

## AN ABSTRACT OF THE THESIS OF

Jody R. Hepperly for the degree of Master of Science in Water Resources Policy and Management presented on March 21, 2017.

Title: Standing in the Way of Control: Small Farmers, Water Use, and Technology Adoption in Oregon

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Bryan D. Tilt

In recent years, several interrelated forces—prolonged drought, growing populations, heightened environmental protections, sustained agricultural use, and hydrologic alterations due to climate change—have increased pressure on water users in the Western United States, where the agricultural sector accounts for up to 90% of total water withdrawals. Technology improvements developed since the 1950s have increased irrigation efficiency on many farms, and more recently networked technologies have promised to transform agriculture again, through advanced analytics, in-field sensors, and other telecommunications technology. While economies of scale and access to capital have spurred growth on larger farms, implementation on smaller farms has lagged. This thesis is based on research initially proposed by Intel Labs and uses ethnographic interviews with farmers and policymakers in Oregon to understand the both the barriers to technology implementation and the underlying factors associated with on-farm water use and technology adoption in Oregon. An analysis of interview data reveals several significant barriers to technology implementation, many of which are related to the perceptions small farmers hold about themselves, their community, technology, regulation, water use, and the future. This thesis also examines the interconnections between Integrated Water Resources Management (IWRM) and networked technology implementation, and examines the utility of that policy framework to explain the challenges faced by small farmers as stakeholders in relation to water management decisions in Oregon.

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Standing in the Way of Control: Small Farmers, Water Use, and Technology  
Adoption in Oregon

by  
Jody R. Hepperly

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APPROVED:

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Major Professor, representing Water Resources Policy and Management

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Director of the Water Resources Graduate Program

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Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Jody R. Hepperly, Author

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## Prelude—A Field in Eastern Oregon

The grizzled old rancher told me to meet him at 6:30 a.m. and I said I'd be there, like it wasn't a big deal. In fact, this would mean waking up several hours earlier than I had for most of the summer, if I wanted to make it from my John Day motel room to his field on time. *"It's not very exciting,"* he warned me. *"I'm basically just going to move a big tarp I got up there and flood my field. Don't know why you want see that. But you can come if you like"*.

I don't know if I was expecting an award for making it there, but if he was impressed, he didn't show it. Apparently, he had been awake since 4:30 to take care of his cows, as had been his routine for most of his life.

In the three hours I spent with him that day (and two the next day), interviewing him as part of an internship with Intel Labs about farming, technology, and water use, I learned that he worked an average of 15 hours each day, seven days a week. His most recent days off, 14 months prior, had been spent not on a beach but bringing two hundred head of cattle to sell at an auction in Reno. As he was telling me this, I thought to myself that I couldn't remember what I had eaten for breakfast that morning. He pointed to a house in the distance, where he was born, 65 years prior, and another where his wife of 47 years was born.

And I learned that, he was in possession of a winning lottery ticket, but some months had trouble paying his bills on time. *"Well, it's not a real lottery ticket. What I mean is that this land is worth millions of dollars. If I sell. But I'm not going to sell"*. As he put it, he was, like most of his neighbors, *"land rich, cash poor"*.

On my way back to town, I had some time to consider how strange it was that an intern working for the largest computer chip company in the world would be out in the middle of nowhere, talking to a rancher about his perceptions of networked technology, a guy whose irrigation scheme would seem familiar to an ancient Sumerian. He told me that flood irrigation, as it is known, is better for the ecosystem than leaving the water in the stream, and that the scientists who said otherwise were misinformed. *"it's because of the specific geology of the area"*, he explained. I told him that I didn't know, because *"I'm not a scientist"*. He nodded, approvingly.

Just a few days prior, I was in Hillsboro, Oregon, in a windowless room deep inside a steel and glass building (coincidentally named *Jones Farm 2*, after the farm that apparently once occupied the

land). My co-intern, Janette Byrd, and I were receiving an introduction to Intel Labs from Dr. Kathi Kitterner, a researcher and anthropologist who would go on to lead and guide us throughout the project. That day, and in the subsequent weeks and months, I received training and experience doing interdisciplinary anthropological research for a large corporation, and spent two months in the field conducting ethnographic interviews with small farmers and ranchers in Oregon.

Interactions between cutting edge technologies and traditional lifeways are becoming more common. Networked technologies are transforming many aspects of society, including farming. How farmers and ranchers react to these changes and interact—or resist—new technologies, will shape farming and water use in the 21<sup>st</sup> century.

## 1. INTRODUCTION

### 1.1 The Problem

In recent years, several interconnected factors have put increased pressure on water resources. Drought, population growth, hardening demand, and increased attention to environment issues, among other factors, have led to questions about the sustainability of freshwater supplies across the Western United States (Dalton et al. 2013) and internationally (Zolin and Rodrigues 2015) (Turrall et al. 2011). Climate change is exacerbating these pressures on both human populations and ecosystems (Schaible and Aillery 2012) (Vörösmarty et al. 2010), and climatological variability is likely to increase in the future (Pachauri et al. 2014). Rising temperatures in the Western US (henceforth referred to as the West) mean areas now receiving snow likely will see that precipitation occurring as rain (Fischer et al. 2005). Human and ecological systems are both reliant on predictable hydrologic patterns, and the collective uncertainty caused by these changes may pose serious problems for water users at every scale (Poff 2015) (Carey and Zilberman 2002). The effects of climate change, coupled with pressure from water-stressed municipalities and environmental advocates, have put increased pressures on the agricultural sector, which accounts for up to 90% of consumptive water use in some states in the West (USDA 2016).

In Oregon, agricultural users account for 85% of consumptive use (OWRD 2012). Mirroring several other Western states, total precipitation varies considerably between the arid east and the wetter west, with the Willamette Valley receiving several times more precipitation than areas east of the Cascade Range (Dalton et al. 2013). Though facing uncertainties in terms of future water availability, many

irrigators continue to use—some may say *waste*—water in the same ways as their grandparents—opening a crude metal gate that connects an earthen ditch to their field, and soaking their crops in a flood of water. This lack of change in agricultural water use is striking, especially considering the monumental changes that have occurred in other aspects of technology and society over the past century (Schuck et al. 2005).

There are several reasons for this lack of response. Western water law, specifically the *prior appropriation doctrine*, is conservative in nature, and permits users meeting minimum requirements to continue traditional irrigation techniques, while providing little pressure or incentive to change (Adler 2010). This legal framework, established in the mid-19<sup>th</sup> century, spurred rapid settlement by European Americans requiring large quantities of water in a relatively short time period, but led to land speculation and an entrenched and inefficient water infrastructure (Reisner 1993). And though society has undergone momentous changes since then, water law and irrigation in many parts of the West continue to function in much the same way they did a century ago.

Though many farmers and ranchers continue to practice traditional methods, others have adopted on-farm technology to assist with irrigation and for other on-farm duties (Merrett 2002). Improved irrigation technologies have the potential to greatly increase agricultural efficiency, thus requiring less water to be applied and leaving more water for other uses (Ajami et al. 2014). Improvements in irrigation technology have promised to bring farming into the 21<sup>st</sup> century through integration of once disparate technologies and communications. And networked and sensor-based technologies promise many other benefits, like the ability to monitor water usage in real time and to make more informed decisions based on factors like weather and crop evapotranspiration. However, there are also many barriers standing in the way of new technology implementation (Schuck et al. 2005).

The interviews that this research is based on use ethnographic methods (Gray 2003), which seeks to inform based on face-to-face communication with knowledgeable actors, while providing culturally-relevant context. This thesis, and the research for Intel Corp. on which it was based, uses interviews conducted with farmers, ranchers, and water policy professionals, collected using ethnographic principles and anthropological best practices (Bernard 2011) to provide a complete and informed picture of the issues and barriers facing the agricultural community in terms of water use and technology adoption.

Additionally, the second half of this paper will examine issues of involvement by small farmers through the lens of Integrated Water Resource Management, or IWRM. A broad and encompassing framework relevant to many aspects of water policy, IWRM encourages coordinated, equitable, and balanced cross-sectoral water use (Schoeman et al. 2014), and has been used by the state of Oregon to develop a coordinated water management plan (OWRD 2012).

## 1.2 Research Questions

This paper seeks to answer the following Research Questions:

1. How do farmers perceive their identities and roles in the community?
2. What are their perspectives on regulation and water rights?
3. How do farmers perceive technology in their operations, and what are the barriers to increased technology use?
4. What are their visions of the future – in general, and specifically related to technology adoption in the water sector?
5. To what extent can the lessons of IWRM be applied in this case to help explain the challenges faced by Oregon water users?

## 1.3 Section Overview

The paper is laid out as follows: Section 1, the Background and Literature Review, serves as an introduction to the issues covered in this paper, beginning with agriculture, continuing to describe water use, technology, and legislative questions, and ending with a primer on IWRM. Section 3, Methods, explains how this project evolved from a phone call from Dr. Kitner at Intel Labs in Portland to a fully-formed research paper—with several detours in rural Oregon along the way. The subsequent section, Results and Discussion, presents the main findings of the project, were gleaned from the large amount of interview data gathered during the first phase of the project, and discusses how farmers' identities and their relationships shape and influence their connections to technology, water use, and their perceptions of the future. Section 5 expands the conversation about IWRM started in Section 2, digging deeper into the concepts of the stakeholder and stakeholder involvement. The section also includes a

discussion of the goals of IWRM in a context like Oregon, and provides analysis and critique of the concept of stakeholder involvement. The section ends with a comparison of the concepts of IWRM and technology adoption by small farmers, imagines how the overarching trends in water use, technology, and technology will shape an integrated future, and provides a series of recommendations for both tech companies and IWRM implementers to strengthen their connections and interactions with small farmers in places like Oregon. I hope the conclusions will be useful, for policymakers and regulators seeking new ways to interact with water users, for technologists interested in learning more about a potential customer base, and for a casual reader with a desire to expand her understanding of agricultural water use and technology change in Oregon.

## 2. BACKGROUND AND LITERATURE REVIEW

### 2.1 Farming

Before proceeding, it is worth discussing terminology. When asked to think of a *farm*, or a *farmer*, most people will likely picture of an idyllic scene with pastures, a barn, animals, farm implements, and a man on a tractor or beside a cow. Those with more imaginations may give him overalls and a pitchfork à la *American Gothic*, and add some banjo music in the background. This image surely has some basis but it is insufficient in describing the multitude of types of farms and farmers in the West. Rolling fields may be beautiful, but many farmers only farm on a few acres. Pitchforks are fun and dangerous, but some farmers do not have hay to fork, or horses to feed it to. They also might not be a man; 30% of farmers in the US—nearly one million—are female (USDA 2014).

When the term *farmer* is defined, the act of definition and categorization itself can obscure. While the focus of this study was on the “small farmer”, the team at Intel (see *Methods* for an explanation) quickly realized that there is no simple definition of what a farmer is and is not. The USDA, with a focus on farming and an annual budget in the billions, cannot settle on a suitable definition for many of the terms commonly used to discuss the agricultural community (USDA ERS 2016). The USDA defines a farm broadly and in a strictly economic way. A *farm*, by their definition, is “any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year, and *small farm* while a small farm is a farm with an annual cash income of less than \$350,000. In the US, Eighty-nine percent of farms are considered small by this definition, accounting for 45 percent of total farmland (ibid.). Family farms are those where the owner is also living on-site and participating in farm labor. Other categories are *retirement farms* (also known as Lifestyle), off-farm occupation farms, and low—sales farms.

Further complicating matters is that many individuals are considered a *small farmer* by the above requirements do so to achieve a tax benefit, and likely have no desire to produce crops for sale (IRS 2013). Benefits include tax deductions and access to farmer-focused loans. Further, larger farmers, who may earn more than \$350,000, also occasionally mask their income with deductions and purchases to retain the label of *small farmer* (USDA ERS 2016). Several of the individuals interviewed consider themselves *ranchers* due to their focus on cattle and animal husbandry. Though ranchers may have different viewpoints and opinions compared to more traditional farmers, they are considered farmers under the USDA guidelines.

While I desire to be as clear and straightforward about the categorization of the farms we visited and the individuals we spoke to, clearly there is a definitional problem at work. Gathering the familial, financial, and technical information required to make these determinations, during our relatively short visits, was not possible. The farms in this study range from a single acre up to several hundred acres, and income—at least as far as we could tell, ranged from zero to over \$1 million for the largest operation we visited. There was a significant amount of carryover between farmers and policymakers. Farmers worked at Soil and Water Conservation Districts, watershed council employees farmed, and a rancher ran a water-related non-profit. For expediency's sake, and for the reasons outlined above, I will usually use the term “small farmer” in a broad sense to describe both the farmers and ranchers profiled below, specifically noting and clarifying exceptions to this terminology as they arise.

