Understanding Dangerous Work: Implications for Pesticide Applicator Education in Idaho

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Authorization to Submit Dissertation

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Abstract

This document presents the findings of a qualitative, grounded theory research study on pesticide worker safety education and learning. A variety of factors contribute to the reasons pesticide applicators are not always fully engaged in the education required for them to practice their work safely, resulting in long-term health and environmental risks. The purpose of this study was to identify critical learning components and approaches that lead to the safe use of pesticides, mainly in large-scale agriculture.

Background. Approximately 8,000 licensed applicators in the state of Idaho apply pesticides on approximately 12,000 farms (NASS, USDA, 2017), roadways, parks and other types of landscaping. Pesticide use is highly regulated by federal and state government because of the potential significant and toxic effects if misused. It is well documented that pesticide accidents and drift occurrences can affect the health of workers and others who are inadvertently exposed to these potentially dangerous chemicals.

In 2017, I conducted a pilot study to gather data about work and educational practices for pesticide application in Idaho. The pilot study, a form of theoretical sampling, applied adult learning theory as a foundation for a priori themes, in concert with grounded theory to explore emergent data and categories. The study revealed four categories relevant to pesticide applicator safety training: knowledge and learning, worker practices, worker beliefs and attitudes, and work environment. The study was expanded in 2018 to include prior results and to develop a conceptual model of pesticide applicator safety in Idaho.

Methods. This study employed four focus group interviews with 24 pesticide applicators intended to elicit stories and effective learning mechanisms for pesticide safety. The study also included ten one-on-one interviews with experts to reach theoretical saturation of data categories, and also included a statewide survey of pesticide applicators to gather baseline data about the population of pesticide applicators in Idaho. Researcher observation was valuable in understanding the cultural context of pesticide applicators. Using grounded theory constant comparative method, data was coded through an iterative process in various stages: initial hand coding, open coding, incident coding, focused coding, and axial coding

Results. In addition to categories that surfaced from theoretical sampling: *knowledge and learning*, *worker practices*, *worker beliefs and attitudes*, and *work environment*, four additional categories arose from the data: *changes over time*, *worker development*, *interfacing with the public*, and *dangerous work*. Data also illuminated pesticide applicator subculture by clarifying that narrative, in the form of *exposure* and *non-exposure* stories, plays an integral role in learning.

Conclusions. Understanding the reasons pesticide applicators may take risks is key to developing effective safety training. The pilot study found that these reasons are embedded in the culture of the workforce, demonstrating the need to develop additional safety education programming that arises from the needs and motivations of pesticide applicators. Providing these workers access to research-based information may reduce risk, and training that utilizes narrative can serve to reinforce learning by providing an educational context. Of further interest is development of self-efficacy among pesticide applicators that could increase their safety and the safety of their co-workers. These findings offer a positive direction in development of future educational curriculum for pesticide applicators. Multiple topics call for further research. A conceptual model reveals forces that contextualize and contribute to the current pesticide safety education situation.

Keywords: pesticide safety education, subculture, worker learning, Idaho qualitative study, narrative

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Dedication

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CHAPTER ONE

INTRODUCTION

The purpose of this qualitative study was to identify critical learning components and approaches that lead to the safe use of pesticides by pesticide applicators. This dissertation document is organized in six chapters: Chapter One Introduction, Chapter Two Literature Review, Chapter Three Methodology, Chapters Four and Five are two publishable papers, and Chapter Six Concluding Discussion. The eventual goal is to improve safety and health outcomes for applicators and any other workers who handle or are exposed to pesticides. Use of pesticides is considered necessary for efficient large-scale food production, smaller-scale operations, and to protect land and soil from invasive species. Due to the potentially toxic and varied effects of pesticides, safe and appropriate handling of these chemicals is extremely important. Misuse of pesticides by applicators can affect many others in their families and communities as well as themselves. Results from this study may be used by pesticide educators to enhance their courses or develop new educational programs for applicators.

Pesticides are used worldwide to assist in the production of most agricultural products. While some of these chemicals are somewhat non-toxic, others are highly toxic, and can persist in the environment or through the food chain longer than anticipated. For example, horses may eat grass in a pasture sprayed with an herbicide that does not break down for several years. Horse manure containing spray is then composted and applied to a vegetable garden resulting in failed crops. This persistence and other types of unintended contamination can have a major economic effect on a large-scale basis.

The state of Idaho has a fairly low population nationwide (ranked 41st) but is a top producer of many agricultural products exported nationally and internationally. In December of 2017, Idaho was documented as the fastest growing state in the U.S. by the U.S. Census Department (2017). The interface between housing developments and agricultural operations is increasing as additional developments are built around the state.

Problem Statement

The major problem in pesticide use is the potential for contamination and poisoning of people and the environment. The Center for Disease Control (CDC) estimates physicians diagnose 10,000 – 20,000 pesticide poisonings in the agricultural sector each year (2018). The National Pesticide Information Center (NPIC) reported 1,927 pesticide poisonings or accidents, called “incidents,” in 2016 caused by mishandling of pesticides (Jenkins, 2016). These incidents, however, were not specific to agricultural uses. Based on Center for Disease Control (CDC) data, approximately 25 acute pesticide poisonings were reported in Idaho in 2013, which is 2.94 – 3.88 per 100,000 people in 2013, based on the most current available data (CDC, 2018). Six agriculture-related deaths occurred in Idaho during 2016 (Bureau of Labor Statistics, 2018). While the specific cause of death is not specified, the number indicates that agriculture is, in general, a dangerous occupation. According to Kearns (2016), five deaths in the first half of 2016 were non-native English-speaking persons.

Mishandling and overuse of pesticides has a potential cumulative, long-term effect on human health and is not necessarily apparent within a short time frame or on a small-scale. The chronic health effects may include “respiratory problems, memory disorders, dermatologic conditions, cancer, depression, neurologic deficits, miscarriages, and birth defects" (McCauley, et al., 2006). Parkinson's disease and thyroid disease have also been linked to pesticide exposure in farm workers (Pouchieu et al., 2018; Lerro, et al. 2018).

Based on the above data, agriculture is considered a dangerous occupation. According to the Occupational Health and Safety Administration, (OSHA), in 2011, "570 agricultural workers died from work-related injuries. The fatality rate for agricultural workers was 7 times higher than the fatality rate for all workers in private industry; agricultural workers had a fatality rate of 24.9 deaths per 100,000, while the fatality rate for all workers was 3.5" (OSHA, 2013). During the height of the spraying seasons, applicators may work more than eight hours, six to seven days per week, for several months, leading to fatigue and an increase in accidents (Gorelick, 2003).

In *Tomatoland*, Barry Estabrook documents multiple shocking incidences and resulting health problems from workers exposed to pesticides in the Florida tomato industry (2012). The book lists health problems including newborn deformities; workers being accidentally sprayed with various highly toxic chemicals as a regular practice; pregnant women being coerced into working with methyl bromide, a highly toxic chemical; a worker losing all his toenails after standing in an irrigation ditch; rashes; labored breathing; and lack of safety equipment.

Some practices in Idaho, though, appear to be more in line with EPA regulations than some of the egregious violations in Florida. One applicator in the pilot study talked about using a tractor for spraying where he can sit in an air-conditioned cab. Practices vary by crop type and region as to whether applications can take place via plane, tractor, irrigation lines, or hand sprayers. However, filling and washing tanks for any type of application method can result in workers' exposure to pesticides if they do not use the required safety protocols.

Developing a better understanding of what is happening in Idaho regarding pesticide safety is one of the goals of this study.

While this study does not look specifically at environmental consequences, it is important to note that using pesticides inappropriately can have significant and negative consequences, such as groundwater contamination, that can lead to further effects on humans. Four recent news events reported the potential danger of pesticides. In 2014, the use of methyl bromide was blocked in Idaho because cows and hay were poisoned on two southern Idaho farms that used the chemical for potato disease control. The EPA and USDA purported that the chemical was safe if used according to the label and guidelines; however, the two farmers claim it poisoned their cattle and caused miscarriages of calves along with other animal health problems. As of 2016, the two families have sustained approximately $450,000 in damages due to the poisoning (Haake, 2016).

In another news story, a boy was walking with his dog through a public area near Idaho Falls in the summer of 2017 when he was poisoned by a cyanide device designed to kill rodents. The dog was killed, and the boy sustained injuries related to the event (Harris, 2017). The following year, a Lewiston, ID field technician who had been trained in pesticide handling was injured following exposure to the fertilizer aqua ammonia (Whitman County Gazette, 2018). Although not a pesticide, aqua ammonia is highly dangerous and a potential agricultural chemical health hazard. Pesticides are handled using a similar method.

An article in *Modern Farmer* magazine titled, “Perils of Pesticide Drift,” documents an organic farm in Iowa unintentionally sprayed with a fungicide. Two years later an insecticide drifted onto the farm property, effectively causing the revocation of the farm’s organic status and costing them tens of thousands of dollars in income. Environmental

Protection Agency staff said unreported incidents represent the tip of the iceberg (Novak, 2017). Drift from aerial application and ground application occurs in Idaho, but the full extent of the problem is not known. This presents a complexity to pesticide application, particularly with more organic or diversified farms in the middle of conventional farming operations. As these adjacencies become more common, additional pressure will be put on pesticide applicators to prevent drift incidences.

Background and Context

There are currently about 8,000 farmers, workers, advisors, and applicators certified to apply pesticides in an agricultural environment in Idaho, as well as 700 consultants certified to advise others on pesticide use. Not only are crops for human consumption sprayed with pesticides—such as potatoes, wheat, barley, lentils, beets and more—hay and forage that feed livestock including cattle for the dairy and beef industries, are also sprayed with pesticides.

Idaho's largest industries are agriculturally based with dairy as the largest. Out of 103 industries in Idaho, food production is the sixth largest employment category; crop farming is ninth, cheese manufacturing is 13^{th}, livestock is 18^{th} and dairy cattle and milk production ranks 29^{th} (P. Watson, personal communication, December 30, 2017). The U.S. Census identified Idaho as the nation's fastest growing state in population as of December of 2017 (U.S. Census Department, 2018), indicating a potential for more conflict between industrial agriculture and pesticide application with non-agricultural land uses such as housing developments. It is unknown what the future economic impacts will be due to this factor.

Responsibility for the Problem

Responsibility for the safe application of pesticides is multi-faceted. Companies that produce chemicals and those that use chemicals in agricultural fields, government agencies that regulate chemicals, the education system that trains applicators, and these workers themselves are all responsible for the safe use of industrial chemical pesticides.

Private Companies. To understand the complex problems this study addresses, it is important to understand the multiple entities responsible for the safe use of pesticides on a widespread basis. Chemical companies produce pesticides used in the industrial production of agricultural products and commodities. Agricultural companies purchase those chemical products and sell them to farmers who may apply them or hire applicators or handlers to apply them to fields.

Government Regulation. Understanding governmental processes for approval and classification of chemicals is also important to this study. In the 1950s and 1960s, a chemical insecticide called DDT[1] was legal, used widely, and initially believed to be safe. It was later found to be extremely harmful for humans (NIH, 2008) and animals, including birds (Carson, 2002). The chemical had been widely used in Idaho until its prohibition in the 1970s. One farm wife interviewed in this study said she knew of farmers who still have tanks of DDT in Idaho (personal communication, 2014).

All too often companies and government agencies classify and advertise chemical or food products as safe only to later reverse their decisions after additional wide-ranging outcomes become known. This presents a high risk for agricultural pesticide applicators who are one of the first to be exposed to new chemical products and the effects that are yet to be

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[1] Insecticide, Dichlorodiphenyltrichloroethane (DDT): $C_{14}H_9Cl_5$

realized. The case of the ban of methyl bromide in Idaho exemplifies this point. Workers who are young or new to the job need to understand the risks of exposure to new chemical products to be motivated to use proper personal protective equipment (PPE).

Education System. Nationwide, cooperative extension has historically provided pesticide education and certification in conjunction with state agencies and private company training for their equipment and products. Extension has a 100-year history of providing education on up-to-date research to farmers. Historically, education was designed to help producers increase yields and profitability and to assist pioneer families and youth in necessary life skills such as livestock production, and food preservation. University of Idaho Extension continues this educational delivery of research-based topics that cover agriculture, family and consumer sciences, youth development (4-H), community development, and other programs identified by the local communities.

University of Idaho Extension has a 45-year history of providing education to pesticide applicators. In the 1980s, the federal government, with funding from the EPA, tasked the Extension system nationwide to provide training to applicators. The EPA federal funding has since been withdrawn, claiming that education was not in their mission because it was more under the purview of USDA to provide education. The USDA did not in turn replace funding for the pesticide education that EPA withdrew. The USDA does provide funding to Extension through other mechanisms, some of which is channeled to pesticide education.

The University of Idaho Department of Agricultural and Extension Education serves Idaho communities and economy via educational programs. Its mission is “to improve the economic well-being and quality of life for individuals, families, and communities in the state of Idaho, the nation, and the world through undergraduate and graduate education, Extension, research and outreach activities in agricultural and extension education, communications, leadership, and youth development" (CALS website, 2018). Extension Educators work in all 44 Idaho counties and are also housed by three of Idaho's four federally recognized tribes. There are currently three University of Idaho Extension Educators providing programming in pesticide education, two are full-time.

Pesticide Applicators and Handlers. Workers who handle pesticides have a legal responsibility to apply pesticides according to the requirements and specifications on the product label and to wear the proper personal protective equipment (PPE) and follow all safety protocols to keep themselves and others safe from contamination (Federal Insecticide, Fungicide and Rodenticide Act, 1996). Many farm workers nationwide and in Idaho are not English literate and therefore need extra training in their own languages to understand how to safely use pesticides. Cultural factors may also cause workers to believe they are safe—such as a belief in God, their employer, or bravado—or they may merely be ignorant of the dangers of chemical pesticides (Elmore & Arcury, 2001).

For the purpose of this study, the term, *worker*, includes licensed pesticide applicators and those not licensed but who apply pesticides under the supervision of a licensed pesticide applicator, also referred to as "pesticide handlers." This study is primarily focused on workers who have a pesticide application license. Please see Figure 1.1 Summary of Terms for Types of Pesticide Applicator Licenses and Unlicensed Pesticide Handlers.

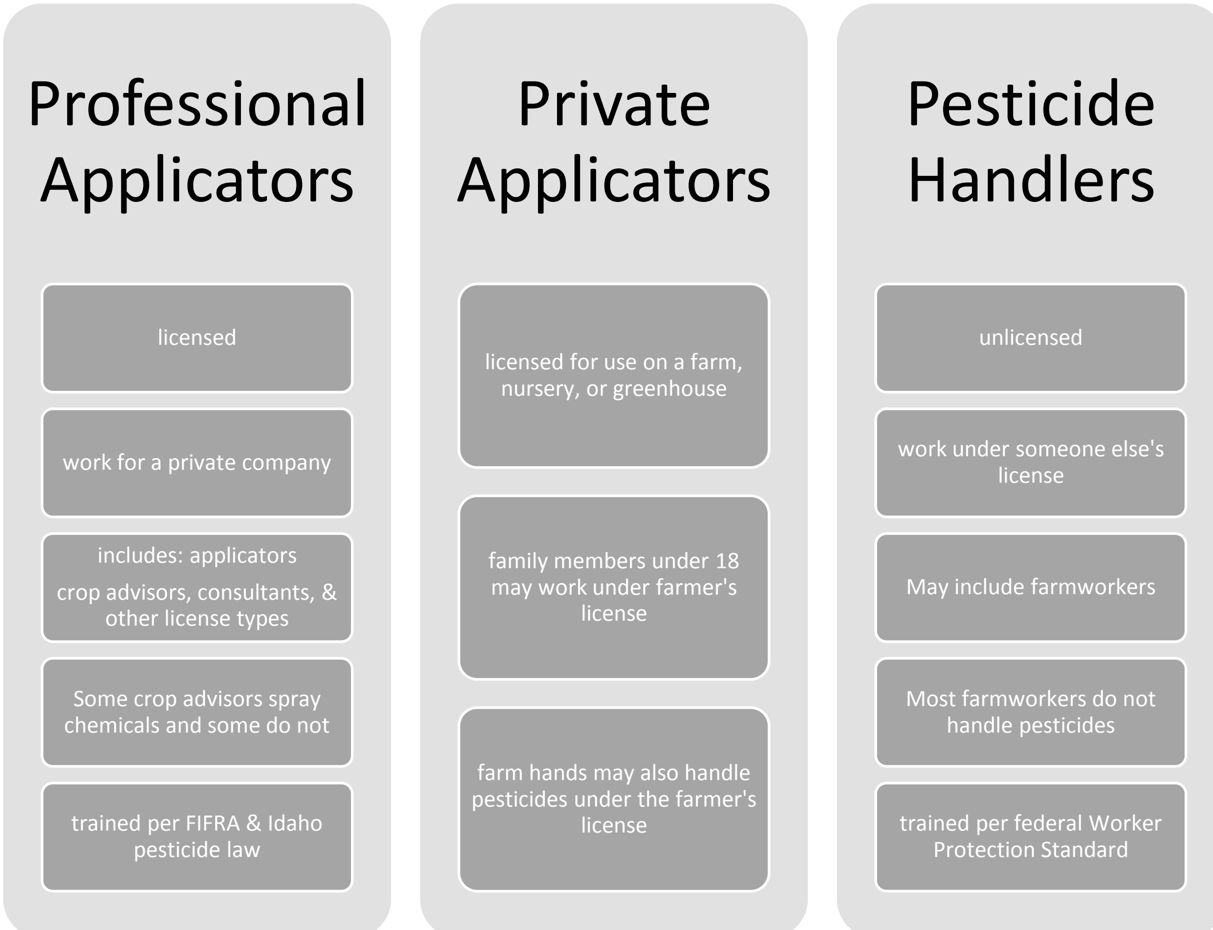

Figure 1.1 Summary of Terms for Types of Pesticide Applicator Licenses and Unlicensed Pesticide Handlers

According to Lumby, 88% of pesticide safety accidents are the result of unsafe acts, whereas 10% are the result of unsafe conditions (2015). Safe handling of pesticides by workers involves several factors including access to PPE, access to information regarding specific chemicals, and the specific PPE to be used with a specific chemical. The most important factor is farm worker motivation to learn safety measures and to consistently use those measures while working. (personal communication, 2017).

Many pesticide applicators and farm workers have not taken chemistry classes and rely on chemists to make the labels and instructions on agricultural products reliable. Federal law requires that those using pesticides adhere to the label and, with some products, there is little room for error. The basic principle of pesticide safety is that pesticides are safe if used properly and there is no drift. Given the dangerous risks involved with toxic exposure to the applicator and the environment, pesticide applicators deserve more support regarding safe and legal use of pesticides.

Organic Farming

Organic farmers also use various forms of pest control that do not fall within the conventional pesticide regulations but are instead managed under the National Organic Standards Board. There are 25 approved synthetic substances that organic farmers can use such as alcohol and hydrogen peroxide. The EPA has approved over 900 substances that can be used by conventional farmers (Roseboro, 2017). Idaho is 10th in the nation in organically farmed acreage according to the USDA at 178,567 acres in 2016 (2017).

Organic methods such as use of pyrethrin products can also lead to worker injury and poisoning if not handled in a safe manner. Some certified organic farms, however, rely more heavily on cultural methods like hand weeding rather than spraying herbicides. One value of organic agriculture is that worms and microbes remain living in the soil. Most synthetic pesticides are considered toxic to soil and without crop rotation can build up in the soil. According to manufacturers, though, glyphosate[2] (Roundup) and paraquat[3] break down within several days whereas other chemicals can stay active in the soil for up to three years, DDT persists for 40 years. Under certain pH conditions some chemicals persist even when thought to have broken down. A pesticide applicator may not know the pH of the soil to which he is applying a pesticide.

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[2] Herbicide, Glyphosate: $C_3H_8NO_5P$
[3] Herbicide, Paraquat: $C_{12}H_{14}N_2^{+2}$

Pesticides in Foods

A common example of unintended pesticide exposure is pesticide residue on food. According to the Environmental Working Group (EWG), a consumer advocacy group reviewed USDA's produce pesticide tests and found multiple pesticides on various types of produce. The organization publishes a list of fruits and vegetables, the *Dirty Dozen* and *Clean Fifteen* to help consumers know what to buy if they want to avoid consuming pesticide residue in their food. They reported that "739 samples of hot peppers in 2010 and 2011 found residues of highly toxic insecticides – acephate[4], chlorpyrifos[5] and oxamylon[6]" at concentrations that were high enough to cause concern. These insecticides are banned in some forms and on some produce, but not hot peppers (Lunder, 2018). This information can inform pesticide applicators of the widespread effects of pesticide use on food products.

Approaches to Pesticide Education

The government requires that pesticide applicators receive training and become licensed. The State of Idaho Department of Agriculture (ISDA) implements the requirements imposed by CFR, Title 40, volume 25, part 171 delegated to the states by the EPA. If companies want to use chemical pesticides, their workers must become licensed and maintain their license. This regulatory requirement provides a built-in audience for pesticide applicator training.

The two educators interviewed for the pilot study shared how the education program relates to licensing and how it is regulated in Idaho. Applicators are required to obtain initial

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[4] Insecticide, N-(Methoxy-methylsulfanylphosphoryl) acetamide: $C_4H_{10}NO_3PS$
[5] Insecticide, *O*,*O*-Diethyl *O*-3,5,6-trichloropyridin-2-yl phosphorothioate: $C_9H_{11}Cl_3NO_3PS$
Insecticide, Methyl 2-(dimethylamino)-*N*-[(methylcarbamoyl)oxy]-2-oxoethanimidothioate: $C_7H_{13}N_3O_3S$

licensing in order to use chemical pesticides, obtained by passing a certification exam. Applicators are subsequently required to take additional credit hours every two years to maintain their license. If an applicator does not maintain a license, he or she has to take a recertification exam to renew. Each hour of training is worth one credit with 15 credits required every two years. Applicators are required to be certified if they spray pesticides on their own farm or on someone else's farm. Unlicensed applicators are allowed to spray pesticides only under direct supervision of a licensed applicator.

To become licensed, an individual must pass the state certification exam. The state offers training on a rotating basis to help workers study for the initial license exam, but the training is not required to sit for the exam. Trainers are certified pesticide applicators ("consultants") from the Department of Agriculture or from University of Idaho Extension. Training consist of lectures with PowerPoint slides and clickers to quiz the audience at the end of each component to see if any content needs review. Study guides are available from the Department of Agriculture for self-guided study and review (ISDA, 2018).

The Idaho State Department of Agriculture uses the *Idaho Pesticide Applicator Training Manual. A guide to safe use and handling for applicators and dealers.* The current manual was published in 2017 and covers the following topics:

1. Introduction to Pests and Pest Management
2. Pesticide Law, Rule and Regulation
3. Pesticides
4. Pesticide Formulations
5. The Pesticide Label
6. Pesticide Hazards and Health

7. Using Pesticides Safely
8. Pesticides and the Environment
9. Pesticide Application Principles

The training is organized following the structure of the manual. The manual also has practice tests and review questions, a glossary and appendices that cover pesticide labels, contact information, and a conversion table for calculating area and amounts of chemicals. The process of getting additional credits to maintain licensure is called “recertification” by the ISDA and can be done by attending trainings or conferences offered by or pre-approved by the ISDA.

Examples of recertification credit opportunities include the Pesticide Stewardship Drift Conference offered in Boise, Idaho in November 2017 and the Procrastinator’s Pesticide Clinic offered in Lewiston Idaho in October 2017. The November conference was held at a hotel in Boise and was a two-day series of PowerPoint slide presentations and a Q&A panel at the end. There were approximately 120 people, mostly applicators, in attendance. The conference covered topics on what creates the most drift, how to reduce drift, and weed resistance. Horticultural and urban applicators had a breakout session separate from the agricultural applicators. The conference organizers, UI Extension and ISDA gave up to 15 credits to applicators for attending the conference.

The three-hour training in Lewiston was held in a meeting room at the Lewiston Fairgrounds and included four lectures with PowerPoint presentations. There were 10-minute breaks between each presentation. One of the presentations included a demonstration of the different types of measuring devices the pesticide companies provide with their products and how the quantity can vary from year to year depending on the volume of the mixture. There were approximately 45 pesticide applicators in attendance.

The literature review of pesticide education articles revealed various critical learning components and themes. Additionally, the two educators interviewed for the pilot study identified components they believe are critical to the safe and appropriate use of pesticides that are consistent with the literature. They believe in teaching from a philosophy that supports applicators learning concepts rather than rote memorization of test questions and answers (personal communication, 2017). When asked what topic they thought was most important, both educators interviewed identified *environmental impacts* as the most important. Safety is covered but is not a main focus of the training.

Recertification courses or programs may be similar to the initial certification but typically cover more detail on the topics listed above. Organizers or educators offering related programs can apply to the ISDA to give attendees pesticide credits, expanding the opportunity for applicators to gain the required 15 credits (ISDA, 2018).

Because reading and understanding pesticide labels prior to use is required by law, trainers cover how to read pesticide labels during initial training. Labels are reviewed by EPA and must include certain information such as what pests the product can be used for and detailed instructions for mixing (Federal Insecticide, Fungicide and Rodenticide Act, 1996). The label is not reader-friendly and may be difficult to understand for pesticide applicators. For example, a concentrated formula can be confused with a product that has already been diluted. Still, the responsibility of understanding the labels and using pesticides correctly is the responsibility of the applicators. However; due to social conditions in various parts of the country, some workers are not provided with training and personal protective equipment needed for them to use pesticides correctly and safely. This study explores how pesticides are used in Idaho in relation to applicator safety and provides guidance for future development of educational programs and materials.

There are three types of pesticide applicator licenses depending on the type of work that will be done. These include private applicators (farmers), professional applicators, and pesticide dealers (see Figure 1.1). Consultants do not apply pesticides but advise others using research-based resources such as the Pacific Northwest Management Pest Control Guides (Pscheidt & Ocamb, 2008). There are 23 different certification categories of pest control certification. It is estimated that there are a number of people applying pesticides without a license, which is considered legal only if working under a licensed applicator.

What Has Been Done to Solve the Problem

There are various programs designed to educate applicators on safe pesticide application. Most chemicals are expensive and therefore there is an inherent goal to use pesticide chemicals judiciously. But when applicators have a goal of covering a large number of acres and also to increase their pay, speed is more important than using the chemicals frugally and according to directions. Despite safety precautions, applicators are accidently contaminated and poisoned due to various factors. Some states that have a high number of pesticide applicators, such as North Carolina with approximately 13,000, have developed new education programs (Elmore & Arcury, 2001). Since many farm workers nationwide speak only Spanish, the EPA and some states are also now developing materials in the Spanish language (LePrevost, Storm, Asuaje & Cope, 2014).

In spite of some training improvements, the increased pressure on agricultural producers to “feed the world” and make profits creates the high potential environment for contamination and poisonings. Applicators are expected to be highly productive and accurate, which can pressure them to make mistakes and become fatigued, leading to worker injury (Hirshkowitz, & Sharafkhaneh, 2018). In view of Lumby's research that most safety incidents (88%) are due to human error (2015), more measures are needed to ensure applicator safety and environmental protection. New technologies can also assist with more widespread accuracy and traceability of pesticide application.

If the Problem is Not Solved

If pesticide applicator education and learning is not addressed, safety measures are likely to continue to be implemented in a similar way with a similar, unknown frequency and level of pesticide exposure to workers. Also, education programs are likely to continue to be implemented in a similar manner with the majority being, lecture-style presentations. Applicators deserve to understand how to implement safety measures and work in a safe environment. Extension programs have a responsibility to develop improvements in education that can lead to safer working environments and less contaminations.

Purpose of the Study – Objectives and Outcomes

The purpose of this qualitative, grounded theory study was to identify critical learning components and approaches that lead to the safe use of pesticides. The intent was to explore the perspective of pesticide applicators regarding safety, frame an understudied problem, and provide future directions for improving the safe use of pesticides through educational programming, specifically in Idaho. This study introduces new learning and ideas that may be applied to pesticide safety education programs in Idaho and other states. This research project used several pesticide applicator focus group interviews to elicit critical learning components and stories of their experiences in applying pesticides. One-on-one expert interviews were conducted to better understand the problem from the expert point of view. A survey inviting responses from currently certified pesticide applicators in the state was also implemented. Theoretical sampling, in the form of a pilot study was performed in fall 2017 to inform themes and questions for focus group interviews and for a statewide survey.

Research Question

In this study, I aimed to identify critical learning components and approaches that lead to the safe use of pesticides, as told, in part, through the narrative stories of farmers. I also intended to identify practices taking place in Idaho that lead to increased pesticide safety. The literature review explores current collective understanding of related topics as a foundation for answering the question: *What are the critical learning components and approaches, as told through the narrative stories of farmers, that lead to the safe use of pesticides?* Additional, related questions are discussed in Chapter Three, Methodology.

Significance of the Study

There are no published articles that present locally relevant topics on pesticide application safety in the state of Idaho. University of Idaho College of Agriculture researchers were at the forefront of researching and testing early chemicals used in agriculture in the 1950s (Anderson, 1995). Aerial application is widely used throughout the state and chemigation is used on most irrigated agricultural crops within the state. One 1999 article summarizes the pesticide chemicals used and the economic impact of those chemicals in the Idaho potato industry, but the article was written prior to the widespread use of glyphosate (Guenthner et al., 1999).

Rationale for the Study

At the heart of this study is a concern for pesticide applicators who often labor long hours under extreme conditions, and do not always use proper safety precautions. Workers may not have the educational background to make judgements about the chemical products they are using, but are told, and are required by law, to follow the label instructions. They rely on the education and understanding of chemists who work for chemical companies to develop products they can use effectively and safely. They are told to follow the label. There may be a need for additional applied chemistry education and toxicology (the study of the health effects of poisons) targeted to this group of workers. The need to study pesticide safety education was also identified because there is scant academic literature when compared with the widespread use of chemicals in Idaho agriculture. To understand critical learning components and approaches, it is important to better understand underlying beliefs related to risk or safety behaviors and to explore the subculture of pesticide applicators.

Epistemological Stance and Theoretical Orientation

In beginning work as an agricultural educator, I was required to become a consulting, licensed pesticide applicator. I attended a training for individuals who want to become certified. In my view, the training did not cover enough safety aspects of pesticide application and had no hands-on components. The four-day training consisted of back-to-back lecture-style PowerPoint presentations. The certification exam has a fairly low pass rate and I thought that the training could be delivered in a more engaging manner. Another colleague who attended had a similar critique (Ekins, 2015).

It is a constructionist, human belief that we should control nature—such as bugs and weeds—with chemicals, that led us to develop chemical solutions and a widespread infrastructure and distribution system. My parents were both exposed to DDT on their family farms as children. It was later discovered that DDT was not safe and was then banned in the United States, however, DDT is still present in the foods we eat because it takes about 40 years to completely break down.

When I was a child, my family and I lived adjacent to a chemical application company. We had a shallow well and were also surrounded by industrially farmed fields. I developed multiple health problems at a young age that I now believe were due to that adjacency. Therefore, my underlying belief is that pesticides are dangerous. Equally dangerous is the cavalier use and lack of precaution in using chemical pesticides. With proper protection and practices, farm workers and their families may be able to increase safety and improve their health outcomes.

In this study, my approach is structural. I am a positivist when it comes to chemicals and their use, but constructionist when viewing the human approach of their use. This study uses grounded theory with themes emerging from the data. My intention is to develop a model for pesticide safety education and learning that may develop into a theory. The results of this study may be incorporated into future pesticide safety education programming.

