regulates pesticide sale and use and fosters reduced-risk pest management, expanding on the policies of FIFRA. DPR is responsible for licensing, registration, enforcement, and reporting on pesticides. Funded by regulatory fees and working closely with county agricultural commissioners for reporting and enforcement, DPR evaluates and registers pesticide products before sale or use; licenses commercial dealers, applicators, consultants, and other pesticide professionals; evaluates health impacts through risk assessment and associated illness surveillance related to air, water, food, home and workplace; investigates pesticide related illnesses; determines best practices for workplace pesticide use; monitors potential health and environmental impacts of previously registered pesticides; tests residue on fresh fruits and vegetables; and gives grants, awards, and regulatory incentives to encourage reduction of pesticide use. Furthermore, DPR maintains a number of online databases through California Pesticide Information Portal (CalPIP) that include information related to pesticide registration and licensing, pesticide use, environmental effects, and enforcement. Although DPR releases a considerable amount of data, there is a significant delay, with the most recent reports reflecting data from 2012.

PRI Reporting

Since 1971, physicians in California have been required to report known or suspected cases of PRI (Cal. Dept. of Pesticide Regulation, n.d.). Physicians have 24 hours to report suspected pesticide related illnesses to their local health officer (Cal. Health & Safety Code, n.d.). In cases in which a physician contacts PCS for a consultation, PCS is authorized to report on their behalf. Physicians and other health care providers may also report using an electronic portal. Finally, for work-related PRI, physicians are also required to report to the Department of Industrial Relations as well as the local health officer within 24 hours. They must also notify the insured employer or insurance carrier. (Ca. Office of Environmental Health and Hazard Assessment, n.d.). All reports go to the local County Agricultural Commissioner

(CAC), who has the task of investigating suspected cases of PRI and pesticide misuse. Individuals are advised to report all such (non-emergent) cases directly to the CAC (Ca. Dept. of Pesticide Regulation, 2014).

Although the reporting requirement is enforced by DPR, the Office of Environmental Health Hazard Assessment (OEHHA), which is also part of CalEPA, facilitates physician reporting of PRI with the Confidential Report of Known or Suspected Pesticide Related Illness Form. This form collects the personal information of the patient; including social security number and ethnicity, information about the provider; details about the illness, including onset date; the date, location, type of pesticide, and activity of the patient during exposure; and finally the identity of the employer if the exposure happened at work. Failure of a physician to report illness or injury can result in a civil penalty of $250 for each violation (Cal. Health & Safety Code, n.d.). To increase the likelihood that physicians recognize PRI, OEHHA offers courses on Recognition, Management and Reporting of Pesticide Illnesses in both English and Spanish (see Appendix B).

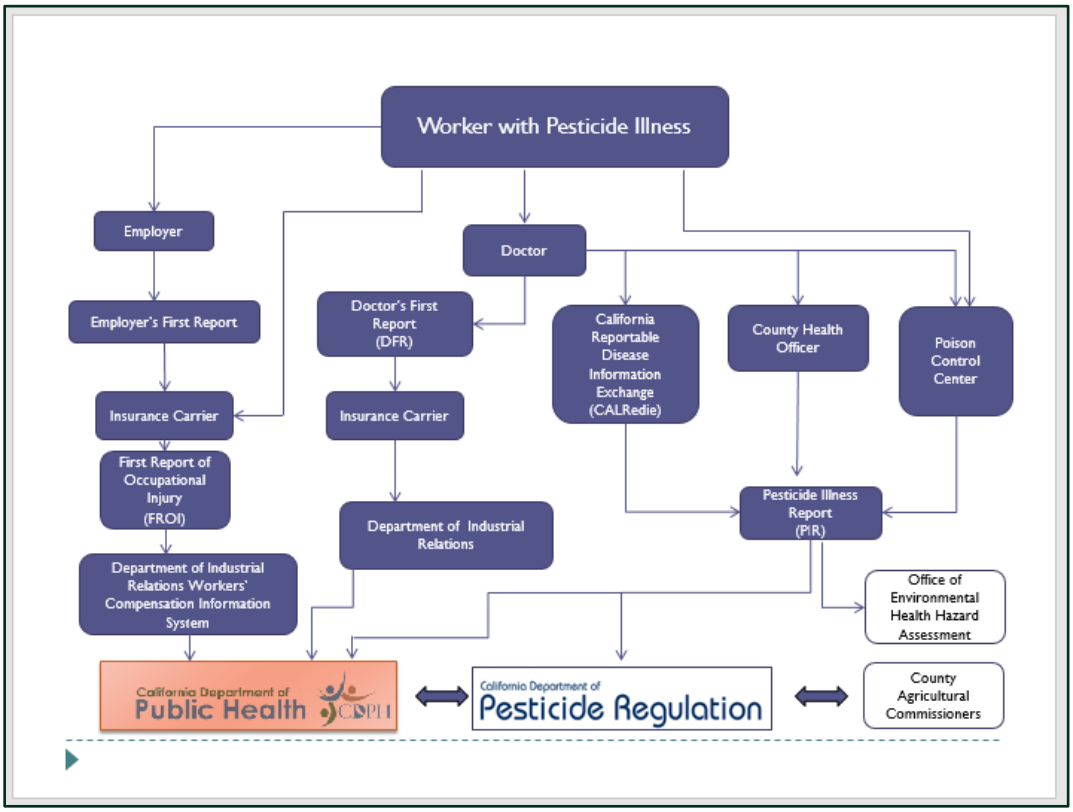

Figure 1. Pesticide reporting scheme in California (provided by CDPH, 2018)

The DPR collects data from the CACs, PCS, and the California Worker's Compensation program. In a communication with DPR, it was estimated that the department records between 1200-1600 cases a year by reviewing both occupational and non-occupational pesticide related illnesses and collecting data from the California Department of Public Health (DPH). The DPH reports collecting about 800 cases a year, though about 200 are discarded as asymptomatic. Overlap between the two departments is avoided by data matching. Relative to other states in this report, 1200-1600 reported cases is a huge number. These numbers reflect the enormity of the agricultural production of California, but it is also possible that they reflect the rigor with which California approaches PRI reporting and the resources that are dedicated to it.

It is important to note that as in other states, reported PRI may miss a large group agricultural workers. When asked about whether undocumented workers were captured in the reported data, representatives from DPR and DPH said that they suspect that undocumented workers are underrepresented in the reported data, as these workers are more fearful of going to the doctor and more likely to face employer retaliation if a report is traced back to them. Although California has a robust PRI reporting program, it still may be missing a key demographic segment of the population.

Strengths of the California PRI surveillance program:	Challenges of the California PRI surveillance program:
– The Department of Pesticide Regulation is self-funded – Each state agency involved in pesticide regulation and reporting has a specified function – When departmental functions overlap, they work together to share information – The data generated by PRI reporting are detailed and comprehensive, coming from the CAC, PCS and the California Worker's Compensation Program – Data generated is publicly available through a dedicated website: The California Pesticide Information Portal (CalPIP)	– Data publishing lags behind data generation by up to five years. – The CalPIP website can be difficult to use – DPR has enforcement responsibilities, but it needs teeth to make enforcement stick – Some of the most vulnerable agricultural workers are missed by the reporting system

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B. NON-SENSOR States

1. Missouri

Missouri is a Midwestern state with around six million residents. The state ranks twenty-first in land mass in the U.S. and is geographically diverse (NSTATE, LLC., 2016). Missouri is bordered by Iowa to the north and by Arkansas and Tennessee to the south. Illinois, Kentucky and Tennessee border Missouri to the east and Nebraska, Kansas and Oklahoma border it to the west (NSTATE, LLC., 2016). The United States Census Bureau estimates that the population of Missouri was 6,093, 000 in 2016, ranking it 18th in the nation. In 2016, Missouri had a per capita personal income (PCPI) of $43,723. This PCPI ranked 33rd in the United States and was 88 percent of the national average, $49, 571. The 2016 PCPI reflected an increase of around 3.2 percent from 2015 (Bureau of Economic Analysis , 2017).