## 2.2 Water

Water is surely a strange substance. It can be the very most important thing, or just an afterthought, depending on when and where it is encountered. Water is as multifaceted as a substance can be. Each day, water meets the needs of individuals and societies, and is used in countless ways, from industrial manufacturing to religious uses (Peppard 2014). Its value has been compared favorably, at times, to diamonds (White 2002), yet every day most of us waste countless gallons of it without a second thought. When treated as a resource, its value is dictated by several factors, including government policies, individual actions, scarcity, drought conditions, uncertainty about the future, and economic valuations (Zetland 2011). (Values, of course, are not only economic in nature. After all, how can one measure the economic value of saving a species from extinction?) But focusing too intently on water as an economically valuable product, or as a tool for solving a particular problem, risks losing sight of an important truth about water—it defies categorization, and resists being constrained (Peppard 2014). However, the task of the thesis author is to attempt to both categorize and constrain. Acknowledging this difficulty, the focus of my discussion is on water as it is used in Western states, and particularly in the agricultural sector.

The federal government does play a substantial—if limited—role in water management in the US, operating dams or diversion projects in nearly every large river basin in the country (Cody et al. 2015). For decades, scholars and policymakers have called for greater integration, but for a multitude of reasons efforts at greater integration and coordination, and the development of a national water policy, have so far been unsuccessful (Grigg 2014). And on a nationwide level, it is not difficult to imagine why a one-size-fits-all approach to water management would face challenges. The US is an immense country,



with wide ranges in precipitation and freshwater availability. Water issues in Maine and Alaska will be quite different than those faced in Los Angeles or Texas, and thus developing unified policies to deal with these cases will be difficult. While federal laws, including the National Environmental Protection Act, the Clean Water Act, and the Endangered Species Act have a national reach, coordinated management on a national or even regional level currently does not exist (Lautze 2014).

If climate change projections are accurate, the future will look drastically different from the present. According to the Intergovernmental Panel on Climate Change, a rise in global mean temperature of at least 3.0°C is likely in the coming decades (Pachauri et al. 2015). In the Pacific Northwest, the most profound effect of this rise in temperature may be on snowpack, which is projected to lessen considerably during the summer months, if not disappear completely. This snowpack is vital to maintaining ecosystems and is relied upon by irrigators, particularly east of the Cascades (OWRD 2012). While there is uncertainty in the long-term projections regarding whether overall precipitation levels will increase or decrease, there is high certainty that the *type* of precipitation will change, with areas currently receiving snow likely receiving rain instead. Further, rising temperatures increase evaporation and evapotranspiration, causing greater crop stress and thus increasing the water requirement to sustain current levels of production (Fischer et al. 2007).

While not all farmers in the West irrigate, dryland farming's potential is severely limited by a lack of sufficient rainfall to grow an economically productive crop (Merrett 2002). There are large inefficiencies in the agricultural sector of western states (Evans 2008). Efforts have been made to increase efficiency, but many farmers continue to operate using the same methods used by farmers one hundred years ago—piping water down clay- or dirt-lined canals to their fields, where crops are watered through flood irrigation. Flood irrigation has an efficiency rate of around 30%, meaning approximately 70% of the water taken from the stream is not used by crops, and eventually evaporates or returns to the stream or water table (Lautze 2014).

In Oregon, agricultural use accounts for approximately 85% of the consumptive uses of ground and surface water (OWRD 2012). This is similar to other western states, where agricultural uses account for over 90% of consumptive use (USDA ERS 2012). Consumptively used water is generally defined as water that is used in a method that makes it not available for re-use by others in the same river basin (Shaffer and Runkle 2007). In relation to agriculture, is *evapotranspiration*—the water a plant uses to grow—plus *evaporation* that occurs during water application (OWRC 2007). An example of a non-agricultural consumptive use is steam produced by power plants to make electricity. Non-consumptive uses

are also important to consider. We use water that is not “consumed” daily, when we wash our hands or flush the toilet. Because this water is (hopefully) cleaned at a treatment plant and then returned to a river, it is not considered to have been consumed. A non-consumptive use common in the Pacific Northwest is hydropower generation. The water performs a task (generating electricity) but remains in-stream. Because agricultural water use represents such a large portion of western states’ water budgets, reducing total use has become an increasingly important priority for policymakers (Layzer 2016).

### 2.2.1 Western Water Law

In Oregon and other Western states, water is publicly owned and its use is approved via a permitting system (Goldfarb 1988). Historically, permits have been provided based on the ability to demonstrate that the water will be put towards a beneficial use (which until the 1980s meant an *economically* beneficial use, but has since expanded to include uses that sustain ecosystems). Once a use of water is permitted, it may be continued, with a few notable exceptions, in perpetuity. The date on the permit is known as a *priority* date. The name of the entire policy allocation system is known as the *doctrine of prior appropriations*. The priority date is very important, because it is the order in which a user receives water. The type of use matters very little in most states, and for the most part, societal and community values and perceptions about what constitutes wasted water versus a good use are not considered (Lautze 2014).

I have found it helpful to think of the prior appropriations system like a single-file line, waiting to drink at a communal trough, which represents the total amount of useable water available in an area. Everyone in front of you in this line is *senior* to you, and can drink first, as much as they are approved for. Those behind you are *junior* to you, and must wait their turn. When the trough is full (wet years), and there is enough water for everyone in line, the line breaks down and everybody drinks at once. But when the trough is less full (dry years), an authority figure (a state regulatory agency) decides how many people in line will be able to drink, and for how long, and makes a determination. Some years, and in basins where there is less water available, a user may receive little or no water based on the date of their permit, even though their neighbor may receive a full allocation of water. This system has remained virtually unchanged since its inception in the late 18<sup>th</sup> century, and has surely been the source of countless headaches.

A pervasive problem throughout the Western US is the over-allocation of water (Lautze 2014). The problem stems from an era where there was less understanding of the hydrological complexities of rivers, and a greater desire to use whatever resources were available to the greatest extent possible to

produce an economic profit. Over-allocation occurs when more water is promised to users through permits than is available. When this happens, usually in the warm summer irrigation season, streams across the West literally dry up, creating obvious problems for any person or animal that is reliant upon the stream's water. Junior users will not receive a permitted allotment of water, and ecosystems will suffer.

Starting in the 1970s, changing social values and a recognition of the importance of environmental flows for ecosystem health and aquatic life led to the passage of regulation requiring minimum in-stream flows to avoid situations like the one described above (Schaible and Aillery 2012). By the end of the 1980s, most Western states (including Oregon) had passed legislation determining in-stream water to be a beneficial use (Turner and Perry 1997), allowing for unallocated water to be reserved for environmental flows, and giving in-stream uses a priority date—and a spot in the line at the prior appropriation water trough. According to Oregon's Water Resources Department, "nineteen million acre feet of the surface water that is not diverted in Oregon is formally protected by more than 1,400 instream water rights. Instream protections are also contained within federal biological opinions and other prescribed minimum flow requirements" (OWRD 2012). Even so, in many locations in the West, precise measurements are still lacking. Data on water levels and actual water use are rough estimates made by underfunded and understaffed water masters and water agencies (Quinby 1999).

Regulations protecting a user (junior or senior) from "harm" associated with water transfers, changes in water right by another user, or new applications, have severely curtailed the types of allocations that were feasible in most parts of the West (Adler 2010). Taken together, these environmental protections have protected endangered fish species and helped restore damaged habitats, but also put even more pressure on water users, and forced difficult decisions for water resource professionals tasked with ensuring these in-flow requirements are met (Schaible and Aillery 2012).

Reading the rules governing Western water law, one may notice a serious—perhaps fatal—flaw located at the core of the prior appropriations doctrine, and one that could be exacerbated considerably by climate change. The prior appropriation rules work well when there is enough water, as it has traditionally been relatively simple to access water for a particular use (though now this is becoming more difficult, for the reasons outlined above).

The issue arises, of course, when there is *not* enough water. At that point, a senior user can satisfy their *entire* water right before any junior can claim a single drop. This is written into the law, and

makes no exception for how socially important a certain use may be (Goldfarb 1988). In fact, a municipality of many thousands of people might have literally no water, while a rancher a mile away receives enough to satisfy the entire town, but uses the water to grow grass. As Adler explains, dams and water transfer systems across the West have forestalled these unequivocally bad results, by providing sufficient storage to meet users' needs, but that perhaps this is changing:

*the harsh implications of prior appropriation have yet to be tested in a significant way...if senior appropriators stand on their absolute rights, the whole system could move from one of predominant winners to one of predominant losers. The most senior appropriators will continue to receive full allocations, but many users could be cut off entirely, resulting in potentially serious economic and social consequences.*

*(Adler 2010)*

The immensely difficult task of making sure junior users do not take water belonging to senior users and monitoring the hundreds of thousands of stream diversions and privately owned wells in the state of Oregon, is the task of just a handful of people. Known as water masters, their primary job is to monitor water use in the area they represent and ensure water allocations and diversions are legal. There are twenty-one water masters serving Oregon's thirty-six counties, divided approximately by watershed (OSL 20). In agriculturally-active areas, a water master may be responsible for thousands of water diversions—the spot where water is diverted from a larger river, stream, or ditch. Some water masters have part-time assistants, others work independently. One step above the level of water master is the Water Manager. Oregon has five Water Managers representing regions of the state. It is their job to oversee water masters and help draft water policy for the state. For this project, I interviewed a water master (OSL 20) and a Water Manager about their jobs, and about the general questions of this topic. While primarily serving as background information for me to better understand the picture of water rights in the state, later in the paper I will discuss their perspectives in greater detail.

### 2.3 Agriculture Technology

Irrigated agriculture has been practiced, largely unchanged, for more than 6000 years (Postel 1999). However, the past hundred years has seen considerable innovation and change in terms of technology implementation. Still, many farmers in the US and globally use irrigation technologies that would be familiar in Ancient Egypt. Even as farmers large and small turn to technology, this transition is not always uniform: farmers employ a mix of technologies, some using a mix of both 21<sup>st</sup> century networked machines and 30<sup>th</sup> century BC irrigation systems to grow their crops.

Between local, state, and federal agencies, private companies, and non-profits, there is a very large amount of information about agriculture in the US. The same is true regarding technology adoption. A very helpful resource in understanding irrigation and technology issues at both broad and specific levels is the Farm Ranch Irrigation Survey (FRIS). FRIS is a comprehensive report on irrigation on US farms released in irregular, several-year intervals. The most recent report, entitled *The Farm and Ranch Survey 2013* (FRIS). The 8<sup>th</sup> edition, published in 2014, is the most comprehensive and current source of information on the subject (USDA 2014).

There are four main categories of irrigation employed by farmers identified by the FRIS: gravity-based systems, sprinkler systems, drip/trickle systems, and sub-irrigation systems (USDA 2010). The gravity-based system I will focus on mostly throughout this paper is known as flood irrigation, where a field is literally flooded without application controls. Sprinkler systems spray pressurized water onto crops using pressure ranging from less than 30 PSI for low-pressure systems to above 60 PSI for stronger systems. They can be mobile (e.g. center-pivot, wheel-line) or stationary. Drip/trickle systems apply small amounts of water directly to individual plants using either pre-set timers or other means. Sub-irrigation systems provide water to the roots of plants through low-pressure, semi-permeable hoses.

The “Internet of Things”, or IoT as it is commonly referred to, is a concept long in the minds of technologists, science fiction writers, and doomsday prophets alike. At its core, IoT represents the interconnectivity via the internet, of a multitude of devices and sensors, and the communication between them without human involvement (Stubbs 2016). It uses off-site (“cloud”) storage and high-speed networked communication technology to connect entities that were once separate, and allow for communication between connected entities.

Networked and wireless technologies may find on-farm applications in several ways, from opening a cattle gate to automatically monitoring soil moisture (Gray and Boehjle 2007). Drones and autonomous vehicles can be used to scan crops for pest damage or other field conditions, and can collect and relay data about farming functions to a smart phone or a centralized computer. Sensing equipment in silos, storage areas, or animal feeding locations can send a notification to a farmer when feed levels get low or when an animal appears sick. And sophisticated computer systems can be used to analyze and interpret results, providing information to the farmer in a relevant and digestible manner. Clearly, the number of applications for this transformational technology is great, and offer farmers real possibilities to save time, money, and improve decision-making.

