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Farmers' Perceptions of the Health Risks of Roundup

by

Karen Stoddard

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To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Karen Stoddard find it satisfactory and recommend that it be accepted.

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Farmers' Perceptions of the Health Risks of Roundup

Thesis Abstract – Idaho State University (2020)

Glyphosate, the main chemical in Roundup, is the most readily used herbicide in the agriculture sector. There is strong evidence that glyphosate is linked to several health issues including non-Hodgkin's lymphoma. Several countries have banned the application of it in their farming practices and on public grounds. However, the U.S. agriculture sector does not limit its use. In this study individual interviews were conducted with twelve Idaho farmers and two crop consultants. Through deductive and inductive analysis, the conclusion was made that Idaho farmers feel the benefits of using glyphosate outweigh the risks. Those interviewed feel that Roundup is a necessary tool that should be used when farming. The information gained in thesis study will aid policy makers in glyphosate application education and glyphosate regulation.

Keywords: health risks, glyphosate

INTRODUCTION

Glyphosate, the main chemical in Roundup, is the fastest acting and most readily used herbicide in the chemical lawn and agricultural industry. It was introduced in the 1970s as a broad-based herbicide and was initially used by farmers only when they wanted all plants killed. Then, in 1996, Monsanto introduced Roundup Ready seeds – seeds that were genetically modified (GM) to grow plants that could be sprayed with glyphosate, killing all weeds around them, while the non-target plant thrived. Corn and soybean farmers were the initial agricultural workers to embrace this new technology. Today there are 100 different types of Roundup Ready crops sprayed with glyphosate. Along with Roundup Ready seed, the broad-based application method is still popular. It is estimated that 56% of American farmers use glyphosate, totaling 300 million pounds of the chemical applied to American crops annually (Benbrook 2016). Based on independent market analysis, investment researchers project that by 2024 the global market for glyphosate will reach \$12.5 billion, a steady 7% in sales growth from now until 2024, despite the negative media attention the chemical company Bayer is getting (Moder Intelligence 2019). It is important to note that Bayer, the German pharmaceutical company, bought Monsanto in 2016. Investors are confident in the trajectory of use of glyphosate because of the lack of availability of alternative chemicals and farming methods that are as efficient as Roundup (Mordor Intelligence 2019).

In Idaho, there is a long history and strong culture of farming. Settlers moved to Idaho in the mid-1800s after the Homestead Act of 1862 was implemented. Through the Homestead Act, early Idaho pioneers were granted 160 acres of free land as long as they filed a deed and “improved” the land. Today, Idaho has 25,000 farms and ranches, ranking it the third- largest

agriculture state in the West (ISDA 2018). Agriculture and food processing generate 20% of the state economic output totaling \$16 billion annually (ISDA 2018). Idaho's top money producing crops are potatoes, alfalfa, wheat, sugarbeets, barley and corn (ISDA 2018). In Idaho, sugar beets are planted exclusively with a Roundup Ready seed, while much of corn and alfalfa are also grown with Roundup Ready seed, resulting in certain use of glyphosate (ISDA 2018).

Glyphosate Benefits

There are several positive benefits from use of Roundup. Plants generally require less water when Roundup is applied. This is because the plant is not competing with other unwanted plants, or weeds, in the field for water. This is especially important in Idaho since the state of Idaho is one of the top three consumers per capita of water in the U.S., and 86% of Idaho's total water use is used for agriculture (USGS 2015). Roundup is also useful when a farmer switches crops on a field, because spraying glyphosate eliminates the amount of tilling required, leaving a more nutrient-rich soil that requires less synthetic fertilizers (Monsanto 2019). Moreover, the effectiveness of Roundup allows for a reduction in the overall amount of chemicals applied to a crop including fungicides, herbicides, insecticides and fertilizers. Lastly, and probably most importantly, crops that are grown with the help of Roundup produce a third higher yield than crops cultivated without it. This is of particular significance since the world's population is at 7 billion people and it is projected to reach 10 billion people by 2052 (Worldometer 2019) and farmers have to face the challenge of producing food to feed all of these people.

Glyphosate Risks

Alas, despite all of these benefits, there are also downsides to Roundup. Three of the main concerns associated with glyphosate are: 1) the unknown effects of genetically modified

organisms (GMOs); 2) the effects the chemical has on the surrounding ecology; and lastly 3) the effects the chemical has on humans by breathing it in or by absorbing glyphosate through the skin, usually by spraying the chemical.

Firstly, some scientists suggest that because genes are modified it is unsafe to consume food germinated from a GMO seed (Keese 2008). However, in some studies scientists have also concluded that GMOs are safe to eat (Nicolia et al. 2013). Due to these mixed results from studies to date, and also of the potential that any ecosystem effects of glyphosate could take years to be observed, the overall effects of GMO foods may not be known for quite some time.