List of Abbreviations and Definition of Terms

Various terms provide the language "used by members of a group and are taught to members during socialization or 'onboarding' process" (Schein, 2017, p. 5). The field of pesticides uses multiple terms for various aspects of pesticide application. A list of terms is provided here for reference. *Pesticides* are defined as synthetic chemicals. These are reviewed and approved by the EPA. Use of these regulated pesticides in food production has been named, "conventional agriculture" [7] by USDA.

Aerial application – Also referred to as "crop dusting." Small airplanes are modified to hold tanks that can spray pesticides onto fields. Pilots fly low to minimize drift.

Adjuvants – Additives that help a chemical adhere to a plant or facilitates some other aspect of the chemical application. Also called a "sticker" by pesticide applicators.

Carryover – Carryover occurs when certain chemicals persist in the environment after the intended window of affect. For example, the herbicide glyphosate has been popular because it breaks down after 3- 14 days and does not continue to kill plants. Some herbicides do not break down for several years and continue to kill plants during that time period even if they move through the food chain. Carryover time periods can be greatly affected by multiple factors including soil pH, sometimes with significant affects.

Chemigation – The practice of applying pesticides via irrigation water lines.

Crop dusters – The pilots and planes that spray pesticides from the air.

Drift – Drift occurs when a pesticide is carried through the air to an unintended target.

EPA – Environmental Protection Agency. The federal agency responsible for implementing federal pesticide regulations.

ISDA – Idaho State Department of Agriculture. Responsible for implementing federal and state regulations regarding the safe use of pesticides.

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[7] "Conventional farming systems vary from farm to farm and from country to country. However, they share many characteristics: rapid technological innovation; large capital investments in order to apply production and management technology; large-scale farms; single crops/row crops grown continuously over many seasons; uniform high-yield hybrid crops; extensive use of pesticides, fertilizers, and external energy inputs; high labor efficiency; and dependency on agribusiness." USDA https://www.nal.usda.gov/afsic/sustainable-agriculture-definitions-and-terms

<u>Nozzles</u> – A fitting on the end of a hose. Nozzle size affects the size of droplets which can lead to or minimize drift.

<u>Time of re-entry</u> - Pesticide labels state how long workers and others must stay out of a field after it has been sprayed. Generally, signs should be posted so that no one enters the field during that time.

<u>Personal protective equipment</u> – Clothes and equipment including gloves, goggles, coveralls, and respirators that applicators wear to protect themselves. Also known as <u>PPE</u>.

<u>Pesticides</u> –<u>Herbicides</u> which are designed to kill weeds, <u>insecticides</u> intended to kill bugs, and <u>fungicides</u>, created to kill fungus and <u>rodenticides</u>, designed to kill rodents. The term pesticides does not include chemical fertilizers.

<u>Precision Agriculture</u> – Technological advances in tracking the activities of tractors in the field and the application of pesticides allows for increased precision and data collection. Allows for geographically based tracking of all field activities, including chemical application.

<u>Pesticide drift</u> – Drift occurs when pesticides applied to an intended field blow on the wind or air currents to a location that was not intended to be sprayed. Pesticides are not permitted to be sprayed when the air temperature is above a certain limit. Drift is a cause of contamination for adjacent land and homes.

<u>Resistance</u> – Resistance of weeds or pests to chemicals occurs because in every population there is a small number that do not respond to the chemical. Over time this population expands until there is a tipping point where the chemical is no longer economically effective. Various factors, such as the rotation of chemical use can accelerate or slow this process.

Restricted use pesticides – Only certified applicators or those directly supervised by a certified applicator are permitted to purchase and use restricted use pesticides.

Signal Words – There are three signal words on pesticide labels. The words "Danger-poison" with skull and crossbones means the product is the most dangerous and highly toxic. "Warning" means the product is moderately toxic orally, dermally or through inhalation. "Caution" indicates the product is slightly toxic if ingested orally, dermally or when inhaled and may cause minor eye irritation. "Danger" is also used without the word poison to indicate that the product has caustic properties.

Assumptions, Limitations and Delimitations

The following assumptions underlie this research proposal: the body of academic literature should address the intersection of pesticides and applicator safety, pesticide applicators deserve high quality, effective, research-based safety training; regionally based research is appropriate given the magnitude of agriculture and pesticide use in Idaho; and qualitative research is appropriate in order to understand the beliefs that shape the daily and specific use of safety measures and pesticides among Idaho's workforce.

Limitations

The first limitation of this study is that focus groups do not provide a statistically significant representation of the pesticide applicators of Idaho. They represent their own point of view and experience and are not generalizable in the same way that quantitative information can be extended. Sub-cultures exist at each chemical company and on each farm, but only some of these subcultures are represented. The results of this study encompass the perceptions of those who participated in the focus groups. One-on-one interviews with experts provided additional data, codes, and perspectives. The data from these sources ultimately contributed to the development of a conceptual model for pesticide applicator learning.

The statewide survey was not designed to be statistically significant but to provide a way to capture certain data, some of which is not appropriate for a focus group interview such as race, and income questions. The survey also included questions regarding work, preferred topics and methods for pesticide safety education helping to fill in a picture of pesticide application work and pesticide safety in Idaho.

Delimitations

This study included 29 licensed pesticide applicators who were willing to share within a focus group interview setting or individual interview. This is a fractional subset of the approximately 8,000 certified applicators statewide. Aerial applicators were not included in focus groups or one-on-one interviews. The statewide survey results were not used to present statistically significant quantitative results. This study is not designing specific safety education curriculum for pesticide applicators but provides a context and research-based information for future researchers and educators.

Summary

Chapter One introduces pesticide safety education in Idaho and theoretical sampling that has informed this next phase of research into critical learning components. This chapter summarizes the background and context, the problem statement, the purpose of the study, the rationale for the study, my epistemological approach and theoretical stance, the definition of terms, assumptions, limitations and delimitations of the research study. Chapter Two reviews literature that relates to each of the topics such, as adult learning theory, and includes a review of the use of narrative in education. Methods are detailed in Chapter Three.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In Chapter Two, I review academic research that pertains to the education of pesticide applicators regarding safety. The topics in academic literature include theory and practice of adult learning, extension education theory and practice, pesticide safety education, and the applicability of narrative in educational programs. I identified a gap in the body of peer-reviewed literature regarding pesticide applicator safety and review of standard pesticide safety programs in the U.S. Both are rarely evaluated or discussed in academic literature.

Search Descriptions

A computer-based literature search of Summit and the articles database at University of Idaho library and Google Scholar helped me identify published articles and conference papers related to pesticide safety education. I used the terms: *pesticide safety education, pesticide education, pesticide safety, adult learning, narrative in safety education, mining safety*, and *safety training* in my search. I also searched the Journal of Extension with these terms. In addition, I accessed reference materials suggested by adult learning experts as well as personal communication with farmers and other pesticide experts.

I also searched for articles on "adult learning theory" with multiple books and articles by Malcolm Knowles. In order to understand adult learning in relation to pesticide applicator learning, I searched for and investigated: *adult learning theory, adult motivation to learn, goal setting theory, transformative learning, role of adult educators, understanding the adult learner, components of adult learning, process of learning, barriers to adult learning, farmer* and *farmworker learning*. Nahrgang, Morgeson, and Hofmann (2011) in their meta-analysis of safety in the workplace cite Thomas Arcury, a leading author on pesticide worker safety.

Conceptual Framework/Theoretical Framework

The theoretical framework in this study is based on adult learning theory combined with grounded theory. The constructs of adult learning theory were applied to the literature review as they were in the pilot study interview question development which informed this study. Adult learning theory was also the basis for the health belief model as used by Elmore and Arcury (2001) that showed if barriers are reduced, more workers implement safety measures.

Grounded theory supports the concept of a developing theory based on emergent data. The pilot study pointed towards a model and potential to advance a theory of learning among pesticide applicators once saturation would be reached in the following phase of research. This project is also interpretive, designed to analyze practices and components that would make a better pesticide safety education program.

Related Literature

Existing literature on theory and practice, as described in the search descriptions, provides a research context for pesticide safety education. Literature pertaining to adult learning theory was reviewed for a priori themes while grounded theory methods were employed to discover emergent themes. The framework for the health belief model is adult learning theory. Grounded theory supports the concept of theory development based on emergent data.

While adult learning theory and workforce training are heavily covered subjects in the academic literature, pesticide education has generally been discussed in terms of specific chemicals, PPE and certification, for example. The literature is slim when it comes to effective methods for educating pesticide applicators regarding safety. For example, these topics could include higher-level cognitive engagement such as learner-centered programs, decision making, negotiating with superiors, etc. Academic articles that do cover pesticide worker safety focus on projects in southern states where the industry dynamics are quite different from Idaho. For example, climate, crops, pests and worker demographics.

Adult Learning

Knowles (1980) originated the field of andragogy with seminal works elucidating attributes of adult learners and learning processes. Illeris (2017) further developed an adult learning framework that illuminates the role of worker knowledge and learning as central to job success and, in an industrial setting, worker safety. Knowles' (1984) adult learning theory considers skills, experience, and the orientation of adult learners to inform design and assess educational programs for adults. Understanding learning processes pertaining to adulthood, including motivational processes in adults (Mezirow, 1991; Wlodkowski & Ginsberg, 2017) may be considered in educational program design when the goal is to affect a change in behavior for pesticide applicators.

Adult Motivation to Learn

What is the purpose for taking a pesticide education program? Applicators take a three-day class to pass the pesticide certification exam, fulfill their job requirements, and make a living. Farmers may take the program for a similar reason but could have more incentive to understand details, such as if a chemical has a residual effect over several years and what that effect will be since they are farming the same land every year. Another reason for taking classes is to keep the required number of credits each year to maintain a certification (ISDA, 2018). Wlodkowski and Ginsberg describe these as "situational interests" (2017, p. 232) that motivate behavior.

Educational programs designed with adult motivation in mind are more likely to be meaningful and affect more change in behavior (Wlodkowski & Ginsberg, 2017). Two aspects of motivation—motivation to learn and motivation to apply learned procedures in the field—are relevant to pesticide applicators. The learning processes "occur in the context of the learner's line of action, reflecting his or her intention, purpose, and feelings" (Mezirow, 1991, p. 212). Developing a better understanding of pesticide applicators' skills, experience, orientation, intention, purpose and feelings is critical to developing effective safety education programs.

"Individual interest" for learning, related to internal motivation (Wlodkowski & Ginsberg, 2017, p. 232) may be activated in applicators by designing pesticide safety education using their input. Tapping into and triggering the innate curiosity and desire to learn supports higher learning in the pesticide applicator audience. Dewey considers states of mind in his book *How We Think*,

This scientific attitude of mind might, conceivably be quite irrelevant to teaching children and youth. But this book also represents the conviction that in the case; that the native and unspoiled attitude of childhood, marked by ardent curiosity, fertile imagination and love of experimental inquiry, is near, very near, to the attitude of the scientific mind (1997, p. iii).

If it is possible to activate curiosity and interest in learners during a course on pesticide safety, then activation of the scientific mind could empower them to more fully understand the chemicals they are using and how to stay safe.

Wlodkowski and Ginsberg's "Motivation Framework for Culturally Responsive Teaching" (2017) outlines four main conditions that contribute to motivation:

- establishing inclusion;
- developing attitude;
- enhancing meaning;
- engendering competence.

These conditions may contribute to the development of a theory on pesticide applicator safety learning and may be designed in pesticide safety courses. Pesticide applicators and farmers have their own cultures and sub-cultures. According to a study about farmer learning, farmers expressed a preference for learning from other farmers or credible sources. They also value presentations from educators but learning from people with experience (e.g. farmers) appears to increase their receptivity to educational content (Franz, Piercy, Donaldson, Richard & Westbrook, 2010). Elaine Cullen (2008) found that miners preferred to learn safety information from other, more experienced miners in the form of narrative story telling.

According to Wlodkowski and Ginsberg's research (2017), the basis for an adult's motivation to learn is responsibility. Because the use of pesticides includes potential danger, there could be more engagement by pesticide applicators when activating the human impulse to be responsible. "A situational interest can become an individual interest when a person sustains involvement and acquires positive feelings, knowledge and value for the particular content" (Wlodkowski & Ginsberg, 2017, p. 232).

Lunenberg (2011) reviews goal-setting theory developed by Locke and Latham (1990; 2002) that stresses the significant connection between goals and performance. Goal setting is widely studied in academic literature in many fields and embraced in most corporations as essential to workers performing at expected levels of productivity and quality. Understanding how goal setting relates to pesticide worker productivity and safety may illuminate barriers for workers to implement safety practices. Identifying barriers is key in goal setting (Lunenberg, 2011). Goal setting originates from strategic planning theory and practice and originated in the military.

Transformative Learning

Of the many publications and books on adult learning theory, there are several relevant frameworks that can be applied to pesticide safety education. Mezirow defines learning as, “the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one’s experience in order to guide future action” (1991, p. 12). This learning theory applies to the process of pesticide education as the adult learner can use analysis and decision-making to adjust his or her actions.

The concept of “perspective transformation” (Mezirow, 1991, pp. 150-156) may be a factor in pesticide applicator safety. After adolescence, an adult may reinterpret cultural-symbolic assumptions and develop autonomy from earlier assumed paradigms (Mezirow cites Labouvie-Vief, 1991, p. 156). Alternatively, “many individuals fail to negotiate this crisis successfully and enter adulthood with rigid and highly defended thought patterns” (1991, p. 179). He continues that the test of this developmental transition is that the perspective of the individual is “more inclusive, discriminating” and open to alternative perspectives. Mezirow states that the progression of this transformation requires a decision on the part of the individual (1991). This forward movement could be important for those who are using potentially dangerous chemicals. Pesticide applicators who can reflect and change their behavior may be more likely to implement new safety measures or label protocols.

Responsibility of Adult Educator

Mezirow (1991) also outlines the responsibilities of adult educators. Educators should facilitate critical thinking in adult learners to reflect on their own assumptions, establish communities of rational discourse where beliefs may be questioned, and help learners take feasible actions based on that transformative learning (Mezirow, 1991). He also presents the history of understanding adult learning and memory from the field of psychology and education (1991). One process of learning is internalization of symbolic models (Mezirow, 1991). Pesticide safety relies heavily on symbolic models, especially the field of chemistry and safety communications.

Wlodkowski and Ginsberg (2017) also describe multiple strategies for teaching adult learners. All strategies could be implemented—and some are—in pesticide safety education in Idaho. These can be grouped into the following categories:

- understanding the learner;
- creating an emotionally safe learning environment;
- making content and delivery engaging and interesting;
- providing opportunities for learners to share and apply critical thinking skills.

One intention in the study is to understand applicators as learners and understand the educational components that would support their emotional safety and engagement in learning and development.

Knowles' six principles of adult learning present a view oriented towards the needs and perspective, in general, of the adult learner. When designing and delivering programs, educators should take into account the learner's need to know, the self-concept of the learner, prior experience, readiness to learn, orientation to learning, and motivation to learn (Knowles, Holton & Swanson, 2012). Based on my experience in the pesticide trainings, current programming in pesticide safety education in Idaho has generally not been designed with these principles in mind.

Components of Adult Learning

In *The Adult Learner*, Knowles, Holton and Swanson reflect on the history of research underpinning Knowles' work in andragogy (2012) and cite many researchers. For example, according to Bruner, learning is typified by growth, various skills such as describing what one has done, and intellectual capability such as holding various alternatives. Rogers developed teaching concepts from adult learning theory that included personal involvement and evaluation by the learner. Knowles, Holton and Swanson identify Maslow's self-actualization theory as the ultimate aim of learning, which is achieved via goal formation. Bloom's three domains of learning: cognitive (knowledge), affective (attitude), and psychomotor (human senses) provide another framework for understanding learning (Knowles, Holton & Swanson, 2012).

Friere's study is important in the development of adult learning theory for a variety of reasons, notably because he linked individual learning and growth to societal growth (Knowles, Holton & Swanson, 2012). Society's understanding of pesticides is evolving as individuals learn. Societal and cultural developments that are supportive of applicators' safety improve the outlook for the environment and communities.

Gagne's five domains of the learning process include: motor skills, verbal information, intellectual skills, cognitive strategies, and attitudes. The attitudes domain points to peer-influence with the concept of "vicarious reinforcement" (Knowles, Holton & Swanson, 2012, p. 15), which is likely a factor in the pesticide applicator's workplace culture where peers influence learning and behavior.

Gibbons describes three kinds of learning: natural learning, formal learning and personal learning. Natural learning takes place as a person develops outside of formal instruction. Formal learning is school or other types of structured education programs. Personal learning is knowledge that an individual pursues on his or her own (Knowles, Holton & Swanson, 2012). In reaching out to pesticide applicators I plan to explore what they experienced in each type of learning. Applying different ways of understanding to the adult learner in regard to pesticide education, and specifically pesticide safety education, could result in a reduction in exposure and ultimately better health outcomes for workers and communities.

Pesticide training programs could implement personal learning by finding out what applicators want to know and providing resources for them to learn. Readiness to learn is the point when an adult's "life situation creates a need to know" (Knowles, Holton & Swanson, 2012, p. 194). Readiness to learn is driven by the need to receive training or education applicable to an adult's employment. One applicator in the pilot study indicated he was wondering about the risk of using glyphosate. "I've been hearing things that they find Round Up in food now and all this other stuff. So, I don't know if it's true or not," he said. Applicators could use more resources and support for finding out information about the chemicals they are using, especially when they are motivated to learn. This is an example of how personal learning could be linked back to work.

Due to the invisible nature of pesticides (they can be odorless, colorless and still highly toxic), it is critical to provide applicators with research-based information and assist them in formal learning. They cannot rely on their senses, as in other occupations, to know if the chemicals they are applying are safe.

Barriers to Adult Learning

Cross (1981) discusses multiple aspects of adult learning, including barriers such as poverty, and suggests asking and observing stakeholders to discover different types of barriers. Pesticide applicators may have multiple barriers to learning pesticide safety such as pesticide education access and the cost of training and education. On some farms, although it is illegal, workers are told to use pesticides without proper training and personal protective measures and equipment (Estabrook, 2012). The University of Florida Extension responded to this crisis in Florida by developing a new education program for farm labor supervisors (FLSs) who manage farm workers. The supervisors are required to attend training and receive licensure as a farm labor contractor (FLC). This license is required in 12 states, including Idaho. Components of the Florida education program for FLSs include the responsibility of the FLS to provide safety education training and PPE for farm workers (Roka, et al 2017).

Many of the books and articles on pesticide safety education are from the 1990s. In a study of Latino Christmas tree pesticide workers in North Carolina, Elmore and Arcury (2001) identified a need to understand farmworker knowledge and beliefs about pesticides and work safety. They referenced the health belief model, which asserts that workers are more likely to use protective measures if their perception of the benefits is high. When perceived barriers are high, workers are less likely to use protective measures. They wrote, “few studies have considered farmworker knowledge and beliefs about pesticide and work safety” (Elmore & Arcury, 2001, p. 154). Seventeen years since Elmore and Arcury’s study, few research reports have been published on farmworker learning, knowledge, and beliefs. Results from the Christmas tree worker study indicate that understanding pesticide worker beliefs in the agricultural industries is critical to worker safety.

A 2010 study on farmer learning identified key components that may be applicable to pesticide worker safety learning. Farmers in the study indicated a preference for a learning process that relies on first-hand experience, saves time and money, introduces cutting edge research, and includes a social component. Researchers also learned about differences between types of farmer groups, that farmers enjoy peer teaching, they find value in participatory research, want more comprehensive educational programs, and want educators to understand ongoing change in the agricultural sector (Franz, Piercy, Donaldson, Richard & Westbrook, 2010). These topics can be converted into a priori codes and compared data to be collected in this study.

Health Belief Model

The health belief model, primarily used in the medical field, can be applied to pesticide workers as demonstrated by Arcury, et al (2001). The model is a widely recognized conceptual framework for health behavior concentrating on individual behavior change and asserts that people make an internal assessment of the “net benefits” of making a change. The model identifies four aspects of assessment: 1) “perceived susceptibility to ill-health (risk perception), 2) perceived severity of ill-health, 3) perceived benefits of behavior change, and 4) perceived barriers to taking action” (Green and Murphy, 2014, p. 766). See Figure 2.1. Conceptual Expression of Health Belief Model, my visual interpretation of the concept.

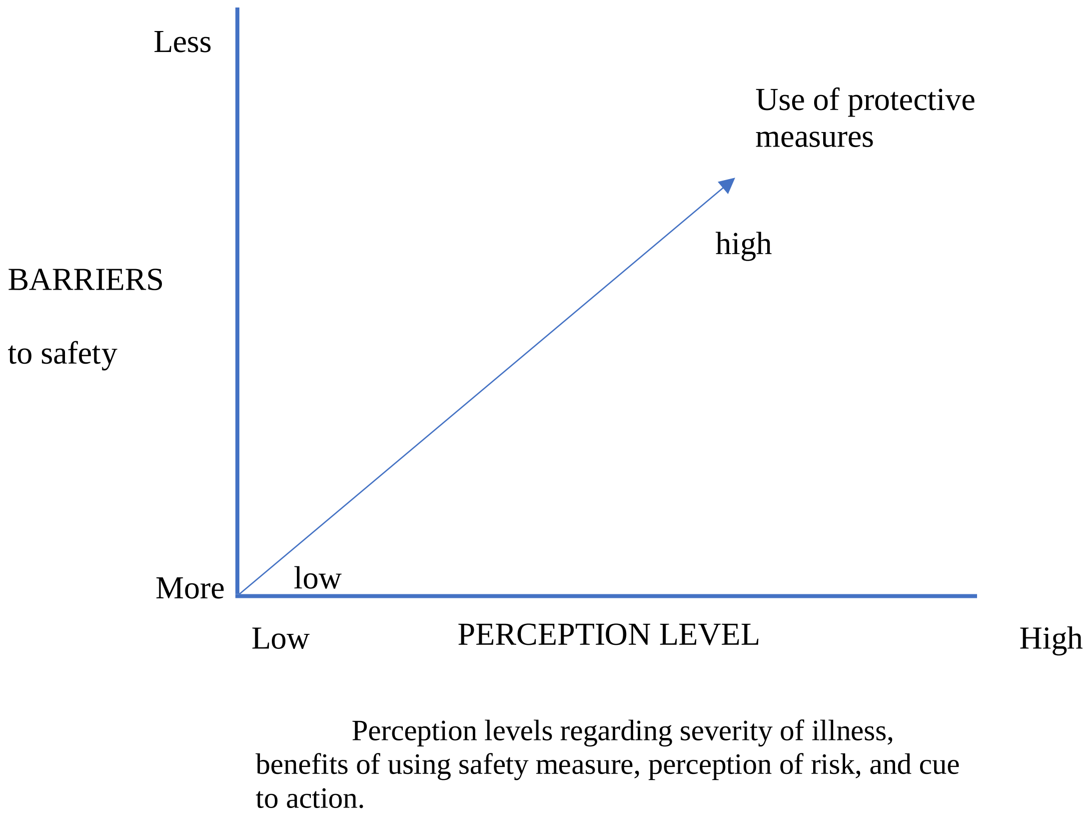

Figure 2.1. Conceptual Expression of Health Belief Model (Green and Murphy, 2014)

In comparing the health belief model with pesticide applicator learning, workers may need to be presented an opportunity to conduct an internal assessment after learning about safety practices. One aspect missing from the health belief model in the world of pesticide applicators is work environment and other factors beyond control of the worker (Green & Murphy, 2014). Externalities may include lack of knowledge about PPE, lack of access to PPE, the level of toxicity of chemicals, or co-worker risk-taking, for example.

Worker Actions and Safety

Depending upon safety practices, pesticide applicators can either prevent on-the-job accidents and/or injury, or conversely employ practices that lead to accidents and/or injury. While the field is understudied overall, Arcury et al. (2001) identified several activities that can lead to increased safety for workers. Workers are known to reduce exposure when they know and apply PPE knowledge. Further detail regarding worker practices are outlined by Arcury et al. (2001). Critical procedures that can directly reduce risk to workers include:

- wearing clothes that cover the entire body;
- washing hands before eating, smoking or using the toilet;
- not wearing work clothing into the home;
- bathing immediately after work;
- wearing clean clothes daily;
- laundering work clothes separate from other clothing and home laundry;
- knowledge of, and use of PPE;
- handling of laundry.

Lumby (2015) identified various facets of worker safety that can be applied to pesticide use in the workplace. These facets represent critical learning components that can be linked to worker actions including: accident prevention activities, understanding the cause of accidents and injury, and worker response to incidents (Lumby, 2015).

Extension Education Theory and Practice

The premise of extension education is that if educational programs are effectively delivered, adult learners gain knowledge and implement new practices that positively impact their communities. Extension educators provide non-credit or informal education identified by stakeholders as needed within each county or community (McCawley, 2009). Some extension education programs focus on single or multiple areas such as agriculture, natural resources, health and wellness, nutrition, community development, youth (4-H), or other topic areas identified by stakeholders.

Several extension educators, and one educator within the Idaho State Department of Agriculture (ISDA), teach workshops and trainings for pesticide applicators. Educators, including the educators interviewed for the pilot study, often rely on lectures in conjunction with PowerPoint presentations at these trainings. There are often 40-50 applicators who attend a training, requiring educators to use microphones. One educator stated that this lecture style may not be as effective as hands-on learning.

Safety represents only a minor component in the initial certification class and is covered in two out of nine chapters in the training manual (Takatori, 2017). The remaining majority of the curriculum covers a wide variety of topics including crop diseases, weed identification and development, pest insects, and pesticide labels (Idaho State Department of Agriculture, 2018). One educator indicated that safety is the main topic of several recertification courses.

University of Idaho and UI Extension have been involved in pesticide research since the 1940s, and UI researchers over the years have tested corporately manufactured chemicals. For example, DDT was tested at UI barns and found to greatly reduce the fly population. Thus, prior to understanding the danger of using DDT to people and the environment, trucks were dispersed throughout Idaho to spray barns and outbuildings on Idaho farms for a small fee (Anderson, 1995).

Pesticide Safety Education

The purpose of pesticide safety education is to reduce accidents, particularly poisoning incidents. The link between education and poisoning incident risk reduction is significant. Langley and Mort (2012) estimated that medical costs associated with pesticide exposure each year amount to nearly $200 million. They stated that incidents can be reduced "by increasing education of parents and workers, encourage use of less toxic agents, and encourage the practice of integrated pest management" (2012, p. 300). Some U.S. communities are largely made up of farmworkers, youth and children are often hired to apply pesticides (Quandt et al., 2006).

Multiple authors address pesticide safety education programs, mostly reviewing new programs. For example, Simeral and Hogan described results from testing a learner-centered program created in response to an "unpopular, routine training program" (2001, p. 1). The new program used a group scenario, problem-solving activity as the basis for training. Of 309 respondents over three years, 85% preferred the new type of training to the traditional lecture method.

Another serious issue identified in the literature is that migrant farmworkers do not receive enough, if any safety training (Quandt et al., 2006). Some workers speak Spanish, but attended trainings offered only in English (Elmore & Arcury, 2001). One study from 1998-99 included interviews of farmworkers in North Carolina with various visa statuses. The percentage of those who received pesticide safety training or information ranged from 27.4% (those without H2A visas) up to 66.7% (those with H2A visas). This percentage indicates that between 33.3% and 72.6% of the farmworker population studied did not receive pesticide safety training or information (Arcury, Quandt, Cravey, Elmore, & Russell, 2001).

Pesticide safety education in the literature covers specific topics or specific programs. One article described an educational PPE display (Johnson & Easter 1999). Another article described new programming for Latino audiences (LePrevost, Storm, Asuaje, & Cope, 2014). Educators from Washington State University (WSU) Extension developed a Jeopardy-style game to quiz class participants on pesticide labels (Ramsay, Schulze, Foss, Scamahorn, &

Ogg, 2001); however, no applicator reviews of the game were included in the article. Researchers also reported findings from programs such as pesticide dealer training (Buhler & Whipker, 2003), recordkeeping education (Ramsay & Foss, 2008), and laundry education (Tondl & Schulze, 2008).

Few authors evaluate standard, existing pesticide education programs. One study of the Texas statewide program used the licensing exam pass rate to measure training success in 2003 (Renchie, Larke, & Jones, 2004). Presumably, evaluations of trainings are completed at a workshop level to improve programs, but articles are not generally published based on those evaluations.

Use of Narrative in Educational Programs

Ricketts (2015) found that "story-based interventions can lead to important and lasting changes in peoples' behavior" (p. 51). Also according to Ricketts, stories used as anecdotes during trainings can reinforce presentations of rules and facts (2015). Polkinghorne (1995) described the function of narrative as "a fundamental mode of understanding by which people make sense of their own and others' actions and life events" (p. 5). Other authors such as Rossiter and Clark (2007; 2010) outline an expanded definition and role of narrative in adult education that can be considered in future pesticide safety education design. Because stories help us interpret our experiences, pesticide accidents and incidences can be understood by workers via story and allow them to think ahead and imagine what they would do in various situations.

In the 1990s and 2000s, Elaine Cullen led a study funded by the National Institute of Occupational Safety and Health (NIOSH) identifying potential importance of narrative in safety education programs for the mining industry. The purpose was to significantly improve safety education and outcomes. The education program was considered highly effective based on comparison of pretest and posttest results (Cullen, 2008). Stories relayed by miners about specific, high priority training topics, such as explosives handling, were recorded on video and then used at trainings to teach those topics. “Behind every regulation and statistical chart is a good story” (2008, Cullen, p. 23). Four types of stories, each with a possible application to education, are identified, including: hero stories, villain stories, adventure or disaster stories, and fool stories. The topics were identified and prioritized by industry experts. Development of the training method included pre- and post-test evaluations. Experienced miners were reminded of important safety procedures and new miners were provided specifics and motivation to learn the procedures new to them. Cullen and her fellow researchers also identified that if miners were going to implement a safety procedure, they would only do so because it was their choice and they had a clear reason to do so. Cullen also got to know the culture of mining and tailored the training and evaluation to fit the miners’ values and the mining culture (2008).

Parts of this storytelling method could be applied to pesticide safety education. Large-scale commercial farming is an industrial occupation with inherent dangers. Many practices are learned on the job from more experienced farmers or supervisors. Pesticide safety training is included in the required training for licensed pesticide applicators. In mining training material development, the goal was to create material that would get and keep the attention of the miners. There is also a need to get and keep the attention of pesticide applicators, for their own safety, in pesticide safety education. Training needs to be interesting and designed to help applicators use the best practices for safely handling chemicals. Storytelling can “communicate beliefs, model behavior, teach skills, provide behavior cues, and simulate consequences of behaviors over time in a compelling fashion" (Slater & Rounter, 2002).

Gaps in the literature

Some research has been conducted in the last twenty years on beliefs and safety education programs for pesticide applicators and farmworkers. However, no study focused on Idaho and the particular issues and needs that may exist with applicators in the state. Additionally, issues and needs may vary by region and farming type. More research is needed to develop a better understanding of pesticide applicator beliefs, motivation, and experience for the purpose of designing effective safety education programs. Gaps in safety education identified in the literature exist between the chemicals used by pesticide applicators and the labeling of PPE by manufacturers.