There are several ways that networked technologies and IoT are being applied to irrigation technology. A wireless system may allow for variable rate of spray for a pivot-type irrigation, rather than a single level of pressure. Pivot-type irrigation can also be controlled to allow for variable rates of coverage within a single rotation, creating zones where different types of crops may be grown (Carr 2016). Soil moisture sensors and drone-based sensors measuring evapotranspiration rates can communicate with the irrigation equipment to lessen or increase water application automatically. Weather data can also be gathered, both within the field and from other users, to further inform watering decisions, sending this information to the farmer via a smartphone app or a text message, or communicating with the irrigation equipment directly (Morrison 2012).

Although this paper focuses primarily on networked irrigation technology adoption, it should be noted that there are many important non-networked technologies that farmers rely on or consider implementing (Wichelns 2002). This includes lightweight pipes that increase mobility of irrigation equipment; pumps that lift water out of a stream to a pipe or ditch leading to the field; pond liners to prevent losses caused by seepage; and concrete used to line clay or dirt irrigation channels. While these technologies are not “smart” per se, they can be used in conjunction with other monitoring or networked equipment to reduce time and water use on the farm. They also represent more commonly-known alternatives to smart farm technology (Schaible and Aillery 2012).

## 2.4 Integrated Water Resources Management

This subsection will introduce the core tenets of Integrated Water Resources Management (IWRM), and discuss how it relates to the issues surrounding small farming and networked technology discussed above. Later in this paper I will discuss how the barriers to small farm implementation of networked technology relate to IWRM implementation, identify several similarities between an IWRM approach and the process of new technology implementation, and provide suggestions that could strengthen IWRM in its relationship to stakeholders.

At its most basic, IWRM acknowledges the interconnectivity of water uses and the necessity to manage them effectively, for all the manifold purposes that water serves for people and the environment. Its aim, distilled to a single sentence, perhaps could be to “achieve a combination of economic, social, and environmental objectives” in a just and equitable manner (Baldwin and Hamstead 2015). Water is complex, and inexorably linked in some way to our society’s social and economic well-being. Basically, we all need water, and we all think it is important, and our policies should reflect this.

IWRM has gained popularity, in part, due to the realization that the water policy community has grown to become both insular and compartmentalized in negative ways (Grigg 2014). Experts in the field become experts in a single portion of water management, rather than studying water in a multidisciplinary way. There was a growing realization that there was a need for collaboration across various segments of the management sphere. To paraphrase Grigg, our problems relating to water are no longer able to be solved with engineering solutions; rather, we need to find human solutions (ibid.).

IWRM has been defined several times throughout its relatively short existence. The most commonly cited definition comes from a NGO called the Global Water Partnership (Agarwal and GWP 2000). In 2000, the GWP's Technical Advisory Committee held a World Summit in Rio De Janeiro to attempt to solidify the core tenets of IWRM. This definition called IWRM "a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (ibid.). The document laid out four guiding principles, which are paraphrased below:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels.
3. Women play a central part in the provision, management and safeguarding of water.
4. Water has an economic value in all its competing uses and should be recognized as an economic good.

(Agarwal and GWP 2000)

The American Water Resources Association, (AWRA) defines IWRM as "the coordinated planning, development, protection, and management of water, land, and related resources in a manner that fosters sustainable economic activity, improves or sustains environmental quality, ensures public health and safety, and provides for the sustainability of communities and ecosystems" (AWRA 2012).

Most IWRM papers published after 1992 (at least those found in the bibliography of this paper) cite at least the GWP definition. However, many spend considerable time in their introductions to offer their own interpretations of the meaning and goals of IWRM. For example, Baldwin and Hamstead identify three goals of IWRM: economic efficiency, social equity, and environmental sustainability, and list sev-

eral challenges to water resource planning that IWRM can address, including the effort to better manage existing resources; maintaining ecosystem and environmental quality; an uncertainty about the future and accompanying implications for water security; and conflicts due to unequal distribution of costs and benefits about water allocation (2015). To this list, Pahl-Wostl adds an incremental, iterative approach to problem solving and stakeholder involvement (Pahl-Wostl et al. 2008). And in a report calling for a nationwide implementation of IWRM, the US Army Corps of Engineers (USACE) echoed both AWRA and the GWP, while presenting their own interpretation of key IWRM concepts, including “holism, systems, watersheds, participation, balance and sustainability”, also writing that “state watershed-based plans should reflect an appropriate balance between economic and human uses” (USACE 2014). Clearly, IWRM contains many concepts, all competing for limited space.

IWRM has been used in a wide array of locations and situations. Most of its applications come from overseas, where it has enjoyed more popularity and debate than it has in the US and Canada (Pahl-Wostl et al. 2008). In the US, it has primarily seen applications in the form of state-wide integrative water management plans (e.g. Oregon, Delaware, California) and in basin-wide management plans (e.g. St. Johns river in Florida and the Yakima river basin in Washington). Additionally, several large organizations that interact with water issues have implemented or called for the implementation of IWRM as an official policy tool, most notably the US Army Corps of Engineers AWRA 2012).

In 2012, The Oregon Water Resources Department (OWRD) published the state’s first integrated water resources plan. Officially titled *Oregon’s Integrated Water Resource Strategy*, it is a 154-page document that uses IWRM to describe and quantify the state of water within Oregon, current and future challenges, and opportunities for collaboration (OWRD 2012). The document presents four principle objectives as it’s stated purpose, which is to understand Oregon’s water resources today; to understand instream and out-of-stream needs; to understand the coming pressures that affect our needs and supplies; and finally, to meet Oregon’s in-stream and out-of-stream needs (ibid.). Like other well-intentioned plans, there appears to be a deficit between the goals of Oregon’s IWRM strategy and the funding available to carry them out. Indeed, the authors make this caveat on first page of the document by stating, “although the Integrated Water Resources Strategy is ambitious (there are not currently enough resources to fully implement all the actions listed here), the intent of the Strategy is to provide a blueprint for future actions”. The second edition of the initial 2012 report will be published in 2017, and should provide an update on the progress made in the previous five years.



While there were only four stated goals listed above, the paper lists hundreds of tasks, projects, and actions for various agencies to focus on. One may wonder, given the importance of each use, how is priority chosen? Who determines which critical issue gets attention and which does not? in an era of increasing budget cuts, this type of question will become even more relevant. For example, lead levels in a rural well relied upon by a small town might be a lower overall priority than meeting ESA requirements for Coho salmon, but if your child gets lead poisoning, it matters much more to you than a million salmon.

*Oregon's first integrated water resources strategy, although led by state agencies, was built from the ground up. Early on, the four state agencies actively sought input from the public, hosting discussions in eleven Oregon communities all across the state. Stakeholders and several water-related organizations also participated in individual workshop discussions. The public input gathered from these discussions resulted in an extensive list of water-related challenges that Oregonians care passionately about and want to see addressed in the state's first water strategy. From the very beginning, Oregonians offered a variety of solutions and ways the State could move forward to improve water resources management in Oregon.*

*(OWRD 2012)*

Oregon's plan claims to be a "bottom-up approach" to decision-making (ibid.). It is hard to argue against any bottom up approach, or stakeholder involvement, or reduced waste, or greater coordination of water use, all of which are called for in the plan. But what do these terms mean? And what sacrifices or tradeoffs are made in achieving them? The plan itself is unclear in this regard. Section 5 digs deeper into these questions of meaning and value, and discuss how IWRM can (or fails to) help small farmers solve their water resource problems. This examination will discuss stakeholder communication, and examine what connections, if any, exist between IWRM and integrated technology implementation on small farms in Oregon. As will hopefully become clear, the individuals profiled in this paper have a legitimate interest in water use and increasing efficiency and communication about water use, and by participating as true stakeholders they can both benefit from and provide a benefit to future water projects in the state. However, the converse is true. By implementing plans that claim stakeholder involvement and a "bottom-up" approach is to potentially cause even more problems.

Whether in collaboration with government agencies, independently, or with the support of private investors or technology companies, the decisions these farmers make in coming years regarding implementation of new forms of on-farm technology will have far-reaching implications for the state's many users of water, and thus should be considered when discussing more integration in the water sector.



### 3. METHODS

#### 3.1 Background

For this thesis, I worked as an intern under Dr. Kathi Kitner, an anthropologist at Intel Labs (note: Dr. Kitner is a member of my thesis committee). Together with another Oregon State graduate student in anthropology Janette Byrd, we designed and conducted a research project that examined farming, water use, and technology change in rural Oregon, the centerpiece of which being a series of semi-structured ethnographic interviews with farmers, ranchers, and water policy professionals. These interviews followed best practices for the project culminated with a presentation to key members of Intel Labs presenting our findings and recommendations for further research endeavors.

Several months following my internship, I was still interested in a deeper analysis of the collected interview data. Wide-ranging interviews with a diverse group of individuals had been recorded and transcribed, and it felt as though there was much more in the data that time and other circumstances did not allow us to uncover. After a series of communications with Intel Labs, they generously provided me full access to these interview data. The confidentiality procedures from the initial phase of the project remain in effect, and I continue to adhere to all original agreements contained within the interview release form that was signed by participants. The Institutional Review Board (IRB) was informed and consulted during this process; the project has since been deemed “IRB Exempt”.

#### 3.2 Initial Data Collection

The first meetings between Dr. Kitner, Ms. Byrd, and myself took place in July 2015 via Skype and in several day-long sessions at the Intel Labs office in Hillsboro, Oregon. During these initial meetings, a plan was developed on how we could best study the intersections between agriculture, water, and technology use among small farmers using a semi-structured ethnographic interview. Dr. Kitner, a trained anthropologist, re-briefed me on anthropological best practices and qualitative methods data collection and recommended readings to better understand the process (e.g. Miles et al. 2014). Our goal was to conduct as many interviews as possible within two months, and then present our findings to the leaders and researchers of Intel Labs. We discussed and wrote about our current state of knowledge about these issues, and Dr. Kitner taught us about the principles of ethnographic interviews and data collection techniques. Over the course of these meetings, we developed a methodology and timeline for our research project, as well as an interview manual and questionnaire (see appendix). The initial question posed by Intel Labs and addressed by us was intentionally vague. Our task was to about what a

small farmer is, and how farmers use technology—specifically networked technology—in relation to water use and communication. There were few specifics or benchmarks for success, which allowed us the flexibility to approach this question from different directions.

### 3.2.1 Interviews

Twenty-five formal Interviews were conducted with a total of thirty-one individuals. Interview length ranged from between one and five hours, averaging approximately two hours. Most interviews were with a single individual, though six interviews had two individuals participating. Ms. Byrd and I both conducted several interviews alone, and other interviews jointly. Additionally, Dr. Kitner was present during four interviews to guide and evaluate our interview technique. Of the twenty-five formal interviews, fifteen were recorded and transcribed. At the request of the interviewees, the remaining interviews were unrecorded. Interviews were recorded using digital recording equipment and transcribed by a professional transcription service under the employ of Intel. Field notes were taken during unrecorded interviews in order to have as complete a record as possible of what was spoken about. These interviews also followed the interview guide as applicable. All interviews took place in person. In addition to formal interviews, which followed anthropological best-practices (Bernard 2011) and involved the signing of a release form, researchers conducted several informal interviews to provide background information on the topic. Material from these conversations was not used in any way, besides as a guide and tool to help understand the topic. While an interview with a state Water Master was conducted, it has been used for information purposes only, due to the existence of only five such employees in Oregon, and the relative ease in identification of such an individual.

Interviews were conducted with a mix of farmers and ranchers, and with those possessing a connection to both farming and water policy. While most of the recorded interviews were with farmers, the non-recorded interviews were primarily conducted with policymakers (see Table 1). For a variety of reasons, this group of individuals seemed less comfortable with having their interviews recorded. Instead of recordings, notes were taken during the interviews. These interviews were extensive and were conducted with the same questionnaire as the recorded interviews, and followed the same principles and standards as recorded interviews (Gray 2003). Because of my background and interest in water policy, this set of interviews were conducted by me alone, without the assistance of Ms. Byrd. These professionals had a wide breadth of backgrounds, experiences and opinions, and included a water master and a Water Manager from the Oregon Water Resources Department (OWRD), Soil and Water Conser-

vation Service (SWCD) and Natural Resource Conservation Service employees, heads of watershed councils, presidents and managers of irrigation districts, and heads of non-governmental organizations that are involved in farming and water issues.