Fast Facts:

- Exposed workers: 245,867
- State Population: 5,988,000
- Major industries: service, wholesale/retail trade, manufacturing (transportation equipment), agriculture
- State GDP: $257 billion
- Major Crops: soybeans, hay, corn, rice, sorghum
- Chemical Expenses: $486,213
- # of Farms in acres: 28,266,137
- Percent Population Urban: 70.4%
- PRI reporting is mandatory (19CSR20-20); not a SENSOR state

Similarly, in 2015, Missouri's current-dollar GDP was $294.5 billion, 21st in the United States. Major industries include: aerospace, transportation equipment, food processing, chemicals, printing/ publishing, electrical equipment, light manufacturing. In addition to grains, major agricultural products are beef, soybeans, corn, pork, and poultry (Mo. Dept. of Ag., Missouri's Top Commodities, n.d.).

Pesticide Regulation

The Missouri Department of Agriculture (MoDA) is in charge of the prevention of the spread of harmful insects and plant disease through the Plant Pest Control Bureau and is responsible for regulating the use of pesticides in the state. The overall goal of the Pesticide Program of MDA is to "prevent unreasonable adverse effects of pesticide use on human health and the environment while helping assure the availability of pesticides needed to maintain the quality of life" (Mo. Dept. of Ag., Pesticide Control, n.d.). This is accomplished by licensing pesticide applicators and dealers, registering pesticides, and performing inspections in the enforcement of the Missouri Pesticide Use Act and the Missouri Pesticide Registration Act (Mo. Dept. of Ag., Pesticide Control, n.d.).

The Missouri Plant Law (RSMO 263.010- 263.180) allows the MDA to inspect and certify nursery growers and dealers. The goal is to provide early detection of pests to facilitate management or eradication, thereby keeping export markets open (Mo. Dept. of Ag., Plant Pest, n.d.).

The Missouri Pesticide Use Act establishes requirements and training programs for licensing of applicators, dealers, technicians and operators. All of the information regarding training programs and certification exams is available online on the MDA website. There are several types of pesticides licenses, each of which requires the applicant to pass a state pesticide certification examination. The Act requires the certification and licensing of commercial, non-commercial, public and private pesticide applicators. In addition, sections 281.100 and 2 CSR 70-25.050 (2) of the Missouri Pesticide Use Act and regulations authorize the MDA's Bureau of Pesticide Control to establish minimum criteria for re-certifying Missouri commercial and noncommercial pesticide applicators and public operators (Mo. Dept. of Ag., Pesticide Control - Certification & Licensing, n.d.).. Applicators are required to use pesticides only as directed by the pesticide labeling.

The Missouri Department of Agriculture, through the Pesticide Program in the Plant Industries Division, also works with a variety of state and federal agencies to maintain the quality of Missouri water. The primary effort is to prevent pesticide-related water quality issues through user education and, if prevention is unsuccessful, to determine if state or federal pesticide laws have been violated in a way that impairs water quality (Mo. Dept. of Ag., Pesticide Control, n.d.).

With the trade name or EPA registration number of a pesticide, it is possible to contact a representative of MDA to ask for related information. Also, Missouri has a research institute called "Beekeepers Association," which is tasked with educating those working in agriculture and production of honey about safe pesticide use.

The Bureau of Pesticide Control conducts enforcement and inspection activities under the authority of the Missouri Pesticide Use Act and Administrative Rule (281.005 - 281.180 RSMo & 2 CSR 70-25). There are several types of investigations and inspections conducted by Bureau field staff. These may include: pesticide use and follow- up, applicator establishment, marketplace, records of use and sales, direct supervision of technicians, experimental use and producer establishment. Individuals suspecting damage caused by pesticide use may file a complaint with the MDA by mail or online. (Mo. Dept. of Ag., Enforcement & Inspections, n.d.) Each incident report is reviewed to determine if an investigation is warranted. At the end the investigation, a report is issued that is available to all parties involved. Investigations may result in civil or criminal penalties. If no investigation is initiated, an explanation is provided to the complainant.

PRI Reporting

There is a reporting protocol connected with the list of Diseases and Conditions Reportable in Missouri to be followed when "a physician, physician's assistant, nurse, hospital, clinic, or other private or public institution providing diagnostic testing, screening or care" suspects a case of pesticide poisoning. (Missouri Department of Health and Senior Services (MDHSS) Rules, 19 CSR 20-20.020(6)). For the purpose of reporting, "Pesticide poisoning means human disturbance of function, damage to structure or illness which results from the inhalation, absorption or ingestion of any pesticide." (MDHSS Rules, 19 CSR 20-20.010(32), 2017). Such cases must be reported to the local health authority or the MDHSS within three calendar days of first knowledge or suspicion.

In terms of the impact of pesticides on individual health, the MDHSS works together with the local health agencies across the state to offer information and assistance. The Department of Agriculture and the Department of Natural Resources handle other aspects of pesticide safety. Together, they are responsible for the creation of a database of all cases of pesticide related illnesses in Missouri.

Table 1. Annual incidence rate of reported work-related pesticide poisoning cases per 100,000 employed persons age 16 years or older in Missouri from 2000- 2011.

Year	Missouri Estimated Incidence rate per 100,000 FTEs	U.S Estimated Incidence per 100,000 FTEs
2000	2.8	2.1
2001	2.7	1.8
2002	2.3	1.9
2003	2.4	1.8
2004	2.5	1.8
2005	1.7	1.8
2006	2.0	1.8
2007	1.9	1.7
2008	1.2	1.5
2009	2.0	1.5
2010	2.7	2.1
2011	2.5	---

Source: CDC, NIOSH, CSTE.

The occupational health indicator data on PRI cases in the state are posted on the MDHSS Occupational Health webpage. Other data are available on request from MDHSS. Table1 and Figure1 show the annual incidence rate or reported work- related pesticide poisoning cases per 100 000 employed from 2000-2011 and a comparison between the cases in the same year of Missouri and the United States. Although these data reflect only cases of occupational PRI, the state collects data on non-occupational PRI as well.

Despite some annual fluctuation, the 2010/2011 data are not radically different from the 2000 data.

Missouri's goal of minimizing adverse consequences of pesticide use is limited by the fact that MDHSS does not follow or otherwise intervene in suspected cases of PRI. In addition, Missouri does not classify pesticides poisoning according the type of pesticide, so disinfectant information is not separately available. A representative of the department

confirmed that the department is not able to perform interventions at this time because of funding constraints, including a lack of economic support.

Strengths of the Missouri PRI surveillance program:	Challenges of the Missouri PRI surveillance program:
– The Missouri Pesticide Use Act establishes clear requirements for licensing of applicators, dealers, technicians and operators – Pesticide poisoning must be reported within three days to either DHSS or the local health authority (mandatory reporting by health care providers) – Data are collected on occupational and non-occupational cases of PRI	– Lack of funding precludes case follow backs and interventions – Missouri's evaluation models for PRI are not effective because the local agencies do not have a strategy to intervene or follow PRI cases (Missouri's experience makes the point that PRI reporting by itself is insufficient without a plan for using the data) – Missouri is not classifying pesticides poisoning according the type of pesticide, so disinfectant information is not separately available

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2. Minnesota

Pesticide Regulation

In 2013, over 123 million pounds of products containing pesticides were sold in the state of Minnesota (Minn. Pesticide Sales Information, n.d.). The use of pesticides is widespread, including for agricultural purposes, commercial use, and domestic use. In Minnesota the four largest use of pesticides in descending order by pounds of use are: disinfectants and sanitizers, crop chemicals, formulating (products used to formulate or manufacture end use pesticides), and wood preservatives (Minn. Pesticide Sales Information, n.d.).