Secondly, spraying crops with pesticides affects the surrounding ecology. The Green Revolution, introduced in the mid-1950s, is the theory that technological advances in the agriculture sector will feed the surging world population (Borlaug 2002). Advances in synthetic fertilizers, introduction of pesticides, and irrigation practices after WWII increased yields four times as much prior to these advancements in crop husbandry practices. However, Rachel Carson's famous book, *Silent Spring* (1962), warned of the dangers of pesticide use, primarily Dichloro Diphenyl Trichloroethane (DDT). This book became a focus event in the 1970s that led to 40 congressional bills intended to regulate pesticide use. Despite this, many deem sustainable use of pesticides necessary for a successful crop.

Recent research proves that microbes, insects, and bees, which are essential organisms for plant growth, are negatively affected in the process of pesticide application on crops (Motta, Raymann, and Moran, 2018). Much attention has been given to the decline of butterflies and bees (National Research Council 2007). These insects are crucial to pollinating plants and their numbers are dwindling. The term Colony Collapse Disorder has been given to vanishing bee

colonies. There isn't a clear understanding of why the bees are disappearing, but a recent study claims that Roundup disrupts the gut enzymes of bees and causes them to die (Motta et al. 2018). These findings are alarming because it has taken research forty years to recognize this one complex effect.

The chemical glyphosate not only affects insects, but over-spraying plants has produced superweeds, or weeds that are resistant to glyphosate. GM seeds have reinforced monoculture crops (Vig and Kraft 2019). When yields are high for a certain crop farmers tend to stick to planting that same crop. Applying the same herbicide over time generates resistance to the weeds. This may result in farmers using more of the chemical that was initially designed to minimize chemical use.

Lastly, as with the insects and plants, the long-term health effects of glyphosate on anthropoids or humans are not completely known. However, there is strong scientific evidence that the chemical is linked to a string of medical problems. Pesticides commonly enter the body in three ways: dermal absorption (through the skin,) ingestion (through the mouth,) and inhalation (through the breath) (Damalas and Koutroubas 2016). In humans, depression, celiac disease and cancer have been associated with repeated glyphosate exposure (Sánchez-Santed, Colomina, and Herrero Hernández 2016; Samsel and Seneff 2013; Zhang et al. 2019).

There is an increase of celiac disease and gluten intolerance worldwide, especially in North America. Samsel and Seneff (2013) argue that glyphosate is the cause for this increase. Monsanto has been unable to make a GM seed for wheat. Yet, some farmers, especially those who grow wheat in wet climates, will spray the wheat plants just before harvest, using the broad-based application method. This allows for quicker and more universal drying of the wheat

kernels. This farming technique is called desiccation. Samsel and Seneff (2013) make a circumstantial case that since fish show gut enzymes reactions with glyphosate exposure, humans may too. More research needs to be performed on this hypothesis using scientific studies.

There are other illnesses associated with glyphosate exposure besides celiac disease including depression and Parkinson's disease (Beard et al.; Sánchez-Santed et al. 2016). Some research points to glyphosate exposure and it's link to suicide (Sánchez-Santed et al. 2016). While these studies generalize to all pesticides, Beard et al. (2014) found that organophosphates, the category that glyphosate falls under, is linked to Parkinson's disease. Researchers found that glyphosate affects the neurological function of the brain.

The health-related issue associated with glyphosate getting the most attention is probably its connection to cancer, particularly non-Hodgkin's lymphoma. After reviewing verifiable research evidence, the World Health Organization (WHO) has classified glyphosate as a carcinogen (WHO 2015; Tarazona et al. 2017). The most common type of pesticide poisoning is absorption through the skin (Damalas and Koutroubas 2016). This happens as a result of splashes, spills, and exposure to great loads of pesticide residue. Dewayne Johnson, a school groundskeeper in California, and his legal team alleged that he acquired non-Hodgkin's lymphoma (NHL) from repeated exposure while using glyphosate to spray weeds on the school grounds, and a jury agreed (CBS 2019). Monsanto, recently acquired by the German company Bayer, was ordered to pay \$289 million dollars to Johnson. Soon after, in March, Edwin Hardeman, a gentleman who was diagnosed with NHL earlier in 2018 was awarded \$80 million

from Monsanto as well (NBC 2019). Currently, there are 8,700 active plaintiff cases against Bayer for its role in producing cancer-causing chemicals while giving no warning to consumers.

THEORY

The debate over glyphosate reflects the theoretical conflict between preservation and conservation. Preservation is the belief that maintaining some area in its natural state so that future generations may enjoy it “untouched” is the utmost responsibility of land users (Muir 1908). Examples of the preservation mindset are national parks and designated wilderness areas. Conservation, on the other hand, is the idea that the wise use of natural resources is acceptable and that these natural resources are there to meet human needs and desires (Pincho 1910). According to Pinchot (1910), farmers identify as conservationists. A conservationist himself, Pinchot argued that land should be developed and not left to sit. The current generation living on the land and their needs in regard to the land’s resources come first as opposed to setting it aside for future generations. Pinchot believed in the prevention of waste in regard to natural resources. He suggested that humans should control the earth and stop natural waste from occurring such as battling forest fires as opposed to letting them burn naturally.