OSL #	Description	Gender/Age	Entry into Farming
01	Organic Farmer in the Southern Willamette Valley. Co-owns a farm with her husband.	F/~40	Saw dryland farming practiced while in India
02	"Subsistence" farmer who also sells products at farmer's market	F/~55	Grew up on a farm
03	Owner of a fruit and nut farm near Portland	M/64	2nd generation
04	Designed and built high-tech hydroponics facility in E. Oregon	M/34	Started his farm several years ago, after a career in turf management
05	Lifestyle farmer near Bend, 20+ years' experience working in water policy, uses her grass to feed her therapy horses	F/55	Purchased current property several years prior
06	Husband and wife seed farm owners	Both ~ 40	1st generation
07	Owner of a farm producing organic pork		1st generation
08	Owner, small flower and vegetable farm near Albany	F/60	1st generation
09	Owner of ~300-acre ranch growing hormone-free beef	M/61	3rd generation
10	President of an irrigation district in Eastern OR	F/60	N.A.
11	employee at precision ag company	M/30	2nd generation
12	Owner at a dairy in the Willamette Valley	M/46	3rd generation
13	ranch owner near Eugene	M/60	5th generation
14	Owner of small farm near Portland; active member of local watershed council	F/35	1st generation
15	Two managers at a large, high-tech farm	both M ~ 30	Unknown

Table 1: Recorded interview code and description.

OSL #	Description	Gender/Age	Entry into Farming
16	Farmer north of bend; founded an irrigators' rights group;	M/75	4th generation
17	Husband and wife ranchers; wife works for local watershed council; husband for US Forest Service	Both late 20s	Unknown
18	Rancher near John Day; Former head of local SWCD	M/65	6th generation
19	Head of NRCS office in eastern OR.		N.A.
20	Water Master in E. Oregon	M/~40	3rd generation
21	E. Oregon NRCS Head	M/~55	N.A.
22	Water Manager for ~1/5 of Oregon	M/~45	N.A.
23	OWEB Representative for E. Oregon	F/~50	2nd generation
24	Bend-Area Farm and Water Nonprofit rep	F/~30	N.A.
25	Rancher/SWCD employee in E. Oregon	M/~35	4th generation

Table 2: Unrecorded interview code and description.

Individuals in the above Tables are farmers, ranchers, policymakers, and employees in the agricultural field. In subsequent quotations, they will be identified by the code in the leftmost column. I identify their professional title as closely as possible without providing information that may compromise their identities. When more specificity would be helpful without compromising privacy, I identify individuals based on the general location where they live.

### 3.2.2 Recruitment and Sampling

A purposive sampling protocol was used (Richie & Lewis 2003). Because we lacked formal ties to the agricultural community, we relied upon several methods for gathering participants. We found participants by visiting farmer's markets, farm stands and agricultural supply stores and initiating conversations with anybody who was around. As we talked to more individuals, we used their recommendations to identify others who were knowledgeable on the subject to interview, or a snowball sampling methodology (Biernacki and Waldorf 1981). Interviews were arranged by in-person contact, or by telephone and email through recommendations.

### 3.2.3 Interview Location

Interviewees were primarily located in two geographic areas of Oregon: The greater Willamette Valley, and the high desert area east of the Cascades in and around the city of Bend and the town of

John Day. These locations were chosen to provide a more representative sample of the types of agricultural operations taking place within the state. In an effort to be as accommodating as possible for interviewees, we conducted interviews at whatever location was most convenient for them. Every effort was made to conduct interviews on their own land, but when this was not possible or convenient for them, we met at restaurants, cafes and at their offices.

#### 3.2.4 Agreement and Compensation

Before beginning an interview, the interviewee was briefed on the purpose of our research project. They were told that if they agreed to be recorded, they could stop recording at any time if they did not feel comfortable. Interviewees were given a release form to sign. This form was very similar in nature to an IRB approval form, and described how their recordings and interviews could be used. As part of my arrangement with Intel Labs and the IRB, I have agreed to follow procedures ensuring that no personal information is divulged nor any agreement with an interviewee broken. Interviews have been de-identified by the researchers prior to transcription. In lieu of names, the acronym *OSL* is used, followed by a number which represents a specific individual. Where descriptions are used, they are done so in a general and non-specific way to avoid mistakenly identifying an interviewee. *OSL* represents Oregon Smart Labs, a company established by Intel Labs to fund this project. Oregon Smart Labs was designed to have a limited scope, and funding for this project originated with Intel Labs. Therefore, *OSL* will be referred to only within citations, while other references to the originators of this project will refer to Intel Labs.

To encourage participation and compensate for time spent away from their work, \$75 prepaid Visa gift cards were given to most participants. To avoid any conflicts of interest, no government officials were offered gift cards. We tried to frame this as a thank-you gift and a token of our appreciation, and was in no way contingent on the type or quality of answers given.

### 3.3 Post-Interview Analysis

During the data collection phase at Intel, I discussed results from interviews and research with Ms. Byrd and Dr. Kitner. Though we developed general themes to assist in our own analysis of the collected data, time constraints did not allow for, and the Intel Labs board of directors did not require formal coding of the interviews, relying on our own interpretations of the results—as per their own style of research. After independently returning to the data, I began reading and re-reading literature on the topic, which helped me compose a set of generalized themes to apply to the interview transcripts (Miles et al. 2014). Paragraph-level coding was performed using a descriptive coding methodology, followed by

thematic coding and analysis of transcript data (Saldana 2015). Interviews were coded using interview transcripts in Microsoft Word, following the guidance of quantitative research textbooks (Bernard 2011) (Gray 2003). Additionally, I created “mind maps” using the program “Simple Mind Pro” to visualize the data in a different way. I found that the visual representation afforded by the mind map benefited me greatly as I attempted to understand—and re-interpret—the data. During this second round of coding, I selected quotes that I felt were exemplary of major themes that arose throughout interviews.

### 3.4 Interview Bias and Reflexivity

While efforts were made by Ms. Byrd and myself to minimize any biases we possessed, our backgrounds and cultural understandings and assumptions shaped the interviews in profound ways. I possessed unconscious biases, images and stereotypes about the people I was interviewing—and as an anthropologist, Ms. Byrd would likely agree. There were many moments where I felt culturally illiterate, and this was painfully obvious both in the moment and when reviewing my transcripts. Dr. Kitner, Ms. Byrd and I were both outsiders to farming who knew relatively little about what it means to be a farmer. Though we were unfamiliar with many aspects of farming, we also did not have to pretend that we were experts on the topic, or feign ignorance to illicit a particular response. Rather, we could engage with the participants on their terms, with their own knowledge on the subject as a guide.

### 3.5 Developing Research Questions

Because this project relied on both an initial stage of data collection, followed by a reanalysis and secondary source data analysis (Whitehead 2005), the development of finalized research questions did not occur for several months after reanalysis began. The process of reanalysis clarified the data, and thematic analysis guided the process of research question development.

### 3.6 Validity and Limitations

The initial, Intel-led study was limited by time, money, and the desire to represent findings in a timely manner. The secondary portion of my analysis was limited by my own resources and the need to work within the collected data. We collected as many interviews as we could in the limited time provided. During this time, attention was paid to “content saturation”, or the point where interviews were not providing novel information (Bernard 2011). While this is difficult to ascertain, this represents our best efforts at achieving a representative sample with a diversity of viewpoints.

This study had several limitations. Firstly, another individual besides myself was involved in a portion of the data collection. Though I received transcripts of interviews, there were several interviews that were conducted by my co-researcher, and thus did not have a chance to meet the individuals in



question. As our goal was an ethnographic approach, face-to-face contact is surely important (Clifford et al. 2010). Not only did I miss a chance to meet these individuals, there were several questions and elaborations that I had while reading the transcript that, were I asking the questions, I may have asked differently.

secondly, when condensing real interactions into recorded words, and then to text, and finally to individual quotations, there appears to be a possibility of a loss of context. With such a wealth of interview responses, I had many interesting and informative quotations to choose from. The quotations included below represent only a small fraction of the overall transcript data, and each quotation could have indeed been replaced by one of equal relevance. After cleaving the quotations from the original interviews—which had themselves been transcribed from real conversations—I had to continuously remember the importance of understanding these quotations based on the larger context of the interviews holistically, spoken by complex individuals, rather than as independent statements of fact. I thus attempted to remain vigilant against the desire to “fit” the interview responses to meet a predetermined response. It was not possible to provide context for each quotation, and there will surely be instances within the following pages where I fail to provide contextual details that would have been helpful. This fault is mine and mine alone.

### Interlude—A Bar in John Day, Oregon

*“I don’t come into your house and ask you what religion your mother is or how much money you have in your bank account. So don’t come in here, to my town, and ask me questions like that”,* my interviewee snarled at me.

I had introduced myself to him and his wife only five minutes earlier, at a local bar where we had agreed to meet for dinner and drinks. They were in their late twenties or early thirties (OSL 17). She worked for the local watershed council, while he worked in the field in a regional office of a large federal agency. In addition to their full-time jobs, they also owned a ranch and had three children, who were not present that evening.

He told me that he had just finished up at his federal job—a *terrible organization*, he said—and between there and his ranch, had been working nineteen hours straight. After introductions, and an explanation of the project (which they listened to in skeptical silence), I asked him what I considered a basic and straightforward question, one that I had asked several other times that day without any issues. But when I asked this individual the same question, his demeanor changed completely, telling me

that he knew ranchers that would end the interview immediately if an “outsider” asked a question like this.

The question I asked was, “*how many acres of land do you have?*”

Apparently, I had touched on a very sensitive topic, and I spent the next several moments apologizing in confusion. After a short time, he calmed down. Maybe the pitcher of beer arriving helped. We ended up talking for a while, and he explained his perspective, and why that particular question made him so angry. He said, “*The land is all we have here, it’s like our bank account. And when people ask how much money is in your bank account, they probably have a reason they’re asking*”. He continued, citing his own water rights, saying that when agents of the government begin asking questions about how much water he uses, they are never asking simply because they want to know. And even when questions start out innocuously, he claimed, they will eventually lead to having his water rights “stolen” by the government that he works for.

## 4. FINDINGS AND DISCUSSION

In traditional scientific studies, it is commonplace to follow a format that presents a paper's findings, followed by a discussion of the findings in an independent section. However, in qualitative studies such as this one, the demarcation between these sections is not as easily made (Patton 2002). Unlike the collection of quantitative data, these results are inextricably connected to living, breathing individuals, and arose during literal *discussions*. Further, due to the holistic nature of the research questions and the retroactive nature of their creation (as noted in *Methods*), combining these two sections into one was the most sensible option. This section presents the bulk of the interview data gathered by myself and my co-researcher, and interprets the interviews we conducted considering the greater trends in farming, water use, and technology change discussed in Section 2. It is roughly divided into three portions: the first discusses the perceptions that farmers hold about their craft, their community, and the regulatory environment in which they practice their business. The second closely examines the barriers between farmers and technology adoption, and the third presents their visions of the future in a changing world. The goal of this section is to both answer research questions 1-4, and to discuss how these data fit into extant research on the topics of discussion. The final research question will be answered in the following section. The research questions are restated below:

1. How do farmers perceive their identities and roles in the community?
2. What are their perspectives on regulation and water rights?
3. How do farmers perceive technology in their operations, and what are the barriers to increased technology use?
4. What are their visions of the future – in general, and specifically related to technology adoption in the water sector?
5. To what extent can the lessons of IWRM be applied in this case to help explain the challenges faced by Oregon water users?

### 4.1 Perceptions of Farming: Community, Regulations, and Water Rights

The following section uses data from the interviews to discuss the perceptions that the interviewees held about various issues. Our interviews were as wide-ranging, as were the perspectives of the individuals we spoke with for this project. While many topics were discussed, two general categories arose. In the following subsections, I use interview data coupled with relevant background information

to show how farmers see themselves as individuals, as farmers, and as members of a community, as well as perceptions of water rights and regulation.

#### 4.1.1 Perceptions of Farmer Identity & Community

In an ethnographic approach, the goal of the researcher is to learn as much as possible about the subjects in both current and historical contexts (Clifford et al. 2010). To express our interest in gaining a holistic understanding of our interviewees, and to serve as an introduction, of our first questions was generally an inquiry into the interviewee's background and motivation for farming. This open-ended line of questioning allowed for the interviewee to start at their own pace and become comfortable with us and the recording device. It also provided us an introduction to the farming operations and the farmers themselves. "*How did you start farming?*", "*Tell me about your farm*", or "*How long have you been doing this type of work?*" were typical phrasings. In the reanalysis and secondary data analysis process, I was also able to compare these answers with extant research on identity in rural communities.