Fast Facts:

- Exposed workers and State population: 368,984
- State Population: 9,883,640
- State GDP: $312 billion
- Major Crops: corn and soybeans sugar beets, sweet corn, and green peas for processing and farm-raised turkeys.
- Chemical Expenses: 783,570
- # of Farms in acres: 26,035,838
- Percent Population Urban: 73.3%
- PRI reporting mandatory; not a SENSOR state

In response to federal requirements and extensive pesticide use, Minnesota has created a network of laws and regulations dealing with the use and safety of pesticides. The Minnesota Department of Agriculture (MDA) is the lead agency responsible for regulating pesticides in Minnesota. MDA collects information and investigates reported pesticide incidents. Pesticides are highly regulated in Minnesota compared with other chemicals. The MDA enforces federal and state pesticide laws and collaborates with the EPA, US Department of Agriculture, University of Minnesota Extension service, Minnesota Pollution Control Agency, and Minnesota Department of Health (MDH). All of these departments work together to provide the strong education, control, and management of pesticide use. The MDA regulates the use, application, storage, sale, handling, and disposal of agricultural chemicals. Pesticides must be registered with both the EPA and the state. The Pesticide and Fertilizer Management Division within MnDA conducts routine inspections and investigates pesticide use complaints. It also monitors possible negative effects of pesticide use on the quality of groundwater (MnDA) and has partnered with the Department of Natural Resources and the MnDH on initiatives relating to safe drinking water (MnDA Pesticide Management Plan). The MDH performs a consultative role for the MnDA with information and guidance about health risks from pesticides.

The MnDA issues licenses for commercial and noncommercial pesticide applicators as well as for structural pest control. Commercial licenses are required for those who apply any pesticides "for hire." Noncommercial licenses are for those who apply restricted use pesticides on their employer's property. Within these two licensure categories, there are multiple fields of specialization. The structural pesticide license is for applicators who apply pesticides on or in structures. There is a private certification for applicators who will be applying pesticides only to land they own, rent or manage for agricultural purposes. Anyone who uses restricted-use pesticides must have a license. Minnesota pesticide license applicants must complete an online application, pay a fee, and pass the appropriate certification exams (License Types, 2017).

Minnesota recognizes that pesticides are of great benefit but must be handled safely such that potential harmful effects on the environment – and humans -- are minimized. MnDA has many programs geared toward ensuring safe pesticide use. One such program investigates the use of pesticides that may be involved in human or animal injury, food or feed contamination, and crop or ornamental plant damage ("Spills & Safety", 2017). Another identifies activities that pose risks of pesticide contamination of drinking water supplies ("Rapid Assessments for Pesticides", 2017). If an applicator needs to dispose of unwanted, unusable or banned pesticides, directions can be obtained from the county solid waste office or household hazardous waste facility, which act in partnership with the MDA. Finally, the MnDA responds to agricultural chemical spills. The state Pesticide Control Law requires MnDA to report biennially on pesticide management and regulation. (Minnesota Pesticide Control Law)

Reporting pesticide related injuries or pesticide spills that may result in injury is mandatory in Minnesota ("Private Pesticide Applicator," n.d.). The responsible party or the property owner where the pesticide spill, injury, or misuse occurred is obligated to make a notification to MnDA about the poisoning or potential poisoning within 24 hours of the incident. Under Minnesota law, all incidents involving agricultural chemicals must be immediately reported to the MnDA incident Response Program through the state duty officer. The duty officer is available from 8am to 4pm on weekdays. All reports of agricultural incidents received by the MN Duty Officer or after-hours calls are forwarded to the

MnDA on-call team, which is responsible for directing and assisting the state response and cleanup of agricultural chemical incidents and which is available 24 hours a day. If a spill occurs on a public highway the local, county, or state police must also be notified.

There is an exception to the requirement of notification if the responsible party or owner of the property is a licensed or certified private or commercial pesticide applicator AND the total amount of pesticide involved in the release plus any other released that have occurred at the site during the preceding year is less than the maximum amount of pesticide, consistent with the label, that can be legally applied to one acre of cropland AND the chemical released during the incident does not go into or near public water or groundwater. All three of these conditions must be met in order for one to be exempt from notifying the MnDA about a pesticide spill ("Private Pesticide Applicator," n.d.). An agricultural chemical incident must be reported to be eligible for reimbursement of cleanup costs from the agricultural chemical response and reimbursement account.

The MnDA has a team of statewide inspectors to conduct routine inspections, some of which are unannounced. Inspectors are authorized to visit any farm, operation, or facility that uses, stores, distributes, or disposes pesticides to ensure they are following correct guidelines to do so. The inspector then specifies any corrections that need to be made and addresses health and environmental risks from pesticide use, injury, or damage. After the inspection is complete, the MDA inspector reports any violations to the enforcement team ("Regulation, Inspection & Enforcement," 2017).

Occupational exposures to pesticides also may result in illness or injury. As mandated by law, the University of Minnesota Extension Service and MnDA provide education about occupational health and safety through manuals, seminars, and training on a regular basis.

PRI Reporting

In the event of a harmful pesticide exposure, individuals are advised to seek medical attention, after which they may contact the Minnesota Duty Officer, who receives reports on hazardous materials incidents (Regulation, Inspection & Enforcement, 2017; MN Duty Officer Program, 2017). PRI is not a mandatory reportable condition for healthcare professionals in Minnesota. However, the MnDH provides consultation and referral services for healthcare practitioners (MN Dept. of Health, 2017). They provide consultation to physicians regarding pesticide exposure and toxicity by evaluating the potential of exposure, consistency of symptoms, and effects associated with active ingredients. They also assist physicians in identifying specialists for additional evaluation. Finally, Minnesota Poison Control (PCC) has a system set up at Hennepin County Medical Center that provides telephone triage services and medical consultation regarding pesticide exposure 24 hours a day, 7 days a week. The MnDH notes on its website, however, that "The Minnesota Department of Agriculture is the state agency responsible for investigating complaints of illegal pesticide use, including any misuse resulting in illness or injury to people."

The PCC collects data on poison control system calls, some of which are available on its website (MN Poison Control System, 2017). In 2013, both pesticides and household cleaners were among the top five non-drug substances involved in poisonings (MN Poison Control System, 2013). In addition, the MnDH and the Minnesota PCC present pesticide injury and illness data, including data on unintentional, non-occupational pesticide poisoning, hospitalization, and emergency department visits through the MnDH's Minnesota Public Health Data Access Portal ("Pesticide Poisoning," n.d.). Hospital and emergency department data are extracted from Minnesota hospital discharge data, which the Minnesota Hospital Association maintains. These data appear on the Portal website, divided by age, sex, and other characteristics. For 2014, there were 12 hospitalizations and 42 ED visits attributable to pesticide poisoning. By comparison, in that year there were 1,086 pesticide-related calls to the PCC.

The MnDH is funded by the National Institute for Occupational Safety and Health to collect the Occupational Health and Safety Indicators (OHIs), a common set of occupational health and safety measures created by a variety of secondary data sources to be compared and monitored overtime and utilized to provide state priorities for education and prevention initiatives. Examples of secondary data used are hospital bills, workers' compensation data, surveys on occupational injury and illness, and poison control data. Examples of indicators are non-fatal work related injuries and illness reported by employers and percentage of workers employed in industries at high risk for occupational morbidity. Indicator 11 is Acute work-related pesticide associated illness & injury reported to poison control centers; the state

health department obtains the data from the PCC and calculates rates based on the employment census in the state. A trend analysis on the number of occupational pesticide poisoning cases from 2000-2013 did not show statistically significant changes in the number of cases or incidence rates during this period (MN Occupational Health Indicators, 2016).

Minnesota has gone to great lengths to ensure the correct use of pesticides and to ensure safety for all citizens. The harmony between all the different departments working together to this end, the frequent inspections, the user-friendly websites and call lines are all significant parts of what make the system work. However, more data -- and more complete data -- are needed to assess the effectiveness of their program. The hospitalization data are limited because symptoms of pesticide poisoning often mimic other ailments and may therefore be overlooked or misdiagnosed, and multiple hospital or emergency department admissions by the same patient may be over-counted. PCC data are limited by self-selection, completeness and accuracy of information provided, and differential access to a telephone and knowledge of the PCC. In addition, the PCC may not be called if a treating health care provider already knows how to manage the case. Because it is not mandatory to report cases of occupational PRI, some occupational poisoning cases are likely to be missed. Finally, Minnesota is not a participant in the SENSOR program, so it lacks data and financial support from the federal government. Longitudinal data that is more inclusive would allow a more robust evaluation of the effectiveness of Minnesota's prevention programs.