Aldo Leopold (1949:217), a follower of Pinchot, wrote, “conservation is a state of harmony between men and land.” He believed there must be a balance between conservation and preservation. If a farmer disregards all plants and species that do not give him economic benefit, he will disrupt the healthy functioning of the land, Leopold (1949). He believed if an owner of their land truly respected the land they would appreciate all of the living creatures on it and only engage in farming practices that would preserve all of the plants and insects on it.

After WWII, in the 1950s, The Green Revolution, started by Norman Borlaug, introduced ideas that seemed to challenge Leopold's ideas of conservation (Borlaug 2000). Borlaug (2000) believed that technology in the agriculture sector needs to be continuously added upon in order for the earth's population to be fed. He promoted advancement in irrigation practices, watering systems, timely weed control, and development of pesticides.

Around this same time Rachel Carson (1962) began to make noise in the farming communities with her book *Silent Spring*, which also seemed to challenge Pinchot's original idea of conservation. Borlaug's idea that science and technology would save people from the issues of the era were not sitting well with Carson. Carson criticized and warned that man's interference in nature's organic regulating process has and will wreak havoc on all environmental processes.

The Green Revolution and *Silent Spring* seemed to challenge each other with their points. Carson suggested that organic farming, as we know it today, was the solution to chemical use in the agriculture sector. Norman Borlaug understood that fertilizers and pesticides were necessary to maintain yields that the agriculture sectors were producing. Some say that Carson won the debate, because 40 bills were introduced to regulate pesticides in the 1960s. Environmental legislation like the Endangered Species Act and the Wild and Scenic Rivers were also passed in the 1960s.

In the 1970s "government saves" was a big theme in the United States (Vig and Kraft 2019). This was the time of "easy legislation" in the United States. In 1969 the Cuyahoga River in Ohio started on fire because of all of the toxic chemicals in it. There was also a large oil spill off the coast of Santa Barbara, CA. These focus events, along with the book *Silent Spring* and

the “Green Revolution” triggered public support for government fixes to these environmental problems (Carson 1968; Borlaug 2002). However, in the 1980s, Republicans took over the White House and environmental legislation took a backseat. The country went from bipartisan environmental goals to partisan environmental goals (Vig and Kraft 2019).

There are two narratives told when referring to glyphosate. The first is told by those who feel the chemical poses unacceptable ecological and human health risks, and the second is told by those who defend Roundup’s key role in producing food (Vig and Kraft 2019). The International Agency for Research on Cancer (IARC), an opponent to glyphosate, declared in 2015 that glyphosate is a probable human carcinogen (IARC 2019). Conversely, the United States Environmental Protection Agency (EPA), the branch of government that is responsible for the laws on pesticides, toxic substances and hazardous wastes, has adamantly pronounced glyphosate to be safe (EPA 2019). These types of contradictions are common in science; opposite sides claim scientific uncertainty or evoke competing scientific results to support their opposition (Sarewithz 2004).

The idea that scientific facts build the appropriate foundation for knowing how to act in the world is challenged by social scientists (Sarewithz 2004). The process starts when a problem is recognized or socially constructed with a framework of values and interests of people. This is accompanied by political controversy and gridlock. It is important to note that scientific knowledge is not independent of political context but is co-produced by scientists and the society within which they are embedded (Jasonoff 1996). Different stakeholders in environmental problems possess different bodies of contextually validated knowledge. Opposing scientific data

is not a lack of scientific understanding, but is often because there is a lack of coherence among competing scientific understandings (Sarewithz 2004).

Issues such as how the data was collected, random errors such as false positives, and errors in choosing what to measure can skew results. People who rely exclusively on science can't explain why some science gets linked to policy and some does not. Those who can socially construct an issue and make it important will bring public awareness to the issue, not the scientific data (Downs 1972). In general, pesticide use in the U.S. and throughout the world is a wicked problem: it is complex, has multiple perspectives, and there is not one single solution to bring environmental justice to all (Van Bueren 2003). Science should be a tool while politics should be the guide (Sarewithz 2004).

Several countries, excluding the U.S., have banned the use of glyphosate for home lawns and in the agriculture sector (Baum Hedlund Law 2019; Robbins 2007). These countries primarily initiated the ban because of the IARC (2019) declaration that Roundup causes cancer. The IARC, a section of the WHO, reviewed thousands of independent scientific reviews relating to the chemical glyphosate to reach this conclusion. L.A. County in California, along with 50 other U.S. cities and counties, have also banned spraying glyphosate in parks, playgrounds and school yards (Formuzis 2019). However, the United States federal law continues to allow glyphosate to be sold and applied in our agriculture sectors unrestricted.