From these questions, we learned that there was a variation within the group regarding how and why people began farming, with an even division between those who grew up on a farm or were exposed to farming at a young age, and those who purchased land and started farming later in life without prior experience. For those that grew up on a farm, continuing the farming lifestyle seemed like the default option. The rancher near John Day in the Prelude stated that he never had, and never wanted to do anything else (*OSL 18*). A farmer located north of Bend said that he had been born on a farm, went to college and tried to be an accountant, but hated it and returned home to continue the family business (*OSL 16*).

One of the farmers (*OSL 05*) described herself as a "Lifestyle" farmer. Lifestyle farmers, meeting the USDA definition of a Retirement Farm (see definition in Section 2), these individuals are in general interested in a rural lifestyle and may participate in some types of farming or agriculture, but do not earn a significant income from the farm (USDA 2014). The head of an irrigation district near Bend explained that most of the irrigation water near Bend flows to lifestyle farmers, stating, "*Most of central Oregon is lifestyle. Not all of it though. Certainly, not Madras. They would never call themselves lifestyle*" (*OSL 10*). She explained that the limited acreages of properties in the area, combined with poor soil quality, make farming a productive plot of land difficult. However, many rural residents, like the lifestyle farmer, possess senior water rights dating back to the 1800s. These water rights provide a steady source of water, year-round, even though the region is high desert and receives approximately ten

inches of rain per year. When I asked the irrigation head approximately how many of her customers are growing a productive crop, she stated, “*Not very many. Out of 662 people that are making an income off of it, with no other source of income, probably, a handful. You could probably count ‘em on one hand*” (OSL 10). This lack of productive use of water should be considered when considering how farmers interact with water.

An individual in Eastern Oregon was an interesting example of how broad the concept of “farmer” could be, and what smart farming could look like—even if only on a small level. After receiving a horticulture degree in Oregon, he then worked for a professional football team in their landscaping department, before using savings from that job along with money from his wife’s salary to start a hydroponic lettuce business in Eastern Oregon. While he was growing a crop, he did not look or act like my image of a farmer, and his route into farming was significantly more circuitous than most of the individuals we spoke with. Towards the end of my interview, I asked him directly, “*Comparing yourself to a traditional farmer, are you a farmer?*” he answered:

*Yeah. Farmers, nowadays have thousands of acres of field. They’re using drones with infrared technology. They’re using technology. They’re incorporating it into old practices. I would imagine cattle farmers are using a lot of information about how much water, how much feed they’re giving to their cattle every day.... the people who are doing a larger scale are trying to manage their farm of whatever type a little bit more actively are probably using some sort of technology. We are definitely on the forefront of that. When you look at larger hydroponic grows, we’re not using as much technology as some of them are. I hope, one day, we will be in a newer facility where we’re using more technology for natural ventilation. And then, maybe, solar and things like that. Do I consider myself a “farmer”? Yeah. What is a “farmer”? Someone who grows or raises cattle, or grows food, grows some sort of product to go to market. We do that. My answer is, definitely, “Yes.”*

OSL 04

The initial data collection focused on how farmers interact with their neighbors and what type of relationship they had. This line of questioning was important for us because we postulated that the type and quality of these relationships would influence how farmers feel about sharing data with those around them. If a farmer already has a relationship that involves sharing data about their crops, techniques, or yields—even in a low-technology setting—they may be more open to collaborating with neighbors, farmers, or even regulators about these same issues using networked technologies. However, if an individual does not feel comfortable sharing information with neighbors or competing farmers, they may be less likely to implement a technological regime that claims at its most basic tenet the free sharing of data.

A rancher near Eugene described his relationship like this:

*We like to know who are neighbors are. A lot of our neighbors, we work with, so in Medford we have a neighbor across the field that he's actually grown crops for us and we've planted and worked with him. So we like to know our neighbors; we like to treat our neighbors well. You always have neighbors that – it's a farming community and then you have folks who want to live out the country but they don't want to live out in the country.*

OSL 13

The majority of those we spoke to reported good relationships with neighbors. This ranged from neighborly acknowledgement to active cooperation on improvement projects for neighboring farms. The 6<sup>th</sup> generation rancher from the Prelude stated that he only had a few neighbors and so “*they become either your best friends or your worst enemies*” (OSL 18). An organic farmer in the Southern Willamette Valley described her husband as a source of local knowledge regarding irrigation systems, knowledge which led to positive interactions with neighbors, as well as supplemental income, during water-scarce conditions. Referring to her husband, she stated:

*There was a period when we weren't – we actually didn't have enough water to farm so he actually got his irrigation license, so he was installing irrigation systems for other people. Like we needed an off-farm income basically. So he was doing that. So it's just funny because he's like the irrigation man. Everyone goes to him for irrigation questions because he knows how to install systems and how to match pump size with water pressure and doing backflow.*

OSL 01

However, relationships surely become more challenging when one must deal with solving, between themselves, issues of water allocation, as is the case within many water districts. The water district acts like a municipality, and delivers a total amount of water, on a weekly basis, to a ditch that is shared by up to 20 individuals. While each have the same water rights on paper, but how the water is used may differ significantly. As the head of an irrigation district described in an interview:

*Now, it's served out to a private ditch serving six to ten, 12, 20 people. And, they don't always work together to maintain that ditch. Where I worked in California, this would be unheard of. Oregon's different. And, in California, every ag water user would have their own turnout and it would be metered and there wouldn't be any sharing with anybody else. This is an old-fashioned system, and, that's where we get most of our complaints – is, people saying, “You're not giving me enough water.” And, we're saying, “Oh, yes we are. We know exactly how much we're delivering to you. You need to work with your neighbors to work out your problems.*

OSL 10

The lifestyle farmer near Bend also described this system as causing a great deal of contact with her neighbors. That this system was so incredibly inefficient causes her to make multiple phone calls each day to her neighbors. Even so, she reported what sounded like an idyllic situation:

*Right. We wouldn't want to do that. We're still in a community, I mean honestly, we don't lock the doors at night oftentimes the keys are left in vehicles. I mean, that's kind of how things are. We know our neighbors. You know, and like when they go out of town, they always let us know. We have a cat that we share.*

OSL 05

A topic of frustration with neighbors included issues related to water use. The subsistence farmer in the Willamette Valley described difficulties with a certain neighbor since moving in five years' prior, regarding her water use:

*(Legal approval to use water) came with the property I bought, right? For five gallons a minute or whatever they call it, a household – I was hooked up to it for the first few years but as I was getting stock and animals, that wasn't enough water. I asked (the neighbors) "can we make other arrangements or something" and they said no. they're buttholes. I tried to conserve water, I tried to collect rainwater, I tried to do a couple things and finally I had to build, I had to put in my own well. I guess I agreed to shut off the water, but I did not sign off my water rights.*

OSL 02

A small farmer and watershed council member near Portland has readily acknowledged how hard it can be to enter the farming world as an outsider. Since purchasing her farm several years ago, she has felt like a perpetual outsider compared to the farming families who live nearby:

*These people are third and fourth – sometimes fifth generation of this area. Most of these squares are Homestead Act squares so I really am the new kid on the block. I took a farm out of a family. Not on purpose, but that's just how it happened. And so it's – people are cautious just to talk to me just for that reason. It's taken me two years for me to know most of my neighbors...*

She continued, describing a large farm in the area that she claimed many individuals had problems with. Though she has been able to remain neutral so far, she stated:

*In this area, that's kind of the talk of this watershed is, the water rights of the J-----'s. I am totally the new kid on the block (and) Everybody tells me everything. It's crazy. I'm like Switzerland. They can make it so there's no water going over their dam 'cause I've driven by it many times where there's just nothing. I don't know how low they can take it – as far as I know, they can go – they can bleed that dry if they wanted to... People do not want to approach the J-----'s. I have not ever met them...*

According to the interviewee, this farmer is known to be quite litigious. At the time of our interview she had a problem with her water rights that potentially involved this farmer, but stated that she had put off addressing it because of this, and concerns about their political and economic power:

*They are a Goliath of the neighborhood so to speak. I've heard that people who have tried to contest water rights or other thing with them often immediately fail because they have a very good legal team. I haven't approached it because I've kind of left it at that. I think well, I should probably have all my ducks in a row before I even go talk to them. I should know more about water rights.*

OSL 14

The lack of upkeep of nearby fields was also mentioned by several respondents. The 6<sup>th</sup> generation rancher noted that the other plots of land around his ranch—which his ancestors had settled on in the 1870s after immigrating from Germany— were slowly being purchased by “outsiders”. These apparent interlopers were either “vacationers” from Portland, Boise, or Seattle, who wanted to “make the land their personal playgrounds”, or industrial-sized farms that had purchased family-owned cattle ranches and began operating larger-scale operations with imported labor and absentee landlords. He reserved his strongest condemnation, however, for an Indian tribe from another part of Oregon that three years’ prior had purchased the adjacent ranch. The goal of the tribe, according to the rancher, was to “re-wild” the landscape by bringing back native plant species and protecting salmon spawning habitats in a stream adjacent to their properties. This had effort, however, had resulted in fences falling into states of disrepair and dealing with considerably more weeds in his own fields (OSL 18).

Among those we spoke with, there existed a clear respect for the land. How this feeling manifested itself depended on the individual. The organic farmers we spoke with expressed desires to provide their communities with healthy, natural products with a minimum of negative impacts on the land. Another group of farmers and ranchers, along with the dairy farmer in the Willamette Valley, expressed a strong love of the land and a desire to care for it, but in a different way. They seemed to see themselves as stewards of the land, which in turn provides a bountiful harvest to be used for the beneficial use of humans. With these similar, but divergent viewpoints, the two groups matched a description of *environmentalists* and *conservationists* (Weber 2003). As a dairy farmer put it:

*But I think by and large, farmers, ranchers, forestry people, they do care about the land because they – especially if they've been here a long time. If I destroyed my soil and my water, one, I'm doing bad things downstream. But I'm killing myself.*

OSL 12



Those identifying themselves as *ranchers* appeared to hold more traditionally “conservative” viewpoints on government and social issues. Several expressed a distain for “environmentalists” from Portland. The farmer north of Bend used the term “Enviro-Nazi” during our interview, and described his political ideology as falling “to the right of Attila the Hun” (OSL 16). A rancher near Salem expressed a similar—if toned down—fear of the values environmentalists espoused, saying, “*The environmentalists look for stuff to—sucker fish and snail darters and every excuse they can to – and I’m afraid the environmentalists, and I hope I don’t offend anybody*” (OSL 09). The liberal/conservative narrative, while tempting, is not always an accurate depiction. While the above individual seemed conservative in many ways—even carrying a side-arm to the interview “*for the two-legged critters*”, he is a strong proponent of a gluten-free diet, has spoken at an annual Slow Food conference in Italy, and raises hormone-free cattle without using antibiotics. In fact, the entire narrative of politically Left-leaning individuals who “care about the environment” versus those on the Right who do not seems unhelpful, as every interviewee expressed a deep connection to their land and water, and expressed their feeling of the importance to preserve its quality.

These findings are consistent with research on rural communities. There is a body of literature that examines farmer identity and perceptions of the environment, and individual, first-hand perspectives like these strengthen the understanding of the complexity and interrelationship between how self-identity and perception shape and inform environmental values. Sulemana and James examine the role of farmer identity on environmental attitudes surrounding on-farm conservation, finding that a conservationist identity correlates closely with an appreciation of environmental ethics (Sulemana and James 2014). Burton and Wilson note an continual increase in conservation-oriented farmers in the US (Burton and Wilson 2006), while Karlsson discusses the tension that arises when an awareness of environmental issues are acknowledged but are not able to be acted upon (Karlsson 2007). Smith and Sullivan investigate the values of farming in relation to ecosystem services, and the possibility for market-based approaches to ecosystem management (Smith and Sullivan 2014).