News articles and reports of drift incidences to the ISDA further indicate the need for additional actions. What is the role of academic literature to influence the current situation? If Extension's role is to interface between academia and agricultural practitioners, it is important to generate research-based information to help improve the situation. Currently the Washington legislature is considering implementing additional pesticide policy after cutting its review panel in 2009 and executing a new, briefer pesticide regulation in 2018 (Jenkins, 2018). This policy situation illustrates an example of the connection between pesticide use, research, documentation of incidents, public safety, and policy. Lawmakers may listen to expert testimony but may have no direct experience with pesticide use. Research-based information may help back balanced political decision-making.

Summary

Literature and emergent codes and themes as well as questions identified from the pilot study point to important capacity for the next phase of study. Further themes and questions were identified including: the role of narrative in learning, the regulatory environment, decision making and problem solving, accuracy, worker beliefs and attitudes, safety and the work environment, the economics of farming and pesticide use, technology, and co-workers.

CHAPTER THREE

METHODOLOGY

In this chapter I describe structure and steps of the research plan (Rudestam, 2014). This qualitative, grounded theory study explores the perspective of pesticide applicators regarding safety and how they could best learn about safety that leads to implementation of more or better safety practices. Methods are based on a theoretical framework stemming from literature on adult learning and from a grounded theory approach as detailed in Chapter Two.

The pilot study illuminated themes, some related to the literature and informed additional study. Focus group interviews, one-on-one interviews, and participant observations in conjunction with a survey of licensed applicators, provided a foundation for understanding the existing conditions and needs of pesticide applicators. Eliciting stories from pesticide applicators was intended to provide example material for future use of narrative in pesticide education trainings.

Research Design

This qualitative study utilizes grounded theory, adult learning theory, and some aspects of narrative inquiry methods. The purpose of using a qualitative method is to consider practices and experiences of pesticide applicators with a goal of discovering stories from the participants that can be used to educate others. A qualitative method makes sense for understanding the experiences of pesticide applicators more deeply. Qualitative research has the potential to illuminate contexts, in this case, the pesticide applicator work context (Patton, 2015).

The use of grounded theory that allows for themes and a theory—or a conceptual model—to arise from interviews of pesticide applicators has not been previously developed. Pesticide applicator safety education and learning was investigated through a focus group process, selected interviews with several experts, and participant observations. Additionally, a survey of pesticide applicators provided baseline information about pesticide applicators and their safety learning preferences.

Interviewing pesticide applicators one-on-one did not always lead to natural sharing of safety stories; however, applicators shared stories when I made a direct request during theoretical sampling. In order to elicit more stories, and natural sharing, I selected focus group interviews as a primary method for collecting data during the research study. A focus group of peers who have a common understanding of their work within a guided discussion has the potential to prompt additional meaningful stories and incidences (Krueger & Casey, 2015). These stories contribute qualitative data about work culture and subcultures of the pesticide applicator workforce.

Patton (2015) describes how qualitative data can reveal how people make meaning out of their lived experiences. In this process, the researcher functions as an instrument of research and in doing so, interprets data from their own perspective (Patton, 2015). I anticipated that shared stories would elicit examples of safety incidents to be used as data and possibly as examples in future pesticide safety training. Exposure incidences were shared during various interviews. Additional themes beyond those identified in the pilot study emerged from focus group interviews and one-on-one interviews.

I also designed and implemented a survey to collect baseline data about the pesticide applicator group. Neither the survey nor results were intended to have quantitative significance but were expected to supply informative data about the stakeholder group to understand what they consider important about pesticide safety, as well as information that is not appropriate to ask in an interview such as salary and race. The data was also expected to inform the direction of analysis for the focus group interviews.

Explanation of the Methodology

Qualitative, grounded theory research aligns with the concept of understanding an individual's experience. By understanding how a person feels about their experience and even what they thought about while working, a theory may be developed. According to Glaser, when using a grounded theory approach, participant interviews reveal "multiple incidences" and also then become "probability statements" (Glaser & Strauss, 2017). In this case, stories of incidences, once collected, may be matched up with curriculum topics as examples of what workers face in their daily lives.

Grounded Theory

Grounded theory was conceptualized by Glaser and Strauss after undertaking a study titled, "Awareness of Dying" in 1965. Kenny and Fourie (2014) reflect on the development of grounded theory: "accordingly, the researcher arrives at a hypothesis (in the form of a theory) at the conclusion of the research which conceptualizes the chief concern of the study." Glaser and Strauss prescribed various conditions to the grounded theory process about which they later began to disagree. Glaser and Strauss then began to write separately about grounded theory in the 1970s, resulting in two different lines of grounded theory, classic and Straussian (Kenny & Fourie, 2014). A student of Strauss and Glaser, Kathy Charmaz, further explored the limits to each of those approaches and published papers on the constructivist point of view, thus developing a third branch of grounded theory.

Methods

Methods implemented for this study included data collection, coding, and analysis. Data was collected through four processes: focus group interviews, one-on-one expert interviews, participant observations, and via a statewide survey of certified pesticide applicators. The focus groups were recorded, guided group discussions. The one-on-one interviews were semi-structured. Survey participants were either emailed invitations or provided a postcard with a link to the survey during pesticide applicator trainings around the state in late 2018 and early 2019.

I conducted four focus group interviews with two to five participants each in order to reach saturation. These interviews were recorded and transcribed using an online, machine transcription service (transcribe.wreally.com) and then edited into a useable transcript format, initially for hand coding in the margin.

Theoretical Framework and Research Questions

Although current literature indicates that exposures among pesticide applicators can be reduced through the implementation of safety measures, understanding why they use, or do not use safety measures has been studied very little, with no studies focused on Idaho or the Pacific Northwest. It is also assumed that educational interventions have the potential to affect behavior. Understanding the subculture of pesticide applicators, their beliefs, attitudes and other factors that contribute to learning, helps in analyzing the dynamics of pesticide exposure incidents. The desire to understand applicators point of view in relation to the health belief model, and the potential role of narrative in pesticide safety training and education led to the development of the research questions.

The main research question I developed for the pilot study was also used for the main research project and shaped the data collection process: *what critical learning components and approaches, as told through the narrative stories of farmers and pesticide applicators, lead to the safe use of pesticides?* Table 3.1 summarizes the relationship between the subject, topic, problem, purpose and main research question.

Table 3.1. Relationship Between Components in Identifying a Research Question*

Component	**Feature of Study**
Subject	Pesticide use
Topic	Pesticide worker safety education and learning
Problem	Pesticide chemicals are potentially very dangerous, workers do not always have all of the resources, training. PPE or time they need to implement known safety protocols.
Purpose	The purpose of the study was to identify critical learning components and approaches that lead to the safe use of pesticides.
Research Question	What critical learning components and approaches, as told through the narrative stories of farmers and pesticide applicators, lead to the safe use of pesticides?

*This table is based on an outline by Savin-Baden and Major (2013, p. 103).

The research question was expanded into several sub-questions:

- What processes and procedures lead to the safe use of pesticides?
- What are the critical learning approaches in pesticide safety education?
- What is the role of narrative in the culture of pesticide applicators?
- Which pesticide applicator subcultural beliefs, artifacts and underlying assumptions contribute to safety?
- What do pesticide applicators need and want in safety training?

Exploring these questions led to the analyses presented in chapters four, five and six. Table 3.2. Outlines the relationship between the study purpose and analyses.

Table 3.2. Summary of Study Purpose, Research Questions and Analyses

Study Component	Description
Purpose	The purpose of the study was to identify critical learning components and approaches that lead to the safe use of pesticides.
Rationale for qualitative grounded-theory method	To understand critical learning components and approaches, it is important to better understand underlying beliefs related to risk or safety behaviors and to explore the subculture of pesticide applicators.
Research Question	What are the critical learning components and approaches, as told through the narrative stories of pesticide applicators and farmers, that lead to the safe use of pesticides?
Chapter Four	The goal of Chapter Four is to use the health belief model framework and interview data to understand how the cultural elements influence risk beliefs and safety behaviors that give insight into critical learning components that lead to safe use of pesticides.
Chapter Five	The goal of Chapter Five is to explore stories of pesticide applicators in order to understand pesticide applicator subculture and the resulting implications for components and approaches to safety education.
Chapter Six	The goal of Chapter six is to synthesize what was learned from the study into a model for pesticide applicator safety. The model can inform new training & education design.

Positionality

The researcher's position and motivation for studying a topic is an important consideration in qualitative research (Egbert & Sandin, 2013) especially because the researcher is the instrument of inquiry (Patton, 2015). In my role as an agricultural educator, I provide research-based educational programming. I am interested in documenting what the pesticide applicator stakeholder group says about their experiences and what factors can lead to a safer environment for pesticide applicators. Figure 3.1 Study Framework Diagram is based on a figure from Egbert and Sanden's Foundations of Education Research (2014, p. 87). The figure summarizes the nested relationship between positionality, conceptual framework, paradigm, epistemological stance, methodological approach, methods selected, and the data to be collected.

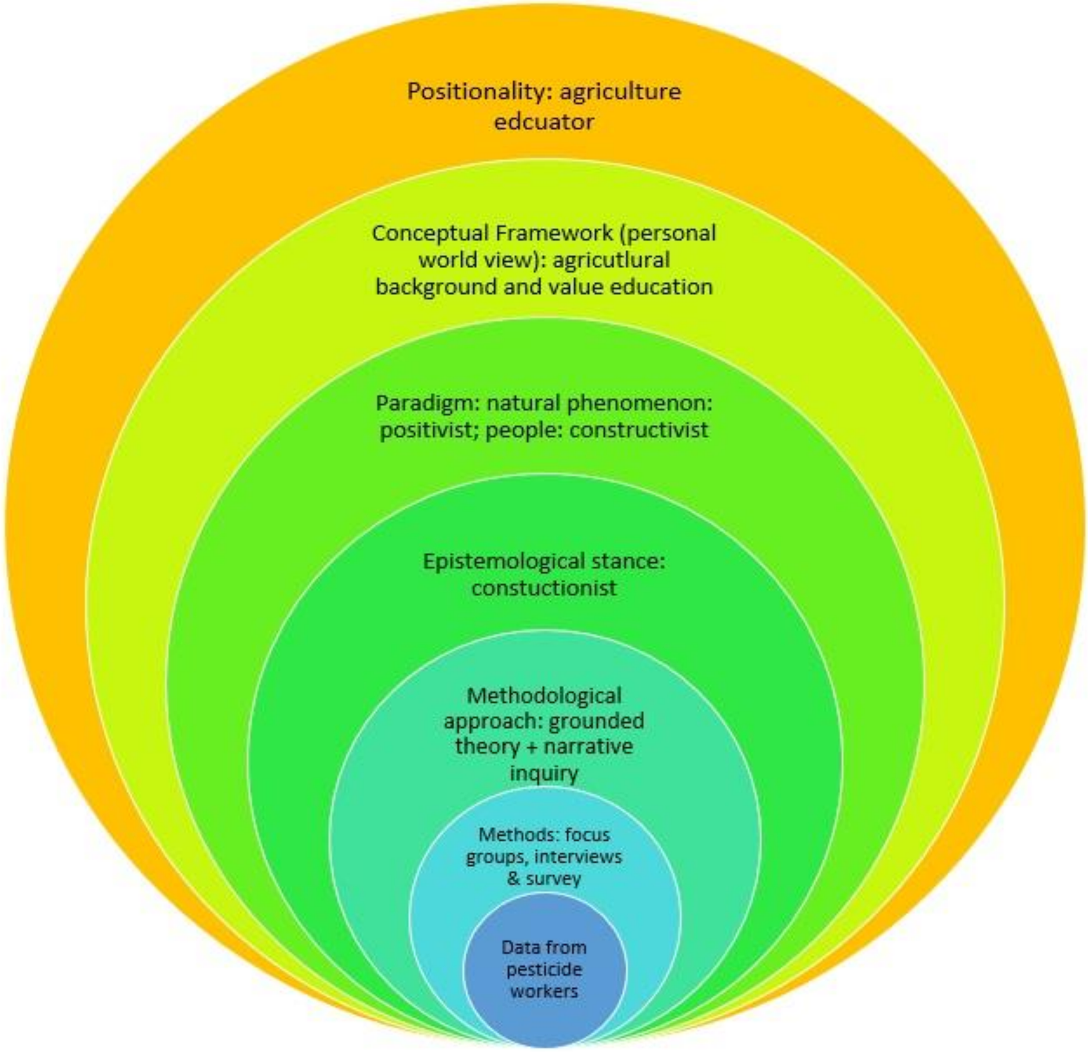

Figure 3.1. Study Framework Diagram*
*Based on a figure from Egbert and Sanden's Foundations of Education Research (2014, p. 87).

Theoretical Sampling: Pilot Study

In the implementation of grounded theory method, theoretical sampling supports development of research design (Charmaz, 2014). In congruence with the grounded theory process of theoretical sampling, in fall 2017, I conducted a pilot study designed to illuminate the pesticide safety context and shape the next phase of study through preliminary investigation and discovery. The research question was: *What critical learning components* *and approaches, as told through the narrative stories of farmers and pesticide applicators, lead to the safe use of pesticides?* The study was approved by the University of Idaho Institutional Review Board (IRB). Emergent codes and categories from theoretical sampling support lines of inquiry within this phase of study.

The pilot study included four interviews, two with pesticide applicators and two pesticide educators. Using qualitative inquiry interview design (Seidman, 2013; Patton, 2015) informed by literature review, I conducted pilot interviews during fall 2017. The interviews were semi-structured and began with a list of questions starting with contextual information followed by questions on components of pesticide safety education and the role of narrative in training.

Four interview participants were chosen for their role in the pesticide industry; two are pesticide application educators ("educators") in Idaho. Each has more than 10 years of experience teaching pesticide education. The other two participants were applicators ("applicator"), each with four years of experience and located in two different regions of Idaho. They indicated they were still learning about pesticide application and safety.

To analyze the data, each theme was summarized as a code. For example, the a priori code, "work environment," was present in the literature as determining various aspects of worker learning and safety (Arcury, et al., 2001; Lumby, 2015). The function of this theme is the *context* for worker safety. This code is also the label for one of the four major categories. Themes and their relationship to pesticide applicator safety are summarized in the discussion section. Interview passages were placed into at least one code and cross-coded if they fit into multiple codes. Word clouds[8] were used to identify repeated words. See Appendix I –

[8] An analysis of text where more frequently occurring words appear larger.

Sample Word Cloud. Coding and repetition of words and concepts informed the emergent themes and categories.

Based on the theoretical framework and interviews, I used focused coding during the pilot study to develop four major categories affecting pesticide applicator safety: 1) knowledge and learning, 2) worker practices, 3) worker beliefs and attitudes, and 4) work environment. Within each of these categories are a priori codes, emergent codes, and short labels for themes. I determined the four major categories by the function and relationships of themes using a grounded theory process.

I identified seven a priori codes from books and journal articles relating to pesticide applicator safety. These include: worker knowledge and learning (Stolovitch & Keeps 2011; Illeris, 2017; Knowles, 1984), mentoring and peer learning (Illeris, 2017; Topping, 2005), the role of education (Illeris, 2017), worker actions and safety (Lumby, 2015), worker beliefs (Elmore & Arcury, 2001) worker mentality and attitude (Lumby, 2015), the role of narrative (Cullen, 2008), and the work environment (Arcury, et al., 2001; Lumby, 2015). These are listed in Table 3.3 Themes and Codes from the Pilot Study: Understanding Pesticide Safety Education in Idaho and discussed in Chapter Three, Methodology.

I identified emergent codes from interviews with both applicators and educators. These included: regulatory environment, licensing, worker safety, economics of pesticide application, decision making and problem solving, accuracy issues, the role of narrative, technology, and worker attitude. Some emergent themes are critical and point to gaps in the literature.

Table 3.3. Themes and Codes from the Pilot Study: Understanding Pesticide Safety Education in Idaho

Code	Theme	Function
Knowledge and Learning		
Worker Knowledge and Learning*	Worker knowledge and learning are central to worker safety and job success. Factors include: worker experience level, knowledge of pesticides, insects, weeds, and crop development **Purpose of the use of pesticides –** an important aspect of the job is understanding what the chemical is supposed to be used for and when it should be used. Purpose of doing this type of work, worker skills and skill development, worker intellectual and personal development (Knowles, 1970)	Role of existing knowledge Learning Role of new knowledge
Mentoring and Peer Learning*	Mentoring and peer learning are critical components of worker training (Illeris, 2017)	Learning about safety
Role of Education*	Educators organize programs that support the licensing process and worker development. (Simeral and Hogan, 2001)	Education can influence safety
Worker Safety	Incidents at work help workers learn cause and effect of safety measures such as PPE (Applicators 1 &2)	Minor incidents can prevent worse incidents
Licensing	Licensing is the mechanism that gives the Department of Ag a captive audience for educational programming (Idaho Department of Ag)	“Captive” but willing audience for training
Narrative *	How are stories or anecdotes used to teach, train or convey new information? (Rossiter and Clark, 2007, Cullen ,2008)	Stories can teach workers how and why to implement safety measures
Worker Practices		
Worker Actions and Safety*	The purpose of worker safety is to prevent accidents and injury in a high-production environment. Activities and processes include: Accident prevention What causes accidents and injury? Knowledge of, use of PPE and handling of laundry Incidents of burns and poisoning and the worker response to incidents (Arcury, 2001; Lumby, 2015)	How workers keep themselves safe
Regulatory Environment	Pesticides are a highly regulated industry (Educators 1 & 2)	Constraints on worker behavior
Code	Theme	Function
Decision making and problem solving	How prepared is an applicator to make decisions in various situations including in an emergency?	Decision making
Accuracy issues	Accuracy is critically important to safety and work productivity	Accuracy can help keep workers safe
Worker Beliefs & Attitudes		
Worker Beliefs*	Health Belief Model identifies a positive relationship between perception of benefits and use of protective measures. (Elmore and Arcury, 2001).	
Worker Mentality and attitude*	What mental states contribute to safety? “Don’t rush” What mental states contribute to accidents? “Complacency.” (Lumby, 2015)	Workers’ mental states and attitudes can help keep them safe or put them in danger
Narrative or storytelling*	How are stories or anecdotes used to teach, train or convey new information? (Rossiter and Clark, 2007; Cullen ,2008)	Stories can teach workers how and why to

		implement safety measures
Work Environment		
Work environment*	The work environment determines various aspects of worker learning and safety (Arcury, 2001; Lumby, 2015)	Context for worker safety
Economics of pesticide application	How much does a customer want to spend? And, how fast does an applicator work?	Financial pressure affects safety
Technology	What is the role of technology in pesticide application and in pesticide education? What is the potential?	Technology can contribute to safety but also to complacency
Coworkers	What is the role of co-workers in safety incidents?	Workers function in teams, especially when there is a safety incident.

*A priori codes

Results of the four major categories from the literature review and data analysis are discussed and organized: 1) knowledge and learning, 2) worker practices, 3) worker beliefs and attitudes and 4) work environment. The relationship between theory, the four major categories and codes are illustrated in Figure 3.2. Pilot Pesticide Safety Education Study, Relationships Between Theory, Code, and Categories.

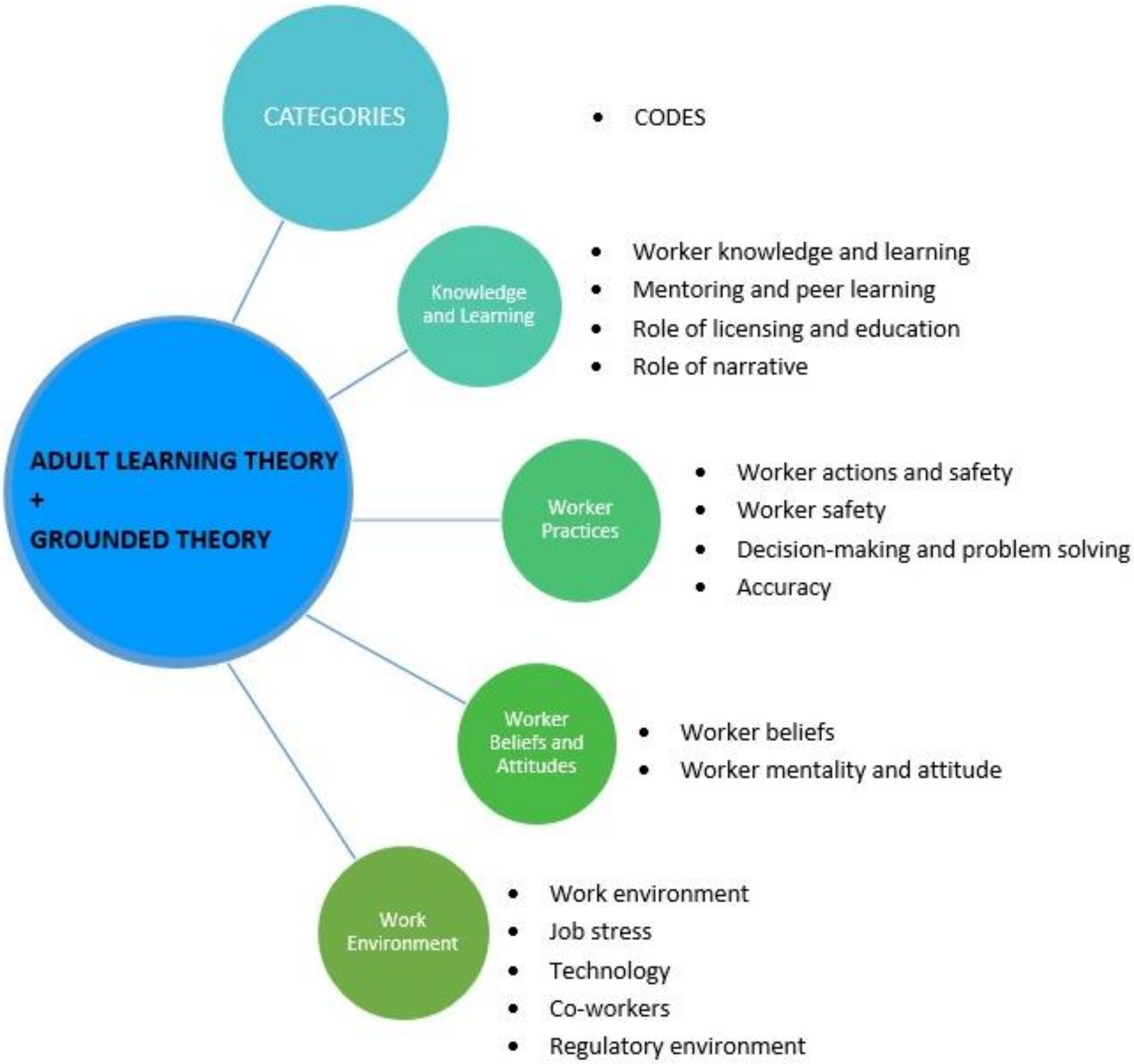

Figure 3.2. Pilot Pesticide Safety Education Study, Relationships Between Theory, Code, and Categories.

Theoretical Sampling and Emergence of Categories

During theoretical sampling within the pilot study, I used codes to analyze the data. Initial codes and categories arose and are discussed in results Chapters Four, Five and Six. Theoretical sampling within the pilot study allowed data to reveal codes and categories regarding pesticide applicators' work and learning and were used to inform research design and provide context for this study.

Worker knowledge. There are multiple categories of knowledge that applicators need to learn and retain. From the pilot study these areas include: understanding of equipment, chemistry, technology, farming processes, crops, weeds, insects, life cycles, weather, and seasonal cycles. Some workers may follow instructions from those above them in their company but may not understand the various details of these topics. A question for further study from this factor is: *which work roles in a pesticide application company have responsibility for the different types of knowledge?*

Worker learning. In the focus group, interviewees may share how training and learning takes place on the job. In order to be productive and safe, pesticide applicators have to know, remember and implement a great deal of information A question for further study: *how does that process of learning, remembering, and implementing take place? Which work roles follow which processes?*

Mentoring and peer learning. Both applicators interviewed in this study indicated that they learned from a more experienced co-worker when they started. The informal learning process seems to be a key characteristic of the work and culture of pesticide application. The two applicators told their personal stories and experiences, including near-miss stories. For this phase of the study, *how can stories be documented and repeated for maximum benefit?*

Licensing and education. The role of licensing and credit acquisition by applicators provides an opportunity to communicate and train applicators. Given this opportunity, *what* *are the most important components that should be covered in licensing trainings? What are the most effective methods for teaching pesticide applicators about safety?*

Worker practices. In initiating the pilot study, I suspected there to be an attribute of bravado or invincibility that caused applicators to take risks similar to those documented in *Tomatoland* (Estabrook, 2012). In discussing the issue with the two applicators, it became apparent that the primary reason they took risks was to meet their production goals. From this observation, we can question, *what are some methods that could assist workers in handling productivity pressure?*

The pilot study, as a theoretical sampling process, informed the next phase of study. See Figure 3.3. Relationship Between Pilot Study, Research Design and Category Development. New categories emerged from the data: worker development, dangerous work, change over time, and interfacing with the public. These are explored in Chapters Four and Five.

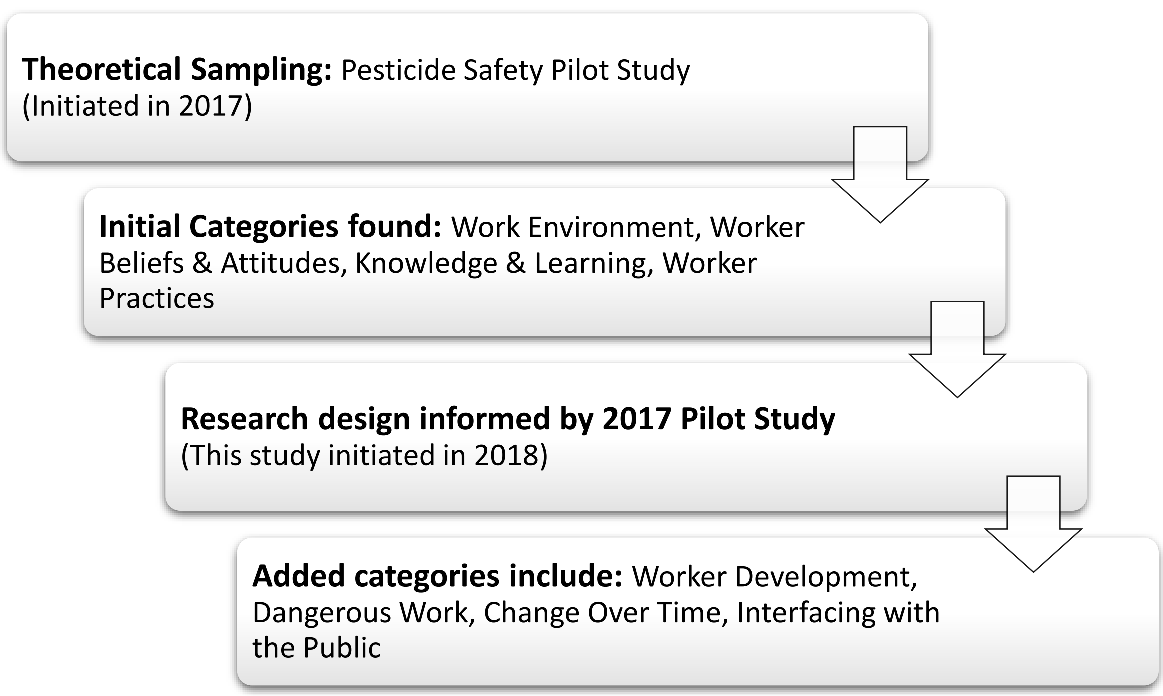

Figure 3.3 Relationship Between Pilot Study, Research Design and Category Development

Setting

I initially thought an ideal setting for conducting focus group interviews would be at the pesticide applicators' workplace. However, when scheduling the focus group interviews, I found that some applicators felt most comfortable meeting in a bar or restaurant. One of the focus groups was held following a training in a student meeting area at Walla Walla Community College in Clarkston, WA. One focus group interview was held in the meeting room of an office. In their advice on interviewing, Creswell and Poth write, "care must be taken to create an environment as comfortable as possible" including using strategies to give space and time for each participant to share (2018, p. 164). I asked pesticide applicators where they would feel comfortable meeting, and as intended, their familiarity and comfort with the place and their co-workers helped trigger memories of incidences that happened at work.

Participant Selection

The subject population includes adults 18 and older who are pesticide applicators, crop advisors, farm workers, and farmers who carry a pesticide applicator license. I identified and invited participants several different ways: invitations to pesticide companies, via my network of applicators, and through an individual from the pilot study. I used a snowball method to find others to interview during initial interviews (Krueger & Casey, 2015, p. 84). I initially contacted three pesticide companies over the phone to ask for a meeting to discuss the project, as recommended by Krueger and Casey (2015). I then selected focus group participants from my discussions with the pesticide companies. See Table 3.4 Focus Group Participants. One applicator from the pilot study offered to help recruit co-workers for the focus group. Through the network of local Idaho pesticide applicators, others were recruited for the focus group interviews. Focus groups were confirmed and reminders sent to the lead contact via text.

Table 3.4. Focus Group Interview Participants.

Location	Number of Participants	Recruitment Method	Date
Rockwood, WA	2	Invitation to applicator from pilot study	November 14, 2018
Walla Walla, WA	6	Invitation to training email list and verbal invitation at training	December 14, 2018
Twin Falls, ID	6	Chemical company contact made through University of Idaho Department of Agriculture	January 30, 2019
Moscow, ID	5	Contact made via chemical company	February 7, 2019

For the survey, I asked applicators who attended trainings to please invite others to take the survey. Criteria for selecting pesticide applicators for the survey and for the focus groups includes those who are certified *and* who currently work as a pesticide applicator or previously worked as an applicator during the last year.

Idaho State Department of Agriculture (ISDA) maintains a database of all certified pesticide applicators in the state. Survey respondents were recruited by emailing an invitation and survey link to ISDA staff who could forward the invitation to their certified pesticide applicator email list. For the most part, ISDA communicates with applicators using USPS and has email addresses for a small subset of certified applicators. Pesticide applicators were told about the survey at various trainings and given a card with the web address to the survey link. The survey was issued using University of Idaho Qualtrics Software. The output reports of responses for this survey were generated using Qualtrics software, Version October 2018 of Qualtrics©.

Another data collection source was one-on-one interviews with ten experts including two retired agronomists, two toxicologists, various agency employees, a weed specialist, a small organic farmer who used to work as an applicator/farm hand and a former farm worker who worked as a youth. See Table 3.5 One-on-One Interviews Participants. Because of my role with Extension as an agricultural educator, I have a network of colleagues who were willing to be interviewed. The agronomists interviewed were in my professional network. They regularly used pesticides and worked in various parts of the state. The Idaho State Department of Agriculture employees were contacted for their specific roles in the pesticide certification process. I contacted a toxicologist from a nearby state due to her role in working with pesticide applicators and trainings. I contacted her via email and she agreed to speak with me about her work. Another toxicologist from my professional network who farms in North Idaho shared her perspective in several one-on-one conversations in February and March 2019.

Table 3.5. One-on-One Interview Participants.

Role in Agriculture	Work Geography	Date
Retired WSU agronomist	Eastern Washington and Northern Idaho	November 5, 2018
Idaho Department of Agriculture Employee	Statewide	November 6, 2018
Weed Specialist	Southern Idaho	November 27, 2018
Retired UI Agronomist	State of Idaho	December 3, 2018
Organic farmer, former applicator/farm hand	Eastern Washington, Montana, North Idaho	January 6, 2019
Idaho Department of Agriculture Employee	Statewide	January 11, 2019
Idaho Department of Agriculture Employee	Statewide	February 8, 2019
State Department of Health Toxicologist	Nearby state	February 4, 2019
Former youth field worker	Southern Idaho	February 7, 2019
Toxicologist	North Idaho	February – March 2019

The former farm workers provided two different perspectives and important stories of their experiences working in Idaho agriculture with and near pesticides. I wanted to understand why they left their former roles and what their experiences were. Their interviews helped to saturate categories. I found one former farm workers by sharing my study with various farmers in my professional network of small acreage farmers.