Most European countries use the precautionary principle (PP) as their general norm when making decisions about the introduction or regulation of consumer products. PP is a proactive health approach that bans or reduces chemicals even when there is uncertainty of the harmful effects (Kriebel et al. 2001). PP follows the code that erring on the side of caution is better than

taking risks with people's health and safety. Individuals who support PP usually identify as institutionalists, or someone who supports government institutions and their ability to address wicked problems (Clapp and Dauvergne 2005).

The United States, in contrast, uses the free market principle. This is the idea that a product or practice is assumed safe until an adverse outcome is identified. Market liberals, or those that follow this theory, believe that economic growth and high per capita incomes are essential for human welfare and the maintenance of sustainable development (Clapp and Dauvergne 2005). Market liberals believe that globalization is positive and once a nation hits a certain GDP the nation will then begin to choose to address environmental problems – an idea called the Environmental Kuznets Curve (Kwong 2005). Kwong notes that the Kuznets curve only works in capitalist markets and not communist or socialist markets. Capitalist markets allow for 1) open trade; 2) secure property rights; and 3) agreed upon rules of law. According to Kwong, free market systems or capitalist societies, naturally regulate themselves. Free market systems respect the rule of law. When people trust that their contracts of trade will be honored, they will have confidence in the system to continue with trading. In Free market systems property owners are motivated to keep their land in good condition for their lifetime, and even many generations after them (Kwong 2005). If a piece of land is managed by a manager that has no real connection to the land, their main motivation will be to exploit the land to make as much money as possible off of the land. Market liberals believe in liberalism, a worldview that believes individuals know what is best. Change in the economic landscape must be small and little or no government intervention is paramount (Clapp and Dauvergne 2005).

The benefit cost analysis, promoted by market liberals, is an economic tool that allows institutions to analyze the economic decisions that they need to make (Arrow et al. 1996). Institutions and governments should compare the desirable and undesirable impacts of proposed environmental policies. When environmental health and safety regulations are put into effect questions should be asked such as do the benefits of having a cleaner and safer workplace outweigh the costs of increased regulatory prices and the time required to implement the said regulations. When utilizing the benefit cost analysis institutional decision makers should not be prevented from considering the economic costs and benefits of different policies when developing regulations (Arrow et al. 1996).

The bottom line is that glyphosate causes health risks that are not communicated to the public. The health risks getting the most attention are those linked to non-Hodgkin's lymphoma (Hardell and Erikson 2000). Individuals that are using the pesticide may not know the potential harm exposure brings. The purpose of this research is to answer the following research questions: How do Idaho farmers perceive the potential health risks of glyphosate? What have farmers in Idaho heard about the attempts to ban glyphosate and the current lawsuits against Monsanto alleging harmful health effects, and what do they think about them?

Hypothesis 1: Farmers and applicators will not be well informed of glyphosate's risks.

Hypothesis 2: Farmers will be dismissive of risks, so as not to disrupt their operations or the agricultural economy.

METHODS

In this study, qualitative research methods were used to gain insight as to what Idaho farmers' perceptions of the health effects of glyphosate are. The choice to use qualitative methods was made because this type of research better allows for gaining in-depth insight into specific phenomena. Qualitative research demonstrates "how humans arrange themselves and their settings and how the inhabitants of these settings make sense of their surroundings through symbols, rituals, social structures, social roles and so forth" (Berg and Lune 2012:8).

This study relied on semi-structured interviews. There are several advantages of using interviews to elicit information in research such as, they allow interviewees to express their opinions, feelings, and emotions of certain topics. Antithetically, surveys do not allow for an open dialogue discussion.

Between August and November 2019, in-depth, semi-structured interviews were conducted with 12 farmers and 2 crop consultants who farm and work in Southern Idaho. The length of the interviews lasted from 30 minutes to an hour and a half. These interviews were conducted during the farmers' busiest time of year. The farmers were focused on crop watering, cutting and harvest time. The interview timing was not ideal, but inevitable, since this research project coincided with the university semesters. Summer and fall 2019 semesters happened to be the time during the research project that allowed for the interviews to happen. Consequently, four of the 14 interviews were conducted over the phone, since this was the only way those farmers consented to be interviewed, citing they were too busy to meet in person. The in person interviews were conducted with farmers on their farm. There didn't seem to be a difference in the interviews when done over the phone. The interviews conducted over the phone, on average,

lasted as long as the interviews conducted in person. All interviewees were recruited through snowball sampling. Friends and family that have lived in Idaho their whole lives were able to refer to farmer friends that consented to be interviewed.