There was a perception among the farmers we interviewed that they felt misunderstood by “outsiders”, or those without a background in agriculture. Several stated that they feel as though they are blamed for society’s ills—especially during water shortages—but never receive credit for the positive efforts they make on behalf of society at large (i.e. providing food) or for the environment (i.e. working to restore riparian habitat and improve water quality). The following quote is from a rancher who runs a small operation who worked with the Oregon Department of Environmental Quality (DEQ) on optional

but recommended improvements, even though he did not agree with the underlying logic behind the improvements:

*Yeah, we've done a lot of things. We fenced off most of our streams where the cow get in, are fenced off now. You'd have a hard time convincing me science-wise that the cattle and forestry (are negatives). we get a lot of blame. We had our cattle in the creek at the time. And the water quality test came out really, really good. Really good. And I don't know if they were surprised by it, but they were impressed.*

OSL 7

The lifestyle farmer in Bend discussed her perceptions of how the natural beauty of her area was accentuated by her and her neighbors' water use. Like many of her neighbors, she uses most of her allocated water on her lawn. When I arrived at her home for the interview, she had more than a dozen sprinklers on at full blast and her entire property was covered in lush green grass. The water was more apparently more than the plants could absorb, as there were large streams of water running off her property onto the gravel road. She explained to me that though the economic value of her water use was surely low, it provided other types of benefits:

*One of the really beautiful things about this area is the irrigated acreage. To drive by and see the critters in the pasture, to see the cows, to see the horses, to see the green. So, aesthetically, people like to drive by stuff like that. A lot of people recreate here. A lot of people on bicycles. Why do they ride through here? It's beautiful. It's scenic, so some of those values are about the scenic values. So, at some point they kind of have to come to terms with people like this who make a choice to be here. They're good stewards of their land...*

In her opinion, the property itself and the accompanying water use was providing a value for her community, albeit not one that is easily measured economically:

*They're using their water. They've automated their system. I mean, they're using it in the most efficient way possible, so I think that's the flip side of, are they over irrigating, then I'd have a problem with it. Are they using just what they need to use to make that grass green? Yeah. Is there a benefit to have irrigated acreage even though it's not in farm production? They're still saving, I mean they're only using two acre feet per acre, and that other three and a half could potentially be returned to the river. And that's your balance. You know, is it OK for someone else to say for me, well you've got horses, you're not really contributing to the agricultural economy, so we say you can't water? I don't think that's right.*

OSL 05

She also talked about her horses, one of which was a wild horse that she broke herself. Several times per week, she brings two or three horses to a non-profit organization that practices equine psychotherapy. Veterans and victims of physical and sexual abuse—many of whom are teens—spend time with her horses as part of a volunteer program. Her method of flood irrigation, though it appears wasteful, waters the grass that her horses eat. Her horses, then, provide a tangible benefit to real people in need. While it may be difficult to argue that this has any specific discernable economic impact, it surely has a positive social benefit, for recipients of the counseling as well as the interviewee herself.

In the end, farmers—even the successful ones—are not just trying to make a profit (though many are) or to squeeze more “crop per drop”, to borrow a familiar agricultural phrase. This is especially true for small and family farmers, who may be farming for reasons that reach far beyond economics. Farming may connect them to a lineage, or to a neighbor, or even to nature. Their desire is not to find the easiest way of doing something, because their sense of value tells them that is this not correct. Farmers have built their lives around, and are defined by, their relationships, and routines, and connections to the land that they occupy, which may explain why economic incentives may not provide the impetus she needs to change her techniques.

#### 4.1.2 Perceptions of Regulation & Water Rights

Several of our questions dealt with regulations. We asked farmers about the relationship they had and opinion of the government and regulatory agencies in relation to their farms. Farmers provided a wide range of perspectives and opinions. Several had strong anti-government and anti-regulation views, while some expressed the need for stronger regulatory control. The size and type of farming operation appeared to correlate with how farmers felt about government in general, with ranchers and those practicing traditional flood irrigation the most critical of government and regulation than smaller operations in and around the Willamette Valley.

A common perspective we heard repeated from these individuals was that any action by government is essentially about seeking greater control and increasing its own power, rather than about making the world a better place or solving a particular problem. Others, while essentially opposed to regulation, seemed to see government regulation as well-meaning but for the most part poorly executed. One rancher described government intervention in his operations like a surgeon who uses a blunt butcher’s knife rather than a scalpel (*OSL 16*). While acknowledging the “diseases” of ecosystem degradation, forest fires, and water pollution, he found the solutions provided by government cause more even problems.

Several individuals had extremely negative views of science. The perception presented was that scientists had become pawns of the government, and would make politically-motivated decisions to justify a solution favored by regulators, regardless of whether it was true. The rancher near Eugene described his feelings thus:

*And I don't have a problem with some (government decisions), to a point. I mean, as long as the science backs it up. But you can do a lot of things with science.*

OSL 13

Control of water was a reoccurring theme. One rancher stated: “There’s folks who very much want to control water more, so they’ll do – you’ll see Ag fight it really hard. Because whenever somebody else controls you – at that point, they control your livelihood, you know” (OSL 13). The rancher near Salem described it thus:

*It’s very complicated, and as far as it looks like to me, they’re setting us up to charge everybody for water at some point. They want to know where every well is, everything. And I’ve done, from logging I went to building stuff, build big buildings, industrial complexes. And they claim all the water, and then the city’s the one to charge you for all this water that’s being collected on a parking lot or a roof. And they charge you these ungodly fees. And they just – it’s like out of control. By the time you get done paying all the public utility stuff, people can’t afford to rent the building that you’re going to build.*

OSL 09

One of the major criticisms that arose from those interviewed were complaints about regulation as ineffective. Even when it has the best interests of society in mind, regulations disproportionately punish farmers who are often working hard to accomplish the same goals but in a more effective and direct manner. Blaming farmers for problems and targeting them with regulations is easier than more comprehensive—and, in their perspectives, fair—solution. These criticisms of government overreach were not constrained to water. A common complaint regarded forest fire policy. In this regard, an opinion we heard repeated was that employees of government agencies like the US Forest Service allow fires to start and burn large swathes of land as a *raison d’être*. Rather than putting out fires quickly and efficiently, the entire bureaucratic system is designed to funnel more and more money into Forest Service coffers. The rancher near Salem described his experience with the Forest Service like this:

*I’ve got a real sour taste in my mouth for government because when I quit logging, we had a fire...next to us and we were logging. And we were on the radio and we had about two miles to be around this fire, and we got around there. And I had 10 men there, and a couple thousand gallons of water, and we had the fire just so close to*

*being out, and we were on the radio constantly talking to the forest service, telling them to send us water. And we got none. And then when they finally showed up, I was so mad they pulled their crews out of there. And when I drove down the Clackamas River they were at the first park and they were setting up this massive base camp, tents and all the stuff to operate this fire. And if they'd have just sent us 500 more gallons, there wouldn't have been a fire...*

He continued, describing how he connects this type of decision to his larger worldview regarding government:

*And the next few years that we logged that and what I've watched today is these states and governments, they want to have these fires because most of them are salary. But when a fire starts, once they've got their 40 in they go on time and a half or double-time. It's big money rolling through everybody's hands to let these fires get started. And you know what? Clear-cuts, they're unsightly. But you see this hillside, it was clear-cut in 1980s, and look at it now. They grow like a crop of wheat, only it's 40, 50, 60, 100 years. And you can go in and selectively log, but the bigger trees that you leave and stuff are prone to dying. And then they're taller than everything else, so they become lightning rods.*

OSL 09

There were several other examples of problems with government regulations as being nonsensical or ineffective, or producing the opposite the desired effect. Farmers mentioned the frustration of making a decision that represented what at the time was the "scientific consensus" for best practices, only to have this consensus change only a few years later. A cattle rancher in eastern Oregon referenced the claim by ecologists that stream health would be benefited by removing logs and woody debris from the channel, then in subsequent decades reversing course and saying that wood was good for stream health. He felt that these decisions were made by scientists who come out and spend only a few days in an area before making these decisions, rather than asking the ranchers what works and what does not.

There were several complaints about the Endangered Species Act (ESA). During the summer of our interview, there was the potential of a lawsuit brought by the environmental group Earth Justice regarding the Spotted Frog, whose name alone evoked connections to the Spotted Owl battles in the 1990s which led to a halt of most logging operations in the Pacific Northwest. The lifestyle farmer described the issues

*This basin's pretty proactive in trying to be sure that that kind of stuff doesn't happen. The same with the sage grouse. We're fighting that right now. It's supposed to be listed in September, but hopefully it won't be. But that's a whole other threat to range land, so it's a different impact to agriculture, but coming from a different area.*

*Plusses and minuses to it, it brings funding to those kinds of projects, but it also brings a lot more regulation, so it's kind of a mixed bag.*

OSL 05

Though interviewees expressed negative opinions of government, there were stories of collaboration. Farmers who had a negative view of government had worked with both local and state agencies to reduce water use and make improvements. A dairy farmer in the Willamette Valley had a negative view of regulations, which he saw as onerous and overly-burdensome. But as a business owner he still needed to interact with agencies frequently, and thus attempted to maintain positive relationships. He stated:

*There's 19 agencies that oversee everything from weights and measures for the scale house in the silo tanks to the brand inspector that we don't use anymore – we don't brand animals anymore – to the state vet to OSHA, immigration and ICE. You name it, we've got it. I did a talk a couple years ago and I put this matrix on the screen and I said this is what we deal with every day. Now, some of these are only once a year. Some of them are only when you do construction. Some of them are virtually every day. And they were shocked. They had no idea. And I didn't even until I sat down and wrote it all out.*

OSL 12

An owner of a seed farm took a more philosophical approach to regulation (in fact, the husband was a philosophy major in college, and the wife was a political science major):

*It's the original social contract, as theorized by Jacques Rousseau. And it assumes that you signed a piece of paper to agree to a governmental regulation when you were born. No. It's kind of an imminent domain thing, which some people think – these rednecks think is heresy...*

OSL 06

There was a contingent of farmers within those interviewed that viewed regulation in a positive light. Mentioned as reasons for regulation were the effects of resource scarcity, mismanagement, and climate change on Oregon. Several farmers and regulators mentioned the severe and ongoing drought in California and the resultant pressures on the state's water resources, including recent proposed and enacted changes in the state's water law (Cantor 2016). Farmers made comparisons between the two states in terms of increased freshwater use and an overreliance on groundwater during drought.

The Eugene rancher described working with local agencies on a cost-sharing plan to install a more efficient water pump:

*We're working now with the Eugene Water and Electric Board, on some pumping projects to get water, water and cattle off-site, out of the streams completely. What the US Department of Ag had us do, you know, in some of these places, was build alleyways so they're all watering in one spot. So you're reducing soil bank erosion. You know, when they cut a trail down to the creek to drink. And they're still going to that one spot and there's manure there for sure. And so – and it just wasn't within the scope of the US Department of Ag, you know, what they're allowed to do, what they're allowed to partner with is, you know, for pumps. So we're working right now with EWEB on some ram pumps that are non-electrical based.... We're paying a portion, they're paying a portion... And I am very thankful to outfits like EWEB. US Department of Ag. We've also partnered with the McKenzie Watershed Council on a solar pump.*

OSL 13

The Bend Lifestyle farmer discussed the actions that water agencies conduct behind the scenes, working with farmers to solve water resource problems:

*...We have a meeting every month, all of the water managers get together, so all the irrigation districts with the water master's office, the DRC (Deschutes River Commission) comes, anyone, a lot of, I mean it's open to whoever wants to come, but typically it's the irrigation districts, I usually go. The DRC goes. OWEB (Oregon Water Enhancement Board). You know, a lot more people are coming to these meetings now because Kyle (Gorman, the water manager for a large portion of Oregon) will give the report. Here's where we're at. Here's what it looks like. We're going to be in trouble next year with the reservoirs if they don't fill. Now, what are they doing as a result of that? Not any, not anything yet.*

OSL 05

Even among the farmers that appreciated some regulation, several expressed a feeling that one-size-fits-all regulation dictated from Salem does not make sense for many farmers. However, inflexible regulations do not allow for common-sense solutions which farmers are famous (or perhaps notorious) for. The Willamette Valley rancher quoted above described this tension:

*We almost had a forestry tour yesterday afternoon for some folks. And one of the guys pointed out, you know, that so much of the population doesn't want harvesting timber. They don't want logging. They want to shut logging down for so many reasons. They want to do so many things. They're trying to widen the riparian zones and the no-touch zones aside the streams. And part of that's understandable, and part of that's good. There's some good science to a degree. But they want – you know, when you start taking – and they're under the impression to take some Ag ground out of production because of stream health. Quote-unquote. OSL 13*

There were also specific frustrations with the state water agency responsible for approving water rights applications. A Fruit and nut tree farmer near Portland described the problems that ensued from his attempt to move from his household well to an official water right:

*So we were just using our house well, and I thought I ought to get water rights and so I found out I can't get water rights, I have to hire an engineer to do that. So we do that and he said, 'ok we'll ask for 300 gallons a minute and then they'll come back and probably say you probably can't get that much water and then we'll ask for 100 and we will be here under this well', and so we did that. ...it took \$30,000 and finally they gave me...18 gallons a minute. But I couldn't go down into the basalt level where there's lots of water. I stay at a real low level so the final outrage, whatever you want to call it is it's so I applied for just 24 acres. They sent a letter that said you cannot irrigate 24 acres with 18 gallons a minute, so you have to use drip irrigation that's equivalent. And I got furious and I told my attorney to tell those guys at the water resource department I'm the farmer, not them. I'll figure out which couple acres I'm going to irrigate this year and I can do any kind of irrigation I want.*

OSL 03

When asked whether he followed through with his plan to bypass the regulators, he replied in the affirmative. His response to the denial of his water right—to simply ignore the denial and irrigate as he pleased—may seem surprising. But perhaps it should not be.