I also visited the College Assistant Migrant Program (CAMP) office on the University of Idaho campus several times in order to try to find a more diverse group of pesticide applicators, specifically Hispanic applicators or farm workers. The CAMP program assists potential students with seasonal farm work backgrounds attend the university. I heard several exposure stories while I visited casually with people in the office and was connected with a graduate of University of Idaho who had worked in the fields of southern Idaho who I was able to interview.

One-on-one interviews were used to support interpretation of data collected from pesticide applicators. Only some of those interviews were recorded after theoretical sampling, if narrative incidences were expected to be shared. Those were coded as data. Factual information, such as the number of applicators, or the licensing process was not recorded. I typed notes in a Word document from hand-written notes. That information was not coded.

Data Collection Using Focus Groups

Focus groups can be used when the purpose is to "uncover factors that influence opinions, behavior, or motivation" (Krueger & Casey, 2015, p. 21). I hoped that a focus group interview method would inspire stories from pesticide applicators once they heard a story or comment from another applicator. As anticipated, when discussing an incident, other participants remembered and shared related stories, story fragments or affirming comments. Telling people about my research also resulted in spontaneous sharing of other stories. After sitting through a day of training on drift and during a session on public relations, an experienced pesticide applicator spontaneously shared a story. Glaser viewed qualitative data as the collection of incidences (2017). This is a natural fit with the type of data unit's (stories) I worked to collect during the focus group interviews and one-on-one interviews.

Focus group interviews were originally developed as a technique in the 1920s by corporations to understand consumer product and marketing preferences. The practice gained more widespread use in the 1960s. Academic researchers adapted the technique and its use has become widespread in various fields (Savin-Baden & Major, p. 374). Focus groups are a form of group interview used to explore how a group views a topic, shared opinions, and, in essence, can illuminate some aspects of a group's culture (Krueger, & Casey, 2015).

Theoretical sampling revealed that stories do play a role in the culture of pesticide applicators. Two aims in using the focus group were to inspire applicators to share stories with one another that illustrate safety topics, and to further illuminate aspects of their shared culture, such as values, group opinions, and common knowledge regarding safety and how they could best learn about safety that leads to safer practices. Also, in a group of peers, individuals may feel more comfortable. If workers have conflict or issues with co-workers, they may not have felt comfortable sharing their experiences or stories. In the Clarkston, WA focus group, not everyone knew one another before meeting.

It is possible that participants included in the focus group did not feel comfortable sharing certain types of stories such as those when safety protocols were not followed or when accidents took place. Since there is no guarantee of confidentiality between participants, I asked participants to share only what they felt comfortable sharing. Participants were given a consent form that reviews their right to stop the interview at any time. Each participant was encouraged to share useful ideas based on their experience, even if they did not feel comfortable sharing a story. I emphasized that I would not report their activities to anyone in a regulatory authority, so that they could understand my purpose.

Each focus group interview began with a welcome, followed by an overview of the topic, ground rules for participating (Krueger & Casey, 2015) and my background and purpose for conducting the study. Table 3.6 Focus Group Discussion Questions lists questions that were asked during the focus group interviews and the purpose of each question. I shared a one-minute clip from a popular television show, Breaking Bad, to break the ice and introduce my interest in innovative chemistry education for applicators that might include storytelling and humor.

Krueger and Casey advised providing a two-minute summary to the group at the end of the session asking if what was said is accurate, or if there is anything that was not discussed but should have been (2015). Seidman advised asking participants to reconstruct stories by asking “what happened?” but not asking them to “remember” as this can lead to participants trying to recollect details and losing track of what they do recall (2006, p. 88). To conclude the first focus group, I thanked the participants and also asked them to take the survey in paper form. Afterwards, they recommended that I hand out the survey at the beginning of future focus groups.

As soon as possible after the focus group, I wrote a memo about what I learned from the participants and what I was thinking about based on what was shared. Some memos were verbally recorded, some were typed, and some were hand written in my field journal.

Table 3.6. Focus Group Discussion Questions

Question Type/topic	Question	Purpose
Basic information – warm-up question	To begin with, I'd like us to identify who is in the room. Please say your first name and your job title (or if you are a farmer) and how long you have been doing this type of work.	Background information for context and to establish rapport.
Introduction	Show excerpt from Breaking Bad and invite comments	Break the ice; video example of narrative and learning chemistry
Pesticide education & learning	Certified applicators attend various trainings throughout the year to maintain a license. You have been invited to participate in this focus group because you are a licensed pesticide applicator. Of the various ways that you have learned about pesticide application or can imagine, **what are the most effective ways to learn?** Prompt: provide examples: hands-on activities, group projects, learning at work from an experienced co-worker?	Discover preferred ways of learning
	How were those effective for you?	Follow-up
Pesticide safety	What are the most important aspects of safety at work?	Understand the workers' view of safety learning
	In your opinion, what would be the most effective ways of learning about the safe use of chemical pesticides?	
	Do you consider your job dangerous? Why or why not?	
	What do your family members think about your job (or your work) as far as safety?	
	What are the precautions you take in order to prevent chemical contamination in your home or to your family?	
Stories	I am interested in how stories can be used to teach safety. In the mining industry, safety experts developed a series of training videos where experienced, well-regarded miners shared their stories. The videos were very popular with the miners. Videos and stories are not a substitute for hands-on learning but **are there any stories you have heard that affected the way you handle chemicals at work or on the farm?**	Elicit safety stories
	Prompt: if no one shares a story, read stories from the pilot study	
	Please share an incident, close call or situations at work that could help someone else learn. Examples could include what to do when you are fatigued, forget your PPE, a hose breaks, when someone went above and beyond their job to help another, when someone was injured, etc.	
	What risks have you seen other people take that you avoid?	Self-reflection regarding safety
Pesticide safety	What, if any, barriers do you face to implementing known safety practices?	
	What concerns do you have for yourself or others due to using chemicals at work?	
Open-ended	Is there anything else you could say about how UI Extension could help applicators learn about pesticide use or pesticide safety?	Find out anything I missed

Data Collection Using Survey Data

The purpose of surveying the general population of pesticide applicators is to provide baseline or general profile data about this group and their preferred methods for learning safety protocols. The survey was open for two months, December 2018 and January 2019, with periodic invitations sent throughout the survey period. Survey responses were separated by focus group participants (22 respondents) and pesticide applicators who did not participate in a focus group (51 respondents, four were unlicensed). Relevant survey results are presented in Chapters Four and Six.

Data Analysis

Three sets of data were analyzed: focus group transcripts, one-on-one interview transcripts, and statewide survey data. Data analysis included unitizing, initial coding, reflecting and memoing, and open, incident, focused, and axial coding. Through this iterative process, results and findings developed. Data was also coded in relation to a priori themes and codes, and the coding process led to the development of additional categories. The results and discussion chapters (Chapters Four and Five) describe what was found in the data and what it means for pesticide applicator safety education. The Concluding Discussion (Chapter Six) synthesizes the findings of the study.

Memoing

Memoing plays a critical role in grounded theory method in which the researcher reflects on what is said during interviews as well as how the researcher is developing as a scholar and in their understanding of the data (Charmaz, 2014). Immediately following focus group interviews, I wrote initial memos, or if driving, used a voice recorder to record initial thoughts and reactions. I also continued to memo throughout the coding process as insights arose from review and analysis of the data.

Data Coding

In interpreting data and coding data, I used the "constant-comparative" method (Glaser & Strauss, 2017) beginning with theoretical sampling through the conclusion of the study. As I collected data, I reflected in memos, and coded by hand and into an Excel spreadsheet. Initially, I transcribed the focus group and interview recordings using an online machine transcription service and then revised into a line-numbered Word document with a large margin for hand coding.

I initially open coded transcripts by hand, labeling or naming what was said by participants using an orange marker. For example, a participant said, "new people don't realize how seed treats, you gotta respect those" was initially coded "seed treatments are dangerous." Initial coding also included action coding, using the gerund form of a verb to identify incidents. For example, I coded comments as, "spraying chemical," or "learning about potential illness." For action coding, I used a blue marker. These codes were typed into a list in an Excel spreadsheet.

Focused coding is the process of categorizing data (Charmaz, 2014). Focused coding was conducted after hand coding, using Excel. Please see Appendix G – Example of Focused Coding. After hand coding, transcripts were unitized by copying logical segments of data into an Excel spreadsheet and reviewed for a fit with a priori codes and emergent codes from the theoretical sample. New codes arose and were added to the spreadsheet. New categories included: *worker development, dangerous work, change over time,* and *interfacing with the public*.

See Appendix F. List of Codes and Categories. Once data was coded by unit, each code was reviewed for its fit into existing categories. Many of the new codes fit into existing categories and some of the new codes did not. In the case where codes did not fit into existing categories, several new categories were identified. Some units of data were identified as fitting into more than one code.

Categorization

Axial coding is the process of understanding the interrelationship between categories and helps bring the data back together to see the whole picture. Axial coding as developed by Strauss and Corbin (1998) is focused on identifying conditions, actions, and consequences. It can be used if structure is needed, or other analysis of relationships between categories may be used. (Charmaz, 2014). For this study, units of data were coded in Excel with a review of each unit of data for initial code, action code and focused codes.

Theoretical sampling is an initial process of finding emergent themes (Charmaz, 2014). The pilot study conducted in fall 2017 was a form of theoretical sampling. Based on a theoretical framework and interviews, themes of the pilot study were summarized into four major categories that affect pesticide applicator safety: 1) knowledge and learning, 2) worker practices, 3) worker beliefs and attitudes and 4) work environment. Additional categories that arose from the data were: 5) changes over time, 6) worker development, 7) interfacing with the public, and 8) dangerous work.

During the process of coding, new questions arose, and I revised and added questions to the focus group questions that seemed important to ask of participants, such as whether they wanted to learn about potential illness from pesticide exposure. See Appendices H - K Focus Group Questions.

In grounded theory method, clustering is a pre-writing activity to compare relationships between categories that support development of a conceptual model (Charmaz, 2014). Categories from this study were tested for relationships to see where new categories might fit. See Appendix H – Example of Clustering from Field Journal.

Resulting from the related literature and pilot study, a health belief model was used to understand how beliefs and attitudes contribute to risk and safety behaviors (Elmore and Arcury 2001). As it became apparent that culture plays a significant role in risk, safety, and the work of pesticide applicators, data was analyzed using Schein's (2017) three levels of culture and the health belief model. Another process of analyses was unitizing data into stories and story fragments (if a story was not provided in full) and then coding story types.

Unitizing. Unitizing is the decision-making process that determines the unit of data. In qualitative interviews a unit can be a single sentence or a group of sentences describing a single incident. According to Glaser (2017), a unit of data should be combined to represent the incident. Sentences and incidents can be assigned more than one code. In this study, I examined the data for individual stories as units, as well as other data units such as relevant points that applicators made about pesticide safety or incidents. In interviewing multiple experts, data emerged that supported reaching saturation of code categories. Saturation is reached when no new categories emerge (Charmaz, 2014).

Validity, Reliability, and Generalizability

Validity confirms a study has measured what it claims and whether the measures are truthful (Savin-Baden & Major, 2013, p. 5). In this qualitative study, "measure" means to assess and understand the context of pesticide applicator work. Internal validity affirms credibility for the true causes of the findings. Researcher reflection, memoing, is important for recognizing bias; neutrality in data collection, and analysis helps reinforce internal validity of the study. The process of memoing helped me maintain neutrality, with the understanding of the researcher as an instrument.

Transferability is also considered external validity, if the data is true for other cases or, if it can be found to be true outside of the study (Savin-Baden & Major, 2013, p. 524). The conceptual model of pesticide applicator learning that has emerged from this study, may be tested in future studies with other pesticide applicator groups. However, pesticide safety education programs may be developed based on the findings and can then be evaluated and adjusted for effectiveness.

Reliability questions whether or not a duplicate study would result in consistent results. If saturation is achieved, results should be repeatable when duplicated regarding pesticide workers' experiences, what they learned, and how they changed and transformed (Savin-Baden & Major, 2013, p. 525). One goal of this study was to reach categorical saturation. If saturation was reached, another researcher would likely be able to duplicate the study; however, at another time, with another group, in another state or geographic region, aspects of the results would be expected to be different.

An important and significant question in qualitative results is whether results of the study can be generalized to other instances (Creswell & Poth, 2018, p. 102). In this study, some findings are generalizable to pesticide applicators in Idaho, and some findings do not need to be generalized. Once data was collected and analyzed, some incidences were understood to represent common experiences among pesticide applicators and some were unique to those who shared their thoughts and opinions. All data collected was valued for its contribution to development of categories of pesticide applicator safety education.

Triangulation is the process of checking results with several other sources such as literature review, expert review, and additional interviews. Experts such as regulatory agents and two toxicologists were consulted for this study to clarify various statements made by applicators and topics that pertain to pesticide safety. In this way, I developed a fuller understanding of the pesticide safety context expressed in Chapters Four, Five and Six.

Summary

Chapter Three details the structure and steps of the research plan implemented to investigate and explore pesticide safety education in Idaho. The methodological approach, research design, research questions, methods, and procedures are outlined. Using a grounded theory approach with focus group interviews, expert interviews, and a statewide survey, and with the goal of collecting narrative accounts of incidences, this study is methodologically unique and appropriately oriented to an understudied problem. One value underlying this study is a concern for pesticide applicators.

CHAPTER FOUR

THE LABEL SAYS DANGER: WHAT WE KNOW ABOUT PESTICIDE APPLICATOR SAFETY IN IDAHO AGRICULTURE

Abstract

This chapter presents results and data that explore pesticide applicator safety and education. The health belief model was used in this study to reveal the subculture of licensed pesticide applicators in Idaho. The study focused, in part, on the function of pesticide applicator subculture in chemical exposure and the implications for safety training and education.

Background. Pesticides are widely used in growing agricultural crops and products in Idaho. Approximately 8,000 applicators apply pesticides on approximately 12,000 farms in Idaho (NASS, USDA, 2017), in parks, roadways, and on other landscaping. Agriculture is considered one of the most dangerous occupations in the U.S (Sauter & Stockdale, 2019). Pesticide applicators often work with dangerous chemicals daily and are at the forefront of new chemical product releases.

Results. Study results revealed that pesticide applicators have their own subculture that includes artifacts and processes of their trade. Pesticide applicators value safety; however, multiple forces can create barriers to safety including underlying assumptions and values. The principals of productivity, efficiency, and profitability in the workplace contextualize the work of pesticide applicators. Eight categories of data are presented in a model of pesticide applicator safety: worker knowledge and learning, worker beliefs and attitudes, work environment, worker practices, worker development, dangerous work, change over time, and interfacing with the public.

Conclusions. Pesticide applicators are more likely to use safety measures if training is designed with their subculture in mind, including consideration of work pressures, worker needs, and working style. Training should include hands-on learning, use of engaging methods, and testing methods congruent with hands-on work and pesticide label law requirements.

Keywords: pesticide safety education, Idaho qualitative study, pesticide applicator culture

Introduction

The health belief model was used in this study to explore the culture of licensed pesticide applicators in Idaho. The phenomenon studied was how the culture of pesticide applicators contributes to chemical exposure and the implications for safety training and education. The primary research question of this study was: what learning components and approaches, as told through the narrative stories of farmers and pesticide applicators, lead to the safe use of pesticides?

Pesticides are widely used in growing agricultural crops and products in Idaho. Approximately 8,000 applicators apply pesticides on approximately 12,000 farms in Idaho (NASS, USDA, 2012), in parks, roadways, and on other landscaping. Agriculture is considered one of the most dangerous occupations in the U.S. Pesticide applicators often work with dangerous chemicals daily and are at the forefront of new chemical product releases.

The results section presents findings from the study using both the health belief model framework (Elmore and Arcury, 2001; Green and Murphy, 2014) and Schein's three levels of culture concept (2017) to understand the phenomenon. See Figure 4.1 Diagram of Pesticide Safety Training Study: Health Belief Model and Subculture of Pesticide Applicators illustrating these three realms.

The Health Belief Model

The health belief model purports that if a person perceives benefits from using a protective measure, he or she is more likely to implement that measure. When barriers exist or are perceived, a person is less likely to use a protective measure. The health belief model was developed from a behavioral lens in the 1950s to understand why people do not always implement a preventative behavior (Wiley & Cory, Bradley & DiClemete, 2013; Green &

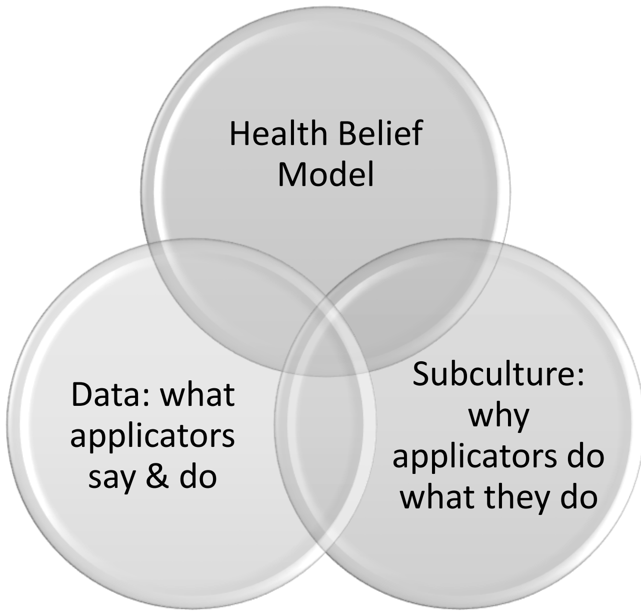

Figure 4.1. Diagram of Pesticide Safety Training Study: Health Belief Model and Subculture of Pesticide Applicators.

Murphy, 2014). Rosenstock, Strecher and Becker (1988) illuminated the role of self-efficacy and social learning theory within the health belief model. See Figure 4.2 Conceptual Expression of Health Belief Model, my visual interpretation of the concept.

Pesticide safety precautions may prevent disease, similar to being vaccinated or washing hands before eating. In understanding pesticide applicators through this lens, a better consideration of how they view risk of illness can help educators design trainings that respond to their unique subculture. When perceived barriers are high, pesticide applicators are less likely to use protective measures as indicated by Elmore and Arcury (2001) in their study using the health belief model as a framework to evaluate farmworker knowledge and beliefs about pesticides and work safety in the North Carolina Christmas tree industry. To fully understand worker behavior, an examination of how culture functions in the pesticide applicator workplace is necessary.

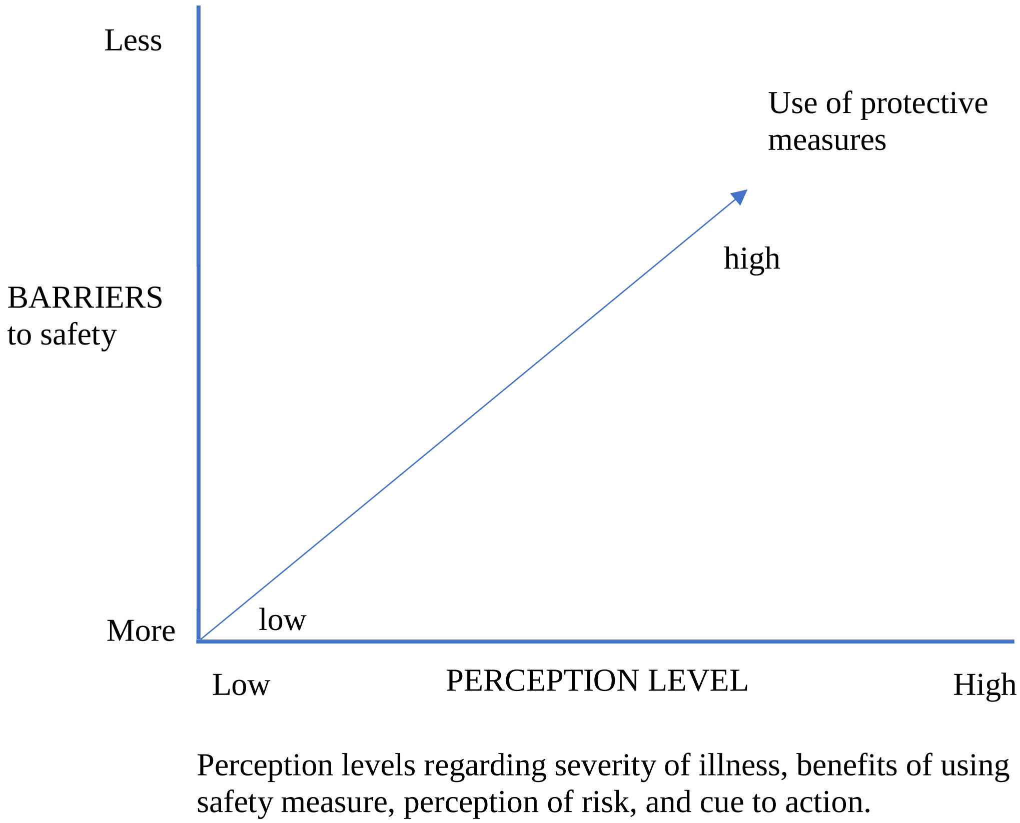

Figure 4.2. Conceptual Expression of Health Belief Model.

Use of protective measures that can prevent chemical exposure have been documented in the literature. Critical procedures that can directly reduce risk to workers include:

- wearing clothes that cover the entire body;
- washing hands before eating, smoking or using the toilet;
- not wearing work clothing into the home;
- bathing immediately after work;

- wearing clean clothes daily;
- laundering work clothes separately from other clothing and home laundry;
- knowledge of, and use of PPE;
- handling of laundry (Arcury et al., 2001).

Three Levels of Culture

Schein (2017) has extensively researched organizations and leadership, and theorizes about three levels of culture: artifacts, espoused beliefs, and underlying assumptions. To outsiders, the purpose behind cultural elements is not visible; however, they serve an important role driven by norms of operation. Underlying assumptions and norms exist because behaviors have been validated by experiences of those within the culture. Schein (2017) also discusses subcultures of specific professions or occupations such as teachers or engineers. In this paper, pesticide applicators are considered an occupational subculture of the agriculture industry.

An artifact is something that can be seen or felt, including observable behavior such as rituals, language, and use of technology (Schein, 2017). In a cultural setting, artifacts are readily seen or observed but not always easy to decipher. For example, a pesticide applicator might wear a tank on his or her back and walk through a field spraying a liquid. Without being told what is being sprayed and why it is being sprayed, an outside observer may not understand the activity. Why is this object or ritual a part of the culture? Is it significant or just a holdover? What is the history behind it? An outsider cannot know the answers to these questions until they get to know the culture from the inside.

Overt beliefs and values are expressed by members within a culture, also known as "espoused beliefs." According to Schein (2017), only actions that lead to "reliable results for the group," or those that bring meaning and comfort to the group, become assumptions. (pp.19-20). If espoused beliefs and values are not leading to positive results for the group, they are in a category Schein calls, "desired" behavior but do not become "observed" behavior. The difference can create cultural dissonance and leave gaps in the understanding of a culture that can then be further explained, in part, by examining the underlying assumptions.

An example of an espoused belief was that applicators should always wear personal protective equipment (PPE) when using chemical pesticides; however, it is known that applicators do not always use required PPE. Cultural dissonance occurs when it is too hot, or if PPE is not available. According to Schein's theory, an example of an observed behavior, not wearing PPE solved a problem. Applicators said that sometimes they need to be able to see without goggles or handle equipment with their bare hands.

Schein describes the underlying assumptions of a group as developing from the repeated successes of a method. As a culture develops, assumptions bring comfort as well as identity to group members. Once a group has assumptions, it becomes more difficult for insiders to see or understand activity of another culture that is inconsistent with how they operate and the members' underlying assumptions (Schein, 2017). Some applicators mentioned feeling misunderstood by the general public.

Schein (2017) defines subcultures as a group of people who work in the same department or occupation. People choose certain types of work, such as information technology, because it fits their personality, which is a factor in the development of professional subcultures. Pesticide applicators have their own occupational subculture based on shared experiences, values, beliefs and opinions. Illeris (2017) also writes about professional identity as, “a special type of work identity that is typically developed through a combination of vocational education and work” (p.40). This study examined the occupational identity and subculture of applicators via their statements about safety and their work.

Methods

This qualitative study explores the culture of pesticide applicators using a grounded theory method of data collection, coding and analysis (Charmaz, 2014). Data were evaluated in terms of the health belief model in combination with analysis of the subculture while using grounded theory processes including constant comparative data analysis.

Initial coding was used to identify incidences and themes and grouped into concepts. Further interviews and axial coding led to the development of categories. A model (concept) of pesticide applicator safety training is presented in this study informed by the health belief model, culture theory, and data collected from the pesticide applicators. This model centralizes pesticide applicator safety and examines the forces that contribute to a phenomenon of pesticide applicator exposure to toxic chemicals.

Participants included 22 agricultural workers licensed to apply pesticides in Idaho and ten experts such as several agronomists, toxicologists, former farm workers and agency personnel. Data were collected via focus group interviews, interviews with experts, participant observations, and via a survey about pesticide application training and safety. Expert participants were invited based on my professional network while focus group participants were found through phone calls to chemical companies and in-person announcements at pesticide applicator trainings around the state of Idaho.

Initial study data revealed that stories play a role in the subculture of pesticide applicators. Two aims in using the focus group were to inspire applicators to share stories with one another that illustrate safety topics, and to further illuminate aspects of their shared culture, such as values, group opinions, and common knowledge regarding safety, and how they could best learn about safety that leads to safer practices. Also, in a group of peers, individuals may feel more comfortable sharing opinions and knowledge (Krueger & Casey, 2015).

The health belief model was used to understand how beliefs and attitudes contribute to risk and safety behaviors (Elmore & Arcury, 2001). As it became apparent that culture plays a significant role in risk, safety, and the work of pesticide applicators, data was analyzed using Schein's (2017) three levels of culture and the health belief model.

An important question in qualitative research is whether results of the study can be generalized to other instances (Creswell & Poth, 2018, p. 102). In this study, results are not expected to be generalizable beyond pesticide applicators in Idaho, with additional limitations. Applicators included in the study represent their own point of view and experience and are not generalizable in the same way that quantitative information can be extended. Once data was collected and analyzed, some incidences were understood to represent common experiences among pesticide applicators. A qualitative method makes sense for understanding the experiences of pesticide applicators more deeply. Qualitative research has the potential to illuminate contexts, in this case, the pesticide applicator work context (Patton, 2015).

Triangulation is the process of checking results with several other sources such as literature review, expert review, and additional interviews. Experts such as regulatory agents and two toxicologists were consulted for this study to clarify various statements made by applicators and topics that pertain to pesticide safety. Further detail regarding data collection, coding, categorization, and data analysis is presented in Chapter Three, Methodology

Results & Discussion

This results section compares and analyzes data from the study using the health belief model and Schein's concept of culture to understand the phenomena. Data collected fell into eight categories of data are presented in a model of pesticide applicator safety: worker knowledge and learning, worker practices, worker beliefs and attitudes, work environment (Mayes & Holyoke 2019), worker development, dangerous work changes over time, and interfacing with the public.

The health belief model entails four main perceptions: susceptibility to ill-health, severity of ill-health, benefits of behavior change, and barriers to taking action (Elmore & Arcury, 2001). There are two other facets of the health belief model: cues to action and belief in effectiveness of new behavior (Green & Murphy, 2014) that also contribute to behavior change; however, these parameters are not explicitly discussed in Elmore and Arcury's work (2001). They mention culture, but it is not a central part of their study.

Schein (2017) discusses groups of workers, such as engineers or teachers, who have their own occupational subculture. This study explored the subculture of pesticide applicators. Artifacts include objects and structures, as well as processes. During the spring, summer, and fall, applicators use trucks and tractors with spray booms for applying pesticides and tanks for holding chemicals and water. Safety equipment such as gloves are also artifacts in the subculture of pesticide applicators. Examples of processes (cultural artifacts) are mixing and loading chemicals into tanks and spraying chemicals onto fields. Underlying beliefs are explored in the ensuing discussion.

Perceived Susceptibility to Ill-health

Pesticide applicators have individually unique educational backgrounds, values, and opinions, and as they enter the profession, they develop a perception of their own susceptibility to ill health in regard to their work with chemical pesticides. *Risk perception* (Green & Murphy, 2014) is the first facet of the health belief model that determines whether a person will implement a safety measure. Pesticide applicators are in danger of becoming sick, or worse, from exposure to toxic chemicals.

Although agriculture and grounds keeping are two of the most dangerous occupations in Idaho (U.S. Bureau of Labor Statistics, 2019), most survey respondents indicated they consider their job only slightly dangerous (46%), or somewhat dangerous (35%). A smaller group (17%) did not consider their job dangerous at all. Only one person considered it dangerous (2%) and no one classified their job as very dangerous. See Table 4.1 Level of Job Danger Identified by Pesticide Applicators.

Table 4.1 Level of Job Danger Identified by Pesticide Applicators

How Dangerous do you consider your job to be?						
	Statewide Survey		Focus Group Participant Survey		Total of Both Surveys	
Level of danger	No. of responses	% of responses	No. of responses	% of responses	No. of responses	% of responses
Not at All Dangerous	2	7%	6	30%	8	17%
Slightly Dangerous	12	43%	10	50%	22	46%
Somewhat Dangerous	13	46%	4	20%	17	35%
Dangerous	1	4%	0	0%	1	2%
Very dangerous	0	0%	0	0%	0	0%
Total of responses	28	100%	20	100%	48	100%

Differences between the two groups may be due to slightly different subpopulations that responded to each survey. Seventeen county government weed control agents responded to the online survey whereas the focus groups participants were invited because they identify themselves as pesticide applicators. The survey was not meant to be statistically significant but to allow pesticide applicators an opportunity to share their opinions and to characterize responses for comparison of the data collected in focus groups. Focus group participants echoed this variability of views regarding danger in the survey and in the interviews.

One focus group participant said the job is not dangerous, but it does come with risk of danger. He stated:

> I know there's risk involved with it, but as long as you take the proper precautions, I don't think you're in danger of anything. I think there's a lot of risk involved, which is I think, different than being dangerous. There's risk to yourself and surrounding crops and plants and areas and people. But I don't necessarily think it's dangerous.

This applicator suffered injury form several acute exposures at past jobs, for which he blamed himself. When asked to define "risk," another focus group participant stated, "maybe not wearing the proper PPE or you don't put your apron on because it's 80 degrees outside." Both of these applicators viewed the individual as being responsible for contributing to the risk.

An important finding of this study expressed by focus group participants was that *everyone gets exposed at some point if they work with chemicals.* This was echoed by multiple individuals interviewed. In designing safety trainings, it may be important to review accidents and exposures so workers can assess the danger level of their jobs within the context of agriculture and also consider risk factors from pesticide exposure.

If reducing exposure incidents is a goal, it would be difficult to measure. There are no comprehensive data collected on the number or severity of pesticide exposures within the state of Idaho. When queried, an ISDA employee stated it is understood that many exposures do not get reported. It is not ISDA's regulatory responsibility to track exposures; the agency only tracks exposure incidents reported directly to their organization in case of a violation of the law.