Strengths of the Minnesota PRI surveillance program:	**Challenges of the Minnesota PRI surveillance program:**
– High quality training is given to people who apply for pesticide application license – The MnDA and MnDH both have very informative websites educating the public about pesticides and answering commonly asked questions. – MnDA is available 24/7 to handle pesticide spill calls and to refer pesticide injuries – Healthcare workers are given educational material on how to assess patients correctly, and medical consultation by pesticide professionals on how to evaluate pesticide exposure and toxicology. – Scheduled and unannounced site investigations are performed by the MnDA. This likely motivates farmers, applicators, and operators to comply with all pesticide regulations. – If MnDA investigators identify corrections that need to be made, they follow up to ensure that corrective action is taken.	– Many departments are involved with pesticide education, inspection, use, and data collection. Coordination and communication among these entities is not apparent from the website. – Data describing pesticide poisoning cases comes from many different data sources. Linking these cases across sources might give more comprehensive information about causes and outcomes and assist in analyzing trends over time. – Lack of mandatory reporting limits capture of cases.

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3. Ohio

Ohio is a Midwestern state situated in the Great Lakes region of the United States. The state's capital and largest city is Columbus. Ohio is located in an industrial region on the great inland waterways and has a wide network of interstate roadways. The unemployment rate for Ohio was 5.1% in February 2017. (The national rate was 4.7% for the same period). The total employment in Ohio is expected to increase by 8.3 percent over a 10-year period from 2012 to 2022, with a projected gain of 455,000 jobs (Economic Overview, n.d.). In 2016, the state's per capita income was $44,876. In 2015, Ohio's gross domestic product was $608.1 billion. This made it the seventh largest state economy in the nation. Manufacturing is the largest sector based on the GDP. About 54% of the state's manufacturing output consists of durable goods (Economic Overview, n.d.).

Fast Facts

- Exposed workers: 345,459
- State population in 2016: 11.6 million
- Major Industries: Manufacturing, Transport & Trade, Business Services, Real Estate, Education & Health, Finance & Insurance, Professional and Technical Services
- State GDP: $608.1 billion (2015)
- Major Crops: soybeans, corn, hay, wheat, tomatoes
- Chemical Expenses in Dollars; $1,483,642
- # of Farms in acres; 14,609,700
- Percent Population Urban: 77.9%

The geographic location of Ohio has contributed to its economic expansion and growth. Ohio links the Northeast to the Midwest and this allows much cargo and business traffic to pass across its borders and extensive highway system. At the Northern border, it has about 312 miles (502 km) of coastline on Lake Erie, allowing for many cargo ports. The Ohio River forms the southern border of the state. Ohio's neighboring states are Ontario, Canada, to the north, Kentucky to the south, Pennsylvania to the east, Indiana to the west, Michigan to the northwest, and West Virginia on the southeast.

Ohio is the #5 egg producing state, and its leading livestock product is milk. It produces beef cattle, young chickens, turkey, and sheep, and is the biggest wool producing state east of the Mississippi. Major field crops include soybeans, corn, wheat, hay, oats, and popcorn. It grows apples, grapes, peaches, and strawberries. Notably from the pesticide standpoint, greenhouse and nursery products, such as Christmas trees and floriculture, earned $365.17 million in cash receipts in 2012. Ohio greenhouses and nurseries also produce aquatic plants, bulbs and more (Ohio Economy, 2016).

Pesticide Regulation

In the state of Ohio, regulation, sales, licensing and training for pesticide dealers and applicators is handled by the Pesticide & Fertilizer Regulation section, under the Plant Health Division of the Ohio Department of Agriculture (ODA). The other sections under the Division are the Apiary, Grain Warehouse, Feed and Seed, Plant Pest Control and the Cooperative Agricultural Pest Survey (Programs & Information, n.d.). The Division's operations include inspection of honey bee colonies, control of gypsy moths and other pests, testing germination of packaged seeds, verification of label statements on feed and fertilizers, and regulation of nursery stocks and financial stability of grain elevator monitoring (Plant Health, n.d.)

The ODA regulations cover pesticide registration, permits, and applicator licensing. The regulations also deal with the use of restricted pesticides. A license is a requirement for any "business that applies pesticides to the property of another for hire, or solicits and takes orders to apply pesticides to property". It is also required for a business that conducts wood-destroying insect diagnostic inspections for purposes of a real estate transaction (Ohio Laws, sec. 921.06v1; Pesticide Business, 2017). The specific division responsible for a particular licensing sets forth the licensing requirements. For example, the Commercial Applicator License under the Plant Health Division is for "any individual who personally or by his/her agent owns or operates a pesticide business or who applies either general or restricted use pesticides to the property of another without direct supervision (formerly Custom Applicators and Custom Operators); applies restricted use pesticides to the property of his/her employer (formerly Limited Commercial); or applies either general or restricted use pesticides to Federal, State or Local public property (formerly Public Operators)". A commercial applicator license is needed for those applicators who apply pesticides for hire or on public property. Even pesticides that can be purchased without a license cannot be applied on public property like schools, churches, parks, etc. without a commercial license (Ohio Laws sec. 921.06v1).

The Plant Health Private Applicator license is for "Any individual who uses or directly supervises the use of any restricted use pesticide for purposes of producing any agricultural commodity on property owned or rented by him or his employer" (Licensing, n.d.; Private Pesticide Applicator, n.d.). Another category is the "trained serviceman". A trained serviceperson is an applicator who works under the direct supervision of a licensed commercial pesticide applicator who is employed by the same company or agency. The trained serviceperson must be instructed in the proper use of equipment and pesticides that will be used on the job (Licensing, n.d.).

Ohio has two different licensing examinations: one for commercial users and the other for private users. "A private applicator applies restricted-use pesticides on his/her own land, or rented land, and produces an agricultural commodity" (Private Pesticide Applicator, n.d.). ODA provides an online service to search for all licensed individuals and companies.

Applicants for licensing prepare for examination based on study materials. These materials vary based on area of competency. For example, the study materials listed for training for commercial applicators are Aerial Pest Control, Agronomic Weed, Soil Fumigation, Industrial Vegetation, Ornamental Pest Control, Ornamental Weed Control and Turf Pest Control. Some of the training materials are available for purchase at the Ohio State University E-Store Site for Pesticide Education while others are online at the ODA website (Programs & Information, n.d.). The ODA works closely with the Ohio State University Extension through its Pesticide Safety Education Program to inform, educate and train the public and interested applicators about the appropriate use of pesticides. It hosts some of the training materials needed for licensing of applicators. The training materials cover "*Harmful effects and Emergency Response"*. This explains the hazards of pesticides and what one is expected to do in the event of an exposure (Pesticide Safety Education Program, n.d.).

The ODA connects with stakeholders and the general public through its website and social media.

PRI Reporting

The Ohio Administrative Code 901:5-11-02, General Safety Provisions(D)(4) stipulates that:

> Pesticide applicators shall report to the department of agriculture:(a) By telephone, within forty-eight hours after learning of any human illness requiring medical attention resulting from or allegedly resulting from a pesticide used by the pesticide applicator or a trained serviceperson, immediate family member or subordinate employee working under the pesticide applicator's direct supervision. Such telephone notification shall be followed by a written report within seven calendar days. (b) by written report within ten calendar days after learning of any property damage in excess of five hundred dollars ($500.00) resulting from or allegedly resulting from a pesticide used by the pesticide applicator or a trained service person, immediate family member or subordinate employee working under the pesticide applicator's direct supervision". [4] Pesticide related illness does not appear on the list of mandatory reportable diseases for healthcare professionals in Ohio. (Ohio laws, section 3701-3-02).

However, the Migrant Clinicians Network describes Ohio as a state where mandatory reporting of occupational pesticide exposure is required. (Pesticide Reporting, n.d.)