Each of the farmers interviewed primary income depends on farming. Additionally, all 12 of the farmers said they use Roundup in some form to control unwanted weeds, while six of the farmers use Roundup on glyphosate-tolerant crops. Both of the crop consultants interviewed work full time consulting farmers on choosing the best seeds and chemicals for their farms. The crop consultants added expert knowledge in regards to farming in Idaho, mainly the type of crops that are grown, why, and the types of fertilizer and pesticides used. This research aimed to understand how farmers feel about Roundup, hence the crop consultants actual responses are not quoted in the results section, yet their knowledge on chemicals and farming techniques were valuable to this study. Each person interviewed identified as white and all farmers were the primary decision makers of their farms. The youngest was 38 years old while the oldest was 70 years old. There were 13 males and 1 female interviewed. The smallest farm was 300 acres and the largest farm was 7,000 acres. Wheat, sugarbeets, alfalfa and potatoes are the primary crops that these farmers grow, sugarbeets being the most popular GMO crop.

Questions focused on the challenges of farming in Idaho, if and how interviewees apply chemicals to their crops, if they use Roundup Ready seed, how they feel about the lawsuits filed against the company Bayer as well as if they knew anyone that has had health problems linked to glyphosate or other pesticides. Both deductive and inductive analysis were used. Deductive analysis tested the hypothesis of these specific questions and analysed their answers as to how farmers perceive the health risks of roundup. Following several readings and codings of each

interview, themes emerged such as challenges of farming, including costs and labor issues. Both the deductive and inductive results will be presented in the results section. Recordings and notes were transcribed and analyzed using the software program Atlas.ti.

RESULTS

Perceptions about the Health Effects of Roundup

After analyzing the interviews, a near-unanimous consensus to this study's overarching question of how farmers perceive the health effects of Roundup clearly emerged. All but one farmer perceived the health risks to be relatively low when using Roundup and all but one farmer interviewed said that Roundup is necessary for them to produce a viable crop and stay competitive in the market for various staple crops. These two sentiments substantiate the cost-benefit analysis. Farmers feel that the benefits of using Roundup, increased crop production and less tillage, outweigh the costs of using Roundup, specifically being exposed to a potentially harmful chemical. Most, including farmers and the public, deem that the cost of acquiring cancer is high, yet those interviewed seemed dismissive of those risks when they analyze the benefits.

Differing opinions by individuals who follow the precautionary principle would argue that restrictions of use should be put in place because of the uncertainty of the harmful effects of glyphosate. Luxembourg is the first country in the European Union to initiate a ban on all glyphosate products, halting its sale and distribution, even to farmers, in February (Lifegate 2020). Luxembourg government officials are issuing farmers financial subsidies when they use alternative products. However, American regulators feel that the benefits of using Roundup, especially those in the agriculture sector are too great to limit use. We report some of the

representative responses of our study's key questions, using pseudonyms in place of farmers' real names for each farmer quoted. In response to the initial question asking farmers whether they use Roundup on their farms, and if so, why and whether they perceived it to have health risks, Farmer Mark said, "It's a tough fight, because it basically, to me, comes down to do we want to feed this planet, or don't we? What are we willing to sacrifice, health-wise?" Farmer Don's response was consistent with Mark's, and also elaborated on the benefits he sees of using Roundup, including what he suspects would be the likely consequences of making the other choice:

Because if we would, had to go back to tillage practices, 40 years ago, even 20 years ago, this nation would starve overnight. That's the truth of it, because we couldn't keep up. And without, if you just let a field go without any herbicides today, you'll lose 20 to 40% of your production, just because you can't keep up. And so, if you were to take 20% to 40% of the food out of the United States today it would not be good.

Overall, each individual interviewed expressed beliefs that coincide with chemical company Bayer's stance that Roundup simplifies weed control by eliminating costly labor and reducing the need to apply other harsh and expensive chemicals to a crop (Monsanto 2019). In addition, Roundup allows farmers to implement no tillage or conservation tillage methods that result in more nutrient rich soil that protects water quality and reduces carbon dioxide (Monsanto 2019). The interviews were structured around three main questions, summarized broadly as: 1) farmers' overall perception of the chemical and its potential risks to human health, 2) how Roundup is applied, and 3) challenges of farming in Idaho. The answers to each of these open-ended questions are discussed in-depth below.

Perception about Roundup and its Manufacturer, Bayer

The interviewed farmers expressed opinions that contradict most non-farming Americans in regards to Bayer (Benbrook 2016; CBS 2019; Damalas and Koutroubus 2016; NBC 2019; Samsel and Seneff 2013). In particular, the farmers we spoke to perceive Bayer, one of the top-grossing agricultural and pharmaceutical companies in the world, as helpful and even sympathetic. The farmers feel that Bayer is doing their best to produce tools that will aid farmers' efforts to grow a viable crop which coincides with the Green Revolution perspective.. Farmer Chris represents this sentiment with his response to our question about his overall perception of Bayer:

The reason Roundup and Monsanto have been on this, well, the reason all the chemical companies are trying to find chemicals that will increase food production, and yet remain safe: Their intent is not to kill people, I can guarantee you that. If we were to go back tomorrow to all-organic, worldwide, with, I believe, 7.3 billion people on this earth, I would say that within a couple of years a couple of billion people would starve to death; that'd be the starter.