The ISDA receives approximately 40 incidents reported per year. This dynamic was reinforced by some of the study participants who did not always make a report when they were exposed to a chemical. One applicator had a "bad night" after he suffered exposure to a chemical that gave him flu-like symptoms. When he shared that he did not report his exposure the next day at work, another applicator responded with support, "you wanna keep your job." The group laughed, meaning they concurred, and another said, "don't wanna deal with the paperwork." Comments such as these, and information presented below, suggest that exposure incidents are grossly under-reported. If educators account for operational norms that prohibit reporting when designing applicator safety trainings, they may be able to address the issue in new ways that impact the target audience.

A former Hispanic farmworker who handled irrigation lines stated that she also did not report her symptoms after being exposed to chemical-laden water that made her hands "tingle." She said she did not know that she should have, or how to report the incident, even though she was working alongside one of her parents. She said gloves, even thin gloves, made it difficult to do the job, so she took them off. She was never informed about what was in the irrigation lines. Sometimes it was likely water and sometimes it was unknown chemicals. She was instructed by her mother to never drink out of the irrigation lines before she stared working in the fields.

The underlying assumption may be that the workers didn't think the harm was severe enough to report. It also appears to be part of the work ethic that if you complain, you are a trouble maker. Not reporting exposure incidences and not complaining, are cultural norms. The problem of not reporting is widespread and the unknown extent of the problem has precluded program educators from addressing minor exposures. In North Carolina, the state health agency implemented a mandatory, 48-hour reporting period after health care providers diagnosed a pesticide exposure, especially when the exposure resulted in a toxic effect. The program was effective in increasing reporting (Higgins, Langley & Buhler, 2016).

Some study participants said they did make a report when they were exposed. Several years ago, one applicator was fumigating soil while overhead pivot irrigation lines sprayed a chemical. He wore a Tyvek suit designed for splashes, but he ended up getting soaked through to the skin due to the volume of chemical-laden water. The soaking resulted in a chemical burn, which he said was “like a sunburn.” He said he reported it, but also said it was “probably my own fault.” He also said the laws have changed now and that situation cannot happen anymore.

According to the EPA, pesticide exposure incidents are underreported for several reasons, but particularly because there is no legal requirement to report and there is no comprehensive system for reporting. Another factor is the difficulty in tracking chronic effects of exposure once an acute reaction has subsided (EPA 2007).

In one focus group, participants stated multiple times that they thought learning about acute and chronic illness should be covered in training. In a nearby state, recertification trainings included presentations by a toxicologist who present case studies where exposures occurred. The toxicologist shares half the story and then ask attendees what they would do next. After a discussion about the options, she would finish telling the story of what actually happened. She reported that this method helped engage the attendees.

Another applicator expressed the view, “who cares, we’re all gonna die someday.” When asked if he thought it was a risky or dangerous job, he stated that it can be, but it depends on environmental factors such as temperature or wind. Earlier in the interview he stated that he is very careful in using the best protective clothing and PPE. This difference demonstrates an example of dissonance between his espoused belief and his actual behavior. Another applicator in the focus group disagreed and stated that he thought most other applicators reject the idea that “we are just going to die” and said he was diligent about using PPE and other precautions.

Within the pesticide applicator occupational group, applicators view risk differently and may hold conflicting beliefs or practice behaviors that are not congruent with their espoused beliefs. Another applicator expressed a risk concern regarding the frequency of his use of chemicals:

> I think there’s risk in it. I worry about it at some point just cause … I’m a commercial operator so I handle it every day, so I have a lot more exposure than somebody maybe in agriculture who does it six times a year or whatever.

Comments about risk reveal several cultural elements. The artifacts referenced are processes, such as the use of PPE. Processes also include the frequency of using pesticides. Some certified applicators are “crop advisors” who hold a consultant’s license and some who do not apply pesticides directly; it depends on their role at their company. Some crop advisors have been promoted from applicator to crop advisor.

Crop advisors sell chemicals and tend to earn a higher income than applicators. This promotion and higher income may indicate an underlying belief that it is beneficial to be in an advising role and not handling chemicals directly. It is important for advisors to understand the job of applying chemicals and the chemical products since they advise and sell to farmers.

An underlying assumption apparent in the behavior of licensed applicators is that the risk is worth it. What motivates applicators to take risks? Some expressed being motivated by income. A majority of survey respondents earn over $40,000 (71%) per year. See Table 4.2 Income Classification Identified by Pesticide Applicator. Thirty-nine percent make over $60,000 per year, which is above the median Idaho income of $52,225 (Department of Numbers, 2019).

Table 4.2 Income Classification Identified by Pesticide Applicators

What is your annual income classification?

	Statewide Survey		Focus Group Participants Survey		Total of Both Surveys	
Income level	No. of responses	Percentage of responses	No. of responses	Percentage of responses	No. of responses	Percentage of responses
Under $20,000	2	5%	0	0%	2	4%
$20,000 to $30,000	1	3%	2	11%	3	5%
$30,001 to $40,000	9	24%	2	11%	11	20%
$40,001 to $50,000	9	24%	0	0%	9	16%
$50,001 to $60,000	5	14%	4	21%	9	16%
Over $60,000	11	30%	11	58%	22	39%
Total of responses	37	100%	19	100%	56	100%

Some applicators said they believe in the purpose of helping grow an abundance of food, or “feeding the world.” Several applicators in one focus group stated they stay at their jobs because they really like their co-workers and customers—the farmers—with whom they work. Camaraderie is a facet of pesticide applicator subculture. This mutual trust appeared to include, in some relationships, guidance from older workers to younger workers.

Training and guiding younger workers appeared to have helped mitigate risk. One applicator shared a story about how he shifted his perception of risk because of the behavior and comments from the farmer for whom he was working. This helped him understand that chemicals used to treat seeds can be very dangerous.

> I think my first exposure [to the concept of the dangers of pesticides] was my boss would not let me load the seed drill because he said "well, you're gonna have kids someday, and I've already had my kids." So, he perceived there was a risk. But he didn't use PPE, other than leather gloves. I figured well, it must not be too bad. But if it's serious enough for him to say that, maybe there's something. I was 16.

A concept that emerged from the data is the role of adult development in the process of understanding the risks and dangers, and the role of older, more experienced peer-applicators in that process.

When chemical pesticides were first on the market, farmers and farm workers using chemicals did not have anyone to rely on for information. Some farmers were, perhaps, naïve about the dangers of chemicals, and some developed a cavalier attitude about chemicals, perhaps originating from depression-era childhoods and a WWII sentiment to not complain and do whatever was asked. One retired agronomist stated that in the Army in the 1950s, the soldiers were regularly "dipped in chemicals" to prevent them from getting bugs and diseases. Farmers and farm workers are known to work hard and work through injuries and fatigue. A newspaper article from 2013 highlighted a story of a Hispanic farm worker in southern Idaho who was told by a doctor that he should have stopped working 10 years previously due to a long-term leg injury (Howard, 2013).

This cultural context combined with not actually having scientific facts about potential danger of chemicals contributed to higher risk for what one 20-something applicator called, the “good ‘ole boys,” referring to the older generation who did not regularly use any kind of PPE.

What are the implications for pesticide safety training? Typically, safety trainings demonstrate safe practices such as how to identify and define signal words on a label, and the use of gloves, respirators, and other safety equipment. For the most part, however, the trainings do not address circumstances, motivations, and perceptions that may affect whether a worker uses a safety protocol. It is likely that safety trainings need to incorporate worker circumstances, motivations, and perceptions, or to consider the learner’s point-of-view. If applicators do not perceive a danger to be present, *when it is present*, that demonstrates a risk. This concept should be included in future training design. Training workers on identification of risk would be beneficial for workers to adjust their perception to accurately match risks that are present in the workplace. Access to researched-based information that includes the risks, and how chemicals may affect short and long-term health would be important components of a safety training that addresses workers risk perception. Special emphasis might be on long-term risks that are not immediately apparent.

Perceived Severity of Ill-health

Perceived severity of ill-health refers to a person’s feelings of how severe an illness is that they are preventing (Green & Murphy, 2014). A rash for a few days is seemingly less severe than cancer, for example. However, whether one acute exposure or repeated exposures lead to a chronic problem is a concern for applicators. This concern was expressed by focus group participants as well as experts.

> When I first started there was a field man who was really really popular in the local area. Everybody liked him, he was good at what he did and he was diagnosed with colon cancer and he died really really quickly. There was a lot of speculation that it was because he was so reckless with his PPE and so that kind of hit home with me made me think twice.

A toxicologist in another state conducted a study of pyrethrin-based pesticide[9] exposure among pesticide workers. She indicated that workers may be at more acute and long-term risk from smoking, breathing diesel fumes while idling, or driving accidents, than pyrethrins. Although pyrethrins are potentially very dangerous, the toxicologist said applicators had little fear of pyrethrins because they did not understand the risk. Pyrethrins are very dangerous if proper precautions and PPE are not used (EPA, 2019).

Continuous exposure to organophosphates can sicken a person for life if untreated (McCauley et al., 2006). Organophosphate and carbamate pesticides are known to lower cholinesterase (ChE), an enzyme in the bloodstream. When ChE is too low, a person's nervous system is affected. This can lead to acute problems such as sweating, mental confusion, and other symptoms that if left unchecked can cause long-term health effects (Center for Disease Control, 1997). One applicator who had a pre-existing health problem from childhood mentioned that he did wonder if he was at greater risk than other pesticide applicators from working with pesticides. This indicates that at least some applicators think about their health in relation to their work.

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[9] $C_{21}H_{28}O_3$ Pyrethrins are a potent insecticide originally derived from chrysanthemum flowers and now synthetically produced.

In one focus group, an applicator shared the story of another applicator who died several years ago from colon cancer. He was in his 50s, and well-liked, but also known for being “reckless” when it came to using precautionary procedures and PPE. According to the focus group participant, the shared opinion of his co-workers, and the community of local applicators, the worker’s recklessness with the use of chemicals was a contributing factor in his cancer. The focus group participant indicated his co-worker’s death had influenced him, and likely others, to become more careful and more diligent about using PPE. In the health belief model, this is called a “cue to action” (Green & Murphy, 2014). Whether pesticide exposure was a factor in the severe illness and death of the worker or not, the story and the belief that it was a factor could have led to a change in behavior of the other workers.

Some people in the subculture of pesticide applicators take cancer and health risks very seriously. The group, as a whole, need fact-based information about the potential severity of acute and chronic illness in order to make their own decisions about using precautions and PPE. It appears, based on the health belief model and the examples found in this study, if applicators understand the severity of potential illness, most will be more likely to protect themselves and others. The implication for training programs is that including this type of research-based information in training—in an engaging way—will prove useful to applicators.

Perceived Benefit of Behavior Change

Within the health belief model, perceived benefits of changing behavior influence the likelihood of adopting a new protective action. A person’s belief in the effectiveness of a new behavior also factors into whether they will adopt a new behavior (Green & Murphy, 2014). In the subculture of pesticide applicators interviewed for this study, they seemed to understand the benefits of the preventative action or behavior; however, applicators expressed that this was not always the case.

In all focus groups and interviews, participants expressed the belief that workers are behaving in a safer manner than in the past, and that the chemicals are much less dangerous than in the past. They receive numerous trainings at the company they work for, and when asked if there was anything they learned not to do any longer, one interviewee said, "pesticide applicating: probably, don't do what the old guys did." Another applicator responded with, "the guy who trained me? Anytime we mixed chemical? He had a cigarette in his mouth, pouring chemical." Multiple applicators and other experts shared that they saw older workers exhibiting dangerous or risky behaviors.

In the example of smoking while mixing, it is now understood that smoking is dangerous and there is additional danger when combined with chemical application, a synergistic effect. Chemicals can be transferred from the hands to a cigarette and then to the mouth. Furthermore, a cigarette is potentially flammable when combined with some chemicals. It seems clear to the younger applicators who were interviewed that unsafe past behaviors should not be practiced today, and the benefits of behavior change to current practices. Another applicator said, "they knew what it did, they just didn't know what it did to *you*."

Because workers understand the risks of past unsafe behaviors, they are likely willing to change their behavior in the future. Trainings and cultural shifts appear to be making a difference in applicator behavior. A Caucasian, English-speaking crop advisor shared an example of Hispanic farm workers who were trained about the dangers of chemical exposure. The workers, who were Spanish-speaking pesticide handlers (not licensed applicators), would not approach the pesticide delivery truck to turn the valves until the risk of exposure was past. Only after the crop advisor had connected all the hoses, would the workers approach the truck. “Those guys wouldn’t touch it, because it had a skull and crossbones on that deal. They would not touch that,” said the boss about the training the workers had received. “They took it to heart.”

The training these workers were describing is now required under new regulations. The Environmental Protection Agency (EPA) that issues worker protection requirements changed the regulations in 2015. Unlicensed workers handling pesticides under someone else’s license are required to receive annual training. Before the 2015 change, they were required to have training only every five years. (L. Urias, personal communication, Feb. 8, 2019)

In these examples, the knowledge and understanding of past unsafe behaviors as well as trainings had a direct effect on worker behavior. Trainings that reinforce the perceived benefits of preventative action are key components that lead to the safe use of pesticides. The subculture has changed from a cavalier attitude to more careful attention. The work environment also contributes to worker behavior and safety, either facilitating safety or contributing to a less safe environment.

Barriers to Taking ction

Even though workers may understand the benefits of using safety precautions, other issues sometimes arise that prevent the use of a prescribed safety measure. In the health belief model, a barrier is a factor that prevents implementation of a known safety measure (Green & Murphy, 2014). An artifact within the culture of pesticide applicators is the process of using PPE, but there is another process (cultural artifact), which is *not* using the required safety procedure. Understanding the barriers and perceived barriers to action, and underlying causes may contribute to improved safety training.

When applicators are working long hours or are fatigued, they may cut corners or simply forget some procedures, such as forgetting to wear safety glasses, goggles, or gloves. Some may forget to close a valve or tie down a tank or container of chemicals. A former manager of crop advisors stated,

> We've had plenty of incidents were the guy's goggles are on his forehead instead of on his eyes. Yeah, forget to pull them down because you're tired or forget to pull them down because you need to see and the stupid machine's broke for 15 times in the last hour. You're just trying to get to work on it. And then that's when something happens, and your forehead is protected really well but your eyes aren't.

The *espoused* belief is that PPE, such as goggles, are important for safety. Proper use of goggles prevents chemical burns of the eyes from splashes or fumes. However, what happens in use, PPE is set aside due to the fact that an applicator needs to see, or their hands need to be nimble and the gloves are not nimble enough. They may have experienced repeated benefits from the behavior, that is why they do it that way (Schein, 2017).

In the next example, fatigue is a barrier to safe behavior. Lombardi, Folkard, Willets and Smith (2010) showed that sleep reduction can greatly increase the potential for accidents. In the subculture of pesticide applicators, it is presumed necessary to continue working in spite of fatigue and to work very long hours—generally twice that of a normal work week, assuming a "normal" work week is considered 40 hours, five days per week. Most applicators indicated they regularly worked a six-day, 80-hour work week during the spraying season, which may run from March to October depending on the part of the state the applicators are working in, and which crops are being grown. Applicators who work in the lawn and garden business may have more regular schedules.

If something could be done to reduce fatigue, for example, applicators could work a 40-hour week in the middle of the series of 80-hour work weeks. From an outside perspective, it would seem reasonable to hire more applicators for the six-to-eight-month season, but from the company perspective, it is more difficult to hire seasonal workers for this type of work. Furthermore, the applicators themselves appreciate the extra money they can make by working more hours. Educating applicators to recognize signs of fatigue and advocating for recharge policies like time off or a five-day work week in the middle of the season might be helpful. This decision-making may be more appropriate for management. Assessments of work environment might help evaluate the best ways to improve worker's safety.

Another possible barrier to safety for some workers is: when a person who has been exposed to organophosphate and has reduced ChE, may have reduced neurological function that could lead to further exposure. It is a possible effect for workers exposed to, and poisoned by, organophosphates to be more forgetful of using PPE in the future due to the side effect of those chemicals. According to a CDC report of workers who were "definitely poisoned" and also required hospitalization, "the hospitalized group did less well on the test of repeating a simple task many times" (Center for Disease Control, 1997).

When interviewed, applicators only identified a few of the barriers to implementing these measures, but further investigation is warranted. Training can be provided that explains why these procedures are important. Providing an on-site laundry and a shower facility may help reduce perceived barriers for applicators by stressing the importance of washing off chemical residue. They may also understand that if the employer is providing the shower and laundry facilities, it must be important. Likely, some work environments lend themselves to implementation of safety behaviors such as showering and some do not. Cultural norms likely vary at each company and which of these eight safety behaviors are exhibited likely varies between companies.

Lumby (2015) identified various facets of worker safety that can be applied to pesticide use in the workplace. These facets also represent critical learning components and can be linked to worker actions. These include: accident prevention activities, understanding the cause of accidents, and injury and worker response to incidents (Lumby, 2015).

Cue to action

Cues to action are anything that triggers implementation of a safety procedure (Green & Murphy, 2014). Currently, training may only address some of these issues. Cues to action in the subculture of pesticide applicators may be external, such as a requirement at work, or internal, such as one’s fear of ill-health. An educational program that helps applicators identify their own internal motivations that link the use of safety precautions to improved health outcomes may help applicators improve their use of PPE. Educational programs designed with adult motivation in mind are more likely to be meaningful and affect more change in behavior (Wlodkowski, 2017). One applicator said that having a co-worker notice and mention that he forgot to put on his gloves helped him remember during long work days when he was more likely to forget.

Additional Discoveries

There are several categories of data related to worker safety that are not addressed by the health belief model: worker development, dangerous work, changes over time, and interfacing with the public. Table 4.3 compares the categories, health belief model, and Schein’s three levels of culture (2017) with development of a concept for pesticide applicator safety.

Table 4.3. Comparison of Data Categories, the Health Belief Model, Schein’s Three Levels of Culture and Model of Pesticide Applicator Safety

Data Category	**Health Belief Model**	**Levels of Culture** **Artifacts** **Stated beliefs** **Underlying assumptions**	**Development of Pesticide Applicator Safety Model**
Worker Knowledge and learning	Risk perception	Stated beliefs	Adult Development Theory: Considers skills, experience and orientation of the learner
	Perceived severity of ill health	Stated beliefs	
Worker beliefs and attitudes	Perceived benefits of behavior change	Stated beliefs	
Work environment	Barriers to implementing safety practices – these can be work environment or can be practices	Artifacts – equipment and processes	
Worker Practices			
• Worker practices – contribute to barriers		Underlying assumptions contribute to barriers	
• Worker practices that facilitate safety	Cues to action; additional practices	Artifacts – equipment and processes	
Worker development – role of older peers	Not addressed in the Health Belief Model	Not addressed in three levels of culture	Adult development theory addresses worker development over time: social learning does not address older peer-to-younger peer learning per se
Interfacing with the public	Not addressed in the Health Belief Model	Not directly addressed in in three levels of culture nor job role of pesticide applicators	Concept of pesticide applicators emerging from the data
Change over time	Not addressed in the Health Belief Model	Not addressed in three levels of culture	Concept of pesticide applicators
Dangerous Work - relative danger or safety on a continuum	Not addressed in the Health Belief Model	Not addressed in three levels of culture	Concept of pesticide applicators

Worker Practices

In addition to practices that impede safety, some work practices and processes facilitate safety or are a factor in safe handling of pesticides. The data revealed worker practices that contribute to safety and danger along a continuum. Additionally, practices have changed over time. During a focus group, when asked if farmers are improving their safety practices, one professional applicator expressed his opinion.

> I think that we've kind of been leading by example, especially the younger generation. I think the growers are watching how our guys are doing it with the goggles and the gloves. They're trying to do everything correctly and especially the younger generation, you know the good ole' boys maybe still aren't, but that next generation of the younger farmers, I think they're watching it so they can stay safe. And I think they're a little more educated on the risks and everything so that makes them want to be safer with them.

This statement reveals how, as a result of professional applicators wearing goggles and gloves more regularly than in the past, farmers are following their lead. The idea of peer influence in the field of pesticide application is a potentially powerful tool. Extension, as well as other professions, use the concept of "early adopters" to share emerging research-based practices among a stakeholder group. Early adopters are those people who will try something new and tell others how it worked for them. Peer influence is a factor in the culture of pesticide applicators and appear to have a positive effect on the use of PPE.

Some worker practices carry more potential for risk of exposure or accident such as the handling of large quantities of chemicals, liquid or bulk. One applicator indicated that the volume of product is a factor, "You know to my mind it's all dangerous but it's in moderation. When you're handling the bulk amounts of it, that's the most dangerous portion of it." A spill of a large quantity is a greater danger than a small amount. Getting exposed to a large quantity of chemical is also more dangerous. The purpose of handling large amounts of pesticide is for economic efficiency and productivity. This reveals the underlying value, the unspoken goal of profitability. This cultural element also arises when applicators interact with others outside their profession.

Interfacing with the Public

Several applicators shared experiences where they interfaced with members of the public or they commented on how they are perceived by the general public.

> I've been in the ag industry since 1970 and I get a little disgusted with the public perception of what we do in the ag industry. We're trying to produce food and trying to produce it competitively. We market our products on a global basis. We need to be competitive with every country in the world in order for our economic base to do well and you know people just beat up on us. As a spokesman with an ag hat on nobody listens to you, you know, they don't listen to all the good things you guys said. They just immediately rubber stamp you as 'no good,' and I'm disgusted with that.

This feeling was echoed by several participants in the same focus group as well as other groups. This reveals the cultural cohesion whereby a cultural group identifies with their own norms and does not understand the outsiders' perspective (Schein, 2017).

One applicator shared a story of a passerby entering a field right after he had sprayed the field. He was in a remote location and the person was lost and looking for directions. The applicator had to help him wash off and provide him with information. The applicator expressed anxiety that the man's exposure would become a serious problem.

The large-scale agriculture industry has, until recently, been located in remote areas. However, Idaho was identified as the fastest growing state in the country in 2017 (U.S. Census, 2017). Many homes are being built, and neighborhoods expanded into former agricultural areas, especially in the greater Boise area, the Coeur d'Alene area, and eastern

Idaho. These factors point to the need for communication training and additional drift prevention training for applicators. Applicators want to be understood as fulfilling a necessary role in agriculture and also asked for trainings for the general public. This will likely become more critical as the population continues to grow and expand in Idaho.

Changes Over Time

Over time, the subculture of pesticide applicators has changed to become more careful, and will likely continue to change, perhaps in keeping with a more risk averse culture in general. The time factor is missing from the health belief model, which presents a static view of beliefs at a single point in time. Within the subculture of pesticide applicators, a more sophisticated training system and understanding of chemistry have evolved than at the outset of chemical pesticide use in the 1940s. Additionally, in other states the demographics of pesticide applicators has also changed within a short amount of time. In North Carolina, the group of applicators was predominantly African-American and Caucasian and within 15 years, from 1995 - 2000 became predominantly Hispanic (Quandt, Arcury, Pell, 2001).

Changes in the subculture of pesticide applicators in Idaho were expressed by applicators in the focus groups. They stated that they behaved differently than the older generation; for example, wearing safety glasses or goggles, removing shoes, hand washing, and fewer workers smoking. This behavior indicates the current population has the capacity to change over time and become safer, if provided training and the resources to do so. Future study is needed to quantify continuing risks and exposures.

Adult Development

Some individual applicator’s development through adulthood coincides with development of the industry and industry safety. Data revealed that some older adult men were less cavalier in later years than at the outset of their careers. If younger men working now follow a similar trajectory, they may become more careful over time also. One semi-retired but licensed applicator stated, “I kind of had a cavalier attitude way back when I was young. I do not have that cavalier attitude anymore. I did a 180.” When asked what changed his attitude, he answered, “maturity.” Over time he had experienced or witnessed close calls. His understanding of the risks evolved over time and he viewed that as a maturing process. This is confirmed by adult development theory that verifies adults grow and mature over their lifespan, however, not necessarily in a linear trajectory (Knowles, Holton III & Swanson, 2015).

There were several examples of older adults protecting younger adults. A former landscape worker said, “I didn’t want anything to do with it [chemicals], and then working for [my boss], he basically refused to let me be exposed to any of it.” This protective attitude helped the younger worker reduce his own exposure and allowed him a sense of agency in his work. He was not made to do something he didn’t want to do because he expressed a concern for his own safety.

Each work environment may differ in that some workers may have less personal power in their work situation for a variety of reasons including age, race, ethnicity, gender or other power dynamics. Protections for worker safety are in place; however, vulnerable populations, such as youth, and non-English speaking workers may need additional training and protection. Employees, including workers, managers, and farmers who employ workers, should be trained in worker safety and rights.

Training

Focus group participants and survey respondents commented on various aspects of training. Many mentioned that they preferred hands-on training and wished for more engaging training. When asked how educators could test for competency without creating a whole new testing system, they stated that they prefer the use of the “clicker” system. These are hand-held devices that each training participant receives at some trainings. These can be linked to individuals or used anonymously by individuals in a group. One retired agronomist had several suggestions for making training effective.

> I think that periodically what we should do, we should require people, when they go to a pesticide training, they actually have to go out to a piece of equipment in the yard or the parking lot. Go through the steps of calibrating the machine or do something like that. And put a phosphorescence dye in it. And then, later on, then have them see what kind of level of exposure they have. I think people would be shocked at how much chemical they get on themselves. People would be shocked.

This type of technique could heighten motivation. Following up with a method to help reduce exposure and strategies for implementing those measures could actually help applicators reduce their exposure. When compared to the norm, which is sitting through three-hour lectures with slides, this type of training would likely be more popular. Additional ways of measuring effectiveness should also be developed.

Conclusions

Data from this study of pesticide applicator subculture revealed important findings that led to development of a model of pesticide applicator safety Figure 4.2. Critical Components that Affect Pesticide Applicator Safety. This model centralizes pesticide applicator safety and illustrates critical components that contribute to the phenomenon of pesticide applicator exposure to toxic chemicals. These forces affect one another and include: work environment, worker beliefs and attitudes, knowledge and learning, worker development, worker practices, dangerous work, changes over time and, interfacing with the public.

Table 4.4 Examples of Occupational Subcultural Elements and Data Excerpts of Pesticide Applicators Work illuminates underlying beliefs that arose within a category of data: worker beliefs and attitudes. Artifacts listed in Table 4.4 highlight the category of worker practices and the corresponding selected underlying beliefs that should be used in

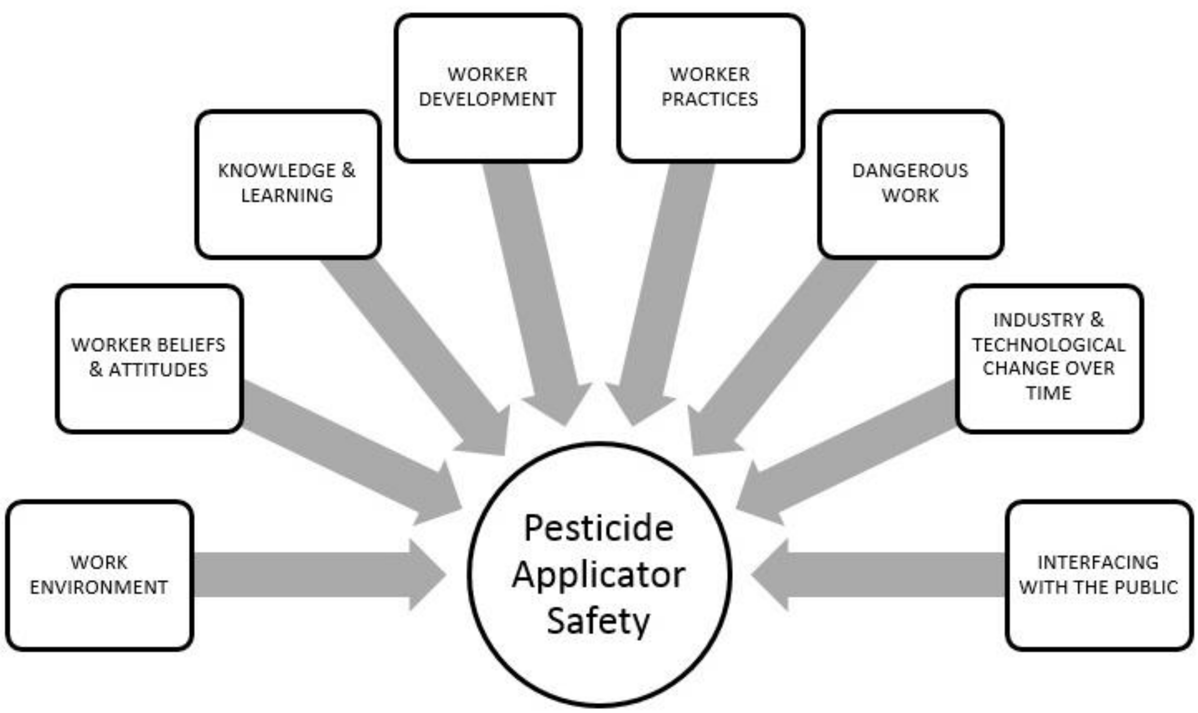

Figure 4.3. Critical Components that Affect Pesticide Applicator Safety.

Table 4.4 Examples of Occupational Subcultural Elements (Schein, 2017) and Data Excerpts of Pesticide Applicators Work

Artifacts: objects or processes	**Espoused Beliefs**	**Underlying Beliefs**
Personal Protective Equipment (PPE) • Rubber gloves • Apron • Tyvek coveralls • Cloth coveralls • Long sleeve shirt • Boots made from chemical-resistant rubber	**What is the most important aspect of safety?** "wearing the proper PPE and following the label. The label will tell you pretty much everything you need to know, [it] is on the label. "	Applicator trusts the label made by the manufacturer that is approved by EPA. It is assumed that the label is accurate and that all the instructions are able to be followed such as temperature and wind speed requirements to avoid drift.
	"And how do you do that [stay safe]? "Personal protection equipment. "	Applicator believes he can be safe if he uses PPE.
	Is there anything that you would like to learn more about, that you feel has been missing from trainings? "As far as safety goes, in general, what it says on any label, is as far as PPE requirements, is what to wear in order to stay below the EPA's threshold, that they've dreamt up. What I'd like to see more of is, if you do want to wear additional PPE what's the ideal stuff to wear to minimize exposure? Like some of these, like say 2-4D, a lot of your phenoxy-based herbicides. Wearing a regular dust mask, while it is going to prevent you from inhaling a lot of the spray and salts, it's not going to do anything for the organic vapor. So, I'd like to see more mentioning, okay, you can't just wear a basic particulate dust mask or 2-4D. That might work for bifenthrin, that might work for trifluorolin, but it's not going to work for those organic vapors from getting into your body… with this particular product. So I'd like to see like some sort of chart that says okay for these products, these are the masks that work for these products. You got to have organic vapor reducing properties and cartridge for these products and you have to have a respirator or whatever"	Applicator wants to be safe in his work. He believes he can be safe if he has the best PPE. He values safety.
Spraying Equipment • Backpack sprayer • Hand-held tank • Tank in pick-up • Tank on trailer	**Okay, in your opinion, what would be the best way to learn about safety?** "Well, cause there's like different applications to everything. You can use the same chemical for something completely different. Like, you put it in a backpack sprayer and you just measure it out and dump it in. Or you're loading it in a self-propelled sprayer and things are splashing around. It's totally different."	Applicator wants to understand the difference in the uses of one type of chemical in all it's formulations: dry, liquid, etc. Applicator values knowledge of chemical products.