The Ohio Poison Control Center (OPCC) advises that in the event of unconsciousness from poisoning, the public should call 911; otherwise for a poison emergency, OPCC should be called (Central Ohio Poison Center, n.d.). OPCC keeps records of these calls. The ODA receives occasional reports of Pesticide Related Illnesses. Once a report is received, the department reaches out to the affected person to determine whether the pesticide was applied according to its labeled directions for use and whether the treating physician could definitively determine the cause of the illness. If the physician is able to confirm the pesticide exposure, it is then reported to USEPA Region 5 in Chicago so that EPA can assess the need to modify the registration of the pesticide or otherwise. The ODA typically receives only a handful of these reports each year, which often come from persons that sought medical treatment (Interview, 2017).

For those who may not have sought medical attention, even if such persons were directly exposed to the pesticide or there is some other potential violation of the Ohio Pesticide Law, the ODA will conduct an investigation and address

any violations of the Ohio Pesticide Law with the person that made the pesticide application. These reports are not automatically sent to USEPA. However, if there is no evidence of a potential violation of the Ohio Pesticide Law, then the investigation would not be conducted simply based on the claim of exposure to a "legally applied pesticide" (Interview, 2017).

The Ohio State University Extension Pesticide Safety Education Program website states that pesticide exposures which are emergencies should be directed to the Ohio Pesticide Control Center (OPCC), and exposures which are non-emergencies, should be reported to the NPIC. This includes all exposures, both occupational and non-occupational (Emergency Numbers, n.d.). The NPIC then provides de-identified summary reports of these cases to the EPA. The major agencies involved in pesticide exposure reporting and capture of data in the state are the Ohio Pesticide Control Center (OPCC), National Pesticide Information Center (NPIC), Ohio Department of Agriculture and the Ohio EPA.

Stakeholders

There are a number of government agencies in Ohio and nationally that have somewhat overlapping responsibilities in the area of PRI. They include:

Agency/Organization	Responsibilities
Ohio EPA	– Receives reports of pesticide exposures and shares information of pesticide exposures with the National Pesticide Information Center
Ohio Department of Agriculture	– Regulates pesticide and fertilizers, trains applicants and issues licenses for pesticide applications in the state. – investigates and receives reports of pesticide exposures. – Submits reports to the EPA on pesticide exposures.
Ohio Poison Control Center	– Receives reports of exposures from the public and from their healthcare providers during a clinical encounter where pesticide poisoning is possible – Provides information to the public on PRI
Ohio State University	– Partners with the ODA to provide the pesticide safety education program for certification and recertification of pesticide applicators
Pesticide Program Dialogue Committee	– Meets with EPA on a regular basis to discuss pesticide regulatory, policy, and program implementation issues.
FIFRA Scientific Advisory Panel	– Provides independent scientific advice to the EPA on health and safety issues related to pesticides. – The FIFRA SAP is comprised of biologists, statisticians, toxicologists and other experts and is augmented by members of the Food Quality Protection Act Science Review Board.
National Pesticide Information Center	– Receives reports on pesticide exposures and reports to the EPA

Note: this PRI reporting policy project was unable to obtain any information from the Ohio Department of Public Health concerning coordination, surveillance or other details of pesticide related Illness reporting in the state beyond the fact that such pesticide exposures should be reported to the OPCC. In response to follow-up questions, project members were directed to the ODA, which provided much of the information presented above.

Strengths of the Ohio PRI surveillance program:	Challenges of the Ohio PRI surveillance program:
– The state requires quick reporting of certain cases of PRI by applicators – The National Pesticide Information Center and the EPA receive data on pesticide exposures. Assuming that they accept data on the general public and structural pesticide-related exposures, they could play a significant, supportive role in state public health surveillance	– Absence of PRI surveillance system in the state – No PRI data available on state website – Lack of official coordination between various agencies involved in pesticide exposures and PRI reporting. (If such coordination exists, the information is publicly inaccessible) – OPCC surveillance data are not incorporated into state public health surveillance or regulation

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4. Illinois: Current Status and Goals

The major goal of this project was to explore the possibility of creating a system of PRI reporting in the State of Illinois. Like most of the other states included in this report, Illinois is a heavily agricultural state. About 75 percent of the state is farmland, and Illinois is a major producer of soybeans, corn, and swine. Over the last almost six decades, the number of farm operators has dropped by more than half, while the average farm size has doubled (Facts about Illinois Agriculture, n.d.). Since most hired farmworkers are found on larger farms, [iv] this trend in farm growth may have changed patterns of exposure to PRI during a time in which pesticide use has steadily grown. Nationwide, farm workers are less likely to be well educated; they are younger, more likely to be Hispanic, and less likely to be U.S. citizens than employed workers as a whole (Background, n.d.). These attributes all raise concerns about the ability and likelihood of members of the group to report or receive medical treatment for PRI.

Fast Facts

- Exposed workers: 368,984
- State Population: 12,830,632
- Major industries: Service, Manufacturing (machinery and food), Agriculture
- State GDP: $692 bil (2016)
- Major Agricultural Commodities: soybeans, corn, swine
- Chemical Expenses: $1,094,846
- Farms acreage: 26,937,721; 75% of state's land area
- Percent Population Urban: 88.49%
- PRI reporting not mandatory; not a SENSOR state

Pesticide Regulation

Illinois was one of the first states to pass a comprehensive pesticide law. The Illinois Pesticide Act (IPA) divides the responsibilities for pesticide regulation among a number of different departments (415 ILCS 60/8/2). It places the responsibility for regulating "the purchase and use of pesticides pertaining to the production, protection, care, storage, or transportation of agricultural commodities and to control the use of pesticides applied by agricultural equipment" on the Illinois Department of Agriculture (IDAG). The Illinois Department of Public Health (ILDPH) bears the responsibility for controlling structural pesticides, as well as for "vector control, control of pestiferous and disease carrying insects, rodents and other animals, and control of birds and other mammals that may pose a threat to the health of the public." "Structural Pest" means any pests which attack and destroy buildings and other structures or which attack clothing, stored food, commodities stored at food manufacturing and processing facilities or manufactured and processed goods" (415 ILCS 60/4/37). It is "the duty of the [Illinois] Environmental Protection Agency [IEPA] to enforce such provisions of this Act and other Acts intended to protect and preserve the quality of air, water, and guard against unreasonable contamination of land resources" (415 ILCS 60/3). IEPA is responsible for granting NPDES permits to applicators who use pesticides on or adjacent to water ("NPDES Permits," n.d.). The Illinois Emergency Management Agency (IEMA) is in charge of responding to accidental spills of certain quantities of extremely hazardous substances, a number of which, by statutory definition, are pesticides (29 ILA 430). IEMA must be notified immediately if a member of the public is injured seriously enough to require hospitalization from an incident involving a hazardous material. The state may delegate certain tasks in the area of pesticide regulation to localities. However, pursuant to state law, only the largest political subdivisions (those with a population over 2,000,000) maintain any independent power to regulate pesticides (415 ILCS 60/3(4)).

These State entities do not act entirely independently of one another. The IPA empowers the Director of IDAG to create an interagency committee on pesticides to study and advise with respect to pesticide use on state property and to advise state agencies "in connection with quarantine programs or the protection of the public health and welfare, and to recommend needed legislation concerning pesticides." This committee is to include the Directors of IDAG, the Illinois Department of Natural Resources (IDNR), the IEPA, and ILDPH, the Illinois Secretary of Transportation, the President of U of I (or designee, representing the State Natural History Survey), and the Dean of the U of I College of Agriculture (415 ILCS 60/19). Among other critical functions, the committee is tasked with conducting a pesticide education campaign every spring and creating a toll free number for members of the public to report pesticide misuse (415 ILCS 60/19/6). The interagency committee is also charged with investigating the issue of agrichemical pesticide contamination at agrichemical pesticide facilities within the state (415 ILCS 60/19/8). In addition, the IPA calls for the creation of an uncompensated, mixed public-private Agrichemical Facility Response Action Program to deal with such

contamination (415 ILCS 60/19/3). Remediation under this program is largely voluntary. The Act also creates a number of funds to cover education and administrative activities as well as remediation (415 ILCS 60/22.1, 22.2, 22.3).