When farmers were asked specifically what they thought about the recent multi-million dollar jury awards against Bayer, claiming Roundup causes cancer, the farmers expressed a feeling of resentment towards the legal and judicial system and sympathy towards Bayer. Farmers seem to contradict themselves when they agree with and support the government EPA decision that Roundup does not cause cancer. It's as if the farmers support government interference and regulation as long as it enables the Free Market Principle ideology. Farmer

Chris expressed how he feels when he sees commercials featuring attorneys advertising their services to help in Roundup lawsuits:

My initial response every time I see that advertisement it is: somebody's trying to get a bunch of money for something stupid. And in the end, it's going to cost me a whole bunch of money because I'm going to have to pay for it all.

Farmer Mac expressed a similar view, along with his fear of losing access to Bayer's products due to the lawsuits:

I don't want to lose the technology. I don't want the government to come in and tell me I can't use it. So I go out of my way and try to do what we're supposed to do. And I don't want Monsanto or Bayer or whoever to get in trouble for it either.

Farmer Jack explained his opinion as to why the juries in prior cases favored the plaintiffs and was not unique:

Well, the problem, this is my opinion now, that in a court of law you don't have to prove cause and effect, you just have to be able to show a linkage between what disease you have, and that you used a product. And if you get a sympathetic jury or a judge, they make that link happen, not the science. That case was tried in California, the most liberal courts in the country. Had that case been tried in Idaho or Wyoming or Montana, Eastern Washington, I don't think you'd see that [jury award].

Farmer Clayton agreed, and explicitly placed the blame for the large settlements on lawyers rather than the actual product that the jurists concluded had caused the plaintiffs' cancer:

To me, the court case on Roundup and the issue about the cancer caused from Roundup is more about what's wrong with our legal system than it is about what's wrong with the agricultural chemical product. And I truly believe that. We all have a distaste for the ambulance-chasing attorney or whatever you want to call it.

The farmers seem to feel that Bayer better understands the plight that they are in, while the general public does not. They feel that Bayer is just trying to be helpful by making an enormously useful product and continuing to keep Roundup available. They also seem to feel personally attacked by the public's criticisms of Bayer, and interpret efforts to regulate Bayer's products as unnecessary meddling in the agricultural industry as a whole. Farmer John explained it this way, "I just, I hope one day people realize how important the farmer is and respect him a little bit. I guess not so much in southeast Idaho, but in other places."

Application of Roundup

Of the 12 farmers interviewed, only one farmer pays a chemical company to apply Roundup to his crops. The other 11 farmers apply the chemical themselves using a tractor with a spray rig attached to it or with a hand sprayer when they are spraying areas other than a field. Roundup is labeled as a general use pesticide, meaning it is available to the general public and does not require specific licensing to purchase, handle, or apply (EPA 2019). Conversely, restricted use pesticides (RUP) are not available for purchase or use by the general public and require a specific license (EPA 2019). Chemicals that are listed under RUP usually pose a greater risk for groundwater contamination. Of the 11 farmers who apply Roundup themselves, all have a private applicator license that allows them to legally apply restricted use pesticides that are deemed more harmful as well. Those handling RUPs are required to maintain six continuing

education credits every two years to maintain their licenses and remain up-to-date on the risks of pesticide exposure (ISDA 2018). In addition, most of the farmers interviewed use a crop consultant that counsels them on how much of their chemicals they need to buy and apply.

Farmer Paul said:

We don't want to buy any more of this stuff than we have to. Not one ounce, because it is expensive. People think we maybe just want to put the maximum on there and kill everything. No, that's not the truth, the truth is, is we want to put as little of that [pesticides] on as possible.

All of the farmers interviewed seemed to understand the risks of handling and applying chemicals. For example, farmer Clint explained:

We are very careful, obviously, to spray it when the conditions are perfect. We don't spray it in the wind, because we don't want to kill our neighbors' crops. Everybody polices everybody out here.

Despite their training and experience with chemicals, several farmers acknowledged that pesticides may be linked to health problems especially if they are not applied properly. They all adamantly declared that it was the person applying the chemical's responsibility to follow the label and fault if they did not. Farmer Tate described it this way:

Yes, I mean you can get sick from applying chemicals. First of all, there are safety recommendations and there are people who don't follow safety recommendations. I know people who have handled unrestricted pesticides, when it was either leaking or wet.

They didn't lose their life, but I know they have gotten sick from it and ended up taking a day or two off.

Farmer John recalled this experience when handling Roundup specifically:

One year we couldn't get things sprayed. And we finally had a calm period and we sprayed [Roundup] around the clock. So, I was out there at night, a couple of nights, helping the guys load [Roundup chemical], and within a couple of days, I had two blood clots going to my lungs – went through my heart and into my lungs. The doctors could find absolutely no reason why I would have had those blood clots. Was it the Roundup that I had been working with? That was my suspicion. Would I go out and work with Roundup again? Well, I don't think I would, because maybe my body reacted to it.