Processes • Putting on PPE • Loading tank with pesticide product • Mixing pesticide with adjuvant • Fixing equipment • spraying chemical onto plants	Example above.	Normal processes of daily work. These processes were developed over time by chemical product companies, approved by EPA and are demonstrated to workers at work.
• Safety trainings	**And you did that too, you modeled that good behavior in front of them [your staff]?** **“**Oh, absolutely. Some of the chemicals we used were organophosphates. And at one time they had parathion as a liquid chemical that you would use for the control of certain insects in the crops that we were working with, like on our winter canola and winter rapeseed. There's a cabbage seed pod weevil that used to be controlled by aerial application for example of parathion and we didn't have airplanes. So we applied it with a ground rig and you can't make a mistake with those. You have to wear the full gear! You absolutely have to follow label and have water available to wash yourself off if there's an accident. Emergency phone numbers. You know the whole ten yards. For the herbicides [more benign] that was not an issue, you know, we could train them a lot easier. But again, the same safety principles follow. I mean you just don't get it on you and when you get it on your clothes, make sure you wash them separately. Hose down your boots. Don't use your same leather shoes all the time to spray in and you know, don't forget to wash your hands because if you eat you can ingest it. You know things like that and so most of my training that I gave my people, I followed myself as to what I learned in these classes when I took my consultant test and also … a lot of its common sense in the limited applicator license that I got.	Parathion is highly dangerous. Some chemicals are more dangerous than others. Safety trainings are important. Modeling good behavior is important.
• Forgetting PPE or forgetting to wash hands	“forget to pull them down because you're tired or forget to pull them down because you need to see and the stupid machine’s broke for 15 times in the last hour. You’re just trying to get in work on it. And then that's when something happens, and your forehead is protected really well but your eyes aren’t. Also see row above, “safety trainings” and row below, “working long days.”	Forgetting is common but not necessarily discussed or acknowledged in trainings
• Choosing not to wear PPE	“I’ve seen farm spray help go and mix-up organophosphates with no PPE whatsoever. And then they’re just mixer-loaders, and then there'd be an applicator in the cab of the spray rig and then they'd go and spray the field five feet away from these people that are mixing, zero PPE whatsoever. It's pretty bad.”	The person may not have the proper PPE; It is easier to see or handle tools or equipment under some circumstances such as making a repair or draining an irrigation line

• Not wearing PPE	**Is there anything that you've seen that concerns you regarding pesticide application?** "Oh yeah. I have seen people not have the right personal protection equipment on. They don't have adequate clothing on or the wrong kinda clothing on."	It is easier to see or handle tools or equipment under some circumstances such as making a repair or draining an irrigation line
• Spraying in the wind	**Is there anything that you've seen that concerns you regarding pesticide application?** Not paying attention to the wind direction.	The label explains wind speed maximums but under some circumstances applicators need to get the field sprayed and it is a challenge to be in the field during the required wind speed.
• Getting exposed to chemicals/In case of spill or exposure	**Participant 1 regarding a cloth shirt:** "any fluid is going to seep right through to your skin, it doesn't matter what it is. If it's fluid, it's going through. You know what I mean? All this is doing is slowing it down. **Participant 2:** "That's why they recommend that you change if you spill any on you. **Participant 1:** "Yeah, yeah, and then of course dealing with the boss. Hey, I got to go home and change for 45 minutes. Good luck with that one. Right? [laughter]" **How many people keep a change of clothes in their vehicle? Do you guys?** **Participant 3:** No, I go home.	The label may say to wash off immediately, but this can pose a problem at work if the applicator is out in a field without clean clothes or a tank of clean water. Additionally, supervisors may not approve of a worker leaving the job site to go home and shower and change. The worker may not want to lose the hourly pay if they leave the job site. Productivity and profitability is valued over safety.

• Reducing exposure	"The most important aspect of safety that you can have is…reducing your exposure. That's the most important thing. Any time you're working with a chemical, anything you can do to reduce your exposure to the chemical is paramount." **And how do you do that?** "Paying very close attention to the weather conditions so you don't want to be spraying where the chemical is going to blow back at you. **Why is that the most important? Reducing exposure?** "Just you have direct chemical on your body. Keep the chemical off your body. You've gotta keep it off you. That's the most important thing you can do."	It is understood or assumed that chemicals are inherently dangerous.
• Equipment failure/breakdowns	**And how do you do that [prevent or reduce exposure]?** "having your equipment set up properly so you don't have breakdowns. Breakdowns is a huge one. When you breakdown, then all of a sudden you have to clean a piece of equipment or repair. Now you're at high dosage levels. That's something that's really really important that's overlooked a lot. Make sure your equipment is working perfectly. I've worked with some equipment where if you're not careful you're going to take a bath. You know they would set up a piece of equipment where the filter is up here [eye level]. Why would you want the filter up here? When you take the filter off, what's the chemical gonna do? That's not a good design. That's a bad design! You should have a valve that you can turn off. So exposure is the most important thing to me. Reduce exposure."	Breakdowns happen on a regular basis but it is assumed that there is no time for breakdowns. Because it is unanticipated and unwanted, it is not acknowledged as a normal part of the work day, it is adds to the pressure of having to be productive.
• Working long days	"I think shortcuts definitely would be part of a coping mechanism. You know when you get that 80, 90, 100 hour weeks, if you can shave 20 minutes off seems pretty appealing. So sometimes guys will instead of putting the gloves on for the 20th time and forget them the one time, or reuse them, or not use them correctly or something."	It is assumed that long days are necessary to get the work done. Cropping system differences affect the length of days.

designing future educational programs. Applicators face situations in which training directives and label specifications contradict directives for productivity and achieving results for customers. Safety training for pesticide applicators should include attention to these critical components and be designed with pesticide applicator subculture and adult learning theory in mind. A safety training should have intriguing, relevant content and be presented using an engaging method. Trainings should be designed with evaluation methods to constantly improve and adapt to changing conditions. Also, trainings are more meaningful when participants are evaluated and given feedback based on their learning.

Changes in agriculture, society, technology, and pesticide application are expected to continue. Designing trainings for pesticide applicators that help them navigate these changes and develop effective public communication tools would be beneficial for themselves and society as a whole.

Several findings are important to reiterate. Underlying assumptions and norms exist because behaviors have been validated by experiences of those within the subculture. Getting exposed to chemicals is a side effect of working with them. Exposure and non-reporting were assumed and understood by all of the study participants. It is difficult to measure the extent of the problem without a comprehensive, non-punitive reporting system. Further complicating reporting is understanding when to link a chronic health issue with chemical pesticide exposure.

Some applicators take cancer and health risks very seriously and would like to be better educated about the link between exposure and potential chronic illness. They understand that there is a link between specific PPE and specific chemical products and would like more research-based information on those topics.

Some knowledge, beliefs and behaviors regarding risk topics among pesticide applicators are not uniform, such as recklessness and the role of peers in the work environment. Others, such as standard work practices of spraying, and the understanding everyone gets exposed at some point. Understanding can be further complicated due to exposure to organophosphates that can compromise neurological function such as memory.

Another important finding is the role of economic efficiency and productivity in the pesticide applicators work. Profitability is paramount, and that pressure drives many facets of the subculture. All of these findings have a role in future research, both qualitative and quantitative.

Topics for Further Research

Worker beliefs and practices that create barriers to safety in agriculture and specifically in the occupation of pesticide application should be studied further. Other topics that warrant further research include exploration of the subculture of unlicensed pesticide handlers and other farm workers and their needs around safety in the workplace. This may include training and education, but it could also include other supports. An important area for further research could be to examine the role of gender and race in the workplace in Idaho agriculture.

Studying worker fatigue and burnout, what can be done to reduce it, and how widespread and problematic it is, if used to change practices, may also improve safety. Likely, the issue of overworking and other systemwide issues should be addressed at the company level. If fatigue is an issue, what can be done to reduce the number of hours worked in a week and the repetition of weeks worked overtime? Likely a cultural shift would need to be initiated to make this happen, as the value on profit and productivity are embedded into the culture. There may be other possible solutions that could be discovered.

Another facet for future research is the field of technological fabrics and other materials used for personal protective equipment, boots, and clothing that would reduce exposure. Other technologies such as those that automatically shut off valves or spills may also reduce the severity of exposures or accidents in the future.

Increasing the ability to understand the number and severity of exposures among workers can also be explored further. As long as workers believe they will lose something—their productivity, their job, their status at work, or any other losses—they will continue to not report exposures. It may be that smart fabrics in the future will be able to detect splashes and droplets causing a cue to action resulting in better protection, or even automatically register exposures into a database. Whatever way it is done, a reporting system should be implemented to help protect workers from long-term health issues. This would need to be studied so implementation would not penalize workers for doing their best job, but instead help them improve their safety and health.

In the health belief model, if a person perceives benefits from using a protective measure, they are more likely to implement those measures. This is very similar to Schein's concept of underlying assumptions, that behaviors are repeated because they are effective (2017). Prior to implementing this in training, safety measures and PPE would need to be developed that improve both productivity and safety. Then, in turn, training would demonstrate effective methods for productivity *and* safety, ensuring that applicators are using protective measures while meeting their work goals.

Summary

There are multiple forces at work that affect the incidences of pesticide applicator exposure to toxic chemicals. The applicator has a responsibility to follow the label of the product in use and to engage in learning that facilitates understanding the label and the product. The companies selling the chemicals have a responsibility to fully understand each product prior to putting it on the market, develop new and better products, and continue to sunset products that are too dangerous. Farm owners have a responsibility to provide conditions that promote applicator safety. The government has a role in continuing to regulate companies, thereby providing a balance in this profit-driven agricultural sector. The training and education sector have a responsibility to provide engaging, relevant content.

CHAPTER FIVE

EVERYONE GETS EXPOSED:

THE INTERSECTION OF NARRATIVE AND CULTURE AMONG IDAHO PESTICIDE APPLICATORS

Abstract

This paper explores the subculture of licensed pesticide applicators shared through their informative stories. The study uses a qualitative, grounded theory method. All applicators interviewed work within the state of Idaho. Additionally, several farmers, agronomists, crop advisors, farm workers, and two toxicologists were interviewed. A survey of licensed applicators and participant observations were also collected.

Background. Pesticides are widely used in growing agricultural products in Idaho. There are approximately 8,000 applicators applying pesticides on approximately 12,000 farms in Idaho (NASS, USDA, 2017). Agriculture is considered one of the most dangerous occupations in the U.S. Pesticide applicators often work with dangerous chemicals on a daily basis and are at the forefront of new chemical product releases. In the mining industry, researchers developed the use of stories for safety training videos with a positive result (Cullen, 2008). The first generation of farmers who used pesticides had little training and practiced few safety precautions.

Results. Pesticide applicators use stories to share their experiences with others, including peer learning. Categories of stories include exposure stories and non-exposure stories. Pesticide applicators work very hard, often 80 hours per week, for months on end. The culture includes artifacts, processes, espoused beliefs and underlying assumptions, and values that drive their work. The current generation of pesticide applicators has learned from

the past. Chemical companies also have more rigorous training programs and safety protocols than in the past.

Conclusions. Narrative stories play an important role in conveying the culture of pesticide applicators. In designing educational programs and trainings for pesticide applicators, several conclusions can be drawn from this exploration of narrative data. Training that includes stories and humor has the potential to register with workers on various emotional and intellectual levels. Trainings and tests for licensing should be designed from the pesticide applicator's point of view to make the most sense. Applicators asked for more information about the connection between illness and chemicals, which can be a motivating factor for always using the proper safety protocol and equipment.

Keywords: pesticide safety education, Idaho qualitative study, narrative, stories

Introduction

This paper explores the subculture of licensed pesticide applicators through their shared informative stories. The study uses a qualitative, grounded theory method. The phenomenon studied is the role of narrative in the implementation of safety precautions in a dangerous occupation. The main research question is: What learning components and approaches, as told through the narrative stories of farmers and pesticide applicators, lead to the safe use of pesticides?

The purpose of this study was to identify critical learning components and approaches that lead to the safe use of pesticides by pesticide applicators. In order to identify critical learning components and approaches, an additional goal of this research was to understand, through qualitative inquiry, the context for safety and culture of pesticide applicators in Idaho. This study presents units of data from a narrative viewpoint and analyses of culture within the data. See Figure 5.1 Pesticide Applicator Study Realms of Inquiry. Current literature was reviewed to examine the academic research that applies to educating pesticide applicators. The purpose also led to collection of data regarding critical learning components for pesticide applicator safety.

Background

Pesticides are used widely for growing agricultural products in Idaho. There are approximately 8,000 applicators applying pesticides on approximately 12,000 farms in Idaho (NASS, USDA, 2017). Agriculture is considered one of the most dangerous occupations in the U.S (Sauter & Stockdale, 2019). Pesticide applicators often work with dangerous chemicals on a daily basis and are at the forefront of new chemical product releases.

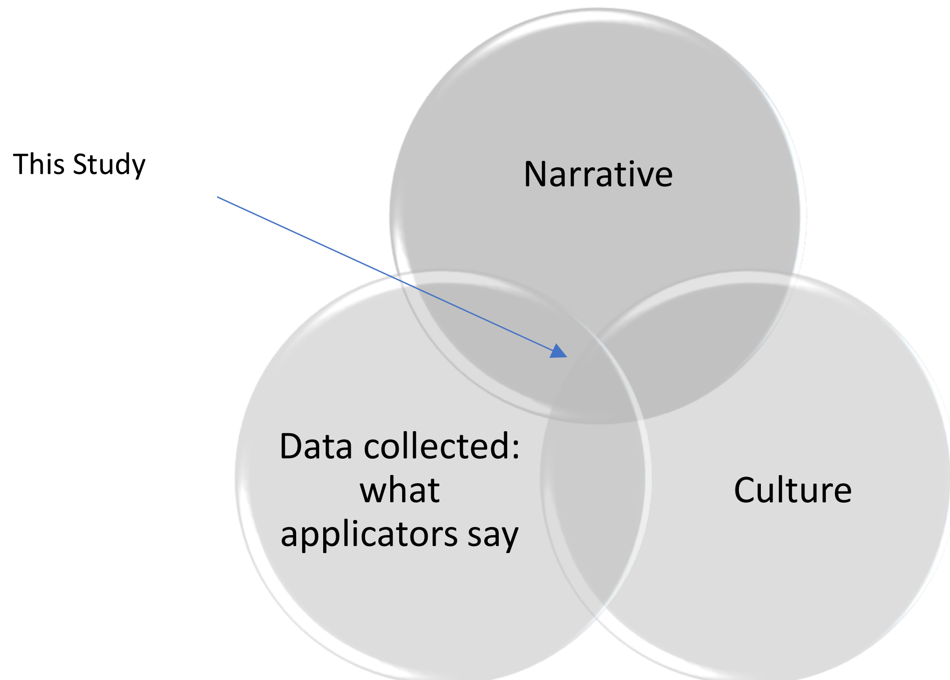

Figure 5.1 Pesticide Applicator Study Realms of Inquiry

Researchers developed the use of stories in the mining industry for safety training videos with a positive result (Cullen, 2008). The first generation of farmers who used pesticides had little training and practiced very few safety precautions.

Pesticide applicators use stories to share their experiences with others, including peer learning. An understanding of the subculture of the pesticide applicators' work can be gleaned from these stories, which include exposure and non-exposure story categories. Pesticide applicators work hard, often 80 hours per week for many consecutive months. The culture includes artifacts, processes, espoused beliefs, underlying assumptions, and values that drive their work (Schein, 2017). The current generation of pesticide applicators has learned from the past. Additionally, chemical companies have more rigorous training programs and safety protocols than in the past.

All applicators interviewed work within the state of Idaho. Additionally, several farmers, agronomists, crop advisors (licensed applicators who sell pesticides), farm workers, and toxicologists were interviewed. A survey of licensed applicators and participant observations was also conducted.

Narrative

Stories can be an effective way of communicating in various settings. Elain Cullen found in her work with the mining industry, that story telling could play an important role in communicating safety precautions to miners. Older, more experienced miners shared stories in order to help train new and less experienced miners using recorded videos. She outlined four categories of stories: hero, villain, adventure/disaster, and fool stories. These categories follow a central character who has an experience (2008). Data collected from pesticide applicators revealed categories specific to their subculture. Stories used in trainings could be oriented around a central character. In the data collected for this study, the applicator is usually at the center of the story and is experiencing a work challenge—usually an exposure to chemicals.

Ricketts (2015) found that “story-based interventions can lead to important and lasting changes in peoples’ behavior” (p. 51). Stories used as anecdotes during trainings can reinforce presentations of rules and facts. (Ricketts, 2015, p.51). Polkinghorne (1995) described the function of narrative as “a fundamental mode of understanding by which people make sense of their own and other’s actions and life events. Other authors, such as Rossiter and Clark (2007; 2010) outline an expanded definition and role of narrative in adult education that can be considered in future pesticide safety education design because they “enliven content and maximize learner interest” (2007, p. 71).

Role of Humor

Pesticide applicators revealed a sense of humor during focus group interviews. Jokes arose once they felt comfortable with the interview process, or to help break the ice. Kmita (2017) explores the role of humor in the research process. She discusses “backstage” or “staffroom” spaces where people drop their “mask” and share themselves authentically and share humorous comments or incidents. In a focus group, the intention is to build rapport to get to the point of spontaneous sharing (Krueger & Casey, 2015). This is similar to the staffroom atmosphere that lends itself to candid comments and stories. Humorous comments and stories can also reveal cultural elements such as those described by Schein (2017).

Three Levels of Culture

Schein (2017) has extensively researched organizations and leadership and writes about three levels of culture: artifacts, espoused beliefs, and underlying assumptions. To outsiders, the purpose behind cultural elements is not very visible; however, they serve an important purpose. Underlying assumptions exist because behaviors have been validated by the experiences of those within the culture. Schein also discusses subcultures such as those of specific professions like teachers or engineers (2015). Illeris (2017) writes about professional identity and learning. Some professionals in a shared field develop defenses and “armor” that reinforce their work and their role but can lead to resistance when there is something new to be learned.

An artifact is something that can be seen or felt, observable behavior such as rituals, language, and use of technology (Schein, 2017, p.17). In their cultural setting, artifacts are readily seen or observed but not always easy to understand. Why is this object or ritual a part of the culture? Is it significant or just a holdover? What is the history behind it? An outsider cannot know the answers to these questions until they get to know the culture more from the inside. In pesticide application, the use of personal protective equipment (PPE) is a cultural process. Also of interest is the process of applicator's *not* using PPE when handling toxic chemicals. Why don't they always use PPE when required? To those outside the subculture, it does not necessarily make sense. This study attempts to answer that question.

Overt beliefs and values are those that are able to be articulated. According to Schein, only beliefs or values that lead to "reliable results for the group," those that bring meaning and comfort to the group, become assumptions. (Schein, 2017, pp.19-20). If espoused beliefs and values are not leading to positive results for the group, they are in a category Schein calls, "desired" behavior but are not then "observed" behavior. This can create cultural dissonance and leave gaps in understanding culture that can then be further explained, in part, by examining the underlying assumptions. Goals are also included in this category of espoused beliefs. Stories that play a role in the subculture of pesticide applicators disclose espoused beliefs, but can also reveal beliefs that are taken for granted.

Schein describes underlying assumptions of a group as developing from the repeated successes of a method. As a culture develops, assumptions bring comfort as well as identity to group members. Once a group has assumptions, it becomes more difficult for them to see or understand activity of another culture that is inconsistent with their assumptions. These underlying, unconscious values determine behaviors and perceptions (Schein, 2017).

Methods

This qualitative study explores the culture of pesticide applicators using a grounded theory method of data collection, coding and analysis. Data is evaluated in terms of narrative units. Initial coding was used to identify incidences and themes and grouped into concepts.

Further interviews and axial coding led to the development of categories. A model (concept) of the role of narrative in pesticide applicator safety is presented from the analysis of culture theory and narrative data collected from the realm of pesticide applicators.

Participants included 24 agricultural workers licensed to apply pesticides in Idaho. Also interviewed were seven experts such as several agronomists who have tested or used pesticides in their work but are now retired, a weed specialist from a university, a chemical company owner, a toxicologist, ISDA employees, and a former applicator who is now an organic farmer. There are many Hispanic farm workers in Idaho. Several key interviews were conducted to include some of their experiences and stories also.

Initial theoretical sampling revealed that stories play a role in the subculture of pesticide applicators. Two aims in using the focus group were to inspire applicators to share stories with one another that illustrate safety topics, and to further illuminate aspects of their shared culture, such as values, group opinions, and common knowledge regarding safety and how they could best learn about safety that leads to safer practices. Also, individuals may feel more comfortable in a group of peers.

Transferability is a form of external validity, if the data is true for other cases or, if it can be found to be true outside of the study (Savin-Baden & Major, 2013, p. 524). The model of pesticide applicator safety that has emerged from this study, could be explored in future research to be further developed and refined. However, pesticide safety education programs may be developed based on the findings and can then evaluated and adjusted for effectiveness.

Reliability questions whether or not a duplicate study would result in consistent results. If saturation is achieved, results should be repeatable when duplicated regarding pesticide applicators' experiences, what they learned, and how they changed and transformed (Savin-Baden & Major, 2013, p. 525). Additionally, saturation may be reached if what stands is rich and sufficient (Charmaz, 2013). One goal of this study was to reach saturation. If saturation was reached, another researcher would likely be able to duplicate the study; however, at another time, with another group, in another state or geographic region, aspects of the results would be expected to be different.

An important and significant question in qualitative results is whether results of the study can be generalized to other instances (Creswell & Poth, 2018, p. 102). In this study, results are not expected to be generalizable beyond pesticide applicators in Idaho. Once data was collected and analyzed, some incidences were understood to represent common experiences among pesticide applicators. Further detail regarding data collection, coding, categorization, and data analysis is presented in Chapter Three, Methodology

Results

This section presents narrative examples from data collected. Pesticide applicators who were interviewed for this study employed the use of narrative incidences for multiple reasons, including to teach new co-workers about possible safety risks, and for humor. Most stories shared by applicators included an exposure incident, which was typically a rare or infrequent occurrence. Narrative categories which arose from the data include exposure stories and non-exposure stories. Subcategories of exposure stories included *close-call, recklessness*, *tragic, acute reaction*, *animal exposure*, and *transformative* incidents. Other narrative categories that did not necessarily contain an exposure, included *PPE stories*, *youth experiences*, *effectiveness of training*, *usefulness of chemicals*, *interfacing with the public*, and *humorous* stories. Many of the stories contained multiple categories and were rich with other codes. Stories reveal cultural elements: artifacts, espoused beliefs, and underlying assumptions (Schein, 2107) that may reveal critical learning components, inform trainings, and thereby reduce exposures.

Exposure Stories

Applicators generally agreed that all applicators are exposed to chemicals, although these incidences are infrequent. One applicator shared, “Everyone has a bad experience with chemicals. No matter what precautions you take, there’s … at some point, someone’s had experiences where they’ve spilled something on them that they weren’t comfortable with.” This comment is a significant disclosure because, although the label provides instructions and methods for using the chemical as well as the appropriate process for avoiding exposure, workers still expect exposures, and exposures still do occur. Several applicators said they share stories at work in order to reduce exposures in the future. Some of these exposures may or may not be a health risk.

Not every chemical causes a severe reaction; one could be exposed to a more benign chemical and have no reaction. As a matter of fact, incidences where someone has an acute, severe reaction are rare. Since there is no comprehensive reporting system, it is unknown how frequent these occurrences are, only deaths at work are tracked by the CDC. Idaho agricultural industry reported 15 deaths in Idaho in 2017 (Center for Disease Control, 2018). These may or may not be related to pesticide use; however, illness or death may result at a later point in time after a chemical exposure. Agricultural jobs are in the top 11 most dangerous occupations according to USA Today reporters (Sauter & Stockdale, 2019). An “agricultural worker” is the 11th most dangerous job while other farmers and other agricultural jobs rank eighth (Sauter & Stockdale, 2019).

In some occupations, an injury is called an "accident." In pesticide application, an unintended contact with chemicals is called an "exposure." The concept around the word "exposure" is passive. A normal sentence structure includes a subject noun, a verb and perhaps some object, such as the sentence, "I ran to the truck." If one experiences a chemical exposure, the sentence structure is usually passive: "I was exposed to a chemical." This passive structure correlates with the insidious, at times invisible nature of chemicals. For example, sometimes people succumb to carbon monoxide poisoning before they realize they have been exposed. Other concepts in chemistry education are also abstract and can covertly affect the profession or industry. For example, "pest resistance" in which a few weeds or bugs are not killed by a chemical pesticide and eventually repopulate, is not intuitive, but is a scientific concept. Another example is invisible radiation exposure that harms a person although it is not instantly visible and does not create any sensation. Like radiation poisoning, some chemicals will also cause a reaction after repeated exposure. However, when applicators experience an exposure that they clearly know is an exposure, it is often a memorable, close-call experience.

Close-call Exposures. *Close calls* are exposures that could have been far more medically serious than they were. For example, one applicator was splashed in the eyes with water when cleaning out a tank. He was not wearing safety glasses and realized that if the splash had been a chemical, he could have had a serious burn in his eyes and possibly become blind. After that, he said he was careful about wearing safety glasses. Close-calls are memorable and can trigger a behavior change and be shared with others as a trainable moment.

Another applicator shared an exposure incident that he experienced approximately 30 years ago. The story reveals how a close-call could have an acute effect.

> I got sick one time. I got the shakes. I was a bachelor. I was younger. I was like these guys. I went out into a sweet corn seed field and … I hadn't sprayed it but the grower had a plane come in and spray it with a pyrethroid. It was Capture. Capture used to be [applied by aerial application] and I got out there about 30 yards and couldn't hear a thing. No bugs. There were no bugs and it was quiet. Silent, and then I smell it … smell it and I'm like, "oh shit!" So I high-tailed it out of there, got out of there, and like I said, I was living by myself and broke a … got the shivers, got the shakes a little bit … and in the middle of the night, broke a sweat, I was just sopping wet. And you knew … I had absorbed something. And this was the early 90s. And that was direct. Usually it'll dry, but when I got in there it was too soon and they were spraying for ear worm, ear worm in corn. I should have had a 48-hour re-entry. Evidently, I got in there before that.

The story above is also an example of an acute reaction. When asked if he reported the incident, he said no, but he did tell his co-workers that he had a bad night. He did not seek medical attention, and the cultural assumption was that he would *not* report the incident formally at work. Although this incident happened 30 years ago, others in the focus group indicated that an applicator can be blamed for an exposure if they report that they were exposed "Don't wanna get fired" one said. This makes sense since exposures usually result from a mistake on the worker's part. Another applicator said, "No one wants to be on the record that they did something wrong." Based on these comments, the assumption is that an applicator may endanger their employment status by reporting exposures. It is also understood within the subculture that exposure incidents do not get reported. that go unreported.

It is difficult for chemical companies to make adjustments to chemical products and the methods for delivery if they do not receive feedback on exposures from chemical delivery companies where many of the applicators work. This difference represents a gap in the culture between espoused beliefs of following the law, using safety measures, reporting exposure incidents, and actual behavior.

Mistakes are a natural part of life and learning. Understanding the most common mistakes applicators make and sharing how to avoid those mistakes during trainings could help new applicators avoid some exposures. For example, it is now required to post signs stating the allowed re-entry time on the edge of fields following chemical application, but this practice was not required 30 years ago when the previous incident took place.

Another continuing potential mistake in chemical application is spraying the wrong field. Another applicator shared that a co-worker sprayed the wrong field and accidentally destroyed a crop. After realizing the mistake, both applicators became more careful in locating the correct fields. Another story illustrated what can go wrong when not following proper precautions. Two applicators shared a close-call situation when a hose broke. Fortunately, the chemical was not a highly dangerous one. In a similar incident, an applicator was burned by chemicals and should have been wearing a long-sleeve shirt. The burn on his arm took several months to heal.

Applicator: Well like the time I burned myself with gramoxone, paraquat. So anytime anyone’s spraying it now I tell ‘em, “Hey! Be careful with this stuff!”

Coworker: … and those are the stories that stick with someone and they know to take precautions after that. Cause, I mean, we … neither one of us had a lot of experience prior to that with it. Once he got it on him and had chemical burns from it, then …

Applicator: it was like an eye opener and everyone started taking a lot more precautions when they were handling it.

At the outset, the applicator and his co-worker assumed he was safe, but in reality, he was putting himself at risk. After experiencing a severe burn that lasted several months, he continues to warn co-workers about the chemical product, and he now always wears the proper protection. In some cases, though, not wearing the proper protection can result in more dire consequences than severe burns.

Tragedy. Some stories had a tragic theme. A retired agronomist told a story about two men who had worked together and who both seemingly died from chemical exposure about 20 years apart. The older worker, in his 40s, trained another man who was in his 20s. Neither man used protective equipment or clothing.

> I don’t know which of the chemicals were responsible for this, but the older guy and the younger guy to some extent weren’t taking the precautions they needed when spraying … for example, full rain gear and the respirators and things of that sort. Some of the chemicals didn’t require respirators, but you handle enough of that over time and basically, I’m not sure which chemicals they were, but [his wife] was up here in Moscow for a few years and it was her husband that died and she still owned the farm down there out of Ashton, and her husband I think died in his early 40s and the cancer got started in the … they figured from the accumulation of the chemical on the tractor seat and running down and they started in his lower back and around on his

> buttocks and other places … anyway fast forward 20 plus years and the farm foreman that they had, who was now probably in his 40s or 50s, he was younger at the time when he was trained … [he died of the same cancer].

One of the tragedies of this story is that the younger applicator did not protect himself, even though he knew the man who had died in his 40s. They likely both assumed they would be fine and that the chemical was not that dangerous. Farmers and applicators work as many hours as possible each day, compounding the effects of exposures. For example, in order to be productive, and applicators may continue to work after an exposure instead of stopping and showering.

Productivity and working long hours seemed to be important values underlying farm worker behavior. Examples include working 80 hours per week for multiple weeks and spraying as many acres as possible (35,000 per year by some applicators). One applicator stated, “When you’ve got tons and tons of acres and timing is critical, I mean, 48 hours one way or the other can mean the difference in 10% of the crop production. So, it’s a huge pressure.” When trying to understand why workers put themselves at risk and work very long hours, it’s important to note that cultural values and underlying assumptions are at work. The combination of work ethic, economic incentive (overtime and bonuses), and profit for the customer (farmer or land manger) are central.

Transformative stories. Mezirow (1991) describes transformative learning theory as a process or moment where preexisting notions are reexamined and an internal change takes place. Losing a co-worker can lead to a transformation. One applicator shared a story about a co-worker who died.

> When I first started, there was a field man who was really popular in the local area. Everybody liked him, he was good at what he did, and he was diagnosed with colon cancer and he died really quickly. There was a lot of speculation that it was because he was so reckless with his PPE and so that kind of hit home with me and made me think twice.

This story is tragic and helped raise awareness in other workers. The reflective element in his story reveals that he was affected by the loss. He indicated that he was very careful about using PPE after learning of the death. The applicator who died worked regularly without PPE. No intervention was taken to help the worker protect himself and nothing triggered him to be better about using PPE until it was too late. It's also possible his death was unrelated to chemical exposure, but others thought it was, and the person relaying the story indicated that he had changed his behavior because of it. Giving applicators opportunities during training to reflect on their experiences, share, and also set safety goals for themselves, might help facilitate an atmosphere of safety in the profession. Some companies have better safety climates than others, but it depends on various factors, including the managers and leaders.