The IPA legislation creates a significant discretionary role for the Director of IDAG, who may "make appropriate regulations for enforcement and administration of the Act." (415 ILCS 60/8/2) In addition, "The Director is authorized to cooperate with such state or federal agencies as may be reasonable and proper to carry out the provisions of this Act." (415 ILCS 60/8/5) The Director may also require businesses to keep appropriate records in the interest of furthering the goals of the Act. Such records "shall be made available to the Department of Public Health pursuant to the Illinois Health and Hazardous Substances Registry Act." (415 ILCS 60/18/3)

The IPA clearly recognizes the potential for harm to both people and property from pesticide use and requires licensed commercial applicators to post a bond to cover the costs of both types of harm (415 ILCS 60/10/3 et seq.). The stated goal of the licensing process is "to protect public health and the environment, including injury to the applicator or other persons using these pesticides." (415 ILCS 60/11) The Administrator is free to impose, by regulation, new requirements on licensees, in order "to ensure that the licensed commercial applicator meets the requirements of changing technology and to assure a continued level of competence and ability."(415 ILCS 60/10/6; 60/11; 60/11.1/3) In addition, it is a violation of the Act "to handle, store, display, use or distribute pesticides in such manner as to endanger man and his environment, to endanger food, feed or other products that may be stored, displayed or distributed with such pesticides" or "to use, dispose of, discard, or store pesticides or their containers in such a manner as to endanger public health and the environment or to pollute water supplies."(415 ILCS 60/14/3).

In investigating a complaint of "misuse, mishandling, or reported excessive pesticide exposure," the Director of IDAG may inspect private and public property, observe pesticide use, determine facts, and collect samples "in any place where pesticides are produced, manufactured, sold or distributed."9415 ILCS 60/15/2) There are both criminal and administrative penalties for violating sections of the act, with the latter scaled in proportion to the nature of the violation and the nature of the harm (415 ILCS 60/24; 60/24.1).

Illinois has a separate Structural Pest Control Act (SPCA) (225 ILCS 235), which prioritizes the use of less hazardous pest management methods. In particular, it emphasizes the use of integrated pest management (IPM) in schools and daycare centers "to reduce economic, health, and environmental risks" (225 ILCS 235/2). However, these institutions need only implement IPM if it is "economically feasible" for them to do so (225 ILCS 235/10.2/b-1). Like the IPA, the SPCA requires commercial structural pest control businesses to insure against personal or property damage (225 ILCS 235/9/b). It gives ILDPH significant discretionary regulatory power (225 ILCS 235/10/e). "[ILDPH] shall promulgate, publish, and adopt, and may from time to time after public hearing amend such rules and regulations as may be necessary for the proper enforcement of this Act, to protect the health and safety of the public and may, when necessary, utilize the services of any other state agencies to assist in carrying out the purposes of this Act." (225 ILCS 12). Of importance, ILDPH has the responsibility and duty "To conduct a public education program to improve citizen awareness and participation in the reporting of pesticide misuse to better protect the public from such dangerous chemicals. Such program shall include, as a minimum, the dissemination of information to the public and the news media on the requirements of this Act and the Illinois Pesticide Act and the methods of reporting cases of improper pesticide application and use to the Department." (225 ILCS 235/10/h/i) It creates a structural pest control advisory council to assist the Department in making decisions about and under the Act (225 ILCS 235/10.1).

Licensing of pesticide applicators is the responsibility of IDAG for outdoor or agricultural applications and IDPH for structural (in or on structures) applications. Training of applicants is under the auspices of the University of Illinois, Pesticide Safety Education Program, which is run by U of I Extension. Illinois law requires a license for anyone who applies restricted-use pesticides and, in addition, anyone who applies any pesticides in the course of their employment. There are different categories of licensure depending on the licensee's activities and their location. Study materials, which are distributed by the Pesticide Safety Education Program, are particularized to activity and location and include materials dealing with retail and with home lawn management. However, program personnel indicated that the issue of reporting of personal injuries is not covered in the testing.

PRI Reporting

Despite this elaborate multi-departmental pesticide regulatory structure, Illinois lacks a comprehensive schema for reporting PRI. The Illinois Poison Center (IPC) receives inquiries relating to and reports of pesticide exposure, however, the IPC makes no official report of such cases to any of the state departments that are involved in pesticide regulation. Health care providers that see individuals who are suffering from illness or injury caused by pesticide exposure do not contact the IPC unless they have questions about how to treat exposed individuals, and providers have no statutory or regulatory responsibility to report PRI to any State entity. In addition, as noted above, providers and exposed individuals often do not recognize PRI and exposed individuals often fail to seek medical treatment. As a result, the IPC receives reports of only a fraction of PRI cases and the rest remain unidentified and, therefore, uncounted. The next sections of this report explore what is known about PRI rates in Illinois and seek to estimate the total number of cases that would be identified with a more accurate reporting system.

What is known about PRI in Illinois: Summary of Pesticide Exposures in Illinois State Using Poison Control Center and Hospital Discharge Data (2009-2015)

Illinois Poison Center Data

The total cases of pesticide exposures recorded at the Illinois Poison Control Center was 17,009 for the period 2009-2015. Unintentional, occupationally-related exposures comprised 1,018 cases (about 6%) of the total cases. Overall there were 9,361 exposures to females (55.0%), and 7,046 (41.4%) to males.

Hospital Discharge Data

Pesticide exposure cases that required hospital treatment for the same period (2009-2015) from the Hospital Discharge Register numbered 44,013. There were 21,174 cases involving males (48.1%) and 22,839 females (51.9%). In the majority of cases, the sites where pesticide exposures occurred was unknown (about 80%). Of the known exposure sites, the highest percentage of cases occurred in the home (66.2%). The other exposure sites were farms (0.4%), industrial sites (3.7%), outdoor areas (15.7%), public buildings (4.9%), recreational facilities (4.6%), residential facilities (2.5%), and streets/highways (2.0%).

Table 2. Cases of Pesticide Exposure Reported to the Illinois Poison Center and contained in Illinois Hospital Discharge/E.D Databases.

Year	Illinois Poison Center	Hospital Discharge & Emergency Department
2009	2,751	5,156
2010	2,679	2,950
2011	2,485	6,428
2012	2,291	6,947
2013	2,299	7,191
2014	2,177	8,539
2015	2,327	6,802
Total	**17,009**	**44,103**

Table 2 displays total (occupational and non-occupational) pesticide exposure cases broken down by year, as captured by 2 different databases: Illinois Poison Center and the Hospital Discharge/Emergency Department database. If health care providers in the emergency departments or the hospital called the Illinois Poison Center for advice about management, these cases could be duplicates between the two data sources (i.e., there may be duplicates reflected). A separate research project is being done to de-duplicate these data. Despite the possibility of overlapping cases, it is evident from Table 2 that the Illinois Poison Center captures 25-50% of cases in the state. Mandatory notification to a central portal (e.g., if healthcare providers in all settings were required to report to IPC), case capture would be much higher, more accurate and detailed, and usable for planning.

Much of the PRI case capture in the U.S. comes from the National Poison Data System, the data warehouse for all 55 poison control centers across the U.S. Each PCC submits de-identified cases, and NPDS is uploaded in near real time. Data for both pesticides and disinfectants (both covered by FIFRA), and both occupational and non-occupational cases are captured and presented below in Table 3. Discrepancies between Table 2 and Table 3 are being explored.