It is interesting that farmer John is locating blame for getting sick on his body and not on the chemical itself. It seems that if a farmer were to acknowledge that Roundup is dangerous this would interfere with the Free Market Principle. Individuals that are licensed to handle RUP chemicals are trained to read the safety data sheet that every manufacturer is required to supply with chemicals (ISDA 2018). Additionally, users are instructed on the safe storage, safe transportation and safe use of the chemicals. Farmers interviewed believe that the users of chemicals are responsible for the type and amount of exposure they receive from pesticides, including Roundup.

Challenges of Farming in Idaho

In this research, through inductive analysis, two themes emerged when our respondents were asked about their primary challenges as Idaho farmers that influence their perceptions of

glyphosate overall. These themes are the cost of farming and labor issues. Farmers understand that, in order to make a profit, their input costs must be smaller than their overall income from the farm. They have found that Roundup is one of the tools that aids in mitigating costs. As John explains:

I whined a little bit about my cost and stuff, but we have to have a leg up. Our expenses are rising and if I don't get higher production, I can't, I won't make it. It's not sustainable.

The EPA states that when glyphosate is used, farmer inputs are decreased by reducing the number of other chemicals needed and reducing the number of trips a farmer makes navigating their field (EPA 2020), lowering both their fuel expenditure and labor costs. The EPA also maintains that because of glyphosate's ability to reduce the amount of tilling required on applied soil, less water is needed and soil erosion is reduced (EPA 2020). Farmer Allen said:

We used to apply three or four applications of another herbicide [before using Roundup]. We used to cultivate three or four times to control weeds. I would waste water and fertilizer, watering weeds in the field and fertilizing the weeds in the field. So having a product that we applied twice during the growing season and eliminating all of that competition for the crop has been a benefit. Our yields have increased, I want to say 25% since we have been using Roundup Ready seed.

Sugarbeet farmers were especially favorable towards the benefits of using Roundup on glyphosate-tolerant sugarbeet crops. Idaho ranks second nationally in sugarbeet production and sugarbeets are Idaho's fourth most valuable crop, contributing \$300 million in cash receipts in

2018 (ISDA 2018). Ninety-five percent of sugarbeets produced nationally are grown with glyphosate-tolerant sugarbeet seeds (Monsanto 2019). Since introducing Roundup Ready sugarbeet seeds, yields have increased 30% (ISDA 2018). Farmer Nate described the effort and money that used to be required to harvest a sugarbeet crop before GMO options were introduced:

We used to have to spray the beets 5 or 6 times a year [with a pesticide other than glyphosate]; it would just about kill the sugarbeets, the amount of chemicals we were putting on them. It was really hard on them, and even then, it wouldn't kill the weeds, [and] it would kind of make them [the sugarbeets] sick too. Then, clear until the early 2000s, we'd have people come through, we would give them \$100 bucks an acre to go in and manually hoe the weeds out and still we would have to cultivate it 3 times.

Nate continued:

I personally think that if someone came out and saw what we used to do to the sugarbeet, the amount of chemical we used to use on the sugarbeets, then they came out and saw what we use Roundup on, I think they would say that our current practice is more healthy than what we used to do.

Sugarbeet farmers used to hire weeding crews that were usually families that would charge around \$100 an acre to weed sugarbeet fields. Each of the farmers who grow sugarbeets explained that these crews don't exist anymore. Difficulties associated with finding sufficient workers to fill farm labor positions are not unique to Idaho; all farms across the nation are struggling to attract and keep enough farm workers around to meet their labor demands. The California Farm Bureau Federation (2019) explained that one strategy farmers in California are

using to minimize this problem is moving to technology and mechanization to fill labor positions. A survey conducted on farmers found that 40% of farmers in the past five years have been unable to obtain the workers needed for producing and harvesting their crops (CBCF 2019). This shortage of individuals available to fill farm labor positions can be linked to the shift in more Americans going to college and taking professional jobs as well as on restrictions placed on immigration into the United States (US BLS 2020; CBCF 2019). Farmer Paul expressed his frustration with the lack of available employees this way:

Without it (Roundup), I could not farm today. The labor force that is willing to come in and hoe weeds has gone away. I can't find them; they don't exist. I guess if the nation got hungry, which it would in a big hurry [if we stopped using Roundup], people would come back and be willing to hoe sugarbeets again. You won't find them today though, that's just not in our mindset anymore to do that.

Farmer Claine expressed similar concerns:

Second generation, their kids don't want anything to do with it [farm labor]. Well, they are trying to control the border a lot better, which is a good thing. But yeah, even 15 years ago you'd have people stop by all the time looking for work and willing to move handlines and pull weeds, those kinds of things. The manual labor, the kind you can't find anyone else to do. That is all dried up. Nobody comes by anymore. It is just getting harder to find people willing to do the work. There's a lot of jobs for those guys that are more profitable elsewhere.