Animal Exposures. Throughout this study several stories of animal exposures to pesticides arose. In the mining industry, workers used to keep canaries nearby in cages so they would know carbon monoxide levels were too high when the canaries succumbed. With pesticides, on occasion, animals succumb before humans—especially dogs because their faces are close to the ground. Currently, a family in Idaho Falls is fighting to ban the use of M-44 devices that release cyanide when contacted. Their son triggered one of these devices, which is designed to kill predators such as coyotes. The device had been placed 350 feet from their rural home by a U.S. Fish and Wildlife worker to protect livestock in the area. The boy and his dog were exposed to the poison and the dog died (Manny, 2018).

Another instance was shared during the interviews by an applicator who had worked for a wheat farmer. The farmer's dog always ran behind the spray boom to stay near his owner. The dog developed cancerous tumors and died. The applicator's opinion was that direct chemical exposure had caused the dog's illness and death, but it did not trigger any alarm in the farmer. The applicator described the farmer as reckless:

> He just kind of did things like a cowboy. He was fast and reckless. That's what he was. And his whole thing … so when we were calibrating that sprayer he was like … whatever chemical I came up with. He's like, "oh, yeah. I've been sprayed by that. I've been doused with that."

When asked if the farmer was worried about his health, he responded, "it didn't concern him. He was very religious. So I think that he felt like if God meant for him to be sick, he'd be sick." A similar belief in God was identified by Elmore and Arcury in their study of Latino Christmas tree workers (2001). They found that workers trusted in God to keep them safe. Illeris discusses the processes by which people learn and sometimes resist learning. Resistance to learning can include defensive mechanisms that prevent learning (2007; 2017). Illeris (2017) describes distortions in thinking where a person believes reality to be what they want it to be, other than what it is, similar to how a child may think. In some instances, workers were not concerned about using chemicals. In other cases, applicators heard a story that changed the way they viewed chemicals and their own safety.

Non-Exposure stories

PPE Stories. Personal protective equipment (PPE) was mentioned repeatedly in the focus groups, interviews and trainings. Although the statements collected are small stories or fragments of stories, they represent a mechanism for achieving safety. Many stories revealed that PPE inhibited productivity at times or needing to be removed to repair equipment. Also mentioned was how PPE can cause a person to overheat in some circumstances. PPE in the pesticide applicator industry could include a number of different garments or items such as regular clothing, coveralls, gloves made of specific types of material, Tyvek suits, of which there are various types, goggles, aprons, specialized boots, and other items. Regular tennis shoes or leather boots soak up chemicals and can also deteriorate quickly from chemical exposure. Several applicators indicated that they wear chemical resistant boots while others do not. “I mean those chemicals just eat up whatever they get on, so you got to have a special footwear and you’re in it all day, every day.”

One applicator who works in the grounds keeping profession mentioned that his company paid for footwear, but he said not all companies do that. Other applicators may not have access to the footwear they need to keep them safe from chemical exposures. “Fortunately our boss is like, ‘go to [the store] and get whatever you need’” said the groundskeeper. “They don’t even question it, but I know some guys who are like, ‘yeah, we don’t get nothing.’” Another applicator said he wears specialized boots. When asked how they know if the rubber is preventing exposure he said, “my feet aren’t coming out smelling like [chemicals] and burning.” The applicator presumes he has not been exposed because he does not have physical symptoms of burning and he does not smell chemicals. These sensory inputs may or may not be accurate depending on the chemical (Center for Disease Control, 2017). This worker also asked for trainings to include more information about PPE and what could be worn beyond the minimum. Applicators need to know how they can prevent exposures but also how to recognize if they have been exposed. Younger workers are especially vulnerable because they have little experience or self-efficacy to protect themselves.

Youth Experiences. Several participants spoke about their experiences as teenagers. Youth under 18 are not allowed to handle pesticides unless it is on their family farm. Yet, it is likely that youth hired as farm help are still asked to handle pesticides due to a perceived urgency during production. Several focus group participants indicated they sprayed chemicals as youth. Workers, including youth working in the fields, can also be exposed to drifting pesticides that have been sprayed nearby or by airplane. Waterlines are another potential source of exposure. A young Hispanic woman described her experience working in the fields:

> I started when I was about 15 or 16 years old. I watched one video. I remember I went to this training site. I watched one video that they played for me, it was a super boring video, not engaging at all … I would work with the irrigation systems. They would send us to open up at the end of each row. They had these little nozzles where they run underground … it looks like a thin layer of tape. And so we would open the nozzle up at the end of each row and let the water flush through it. The water might have chemicals in it, but I can tell you when I was opening up the nozzle to run the lines, I would take off my gloves and that's like a no-no. You just never know so they were trying to be preventive, but the thing is that when you have the gloves on, it makes the job almost ten times harder. You can't unscrew the caps. It would be hard

> to take it apart. I understood the dangers that I was putting myself through, but I just wanted to get the job done.

She said she didn't always know what was in the irrigation line, it could be chemicals, or it could be water. Sometimes after flushing the lines, her hands would tingle, which indicates that she was exposed to a chemical pesticide. She expressed the goal of wanting to just "get the job done," which is a cultural value. The underlying belief is that the work result is more important than using gloves in the moment. Schein states, "when a solution to a problem works repeatedly, it comes to be taken for granted" (2017, p.23). Taking off her gloves solved her short-term problem even though she believed she may have been compromising her future health. She did not have the specifics about which chemical she was being exposed to and what the result could be to her health.

A focus group participant reflected on his experience working for a farmer about 25 years ago. As a youth worker, he was instructed by his employer to avoid exposure to the seed treatment that was on the seeds that were to be loaded into a seed drill (a seed planting machine).

> I think my first exposure [to the concept of chemical danger] was my boss would not let me load the seed drill because he said, "Well, you're gonna have kids someday. and I've already had my kids. So, he perceived there was a risk. But he didn't use PPE, other than leather gloves. I figured, well, it must not be too bad. But if it's serious enough for him to say *that*, maybe there's something, and I was 16.

In this story, the older adult was protective, which communicated to the youth that he needed to be careful. The youth did not have a strong concept of danger until he was told about a possible severe health risk. He assumed the chemicals were safe. Treated seeds look similar to non-treated seeds, but the chemicals can be very dangerous. The youth also observed a difference between espoused beliefs and behavior in action that is hard to decipher. Schein says that observed behavior does not match stated beliefs because the repeated behavior solves a problem (2015). In this case, not using PPE helped the farmer work more efficiently.

Through the course of the study, data revealed that farmers in the past were (and possibly still are) less regulated than companies and therefore may have been more cavalier. In supervising youth, if farmers were cavalier, youth may have been at a higher risk for exposures. One story relayed by a former wife of a farmer was that, approximately 30 years ago, he would put his small children, around 8 years old, into the chemical tank to clean it, because he could fit them in it. These incidences would have been prior to most training and certification programs. Currently, families are exempted from the law that prohibits persons younger than 18-years old from working with chemicals. From these examples it is evident that youth may need special training or extra protection.

Effectiveness of training

During interviews, several participants made positive comments about trainings they attended. On the survey, participants were asked what they thought was effective in trainings they attended. They listed many topics such as rate-calibration, PPE, labels, laws and safety, safety stories, etc. University of Idaho Extension has been providing training in Spanish in eastern and southern Idaho, and these trainings were well regarded by focus group participants, by a chemical company owner, and by ISDA employees during interviews. Creating a training in a relevant language is an example of responding to the needs of a subculture.

One focus group shared a story about how workers were cautious after a new training. A Caucasian, English-speaking crop advisor observed Hispanic, Spanish-speaking farm workers after they received training about the dangers of chemical exposure. The crop advisor arrived, and the workers would not approach the pesticide delivery truck to turn the valves until the risk of exposure was past. After the crop advisor connected all the hoses, only then would they approach. “Those guys wouldn’t touch it, because it had a skull and crossbones on that deal. They would that not touch that.” His boss said, regarding the training, “They took it to heart.”

Several applicators critiqued the pre-certifications trainings for not matching up very well with what is asked on the licensing test. They also felt the materials were outdated from the chemical products that are in use today. People who are trying to become applicators want a training that actually prepares them to pass the test. One applicator, who was a mechanical engineering student in college, known for its demand for intellectual capability, shared his story of taking the test twice and not passing it and his resulting frustration.

Applicators are problem solvers who work with their hands and machinery. Written labels must be followed, but there may be more effective ways to communicate the label requirements and to test for competency. A written test may not be a measure that matches their skillset; therefore, they may need updated trainings and a test that is more congruent with their adult, hands-on, working style. A cultural assumption is the value of productivity and so applicators may be frustrated by a certification system they cannot influence or change.

Usefulness of chemicals. Not surprisingly, all focus group participants expressed a positive attitude towards chemical pesticides. Several applicators made statements about the usefulness of chemicals for food production, or in the case of DDT, reducing malaria. "I don't think people realize that DDT saved a lot of lives, right? Before they found out that it was bad for the egg shells. Millions of people are still alive because of it." The concept that chemicals are useful seems like a training area that could be geared towards the general public.

One supervisor had a concern about the general public not realizing how much less chemical is needed for production because of Roundup.

> People don't realize the amount of active ingredient on sugar beets is way less than it was 15 years ago with Roundup. I mean, we're actually applying less AI [active substance] per acre than we were 15 years ago when we were spraying them five, six, seven times and still had weed problems, still had insect problems. If you look at the AI for Roundup in a few insecticides now, it's probably 70% less, but people hear "Roundup" or "insecticide" in general and they're like, "it's terrible" and its lack of public knowledge.

Several applicators indicated that chemicals have become safer and more effective, so we don't have to use as much as in the past. Applicators had a positive attitude towards chemicals, in part because they see how much chemicals have helped increase crop yields. Underlying assumptions are that crop loss is bad, high yields are good, and profit is good, therefore chemicals, as a tool to achieve those goals, are also good. A difference between attitudes about agriculture today and attitudes in the past are documented by Wendell Barry, who says that high productivity has been a detriment to soil health and the loss of many family farms. (Berry, 2009).

Many focus group participants expressed a desire for the public to have opportunities to learn about what they do and why it is important. Because applicators see their production system positively, some expressed that they felt misunderstood. They do not understand the point of view of those who want only organic food products or soil that has living microbes and is high in organic matter with a variety of nutrients. High crop yields deplete the soil of nutrients over time, and chemical use kills the living elements in the soil.

Interfacing with the Public. Multiple applicators mentioned how the public perceives pesticide application as negative and doesn't understand the importance of the industry to agriculture. One applicator put it this way:

> I've been in this industry long enough that half the stuff out there is ... the general public is really uneducated about it. That's what we're dealing with, the public … that's part of your job too is educating the customer at some point. If you have the answers and information, that data helps.

Another applicator shared a story during a conference in 2017 in which he found himself unexpectedly interfacing with a member of the public who inadvertently was exposed to a chemical.

> A car stopped on the edge of the road. A gentleman gets out in golf shorts and flip flops and proceeds to walk across the potato field looking for directions. So, I get out and I ask him what he was doing. And he was looking for the back way into [a wildland park]. I say it's right over here, but you really shouldn't be out here. I'm spraying fungicide and insecticide. The gentleman was from Michigan and immediately he's on the defense, 'Is my leg gonna fall off? Am I gonna die?' Instead of getting mad and being defensive and tellin' him, 'that wasn't real smart to walk out

> here,' I kinda took the high road and say, 'Well, we need to get you over here and wash you off.' I give him the information, who I worked for, where the store was if he needed any more. Didn't sleep that night but never heard no more about it.

In this case, the bystander was unexpectedly exposed to a dangerous chemical and the applicator was in the role of medical responder. The incident reveals much about the state of the occupation. As with other examples, it can be dangerous to enter a field for a certain amount of time when specific types of chemicals have been sprayed or devices such as an M-44 has been placed. Growing populations near agricultural areas may lead to more of these potentially dangerous incidents and a need for training and planning for interactions with the public.

During data collection, several applicators and chemical company employees indicated that the public doesn't understand what they are doing, and those members of the public are judgmental of the applicators. One applicator shared his thoughts, rejecting splitting, (all-or-nothing thinking).

> On one side, you got the environmentalists saying, "everything's bad, you know, chemicals, oh!" But on the other side, you got, you know, the chemical manufacturers, "Oh no, this is safe." People drinking it. But the truth lies somewhere in between. It would take a full-fledged effort on both sides. But you're just not going to get it. A real discussion to inform people of where the truth really lies.

This quote reinforces the idea that applicators may need training to effectively interact with the public around chemical application topics. Perhaps one of the ways to reach applicators is to bring in the more creative aspects of human interactions and ease up on a serious topic. Humor may be an effective tool for this purpose.

Humor Stories. Focus group participants and some of those attending trainings used humor and laughed at various moments during the interviews. Kmita (2017) examined humorous moments as units of data during research. She defines humor as an amusing communication between parties (Kmita, 2017). Humor usually involved an unexpected turn of events, inside jokes, or something that was obvious to the applicators but not obvious to the researcher. Applicators teased one another about their age and experience and about some of their social activities, such as when they were single and dating, or about their beards.

One funny story illustrates how valves and hoses can behave unpredictably and cause an exposure. One applicator shared how his truck driver was very hungry for lunch, so left to get a hamburger, fries, and a milkshake. When he returned to the field, he took one bite of his burger and then set it on the dashboard with the truck door open and went to help someone. Another applicator was opening a valve about 20 feet away and the chemical they were working with shot out in a perfect arc onto the hamburger meal inside the truck. The driver asked the applicator if he could possibly drink his milkshake since it had a lid on it, the applicator said, “no way!”

This story could be used in a training as a lead-in to talk about keeping food and chemicals separate, and/or how hoses and valves can break and spray, which is one of the reasons for wearing PPE at all times. The story also illustrates the role of peer interactions as well as work challenges and allocating time during the work day to take a break.

Conclusion

The purpose of the study was to identify critical learning components and approaches that lead to the safe use of pesticides. Several conclusions can be drawn from this exploration of narrative data. Training that includes stories and humor has the potential to register with workers on various emotional as well as intellectual levels. Trainings should be designed with the pesticide applicator at the center and respond to what they are asking for, such as a training and test for licensing that corresponds and makes sense form the worker's point of view. Applicators asked for more information about the connection between illness and chemicals, which can also be a motivating factor in always using the proper safety protocol and equipment. Other areas of training that are needed include how to interface with the public, training for the public about chemical use in agriculture, and specialized trainings for youth working in agriculture.

An exposure reporting system needs to be developed that does not penalize the worker but provides support for avoiding exposures and can also track exposures. The blood test for CEC that is given annually to those working with organophosphates is a good model of tracking without penalization. A phone app that allows workers to log the chemicals they are working with and also track any exposures could keep a record of information and also allow workers to control who they share the information with, such as a medical provider.

The data revealed that proper PPE is not always available, depending on who the workers' employers are. PPE should always be made available for workers. Regulator mechanisms are already in place to ensure companies give workers the proper PPE, but some other mechanism or process may be needed to remedy this issue.

More work should be done to understand Hispanic farm worker experiences and their needs in the context of Idaho agriculture. Each generation has different experiences and needs. Although the Idaho State Department of Agriculture trains farm workers via the Worker Protection Program, the academic literature on adult education has not addressed the unique attributes of Idaho agriculture which affect farm workers and their health, safety, and well-being.

CHAPTER SIX

CONCLUDING DISCUSSION

This research project was a qualitative, grounded theory study of pesticide applicator culture and safety. The purpose of the study was to identify critical learning components and approaches that lead to the safe use of pesticides. This dissertation document is organized in six chapters: Chapter One Introduction, Chapter Two Literature Review, Chapter Three Methodology, Chapters Four and Five are two publishable papers, and Chapter Six Concluding Discussion. In developing a theoretical sample, a pilot study was conducted in 2017 to collect preliminary data and explore the original research question. The resulting document that served as a preliminary exam was revised into a publishable paper. Categories of data discovered in that study informed this current project.

The discussion in Chapter Six explores the data further in terms of the research question, and presents a conceptual model of pesticide applicator safety, Figure 6.1. The purpose of this chapter is to illuminate the learning components and approaches, as shared by study participants, and discovered through the research process that may lead to the safe use of pesticides. Applicators shared some problems they face that they hope could be solved by education programs or by changing the licensing system. They stated various topics that they would like to learn about, some covered to a degree in trainings and some are not covered in any current trainings. In addition to stated requests, the data also revealed topics that may support workers in implementing safety measures in the future.

Topics for Future Trainings

Applicators wanted to know more about each type of chemicals they use in relation to PPE that may prevent exposure. Applicators also would like information regarding possible illnesses and long-term effects from exposure. Table 6.1 Topics for Future Trainings Requested by Applicators outlines specific chemical groups, details applicators would like to learn about them, and how they would like to learn them. Informing applicators through advertising about new trainings designed with their input could help support applicator efficacy. Initial pre-licensing trainings cover various groups of pesticides such as herbicides, insecticides, etc., but these are broad categories compared to more specific chemical groups.

Both toxicologists consulted for this study mentioned a lack of research and information regarding adjuvants. Adjuvants are chemical formulas added to pesticides that cause them to adhere to plant surfaces or encourage homogenization, for example. There is little research on the possible synergistic effects of adjuvants and chemicals. A story relayed by one toxicologist was of an applicator whose backpack sprayer exploded and doused him in chemical. He suffered health effects such as long-term sleep problems but was unable to find out what chemicals were in the adjuvant because the formula fell under a proprietary category.

Table 6.1 Topics for Future Trainings Requested by Applicators

<table>
<tr><th>Chemical/
Chemical Group</th><th>Specific Educational Components</th><th>Requested Methods</th></tr>
<tr><td>Organophosphates
(insecticide)</td><td rowspan="5">Additional personal protective equipment (PPE) that would help the applicator further reduce exposure, beyond the minimum PPE
Methods of exposure
Short-term symptoms from exposure
Long-term symptoms
Illnesses that affect applicators</td><td rowspan="5">Hands-on learning
Practice mixing and loading
Stations for training (like a trade show)
Research-based information
Podcasts
Radio announcements during the spraying season
Entertaining or engaging methods</td></tr>
<tr><td>Carbamates
(insecticide)</td></tr>
<tr><td>Pyrethrins
(insecticide)</td></tr>
<tr><td>Glyphosate
(herbicide)</td></tr>
<tr><td>2,4-D (herbicide)</td></tr>
<tr><td>Adjuvants</td><td>Risks from adjuvant exposure</td><td>Include research-based information</td></tr>
</table>

Based on the data, nuances in learning about personal protective equipment are warranted. One applicator put it this way:

> As far as safety goes, in general, what it says on any label as far as PPE requirements, is what to wear in order to stay below the EPA's threshold, that they've dreamt up. What I'd like to see more of is, if you do want to wear additional PPE, what's the ideal stuff to wear to minimize exposure?

Other applicators also shared that they were curious about various types of rubber that allow or do not allow chemical exposure. Applicators were interested in types of footwear, gloves, and aprons. Where there are gaps in protection, new equipment should be designed. For example, applicators said that backpack sprayers had the potential to leak down one's back.

Applicators were queried in the survey for topics that they valued. See Table 6.2 Survey Responses. Eight topics were provided based on theoretical sampling as well as an "other" category that was open ended. The responses are ordered beginning with the most frequent response after combining both sets of surveys. The top three responses were: knowledge of the product, reading a pesticide label, and knowledge of safety procedures. Trainings could be organized around any of these topics using requested methods, such as hands-on activities.

Many suggested topics involve refining knowledge of worker practices. These practices arise from the work and also contribute to the subculture of pesticide application as shared processes. Applicators who participated in the surveys and focus groups wish to learn and improve their work, in part, to reduce accidents and exposures.

During the course of work, applicators experience various decision-making situations. On occasion they are faced with two negative alternatives. A double bind is "a situation in which a person is confronted with two irreconcilable demands or a choice between two undesirable courses of action" (www.dictionary.com). If an applicator is exposed but did not follow the label, they will not want to admit that they did not follow the label and may not go to the doctor or may not tell the doctor everything about their exposure. Further complicating this dynamic is the fact that a label can at times be difficult to follow. Sometimes applicators need to get their job done, even if the wind conditions, temperature, or humidity are not at the right levels according to the label. Training could be developed to help applicators when they are faced with a double-bind situation.

Table 6.2. Survey Responses Regarding Preferred Safety Topics.

Survey Question: Regarding pesticide safety, what are your most valued topics? (select any that apply)						
Topic	Online Survey		Focus Group Participant Survey		Combined Responses	
	No. of Responses	% of Total	No. of Responses	% of Total	No. of Responses	% of Total
Knowledge of the product	34	17.8%	20	18.2%	54	17.9%
Reading a pesticide label	35	18.3%	13	11.8%	48	15.9%
Knowledge of safety procedures	31	16.2%	14	12.7%	45	15.0%
Protecting skin from exposure	24	12.6%	13	11.8%	37	12.3%
Keeping up-to-date with new products	17	8.9%	13	11.8%	30	10.0%
Emergency response	16	8.4%	10	9.1%	26	8.6%
Unsafe working conditions	13	6.8%	10	9.1%	23	7.6%
Preventing inhalation of fumes	11	5.8%	12	10.9%	23	7.6%
Other	10	5.2%	5	4.5%	15	5.0%
Total Number of responses*	191		110		301	

*51 people responded to the survey question

Other topics requested by applicators included resistance management, symptoms of exposure, understanding rates, and several suggestions for summary cards that would provide a succinct place to look for key information when mixing, loading, calibrating nozzle heads (volume of water released) and other aspects of spraying pesticides. Summary cards are not necessarily an educational topic but could be incorporated as a hands-on teaching method. Summary cards could be created from specific chemicals that applicators use.

On the survey, applicators were asked about past trainings. Responses include various topics such as PPE, laws and labels, calibration, how to dress for safety as well as methods. Methods listed as effective include hands-on activities, use of real-life examples and stories, as well as guidance from others.

Applicators were also queried about what changes they would make in trainings if they could. Examples of responses included asking for more energized presentations, new material, and matching PPE material to specific chemicals. One of the critiques mentioned in focus groups was that training would be more useful if it was organized for specific license types. This was also shared by a survey respondent.

Educational Methods

When discussing how applicators would like to learn, nearly everyone said they prefer a hands-on method. Educators interviewed for the pilot study said they would prefer to teach hands-on methods also. One applicator said he would prefer “a combination of hands-on and visual, I’d say, primarily.” One toxicologist who conducted trainings in another state used case study presentations, stories of exposure incidents. She described that she would stop part way through to ask audience members what they would do and then after a discussion would tell them what actually happened.

Another toxicologist recommended practicing emergency scenarios. She said that once someone has been exposed, often times their judgment becomes impaired right away because of the chemical and also because of panic. If an applicator has practiced what to do in an emergency, they are more likely to be able to implement that action for themselves or for someone else.

One idea for hands-on learning from a retired agronomist was to have applicators practice mixing and loading with a harmless chemical that would show up with a black light. After they mix and load, they could see how much chemical landed on their skin. This could be done using PPE and not using PPE so workers could see the difference.

Applicators could be encouraged to take care of their own health by adding an action plan component to trainings after presentations on various illnesses and exposure pathways. After these types of presentations, applicators would likely be more motivated to think about their own future health and be interested in developing their own goals for reducing exposure. Goal setting was not a topic or a method mentioned by study participants and so would need to be tested with applicators. It is possible that development of a phone app could facilitate safety goal setting and progress towards goals. Self-efficacy is an important component in adult learning (Knowles, Holton & Swanson, 2012) and could be further supported among pesticide applicators using goal setting or other methods. Several examples of education programming and evaluation methods from existing extension system adult education programs may also be relevant.

Master Gardener training, an extension system model that started at WSU in the 1970s, is now offered nationwide. The program trains community volunteers in various topics and participants can receive a certificate at the end if they pass a test and serve as a volunteer and community education resource. This type of program could be offered to pesticide applicators, for example a "Master Applicator" program that offers credits for licensing and also community service opportunities including presentations to groups about pesticides and pesticide safety.

In evaluating extension programs, educators often attempt to find out if attendees will (or later if they have) implemented new measures. Providing mechanisms for implementing new skills and tracking changes in behavior helps evaluate program impact (McCauley et al., 2006). Goal setting sessions and a tracking system could help both applicators and educators see if programs are having an impact. Applicators understand that extension provides community education programs and offered suggestions for those trainings.

What Workers Want from Extension

Applicators want the general public to be better educated about pesticides. One reason for this request is so that members of the general public are more careful with chemicals around the home and lawn, and respectful of the label laws when applicators are spraying on their property.

Another facet of education for the general public that applicators would like is an understanding of the role of pesticides in our current food system. If the topic of pesticide use were to be presented as research-based, it may be educational. What applicators indicated they want is to be appreciated for the work they do and be seen as acting responsibly with the chemicals they use. Several applicators in one focus group had participated in Leadership Idaho Agriculture, a program that trains working professionals in leadership and agricultural industry advocacy. That program helps participants communicate to the public about agriculture.

Other Educational Components

Possible facets or components for educational programs can be seen in the conceptual model for pesticide applicator safety presented in Figure 6.1. Conceptual Model of Pesticide Applicator Safety. The conceptual model highlights categories of data as critical influences

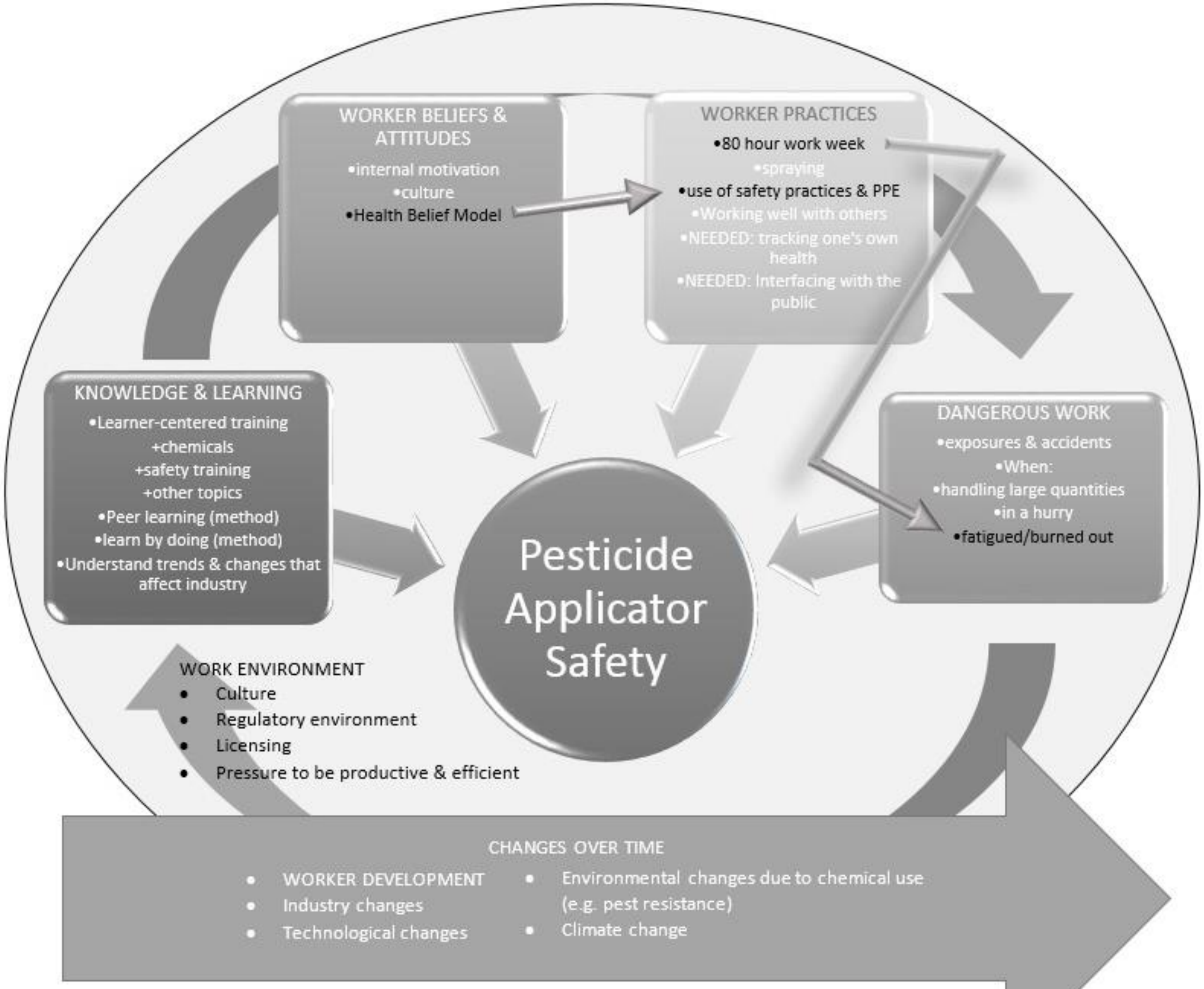

Figure 6.1. Conceptual Model of Pesticide Applicator Safety

in pesticide applicator safety. The *work environment* is the context within which applicators operate. *Knowledge and learning* should include training designed with applicators at the center, meaning, their priorities should be given utmost consideration. The data revealed those priorities include, for example, desire for more information about chemicals, PPE, potential illness and other topics. Applicators interviewed prefer hands-on learning.

Worker beliefs and attitudes, as discussed in Chapter Four, discusses how cultural norms reflected in beliefs about risk, contribute to behaviors such as the use of PPE. Other *worker practices* such as working 80-hour weeks may lead to *danger at work*. All of these factors are subject to *change* as time passes. Workers grow older and mature during which time the industry also changes. Other important facets of change in Idaho agriculture will likely include loss of agricultural lands to housing development and climate change.

The work environment is more collective and represents one of the ways culture functions in the workplace. The environment and subculture are not normally changed by one individual, and cultural elements are not always viewable or understood by people living within them (Schein, 2017). By collectively prioritizing worker safety over the last 50 years, the work environment has significantly changed.

Changes Over Time

It is expected that pesticide applicators' work in the agricultural industrialized system will continue to change, possibly at an advancing pace in keeping with technological advances. Each agency, company, and educator are responsible for supporting workers in adapting to changes that occur. Two examples of emerging technology are drones that can apply pesticides, and a skin gel that neutralizes chemicals that land on the skin. Industrialized agriculture is also scaling up with larger tractors and boom sprayers becoming more common. Climate change affects the agriculture industry. According to reports from Regional Approaches to Climate Change (REACCH) – Pacific Northwest Agriculture, more severe weather events that can wipe out crops in a short amount of time, have become more common. Information from the REACCH project could be tailored to help applicators understand coming challenges (www.reacchpna.org/home).

Another facet of change over time is the natural development of adults who work within the pesticide applicator industry. As an applicator matures, he or she grows and changes over their entire careers. Applicators described changes such as energy level, temperament, health beliefs and attitudes. Although not a central topic of inquiry for this study, other changes that arose as a factor in safety during this study could be identified and explored in future studies.

Future Research Topics

Many topics warrant further research pertaining to pesticide applicator safety including pesticide drift, the role of race, class, and gender in the profession, and issues around reporting exposures. There are a multitude of societal issues around the use of chemical pesticides that also warrant further study such as homeowner use, organic farm pesticide safety, environmental issues of chemicals building up in natural systems, and many others that are outside the scope of this study. All of these issues can become interrelated if pesticides are not properly handled.