Table 3. Summary of Pesticide Related Illness for Illinois State, NPDS, 2010-2016

	Exposure/Year	2010	2011	2012	2013	2014	2015	2016	TOTAL
A	**Pesticides (B+C)**	**1231**	**1130**	**1035**	**1066**	**939**	**1080**	**1160**	**7641**
B	Occupational	44	56	69	69	47	102	97	484
C	Non-Occupational	1187	1074	966	997	892	978	1063	7157
D	**Disinfectants (E+F)**	**1318**	**1292**	**1208**	**1159**	**1167**	**1203**	**1292**	**8639**
E	Occupational	86	75	72	60	71	100	102	566
F	Non-Occupational	1232	1217	1136	1099	1096	1103	1190	8073
TOTAL (A+D)		**2549**	**2422**	**2243**	**2225**	**2106**	**2283**	**2452**	**16280**

*Excludes animal-related and unknown exposures
NPDS: National Poison Data System Estimating PRI in Illinois

Moving Forward: Goals for PRI Reporting in Illinois

It is clear, that the bulk of PRI goes unreported and, therefore, unrecorded in Illinois. The lack of an accurate and effective PRI reporting system has significant ramifications for pesticide regulation as well as for public health surveillance in the state. As discussed in the first section, accurate PRI data form a critical precondition for the effective regulation of pesticides on both federal and state levels. The Illinois Pesticide Act indicates that the Director of IL Dept of Agriculture may refuse to register a pesticide upon a determination that "unreasonable adverse effects on the environment would result from continued registration." (415 ILCS 60/7(1)B) But the Director can only make such a determination with full information about the likely consequences of using that pesticide for workers and the general public. Furthermore, ILDPH cannot carry out its statutory responsibility under the SPCA "to protect the health and safety of the public" without surveillance data, which could reveal patterns and practices that might respond well to professional or public education or regulation. The Directors of both departments/divisions have, as discussed above, full statutory authority to implement reporting programs. In addition, there are personnel in place in both agencies -- and IEMA -- who already accept reports of alleged pesticide misuse or harm. As noted above, IEMA must be notified immediately when a member of the public is injured severely enough to be hospitalized as a result of an incident involving hazardous substances including pesticides. Personnel at IDAG are responsible for receiving and investigating pesticide misuse complaints, and the Director of IDAG has the statutory authority to report these cases to other state agencies with relevant authority. IDAG currently receives about 120 complaints about pesticide misuse per year,

mostly dealing with drift. (Pesticides: Uses and Misuses, n.d.) However, few of these deal with harm to humans. With respect to structural pesticides, anyone certified to apply pesticides must notify IDPH, Environmental Health Division, within one business day upon learning of an incident in which the illness or death of a person, pet, or non-target animal species was "allegedly caused by the use of pesticides under their control." (Illinois Administrative Code) **Despite the existence of these reporting mechanisms, there are few reports relating to human exposure, perhaps because the portals are not well publicized and reporting is not stressed in the teaching materials for licensees.** [personal communication] In addition, the Illinois Poison Center does not report cases to either IDPH or IDAG.

A more comprehensive and cooperative reporting system could be achieved in Illinois without a change in statute. Better communication among the State entities—Illinois DPH, EMA, DNR, EPA, DAg, Poison Center—would facilitate case ascertainment, a better understanding of the mechanisms of exposure, problematic individual pesticides, and identification of failures in protocol. It might also lead to a more efficient approach to obtaining information. For example, findings could point to a focus on pesticide applicators: if the reporting responsibility were placed on applicators, case ascertainment would likely be better and such a system could be implemented with little change in regulations simply by emphasizing and enforcing those that already exist. Reporting by applicators could be promoted through study materials provided in connection with licensing. However, applicators may be reluctant to report because of consequences that could reflect their own misapplication or mishandling, or the appearance of such. Also, they may be unaware of affected individuals that are exposed to chemical drift or environmental contamination, or those who become ill at a later time (i.e., after the applicator has left the area). Furthermore, those who are applying chemicals widely in outdoor environments may be less aware of affected individuals who are far from the site of application. A comprehensive approach to collecting and evaluating data would elucidate best practices with consideration of economically feasible approaches.

If, however, the state chose to follow the path of other, more effective, states by requiring that health care providers report suspected cases of PRI, the authority to implement such a system by regulation is already granted by statute to the Directors of IDAG and IDPH. The state could use the Illinois' National Electronic Disease Surveillance System (I-NEDSS), which already creates a single portal for disease reporting by Illinois health care providers under the auspices of IDPH. (IDPH. n.d.) And the program could be self-funded as in other states through fees and fines. Another approach may be through the Illinois Poison Center, since it is already recognized as the "go-to" place for poisonings of all types. The communication line between IPC and ILDPH could be clarified and strengthened to provide the highest quality, and quantity of, data. Both of these sources would require extra questions about actual chemical agents and their use to provide an evidence base that would inform EPA regulation.

Finally, data linkage between data sources the contain information about PRI could yield the best results. Linking cases across Hospital Discharge, Emergency Department, EMS, Poison Center, and calls to the State entities noted in the Illinois Pesticide Act, is likely to lead the highest case ascertainment. Passive reporting is less expensive than active surveillance and may yield better information. The addition of records reviews and follow-backs to affected individuals could provide more comprehensive information about individual pesticides and mechanisms of action.

Irrespective of changes to PRI reporting in Illinois, the State should leverage educational and outreach opportunities by partnering with stakeholder organizations with an interest in preventing PRI and environmental contamination. They groups include school districts, parent-teacher organizations, farm owners/operators, retailers including grocery and home improvement stores, warehouse operators, pesticide manufacturers and applicators, health provider organizations, insurance providers (personal, business, and workers' compensation), worker centers and advocacy groups, unions, research institutions, advocates of environmental protection, and policy groups. These groups can help with education, outreach, and research relating to how, when, and why to report PRI. The educational process may, in turn, create an awareness of the risks of pesticides that may motivate primary prevention of PRI by the increased use of Integrated Pest Management and safer pesticides and, additionally, more vigilant adherence to application protocols listed on pesticide labels.

Public Health Surveillance—the continuous, systematic collection, analysis, and interpretation of health related data needed for the planning, implementation and evaluation of public health practice--can serve as an early warning system, document the impact of intervention, track progress toward specified goals, and clarify the epidemiology of health problems to allow priorities to be set and to inform public health policy and strategies. PRI surveillance (in the

public health use of the term) is critically important in protecting the public from pesticide poisoning. Reporting can inform product registration as well as detection and treatment protocols for healthcare providers. It can point to failures in pesticide application and the need for educational reinforcement in training of licensees, agents of State charged with protecting the public, healthcare providers who may encounter these cases but often do not recognize them, businesses that are liable for adverse events, and the public, at large. A PRI reporting system would raise the profile of the risks and benefits of pesticides so that unnecessary risks are minimized and the beneficial aspects of pesticide use are maximized and benefit all Illinois stakeholders. This policy analysis provides a basis for dialogue and advocacy of a PRI reporting system in Illinois.

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V. RECOMMENDATIONS FOR PRI SURVEILLANCE IN ILLINOIS

Illinois should implement a PRI surveillance system that incorporates the best practices of other states that already have PRI reporting. Such a system would allow the state to target educational, regulatory, enforcement, and preventive services in the most effective and efficient manner possible, insuring that the advantages of pesticide use are maximized while minimizing risks.

Specific recommendations include:

- **Create a well-publicized, simple mechanism for PRI reporting in Illinois**. At the very least, requirements for notification of PRI by applicators should be enforced. But a mandatory reporting system including health care providers is a more effective alternative that is already in place in most states.

- **Implement educational programming for health care providers so that they can more easily identify cases of PRI.** (Case management is already well handled by the Poison Control Centers, health care specialists, and other accessible entities including the National Pesticide Information Center). A number of states already have concise and easily accessible teaching modules for health care providers. (see Appendix B)

- **Institute a single portal reporting system for all cases of PRI** whether structural or agricultural, occupational or nonoccupational. The IDPH I-NEDSS system could be modified to include PRI reporting by health care providers.

- **Create a gatekeeper position for all pesticide-related inquiries.** The gatekeeper should serve as the primary point of contact for PRI inquiries. The position should be filled by a member of one of the agencies involved in collecting or reporting PRI data. With an expert understanding of how pesticide related issues are handled within the state (who gets what information and where it goes to be aggregated, analyzed, and reported), the gatekeeper would be in a position to refer inquiries to the appropriate department, individual, or program.

- **Insure that the flow of information within and among departments is seamless and efficient.** The experience of other states reveals that the regulatory system is heavily dependent upon interagency coordination, which could be facilitated by the Illinois Interagency Committee on Pesticides and by the gatekeeper, who could serve as a strategic interagency liaison.