Each of the individuals interviewed, believe that Roundup is a necessary tool for farming in Idaho. Farmer Don shared his experience of being on the Idaho sugarbeet board. He explained that there was a consensus among the board that Idaho farmers needed the chemical to survive farming, he said, and I suspect this applies to other crops as well:

We had this discussion when I was on the board of the beet company, if we lost Roundup, we felt that the sugarbeet industry would just die right there in its tracks. There was nothing we could have done. And nobody wanted to go back.

DISCUSSION AND CONCLUSION

Farmers feel a responsibility to feed the world and sacrifices must be made as they try to do this, including using Roundup. This study lends itself to the conclusion that farmers seem to acknowledge that Roundup poses a health threat. However, they feel the benefits of Roundup outweigh the risks. First, farmers believe that the health consequences of using Roundup are low when compared to the benefits that using Roundup generates. They maintain that if it is applied properly, the risks of getting sick are lowered. Most farmers demonstrated a recognition that Roundup poses health risks to the applicator, particularly if the necessary precautions are not taken, yet none of the farmers expressed resentment toward Bayer. A couple of the farmers admit that they have gotten sick applying chemicals on their farm, including Roundup. Yet, they place the blame of contracting the illness on themselves, by being careless or physically vulnerable. Moreover, farmers in this study deem Roundup necessary to produce a viable crop in southeastern Idaho. Their attitude toward the company Bayer seems to be sympathetic in regard to the lawsuits filed against the company.

Second, farmers are educated on the necessary precautions when handling pesticides (ISDA 2018). As explained earlier, handling Roundup does not require any special training or licensing, yet every farmer in this study has been trained and licensed to handle other dangerous restricted-use chemicals.

Third, through inductive analysis, themes such as the cost of farming and labor issues emerged. In order for a farmer to continue farming they must make more money than they put into operating their farming operations (Borlaug 2002; Pannell, Llewellyn, and Corbeels 2014). Each of the farmers we spoke with told us that keeping costs down on their farm is stressful, and finding available labor exacerbates the problem (CBCF 2019). Roundup is a necessary tool that mitigates these problems (EPA 2019). Moreover, it is proven that by using Roundup Ready crops, yields can increase by as much as 30% (ISDA 2018). Additionally, Roundup eliminates the need for manual weeding, making growing and harvesting crops more efficient and the need for increasingly scarce labor to a minimum (EPA 2019).

Idaho is considered a “red state,” meaning the majority of the population votes for the Republican Party. Idaho follows the social trends of most states where voters in the rural areas identify as conservatives and urban city dwellers identify as liberals (Carolan 2019). Interestingly, in the 2016 presidential election, Hillary Clinton gained 75 percent of Boise’s votes while only 27.5 percent of the statewide vote in Idaho. A study conducted by Michael Carolan (2019) offers insights as to why farmers cling to conservative ideologies. Carolan’s research can help explain why farmers hold positive feelings towards Roundup and Bayer and resentment towards any type of restrictions regarding its use.

Farmers are generally pro-Republican, not only because they value small government, but because of a sense of injustice (Carolan 2019). Carolan explains that government spending on investment projects usually takes place in cities. Tax dollars used to make bike paths, roadways, and public transportation all take place in cities. These types of government investments are aimed at stimulating growth and building human capital. This can help explain why rural residents are generally suspicious of government spending and taxation; they don't get to reap the benefits of these projects. Farmers feel liberal views create unnecessary rules and regulations that cripple the economy and take away good jobs. Conservatives tend to support the ideology of market liberalism (Arrow et al. 1996). Government intervention is not encouraged and individuals should be allowed to govern themselves, even when the goal of intervention is to protect their own health. Idaho farmers and their attitudes toward Roundup are a perfect example of this.

This study is important because farmers are a key stakeholder group in the debate over Roundup. Farmers represent the middle ground between the biotechnology industry and the public. It is necessary for policymakers, lawyers and regulators to understand the opinions of farmers regarding the product. Overall, I found that farmers feel the health risks of glyphosate do not outweigh its significant benefits to their farming operations. Generally, they perceive the lawsuits against Bayer as just another way for the government and liberal judges, who do not understand the challenges of farming, to meddle in their private business activities and limit their freedom.

Limitations to this study exist. For one, it only applies to the farmers in our sample, all of which would be classified as conventional farmers; organic farmers generally have a different

opinion on artificial fertilizers and pesticides than non-organic farmers (Norton et al. 2008).

Only one of the 12 farmers interviewed identified as a minimal pesticide farmer, while the other 11 claimed to be non-organic. Future research should seek to include farmers who identify as organic farmers to glean their perspectives as well. Further, while there are a substantial number of active lawsuits against Bayer, there are currently no statistics available as to the number of farmers claiming that because of their use of Roundup, they have gotten sick (Benbrook 2016; Keese 2008; Motta, Raymann, and Moran 2018; Nicolia et al. 2013), which would better account for the scope of the problem and help contextualize farmers' risk.

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