Pesticide Drift

When pesticide drift spreads onto neighboring small acreages managed by families, rather than corporations, it impedes small acreage farmers and/or gardeners from providing their own food and oftentimes worse. The pressure and resulting tension from the development of suburban neighborhoods amidst farm fields is likely to increase as Idaho becomes more populated. Supporting applicators in preventing drift and interfacing with the general public would be beneficial as this situation worsens.

Race, Class and Gender

While race, class and gender were not the focus of this study, it is important to note existing bias in the agriculture sector. Hispanic farm workers tend to hold lower wage jobs than white workers. The profession of licensed pesticide applicators is primarily occupied by Caucasian men. Also, there are very few women in the profession. Further study about ways to diversify the profession is warranted. Due to power differences that appear stratified by race and class, workers of color may be at a greater risk of pesticide exposure. For example, if a worker has not been provided PPE at work, and is making a low wage, he/she may not be able to afford to purchase their own PPE. A person making a higher wage, may have the financial freedom to purchase PPE. Another example is the cost of laundering clothes. A low wage earner may not be able to afford to launder clothing every day. All workers are vulnerable if the industry suffers setbacks such as large crop failures; however, low-wage workers will likely have fewer resources and savings if they lose their income.

Implications for Policy

Policy makers have a responsibility to understand the effect of regulations on the profession of pesticide applicators and handlers. The industry is already highly regulated, and any additional regulations may have significant economic effects. However, eliminating regulations that put workers in greater danger if there are less protections, is not advised. Policies that balance power and economics are important for continuing high levels of agricultural production on which many workers jobs rely.

One area for consideration is adjuvants, chemical additives that alter the properties fo pesticides, such as to help them stick to the leaves of a plant. Adjuvant ingredients are not required to be listed on product labels but may contain carcinogenic properties. One toxicologist shared a story of someone who experienced an exposure, but the chemical manufacturer would not share what was in the adjuvant. Laws could be crafted that require all ingredients to be listed and synergistic effects to be tested, prior to chemical release.

Summary

This qualitative, grounded-theory study has examined various facets of pesticide applicator profession, culture, education and safety. The purpose of the study was to identify critical learning components and approaches that lead to the safe use of pesticides. Pesticide application is a potentially dangerous job. Pesticide applicators need engaging trainings that help them prevent pesticide exposures and prepare them to address challenges they face when exposures occur. Additional research is warranted regarding the needs of pesticide applicators and handlers, and ongoing improvement to education and training in response to what is learned in future studies.

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APPENDIX A - INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

University of Idaho
Office of Research Assurances
Institutional Review Board
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010
Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Laura B. Holyoke

Cc: Iris Anne Mayes

From: Jennifer Walker, IRB Coordinator

Approval Date: November 15, 2017

Title: Identifying Best Practices for Pesticide Safety Education Through Narrative Inquiry

Project: 17-237
Certified: Certified as exempt under category 2 at 45 CFR 46.101(b)(2).

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the protocol for the research project Identifying Best Practices for Pesticide Safety Education Through Narrative Inquiry has been certified as exempt under the category and reference number listed above.

This certification is valid only for the study protocol as it was submitted. Studies certified as Exempt are not subject to continuing review and this certification does not expire. However, if changes are made to the study protocol, you must submit the changes through VERAS for review before implementing the changes. Amendments may include but are not limited to, changes in study population, study personnel, study instruments, consent documents, recruitment materials, sites of research, etc. If you have any additional questions, please contact me through the VERAS messaging system by clicking the 'Reply' button.

As Principal Investigator, you are responsible for ensuring compliance with all applicable FERPA regulations, University of Idaho policies, state and federal regulations. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice. The Principal Investigator is responsible for ensuring that all study personnel have completed the online human subjects training requirement.

You are required to timely notify the IRB if any unanticipated or adverse events occur during the study, if you experience and increased risk to the participants, or if you have participants withdraw or register complaints about the study.

APPENDIX B - INVITATION EMAIL FOR FOCUS GROUP PARTICIPATION

Dear [PARTICIPANT],

I am a graduate student at the University of Idaho in the College of Education and I also work for University of Idaho Extension. I am working on a study regarding pesticide education. I am interested in meeting with certified applicators in a group setting to hear from this stakeholder group who apply pesticides in Idaho.

I am willing to come to the workplace or I can set up a space. For focus group participants, I am offering a meal and a $5 gift card. I have met with 3-5 people for the focus groups. Please feel free to call me to discuss!

This information will be used for my graduate research project and to help University of Idaho Extension educators design and offer effective educational programs in the future.

Thanks for your help!

Iris

Iris Mayes | Extension Educator, Small Farms and Horticulture

University of Idaho Extension – Latah County |

200 South Almon Street, Suite 201| Moscow, Idaho 83843

Phone: 208.883.2269 | Fax: 208.882.8505 |

Email: **imayes@uidaho.edu**

APPENDIX C - THANK YOU EMAIL FOR FOCUS GROUP PARTICIPATION

Dear [PARTICIPANT],

Thank you very much for participating in my focus group interview regarding pesticide safety and education. I really appreciate you sharing point of view. This information will be used for my graduate research project and to help University of Idaho Extension educators design and offer effective educational programs in the future.

Sincerely,

Iris

IRIS MAYES, M.S., 2010
Extension Educator, Small Farms and Horticulture

College of Agricultural and Life Sciences
Northern District Extension
Office: Latah County
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208-883-2269 | 208-882-8505 (Fax)
200 South Almon, Suite 201 | Moscow, ID 83843 | United States

APPENDIX D - INVITATION TO PARTICIPATE IN ONLINE SURVEY

Dear [CONTACT/RESPONDENT],

Please forward this email to any pesticide applicators you think may be willing to take this survey. It should only take 5-10 minutes and is completely anonymous.

Hello, My name is Iris Mayes. I am a graduate student at the University of Idaho in the College of Education and I also work for University of Idaho Extension. Wearing my student hat, I am working on a study regarding **pesticide education**. This information will be used for my graduate research project and to help University of Idaho Extension educators **design and offer effective educational programs in the future**.

Thank you for taking the time to fill out this survey. Please forward to any other applicators or pesticide handlers who may be willing to take the survey.

Here is a link to the anonymous survey: Online Pesticide Education Survey
If for some reason the link doesn't work, here is the URL: http://bit.ly/pesticidesurvey

Thank you very much for your help with this study! If you have any questions, please email imayes@uidaho.edu

Sincerely,

Iris Mayes | Extension Educator, Small Farms and Horticulture
University of Idaho Extension – Latah County |
200 South Almon Street, Suite 201| Moscow, Idaho 83843
Phone: 208.883.2269 | Fax: 208.882.8505 | Email: imayes@uidaho.edu

APPENDIX E - SURVEY FORM FOR PESTICIDE APPLICATORS

Pesticide Safety Survey

Thank you for taking the time to participate in this survey. I am a graduate student at the University of Idaho in the College of Education and I also work for University of Idaho Extension. Myself and other educators would like to better understand how farmers and pesticide applicators learn about pesticide use and safety.

This information will be used for my graduate research project and to help University of Idaho Extension educators design and offer effective educational programs in the future. Your participation is voluntary and you may withdraw at any time. The survey is anonymous and no identifying information will be connected with your responses. The survey may take about 5-10 minutes.

Q1 Are you a certified pesticide applicator?

○ Yes (1)

○ No (2)

Skip To: Q2 If Are you a certified pesticide applicator? = Yes

Skip To: Q3 If Are you a certified pesticide applicator? = No

---

Q2 In which areas are you certified to apply pesticides? I am certified in: (select all that apply)

☐ Law & Safety (1)

☐ Agricultural Insecticide/Fungicide (2)

☐ Agricultural Herbicide (3)

- Soil Fumigation (4)
- Forest Safety (5)
- Right-of-Way Herbicide (6)
- Public Health Pest Control (7)
- Livestock Pest Control (8)
- Ornamental Insecticide/Fungicide (9)
- Ornamental Herbicide (10)
- General Pest Control Operator (11)
- Structural Destroying Pests (12)
- General Vertebrate Control (13)
- Rodent Control (14)
- Aquatic Pest Control (15)
- Seed Treatment (16)
- Commodity Pest Control (17)
- Potato Cellar Pest Control (18)
- Wood Preservative (19)
- Statewide Pest Control Consultant (20)
- Demonstration and Research (21)
- Chemigation (22)
- Other, please specify (23)

____

Q3 What type of farming job do you have? (you may provide multiple responses if you work in multiple jobs)

- I own and operate a farm (1)

☐ My farming job is (2) ____

☐ Other (please explain) (3)

____

Q4 Do you apply pesticides **other than on** your own land?

◯ I only apply pesticides on my own land (1)

◯ Yes, In addition to my own farm, I also apply pesticides for other land owners (or farmers) (2)

◯ Other, please explain (3) ____

Q5 I apply pesticides on multiple farms

◯ Yes, I apply pesticides on multiple farms (1)

◯ No, I do not apply pesticides on multiple farms (2)

◯ Other, please explain (3) ____

Q6 Is there any topic that you would like to see covered in pesticide training provided by UI Extension?

◯ Topics that UI Extension training should cover are: (1)

____

Q7 Are there any methods that UI Extension should use in trainings or meetings?

◯ Provide hands-on training such as: (1)

____

◯ Use stations like a trade show. Stations should cover: (4)

____

◯ Other, please specify (5) ____

◯ Other, please specify (6) ____

Q8 Regarding pesticide safety, what are your most valued topics? (select any that apply)

- ☐ knowledge of the product (1)
- ☐ preventing inhalation of fumes (2)
- ☐ knowledge of safety procedures (3)
- ☐ protecting skin from exposure (4)
- ☐ reading a pesticide label (5)
- ☐ unsafe working conditions (6)
- ☐ emergency response (7)
- ☐ Keeping up-to-date with new products (8)
- ☐ Other (9) ____
- ☐ Other (10) ____
- ☐ Other (11) ____

Q9 Is pesticide safety covered during your training at work?

- ○ Yes (1)
- ○ No (2)
- ○ Other (please explain) (3) ____

Q10 Have you taken a pesticide safety training **outside of work**?

- ○ Yes, I have taken a pesticide safety training outside of work (1)
- ○ No, I have not taken a pesticide safety training outside of work (2)
- ○ Pesticide safety was a component of a training I attended (3)
- ○ Other (please explain) (4) ____

Skip To: Q16 If Have you taken a pesticide safety training outside of work? = No, I have not taken a pesticide safety training outside of work

Q11 If yes, how many trainings specific to pesticide **safety** have you completed?

◯ I have completed _____ (number) of pesticide safety trainings (1) ____

Skip To: Q13 If If yes, how many trainings specific to pesticide safety have you completed? = I have completed _____ (number) of pesticide safety trainings

Q13 If yes, please tell us the earliest year you completed a pesticide safety training?

____

Skip To: Q14 If If yes, please tell us the earliest year you completed a pesticide safety training? =

Q14 What was the most effective part of the training that you participated in?

____

Skip To: Q15 If What was the most effective part of the training that you participated in? =

Q15 If you could change the training, what would you suggest?

____

Q16 When you were learning about using pesticides, were there any incidences, experiences or stories you heard that helped you take less risks or helped you learn a safety tip?

◯ Yes (1)

◯ Maybe (2)

◯ No (3)

Skip To: Q17 If When you were learning about using pesticides, were there any incidences, experiences or stories... = Yes

Q17 If yes, please share the story?

____

Q18 How long have you been applying pesticides?

- ○ I have been applying pesticides for _____ years (1) ____
- ○ I have been applying pesticides for ____month(s) (2)
- ○ I do not directly apply pesticides (3)
- ○ I used to apply pesticides but haven't for _____ year(s) (4)

Skip To: Q19 If How long have you been applying pesticides? = I do not directly apply pesticides

Skip To: Q20 If How long have you been applying pesticides? = I have been applying pesticides for _____ years

Q19 If you do not directly apply pesticides, what is your role?

- ○ I am a supervisor (1)
- ○ I do not use pesticides in my farming activities (2)
- ○ Other (please explain) (3) ____

Skip To: Q29 If If you do not directly apply pesticides, what is your role? = I am a supervisor

Skip To: Q28 If If you do not directly apply pesticides, what is your role? = I do not use pesticides in my farming activities

Q20 What are the main herbicides you work with?

____

Q21 On which crops do you apply herbicides?

____

Q22 What are the main insecticides you work with?

____

Q23 On which crops do you apply insecticides?

____

Q24 How dangerous do you consider your job to be?

- ○ Not at all dangerous (1)
- ○ Slightly dangerous (2)
- ○ Somewhat dangerous (3)
- ○ Dangerous (4)
- ○ Very dangerous (5)

Q25 In which seasons do you apply pesticides? (check all that apply) I apply pesticides in:

- ☐ fall (1)
- ☐ winter (2)
- ☐ spring (3)
- ☐ summer (4)
- ☐ Other, please explain (5) ____

Skip To: Q17 If In which seasons do you apply pesticides? (check all that apply) I apply pesticides in: != Other, please explain

Q26 In the seasons when you apply pesticides, how often do you apply them?

- ○ I apply pesticides daily (1)
- ○ I apply pesticides 2-3 times per week (2)
- ○ I apply pesticides 3-5 times per month (3)

- I apply pesticides monthly (4)
- I apply pesticides a few times per year (5)
- Other (please explain) (6) ____

Q27 At what scale do you work?

- I am a large-scale producer or farm worker (1)
- I am a small-scale producer or farm worker (2)
- I have (or work on) both large and small scale operations (3)
- Other (please explain) (4) ____

Q28 How many other workers do you oversee who apply pesticides?

____

Q29 Please indicate if you use conventional or organic farming methods.

- I use only conventional methods (1)
- I use only organic methods (2)
- I use both methods (3)
- Other (please explain) (4) ____

The following questions are about you. As with the rest of the survey, these are anonymous and will not be linked to your identity. Answering will help us understand more about the group of pesticide applicators.

Q30 Please identify your gender

- ○ Male (1)
- ○ Female (2)
- ○ Other, please specify (3) ____________________

Q31 Please identify your age group

- ○ 18 - 25 (1)
- ○ 26-35 (2)
- ○ 36-45 (3)
- ○ 46-55 (4)
- ○ 56-65 (5)
- ○ 66+ (6)

Q32 During the year do you work hourly, seasonally, and/or year-round?

- ○ hourly (1)
- ○ seasonally (2)
- ○ year-round (3)

Q33 What is your income classification?

- ○ Under $20,000 (1)
- ○ $20,001 to 30,000 (2)
- ○ 30,001 to 40,000 (3)
- ○ 40,001 to 50,000 (4)
- ○ 50,001 - to 60,000 (5)
- ○ Over $60,000 (6)

Q34 What is your educational background?

- ☐ High school graduate (1)
- ☐ Bachelor’s Degree (2)
- ☐ Private/Professional Applicator License (6)
- ☐ Professional Certificate: (3)
- ☐ Masters Degree (4)
- ☐ Other (please explain) (5) ____________________

Q35 What is your race?

- ☐ Caucasian (1)
- ☐ Hispanic (2)
- ☐ African American (3)
- ☐ American Indian (4)
- ☐ Asian American (5)

Q36 What is the zip code of your workplace?

____

Thank you for completing this survey! If you are interested and available to participate in a focus group, please email: imayes@uidaho.edu

APPENDIX F - SUMMARY TABLE OF CODES AND CATEGORIES

Appendix F – Summary of Codes and Categories

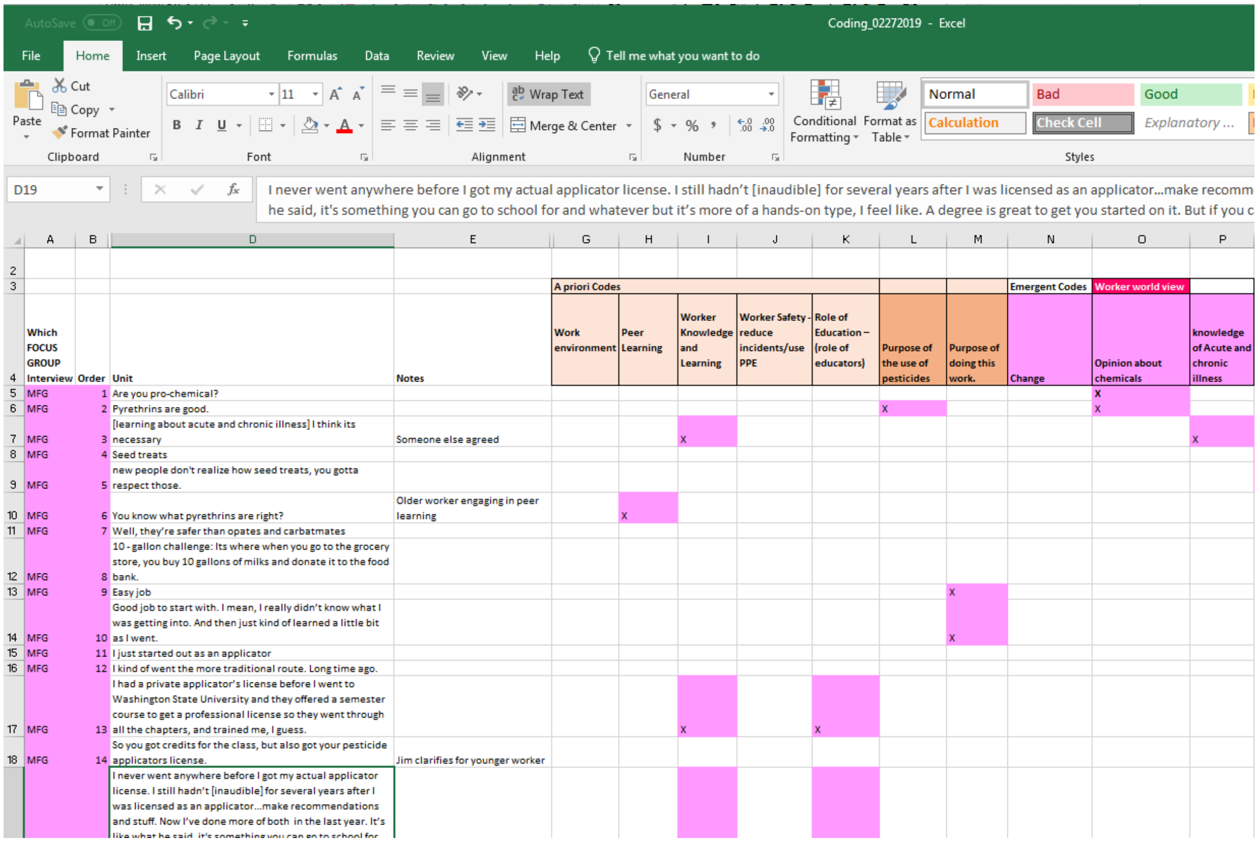
Code*	**Description of the code**	**How code functions within the study**
Knowledge and Learning		
Worker Knowledge and Learning*	Worker knowledge and learning are central to worker safety and job success. Factors include: Worker experience level Knowledge of pesticides, insects, weeds and crop development Purpose of the use of pesticides – an important aspect of the job is understanding what the chemical is supposed to be used for and when it should be used. Purpose of doing this type of work Worker skills and skill development Worker intellectual and personal development (Knowles 1970)	Exploring the role of new & existing knowledge & learning in pesticide applicator subculture
Mentoring and Peer Learning*	Mentoring and peer learning are critical components of worker training (Illeris, 2011)	Understanding how workers learn about safety
Role of Education*	Educators organize programs that support the licensing process and worker development. (Simeral and Hogan, 2001)	Education can influence safety
Worker Safety	Incidents at work help workers learn cause and effect of safety measures such as PPE	Minor incidents can prevent worse incidents
Licensing	Licensing is the mechanism that gives the Department of Ag a captive audience for educational programming (Idaho Department of Ag)	'Captive' but willing audience for training
Narrative*	How are stories or anecdotes used to teach, train or convey new information? (Rossiter and Clark 2007, Cullen 2008)	Stories can teach workers how and why to implement safety measures
Knowledge of acute and chronic illness	Workers desire knowledge of potential illnesses from the chemicals they are using and are occasionally exposed to	Applicators want to know more about what illnesses can occur from exposures
Asking about my knowledge of chemicals	Some participants wanted to know what the researcher understand about chemicals	Knowledge of specific chemicals is valued by applicators
Comparison of danger between chemical types	Applicators expressed differences in danger and risk between types of chemicals	Knowledge of specific chemicals in terms of risk level is valued by applicators
Worker Practices		
Worker Actions and Safety*	The purpose of worker safety is to prevent accidents and injury in a high-production environment. Activities and processes include: Accident prevention What causes accidents and injury? Knowledge of, use of PPE and handling of laundry Incidents of burns and poisoning and the worker response to incidents (Arcury 2001, & Lumby 2015)	How workers keep themselves safe
Regulatory Environment	Pesticides are a highly regulated industry (Educators 1 & 2)	Constraints on worker behavior
Code	Theme	Function

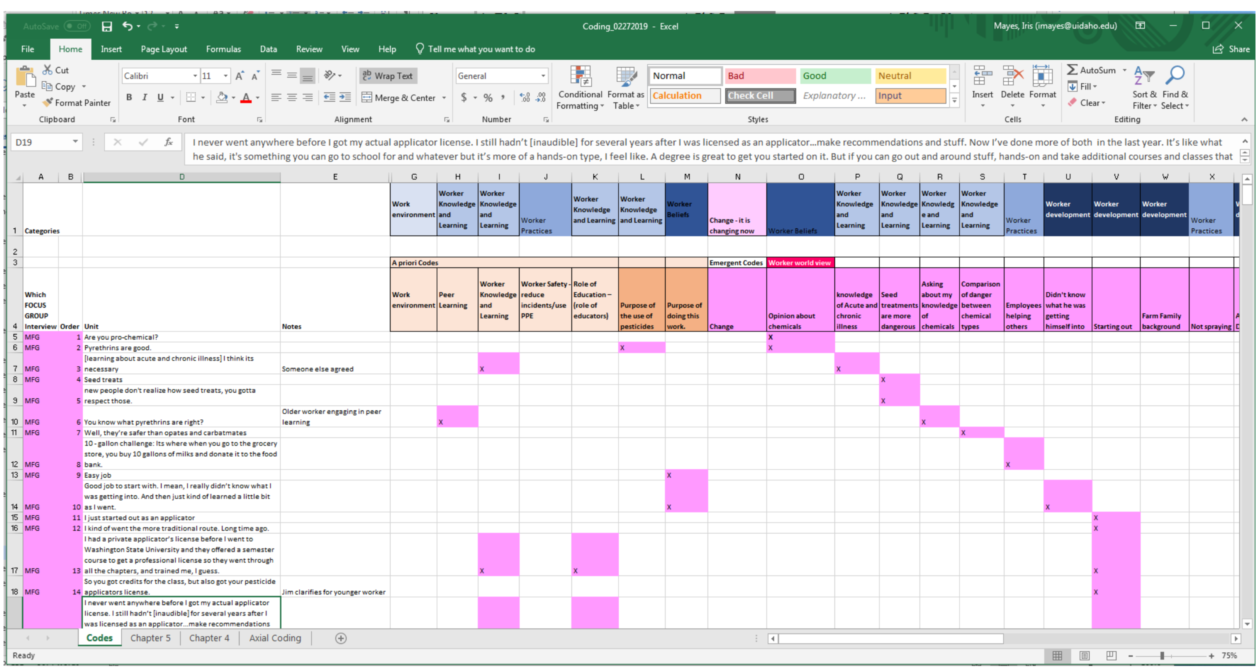
Decision making and problem solving	How prepared is an applicator to make decisions in various situations including in an emergency?	Decision making
Accuracy issues	Accuracy is critically important to safety and work productivity	Accuracy can help keep workers safe
Not spraying	Some applicators who have a license do not spray chemicals as part of their job	People who don't spray tend to make a higher salary
New worker practice: Interfacing with the Public	Applicators encounter members of the public during their work day and outside of work.	Applicators need training on how to interface with the public regarding their work. Applicators want understanding from the general public
Forgetting PPE	Sometimes applicators forget their PPE. This can result in an exposure to pesticides.	Forgetting PPE is dangerous
Preparedness for incidents	Applicators can be prepared for exposure incidents or other accidents	Training on incidents response can benefit applicators in an emergency
Worker Beliefs & Attitudes		
Worker Beliefs*	Health Belief Model identifies a positive relationship between perception of benefits and use of protective measures. (Elmore and Arcury 2001).	If applicators perceive benefits and risk, they may be more likely to improve use of preventative measures
Worker Mentality and attitude*	What mental states contribute to safety? "Don't rush" What mental states contribute to accidents? "Complacency." (Lumby 2015)	Workers' mental states and attitudes can help keep them safe or put them in danger
Narrative or storytelling*	Narrative data reveals culture.	Stories can teach workers how and why to implement safety measures
Opinion about use of chemicals	Applicators have opinions about the benefits of using chemical pesticides	Shared opinions create a cultural bond
Employees helping others	Some participants expressed altruism in their work day	Higher level value
Cavalier attitude	Some participants expressed having a cavalier attitude in the past. Some applicators observed others being cavalier.	A cavalier attitude can lead to exposure
Work Environment		
Work environment*	The work environment determines various aspects of worker learning and safety (Arcury 2001, Lumby 2015)	Context for worker safety
Economics of pesticide application	How much does a customer want to spend? And, How fast does an applicator work?	Financial pressure affects safety
Technology	What is the role of technology in pesticide application and in pesticide education? What is the potential?	Technology can contribute to safety but also to complacency
Coworkers	What is the role of co-workers in safety incidents?	Workers function in teams, especially when there is a safety incident.
Work season is longer than farmers' season	Applicators work on many different crops and so the season over which they work long hours is more months than an individual farmer.	Contributes to fatigue and burnout
Monocrops	When there is an abundance of one type of crop, many acres of crop have to be sprayed at the same time contributing to long days for workers	Contributes to fatigue and burnout; business decisions based on underlying cultural values

Work challenges	Applicators face various challenges such as extreme heat, expectations to spray many acres in a short amount of time, and other challenges.	Applicators need support to solve challenges
Worker Development		
Didn't know what he was getting himself into	Applicator did not understand all of the aspects of the job until he had worked for a while.	Workers grow and learn as they spend more time in the profession
Starting out	Applicators shared their stories of how they started working in this profession	Some workers have farm experience, and some do not when they start. Each type of background might warrant a different type of training
Farm family background	Some applicators shared that they grew up on a farm.	Applicators understand agriculture
Adult Development	Older workers indicated that they became more careful as they aged	Workers grow and learn as they spend more time in the profession
Industry and Technological Changes Over Time		
History	Participants shared how they have seen the industry change over their lifetime	The industry has changed significantly and indicates that it will continue to change
Better than it used to be, i.e. Safer/More danger in the past	Chemical products and the industry overall are safer than they used to be.	Workers need ongoing training to identify changes and to learn about new chemicals
Dangerous Work		
Accidents	Accidental exposures and other types of accidents happen at work	Workers need training to avoid danger and accidents
Handling bulk amounts is dangerous	One facet of danger at work is handling large quantities of chemicals	Different safety training for various transfer methods is needed
Comparison of danger between chemical types	Some chemicals are more dangerous than others	Knowledge of specific chemicals in terms of risk level is valued by applicators
Interfacing with Public		
Drift, environmental exposure	When pesticides drift unexpectedly, the result necessitates interfacing with land owners or members of the public who are not the customers.	There is a need for training applicators on reducing drift and also what to do when drift occurs
Interfacing with the public	Pesticides are occasionally in the news. Some applicators mentioned feeling judged or misunderstood for their role in working with pesticides	Workers would like understanding from the general public. Workers need training on what to say to people and how to say it

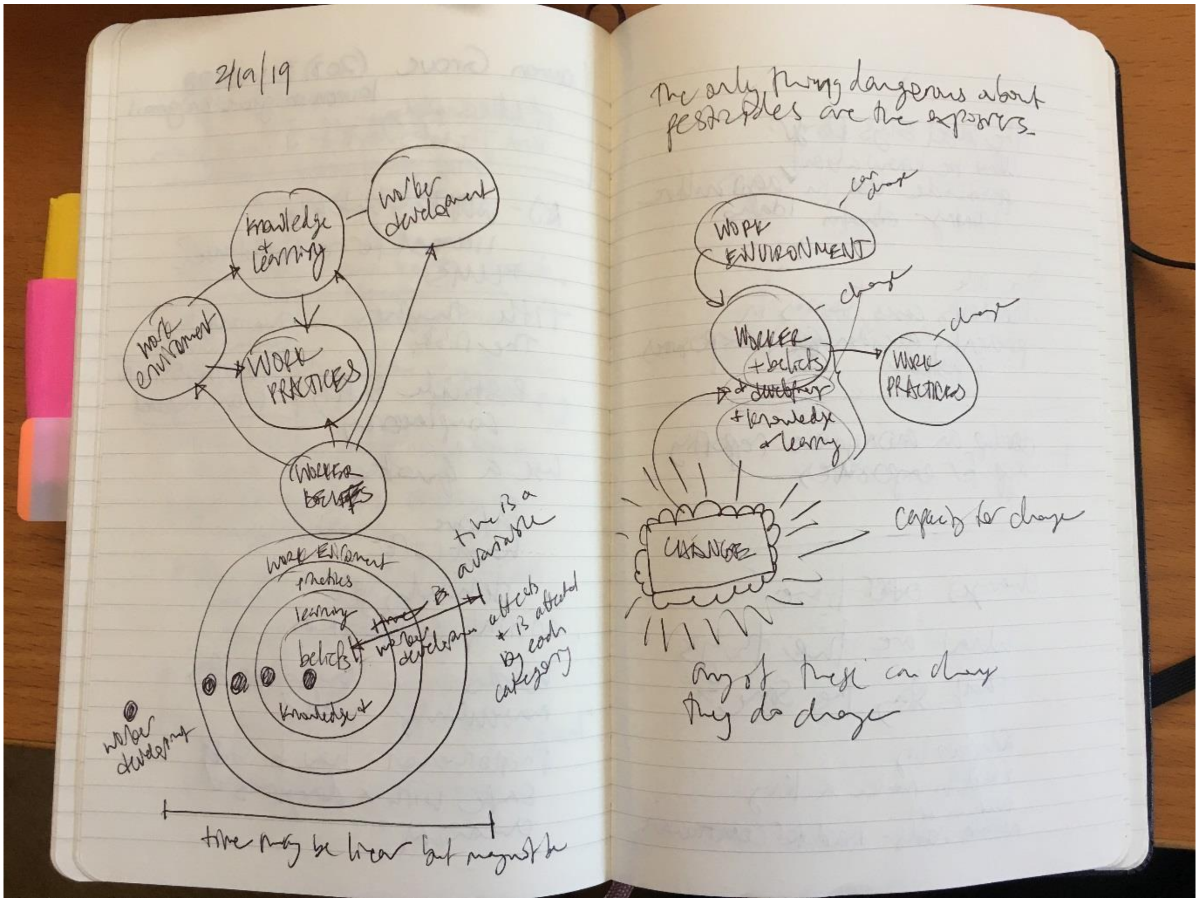
Shaded codes emerged from the pilot study
*priori codes

APPENDIX G - EXAMPLE OF FOCUSED CODING





APPENDIX H - EXAMPLE OF CLUSTERING FROM FIELD JOURNAL



APPENDIX I - SAMPLE WORD CLOUD