Considering that farmers, in general, need water to grow crops, I found it surprising to meet farmers who either did not know, or did not understand, their water rights. For example, the grower outside of Portland, who worked for a watershed council, did not know how much water she was entitled to, if any—even though they irrigated:

Farmer: *I don't know what my water right is...I don't know who my water master is.*

JH: **Do you have a water right?**

Farmer: *I don't know yet. I think I do.*

JH: **When you bought the property, a lot of times, it's included in it.**

Farmer: *Yeah, if you do it in a traditional way. But we didn't go through – we bought it directly from her – this woman, so we didn't have a lot of the same kinds of – paperwork I guess that goes with it. I don't know. I just haven't made the time to kind of go that way.*

OSL 14

While this perspective represented the minority of farmers we spoke to, there was a range in both professed knowledge in their own water rights, as well as general knowledge about water law relevant to their situations.

An aspect of water rights that nearly every farmer we talked to was aware of or concerned about was the possibility of getting their water rights canceled. In Oregon, as in most other Western



states, water rights are granted *in perpetuity*—that is, forever. There is no sunset clause on a water right (Adler 2010). However, there are certain circumstances whereupon a water right may be canceled. One such way is by not exercising your right, which is commonly known—rather unfortunately—as “use it or lose it”. Talking with farmers, if they knew one thing about water rights, it was this term. Legally, the requirement is for a full use *once every five years*, but a surprising number of people I have encountered believe this to mean that they must be continuously using water or risk its cancellation.

The hydroponic farmer saw the results of this misunderstanding firsthand, in the field next to his greenhouse. Next door to his greenhouse there was an open field that was overgrown with weeds. When I arrived for the interview there was a large wheel line irrigation system watering the field, shooting what must have been several gallons of water per second onto the field, which was thoroughly soaked. According to the him, his neighbor waters this field nearly continuously:

*They're not cutting the field this year. They've not done anything to the field this year but hook up the water and just blast out there 'cause they want the water rights. We go out there and look at it, and, the guy who does all the hay, here, they contracted out 'cause they don't have all the equipment.... Anyhow, I was like, "Dude, what the Hell is going on over here? Look at all these weeds and 'this' and 'that.'" Why does that concern me? 'Cause we don't wanna be packing a bunch of insects in here and all that kind of stuff. I can't believe that the water district hasn't come out here and been like, "Dude, you guys have to do something. Either turn off the water, or, something." It's a joke. You couldn't have cattle out there and have them eat in the field, it's so junky.*

OSL 04

Interestingly, this he readily acknowledged to me that he was not well-versed on water rights, did not have a water right of his own, and was relying on his household water to illegally irrigate his produce. However, he felt more than justified, as he could quantify that he had used such a miniscule amount of water to produce an actual product—especially compared to this neighbor. In his words, “So, in here, we’ve got our greenhouse logs which we plug data in every day. So, I can come in here and tell you, yesterday, we used 55 gallons of water for the entire facility for over 7,000 plants.” One of the stranger aspects of western water law is that, of these two neighbors, one of them is breaking the law.

The rancher near Eugene seemed more familiar with water rights in general, but equated them with a government overreach:

*Well, I don't know how we have water rights on the creeks. You know, we have water rights there. And I don't know how – I don't think the springs have ever had – I'm sure it's going that direction, 'cause the state would love to control all of our water. I think in the past, maybe speaking out of place here, but I believe that in the past, it's been*

*like “navigable waters.” And so like in “high water mark,” you know, in theory someone who wanted to walk right up the middle of the creek, we couldn’t stop them. They couldn’t come on the bank above the high water mark or they’d be trespassing, because it was waters of the state.*

OSL 13

When the state is in drought, or conditions are poor for water, a user that might normally receive an allocated amount of water may see her water shut off. This aspect of water rights was not popular among the farmers we spoke with. The farm manager described the situation:

*And it’s tough when you’ve got somebody that you want to use water to grow weeds and you’ve got someone that wants to use the same water to grow a pear, and so it’s that balance. And they understand, because in Medford when water was plenty, we were able to irrigate up ‘til October 15th, no big deal, where this year they cut us off September 1st from any water. And it’s not only that, because they’re cutting the pear guys off, they’re cutting everybody off.*

OSL 15

The feeling that water rights were a fluid commodity was omnipresent. These interviews were conducted in late Summer of 2015, when most of the Western states—including Oregon—were in severe drought. The previous month, the water agency for the state of California had placed limits and canceled some senior irrigation water rights, the first such occurrence (Cantor 2016). Farmers began wondering if their water rights were as secure as they once assumed. The Salem rancher expressed his feelings as follows:

*we have water rights filed here, and at some point they could come along and say, “You filled that reservoir, but we want it for the city of Monmouth, or the city of Independence.” And that’s happening in California now, and the Klamath basin.*

OSL 09

## 4.2 Networked Technology: Perceptions & Barriers to Adoption

### 4.2.1 Current Relationships with Technology

One of our interview questions that were quite excited about during the planning phase turned out to be rather disappointing—not unlike the way a new gadget or device invariably ends up disappointing. Towards the end of interviews, after spending several hours talking about farming, water use, and technology with these farmers, we asked them to disregard both feasibility and cost and to imagine a new technology for their farms, one that would simplify their lives and increase their profits. While it could be a real piece of technology, we asked them to stretch their imaginations and tell us, unbounded by details. However, the farmers that answered provided ideas that were only slight variations of the

technology they already had on their farm, and in all cases suggestions were related to technology that already existed. The only farmer that seemed to stretch their conception of technological possibilities had the idea for a smart phone app that could be used to identify pests, but...*there's an app for that* (sorry).

Perhaps I am being too critical of these individuals. After all, the idea of “new technology” is an amorphous and at times overwhelming concept to consider. We grow accustomed to doing something a certain way with the technological tools we are familiar with. One of the reasons that there is a collective mix of shock and awe when a new gadget or tool is released—because we are not expecting it, and perhaps not even able to *imagine* it, until we see it in front of us (Early Egyptians, master builders incredibly adept at geometric calculations, apparently could not comprehend the concept of a *wheel*, which surely would have made the pushing of rocks up the side of pyramids much easier).

Unfortunately for us, we fell into a similar mode of thinking. As interviewers, Ms. Byrd and I also had difficulties imagining the types of technology that would work on farms. We assumed that the individuals we spoke to would provide us with all the answers we needed, which turned out to not be the case. Our questions dealt with sensor-based technology, smart phones, internet connectivity, and data sharing, but the lack of knowledge at the time of our interviews about specific suites of technologies at times left our questions vague and general rather than precise and specific.

We were interested in farmers' use of networked technology and smart phones. While all except one of the respondents used a cell phone, cell reception was generally weak and uneven; several told us that their phones worked in some locations on the farm but in other locations not at all. Use of smart phones was varied, with approximately half of those interviewed using a feature phone instead. All but four reported having internet access in their homes, but the speed and quality of their connections varied. The majority reported using some combination of their computers or phones to help their business, from texting with potential customers to accessing information about farming techniques online. As an organic pork farmer in the Willamette Valley put it, “*My gosh, having constant access to my cell phone is important because I keep track of orders that way. A lot of people text me so I can organize myself that way*” (OSL 07). The only person we spoke to who did not have cell phone service or internet access was a small farmer in the Willamette Valley, near Corvallis. She runs what she describes as a nearly subsistence farm, working full-time on her several-acre property, which she has shared for the past several years with her daughter. Though both internet and cellular service are available on her property, she said that not using them was her choice:

*I really choose not to. To get it in would be expensive and any technology you need to know how to use it before you do it. My example is you don't go out and buy a chainsaw unless you know how to run a chainsaw. So until I understand and am capable, I think internet service and stuff would cause more potential problems.*

OSL 02

However, she did state that she has a computer that she uses to keep farm records and photographs on. At this point of the interview, her daughter entered the room and noted that she has a laptop, which she asked her mother if she could use. Her mother replied, blithely, *“But we don't have any internet. So doesn't do no good.”*

The organic farmer in the Southern Willamette Valley described both her access to and worries for technology rather succinctly:

*“We have internet. It's a satellite internet so it's not great. Satellite internet is not great. And we don't have cell phone reception at our house either so we're really remote. And I like it, especially with my kids. Part of me is dreading the high speed because it's going to come eventually and I feel like there's a little bit of a protective layer. Not that I don't want them to have access but it's just like all that access at that speed and all the time.*

OSL 01

We asked about sensor-based technology in a general sense, and the response to the idea of these technologies was mixed: farmers expressed concern about sensors' longevity, both as a technology (not wanting to be forced to purchase a new model each year) and their durability (breakdown or “planned obsolescence”). Others quickly saw potential uses for them. Several farmers stated that having sensors to monitor water use or allocation would be helpful, and that knowing more information about what was happening on their land would be beneficial. The newer farmer near Portland, who was involved in a watershed council and considered herself an environmentalist, liked the idea of sensors to monitor stream temperature for the benefit of salmon spawning:

*Where tech could help more. With water, for me less in a farm way and more in a conservation way the water temperature is a huge thing. It's a really great indicator – it's easy. But most of our temp loggers are these things and we have to go collect them and it's a pain. I've got one on my property...if we could have something – there are USB chords that are plugs that are this big that hold 40 gigs of data. Why can't we a thing that size we can put into the bottom of the stream that will stay there – glue it to the bottom of a rock. I don't care. Put it down there so we can always know – from the internet, what the water temperature is.*

OSL 14

The individual who had implemented, by far, the most technology was the hydroponic farmer near Bend. His perspective and approach were interesting, as they represented what seemed to me to be an example of the limits that one could stretch both their water efficiency and their technological implementation. He had, for want of a better term, created a 2000 square foot smart farm in a greenhouse. Growing a single crop—lettuce—in an environment controlled down to the tiniest detail, he took pride when he showed me exactly how much water and fertilizer he was using to produce the plants. For him, using technology was about achieving the greatest efficiency possible, and he used other technologies to prove it. I commented on how efficient his facility was, to which he replied, “*Yeah. So, when people are like, “I’m efficient” – “Well, tell me how you’re ‘efficient.’” And, that’s the way I know that we are efficient” (OSL 04).*

For the most part, respondents did not appear overly concerned with cybersecurity issues or hacking, in general, or as it related to potential implemented technology. Perhaps this was more of a function of their lived experience and their relationship to technology than anything else. With so many more valuable and important targets for hackers, why would they target a small farmer?

Another aspect of technology seemed troubling to those interviewed. While technology is creeping into every aspect of our lives, so too has a feeling in some that we may be too connected and reliant on our devices. Particularly troubling, and an issue mentioned several times through the interviews, is the effect of new technologies on young people—specifically the farmers’ children. The farm manager we interviewed described an interaction with a coworker’s child:

*You look at kids with iPads now. My mom – I had to train her how to turn the thing on and I’ve seen five-six year-olds scroll through that thing...I saw a guy I work with, he’s got a little boy – he’s probably three. He took my phone and took a picture and then he knew how to zoom in and stuff with his two fingers and stuff. It’s just naturally – how we’re slowly evolving into it. I think they’ll just naturally have it. They’re not gonna be oblivious to it.*

OSL 15

How will young children in farming communities reframe their identities based on early exposure to technology? How will they view farming, and how will their relationships with their gadgets change their perspectives of which communities they are a part of? While there does not appear to be a body of literature digital natives in agricultural communities, it is an interesting question whose answer could have profound implications on the future of farming.

#### 4.2.2 Economic Barriers

Many small farms—including the ones in this study—simply do not have the economic means to invest in new technologies, precision or otherwise. Of the individuals we spoke with, none mentioned having the type of disposable income required to make their farms *smart* (though I now understand how unlikely it would be for them to brag to me about their financial situation). Rather than having extra money to spend on projects, many had the opposite problem, that they were having trouble paying their bills. As the rancher in the Prologue discussed, he is a multimillionaire on paper, but his income barely covers his costs. And while he could sell his farm to earn the money he would need for upgrades, that plan does not make very much sense, as then he would have some very expensive networked equipment, but no farm.