- **Emphasize and strengthen the requirements for reporting PRI in testing and training materials for applicators.** Insure that the penalty structure for failure to report reflects the importance of reporting in cases of illness or injury.

- **Incorporate PRI data into the process of deciding whether or not to register or reregister pesticides in Illinois**. With the availability of a more complete PRI database, the Director of IDAG will more easily be able to rely on the data in evaluating the risks of pesticide use in making registration decisions.

- **Strengthen relationships with stakeholders**. Strengthen relationships with stakeholders that can help with education, outreach and research on PRI and that can advise their constituencies on how, when, and why to report PRI.

- **Fund PRI reporting through licensing fees, product registration fees, fines, and penalties**. Raise fees if necessary so that the cost of pesticide poisoning and its reporting are incorporated in the cost of using pesticides in the state.

Appendix A. Abbreviations

ADPER&EH	Iowa Acute Disease Prevention, Emergency Response and Environmental Health
CDC	Centers for Disease Control and Prevention
CDSP	Chemical Disease Surveillance Program of Florida
EPA	Environmental Protection Agency (has US and State agencies)
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FDACS	Florida Department of Agriculture and Consumer Services
FDOH	Florida Department of Health
FPCN	Florida Poison Center Network
IDAG	Illinois Department of Agriculture
IDALS	Iowa Department of Agriculture and Land Stewardship
IDPH	Iowa Department of Public Health (distinguish from Illinois)
IEPA	Illinois Environmental Protection Agency
ILDPH	Illinois Department of Public Health
IPA	Illinois Pesticide Act
ISPCA	Illinois Structural Pest Control Act
ISPCC	Iowa State Poison Control Center
MDHHS	Michigan Department of Health and Human Services
MIOSHA	Michigan Occupational Safety and Health Administration
MnDA	Minnesota Department of Agriculture
MnDH	Minnesota Department of Health
MoDA	Missouri Department of Agriculture
MoDH	Missouri Department of Health
NCEH	National Center for Environmental Health (at CDC)
NIOSH	National Institute for Occupational Safety and Health
NIOCCS	NIOSH Industry and Occupation Computerized Coding System
NPDES	National Pollution Discharge Evaluation System
NPDS	National Poison Data System
NPIC	National Poison Information Center
OHSSP	Occupational Health and Safety Surveillance Program (Iowa)
OSHA	Occupational Safety and Health Administration
PCC	Poison Control Center (sometimes called Poison Center)
PESP	Pesticide Exposure Surveillance Project (Iowa)
PRI	Pesticide Related Illness

RCW	The Revised Code of Washington (RCW) is the compilation of all permanent laws now in force. It is a collection of Session Laws (enacted by the legislature, and signed by the governor, or enacted via the initiative process), arranged by topic, with amendments added and repealed laws removed. It does not include temporary laws such as appropriations acts.
SENSOR	Sentinel Event Notification System for Occupational Risk (NIOSH)
UF/IFAS	University of Florida Institute of Food and Agricultural Sciences
WAC	Washington Administrative Code (WAC)- Regulations of executive branch agencies are issued by authority of statutes. Like legislation and the Constitution, regulations are a source of primary law in Washington State. The WAC codifies the regulations and arranges them by subject or agency.
WAPC	Washington Poison Center
WDLI	Washington Department of Labor and Industries
WDOH	Washington Department of Health
WHO	World Health Organization
WPS	Worker Protection Standard
WSDA	Washington State Department of Agriculture

Appendix B. Data Sources

Sources for Fast Facts*

1. Exposed Workers 2012. Total farmworkers plus workers in occupations with higher risk for pesticide exposure. Farmworkers data (includes workers both hired and unpaid) from US Department of Agriculture. Census of Agriculture 2012. Table 7. Workers and Payroll. Online at https://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/. Other exposed worker data from the Bureau of Labor Statistics, Occupational Employment Statistics, May 2012 State Occupational Employment and Wage Estimates. Online at https://www.bls.gov/oes/2012/may/oessrcst.htm.

2. State population 2010. U.S. Census, April 1, 2010. Online at https://www.census.gov/data/datasets/2016/demo/popest/state-total.html

3. State GDP 2012 reported in millions of 2009 dollars. U.S. Department of Commerce. Bureau of Economic Analysis. Broad Growth Across States in 2014. Online at **https://www.bea.gov/newsreleases/regional/gdp_state/2015/pdf/gsp0615.pdf**

4. Chemical Expenses 2012 in thousands of dollars. US Department of Agriculture. Census of Agriculture 2012 Table 49 - Fertilizers and Chemicals Applied: 2012 and 2007, online at https://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/

5. Land in farms in acres 2012. US Department of Agriculture. Census of Agriculture 2012. Table 9 - Harvested Cropland by Size of Farm and Acres Harvested: 2012 and 2007. Online at https://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/

6. Percent population urban 2010. U.S. Census Bureau. 2010 Census Urban and Rural Classification and Urban Area Criteria. Percent urban and rural in 2010 by state. Online at https://www.census.gov/geo/reference/ua/urban-rural-2010.html

*This policy analysis was conducted during the 2017 Academic Year accounting for the lag in statistical data. When updated, more recent dates were added in the body of the document.

Appendix C. Continuing Medical Education

These are a few examples of online materials that can be used to educate health care providers about PRI, thereby increasing the likelihood that cases are appropriately treated and reported.

EPA

- Recognition and Management of Pesticide Poisonings, 6th edition. Downloadable at https://www.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings

Florida

Florida Health

- PRI protocol checklist
- Disease reporting
- The disease and its epidemiology
- Case definitions
- Laboratory testing
- Routine Case investigation
- Routine Prevention

Florida Poison Control

- Educational Materials
- Pesticide general Information

California

California Medical Supervision Program

- Designed to protect workers who regularly mix, load, or apply highly toxic Category I and Category II organophosphate (OP) and N-methyl carbamate pesticides (CB).
- Goal of the program is to identify and prevent excessive OP and CB exposure and resulting pesticide-related illness.
- Medical Supervision training for Physicians provided for Free
- Guidelines for Physicians booklet (free)
- Medical Supervision Program evaluation

MedEd Pesticide online training

- Presents various training modules on health issues related to pesticides and offers continuing education credits to medical providers and nurses.
- Some modules provided in Spanish
- Free
- Must register to use

California Department of Pesticide Regulation

Iowa

Pesticide Safety Education Program

- Provides educational information throughout Iowa on the safe and effective uses of pesticides
- Contains Reference materials
- Pesticide Label and Data information
- Integrated Pest Management
- Pesticide Applicator Training Program
    - Private applicator
    - Commercial Applicator
    - Noncommercial Applicator
    - Public Applicator
    - Certified Handler

Minnesota

Minnesota Department of Public Health

- Pesticide Resources and Services for Health Care Professionals
- Minnesota Poison Control System
- Great Lakes Center for Children's Environmental Health
- Patient Assessment
  - Exposure History
  - Human Exposure Data
  - Cholinesterase Testing and Monitoring
- Pesticide toxicology and other chemical/product information
  - Toxicology and active ingredient fact sheets
  - Recognition and management of pesticide poisonings
  - Medical Management Guidelines
  - Searchable Databases
  - Insecticides chemistries and Characteristics
  - Pesticide Registration facts
- MDPH CME
  - Medical Cases and topics for Health Care Providers
  - Case Studies in Environmental Medicine
  - Pesticide Illness and Injury Surveillance

New York

Pesticide Poisoning Registry -

- Recognizing and Reporting Pesticide-Related Illnesses and Injuries - Online at https://www.health.ny.gov/environmental/workplace/pesticide_poisoning_registry/pesticide_poisoning_registry_presentation.htm

Other

- Migrant Clinicians Network, online at http://www.migrantclinician.org/issues/occupational-health/pesticides/reporting-illnesses.html
  - Who must report
  - How to report
- Pesticide Educational Resources Collaborative
  - How to comply
  - Training materials
  - Presentations to train workers and handlers
  - Materials for training the trainers
  - Videos for workers
  - Several handouts
- Association of Occupational and Environmental Clinics, online at http://www.aoec.org/resources.htm