The USDA FRIS survey asks questions regarding the major barriers faced to system improvements on irrigated farms in the US. The survey distinguishes between large and small farms, using a yearly cash income of less than \$250,000 as the dividing line. According to the survey, 19% of those polled reported “lack of financing ability” to be a major reason, with small farmers accounting for a greater share answering in the affirmative than large farms (USDA 2016).

If cash is not available, another option is to apply for a loan. However, this can prove difficult as well, as many banks lend money to those they see as a good investment and with steady incomes, which many small farmers do not have. As the subsistence-type farmer near Corvallis described it:

*Nobody borrows – or nobody lends money to me. Because my income is pretty much zero. I have enough just to keep things running. I don't qualify for any loans. FSA has been real lenient with me, farm services. That's what I – that's my second loan. First loan was land and house. Second loan was build it to be a farm business and I got about 15 years to pay that one off.*

OSL 02

And while their farms are surely worth a significant amount of money and could be used as collateral for a loan to pay for upgrades or as an investment in networked technology, I would not assume this to be a likely scenario. As the saying goes, “*don't bet the farm, even on a good idea*”.

For most of the individuals we spoke to, running a farm did not earn much money, so spending tens of thousands of dollars on water-saving upgrades, even if they would make their lives easier, may not be worth it since they would not provide a return on their investment. And while some farmers we talked to seemed like they would have extra money for a project, others gave the impression that any

amount of money would essentially be too much money, when the result does not provide any tangible benefits at the individual level. As the pork farmer put it:

*The classic rubric of sorts is that you don't spend money on your farm or you don't do anything on your farm unless it's going to make you money. So if you're set back 10 grand, are you going to get 10 grand worth of production that year or over how many years just to make up for measurement?*

OSL 07

Other farmers discussed a return on investment in a different way. Rather than an economic return, many types of upgrades that save water and reduce fertilizer inputs constitute an *environmental* return on investment—but still require the initial investment to be of a financial nature. Most small farmers are not earning a large profit on the crops and products they sell, and investing money in a new technology without guarantees that the investment will be returned will be a difficult prospect, regardless of how beneficial it may be in terms of reduced energy or water consumption. The Lifestyle farmer, even though she is a heavy user of water, appeared to genuinely want to solve this problem of “who pays?” versus “who benefits?”. Indeed, she was well-versed on the subject, as she had worked for over twenty years in the water policy world. As she put it:

*Part of the problem ends up being is, it sounds really great if you go, wow, we're going to go in there and we can get grants that are going to pay for half the costs. Great. Well, for someone like me, it's like, well, where am I going to get \$20,000? How am I going to recoup that money? And why should it be on me, the landowner? Because you know what, honestly, my stuff works fine right now. I mean, honestly. Why would I go spend 10,000 more dollars? "We're going to conserve water, and it's for the bigger picture in the basin". Well, then someone else needs to step up and help me pay for these things. So it's an interesting dilemma about putting conservation on the landowners' dollar.*

OSL 05

From the smallest business to the largest corporation, economic incentives are an important driver of innovation of new technologies (Knox et al. 2012). Simply put, businesses will not embark on a new course of action unless there is a perceived economic benefit at some point in the foreseeable future. Individuals make economically non-rational decisions for a host of reasons, including for moral or ethical reasons. But most people running a business will consider the economic implications of their actions in these types of decisions. An action that violates the core tenet of return on investment most likely must provide another type of payoff, such as the feeling that the action will provide a moral or

ethical payoff. If a course of action is perceived to do neither of these, it is hard to imagine it being undertaken.

Usually, in situations where an individual has a non-productive water right, the answer to “who pays?” is “all of us”—either it does not happen, and a *Tragedy of the Commons*-type situation occurs (Hardin 1968), or a government agency steps up, and we all pay with our tax dollars. As the head of a county-level Natural Resources Conservation Service office in the eastern part of the state described to me, organizations like his, which is an arm of the USDA, fund many of the projects that occur in the West. By taking federal funds and connecting with local agencies like Soil and Water Conservation Districts (SWCD), irrigation districts, and watershed councils, they can provide funding for larger infrastructure projects that otherwise may not get funded (*OSL 19*). The types of projects that they mostly work on are lining of ditches (to reduce water use), installing fish screens (to protect endangered salmonid species). As he described it, his organization is much less likely to fund networked technology projects, due to both the newness and feeling of it being of a greater benefit to the individual rather than as a community benefit.

Reducing “wasted” water and providing water in-stream for aquatic species surely would appeal to at least some of those we spoke to, particularly the farmer who worked for a watershed council and worked with them to protect salmon spawning habitats. But for individuals who want to add water to streams, there are other options that make more economic and logistical sense, and that will have more of a chance of succeeding. For example, non-profits like the Freshwater Trust work with farm owners to set up an agreement with the government to essentially rent the state’s water back to them to remain in-stream (Freshwater Trust). This is an attractive option for many farmers, as the time period of the lease is not counted against them as a period of non-use (thus risking the dreaded cancelation). For individuals who feels as though they will have trouble growing a productive crop during a certain period, rather than investing in improvements that might or might not work, they can simply lease their water and put off this decision for several years.

There is a major problem here, which may already be obvious from the interviews or the descriptions above. Due to the water rights structure in western states, the individual often will not see any particular benefit from reduced water use. The benefits will be seen by the junior user who was next in line to receive water allocations. Even though all users want to reduce their water use, the structure of the system provides nothing but disincentives.



There may be other, hidden costs associated with upgrading infrastructure or networked technology. Adopting new, water-saving technologies or converting to a more efficient irrigation system may use less water, but these savings may come at the cost of increased electricity usage. As noted in Oregon's Integrated Water Strategy, these upgrades "may simultaneously increase the demand for energy and may drive up energy costs. This tradeoff of increased energy use may outweigh the water-use efficiency benefits, and should be considered during the design of a project, especially for non-pressurized water systems" (OWRD 2012). Since electricity use is an unfixed cost and capable of changing, this adds both a cost and a layer of uncertainty to many upgrade decisions.

Finally, it should be remembered that the average farmer today was born in 1957 (USDA ERS 2016), the same year that the Soviets launched Sputnik, impressing the rest of the world with its technologically-superior *beeps*. This means that someone who is sixty and operating a business may not be able to see a return on their investment within a suitable timeframe, and thus will be less likely to invest. Conversely, as is pointed out by Schaible and Aillery, younger farmers will have more productive years to take advantage of an adopted technology than older farmers, providing them with a better chance to recover the costs of implementation (Schaible and Aillery 2012). While the younger generation may present an opportunity, the average age of farmers in the US presents a barrier to technology implementation.

The findings in this section correspond to literature on technology adoption. Khanna finds that low rates of technology implementation on Midwestern farms are due to "uncertainty in returns due to adoption, high fixed costs of investment and information acquisition, and lack of demonstrated effects of those technologies on yields, input use, and environmental performance (Khanna et al. 1999).

#### Interlude—My Grandparents' House

A few years ago, I was at my grandparents' house during a break from school. Needing to do some homework, I took out my laptop and connected my USB mouse, before going into the kitchen for a snack. Upon leaving the kitchen, I saw that my grandparents were there, hunched over the sleek ebon device, deep in careful, skeptical examination. I watched from the doorway as my grandmother reached out and lightly touched a side. My grandfather picked up the mouse and pointed it at the screen, trying to turn it on, as though it were a television remote.

It was not unlike that famous scene in *2001: A Space Odyssey*, where the chimps dance around an obelisk, trying in vain to reveal its purpose (luckily, I intervened before they could bash it to smithereens with an animal bone).

It was a funny scene to be sure, and we all laughed about it later. But I remember also feeling slightly sad at that moment. Somehow, this simple scene made me think about my own mortality, and how technology will continue speeding up and getting further out of reach, until we give up, or until we die.

Maybe you have had a similar experience? An older relative buys a new smartphone, and you see them, hunting and pecking at keys, holding the device either too far from their faces, or much too close. After several months of practice, they learn to text—but cannot seem to figure out emoji or the right time to use “LOL”. You laugh at them, secretly—but also feel a bit sorry, that their antique brains are unable to adapt to our new and changing world. And you worry that this is the fate awaiting you, in only a handful of years.

This is a generalization, of course, a stereotype about an older generations’ relationship with technology. but perhaps there is a truth in it. Perhaps you consider the future and imagine a time when *you* are the older relative, your technological inadequacy an alternating source of amusement or embarrassment (or amused embarrassment) for your children, nieces, nephews, or whichever younger relative happens to be around. “*Never mind*”, you think, as you smile to yourself. “They’ll see. Eventually”.

#### 4.2.2 Technological Barriers

Two of the most salient barriers to adoption of networked technologies are a lack of cell phone reception, and a lack of high-speed internet access in rural areas. Therefore, we viewed cell phones, computers, and internet usage both markers of a willingness to try other types of networked technology, and as a baseline requirement for adoption of networked technology. If an individual will not use these devices—for whatever reason—it seems highly unlikely that they would be willing to implement newer types of technology, and if they are already comfortable using them, perhaps they would be more open to consideration. however, if an individual expresses an interest but their property is not able to receive internet or cell phone service, it demonstrates both a barrier to adoption and an opportunity.

Indeed, based on the nature of networked technology, it is hard to imagine attempting to implement networked technology without the network. Reliable phone and internet access have been shown to be prerequisites to effective technology implementation (Whitacre et al. 2014). The reasons are obvious, and are found in the name *networked technology*. In other words, the network is important, but in many rural areas, the network is non-existent (having traveled to these farms, Ms. Byrd and I can both personally attest to this.) The connection to the outside world—along with potential new markets for

goods—that high speed internet provides may also be spur other types of technological implementation (ibid.).

The strength of current networked technologies, and the vision of IoT proponents, is that the large amounts of data that are uploaded online and shared in real time with many other connected devices. They presuppose a strong and reliable internet connection available whenever the system is functioning. While certain sensors and processes could use other technologies, such as radio frequency identification (RFID) system, or create a local area network (LAN), to communicate between devices, these solutions would likely require a high degree of personal knowledge and ability to establish (Stubbs 2016).

Federal efforts to expand broadband in rural areas have faced challenges. An investigation by the online news organization *Politico* found that the government spent billions of dollars in a largely unsuccessful effort (Romm 2015) which managed to bring faster internet to areas already receiving service, but failing to make an appreciable difference in areas without any service at all (Romm 2015). However, the federal government is not giving up. On February 23<sup>rd</sup>, 2017, the FCC announced plans to invest \$2 billion to bring broadband to rural areas in 20 underserved states (FCC 2017).

A lack of understanding about new technologies may present a barrier to implementation. The small farmer near Corvallis, when asked about barriers to technology adoption that she had experienced personally, said:

*I am my worst enemy and I limit myself. So I'm sure there's tremendous technology, it's cost and time. It may save you time but it takes you cost, it takes you time to put it in, to keep it maintained, to check it and to buy it. Someone gave me three, 400 feet of drip line, I still haven't used it. So even if they gave me this stuff. I have to learn and I have to maintain it.*

OSL 02

It follows that a farmer who has trouble with implementing a sprinkler system or a drip line that uses 1950s technology may feel significantly more cautious about digital, networked technologies. In the USDA FRIS survey about barriers to irrigation system enhancement, 22 percent of respondents answered that the largest barrier they face was that they "have not investigated improvements" (USDA 2016), which received the largest share out of the possible responses. Though the phrase was not uttered during the interviews, I would imagine a number of farmers saying, at least to themselves, "if it ain't broke, don't fix it".

There is surely a certain amount of inertia that could be considered a barrier. If you do something one way for your entire life, it may be difficult to change to something different, especially something as radically different as networked technology. Some farmers will probably resist technology simply because they have always done things a certain way, and it works sufficiently well. The methods that they are using may be old fashioned, but at least they still work. A farmer near Albany who grows flowers and vegetables to sell at the farmer's market, seemingly to demonstrate how far removed his system was from networked technology, sheepishly told my co-interviewer:

*Part of it is I want you to understand how this system works and just to get a little feel for how outdated it is. I mean, it's run the way it was in the early 1900s. I mean, very little technology is really involved.*

OSL 08

A barrier to technology adoption for small farms is in a way the same "chicken or egg" problem seen in many other scenarios, where adoption of a technology requires a certain condition being met, but that condition requires the initial technology.

Perhaps a demand is sufficient for a technology company to commit to researching and developing a new product to meet that demand. However, consider the following anecdote from psychologist and technologist Eric Haseltine, who provides a nice example of how difficult this can be. In a recent radio interview, he asked the audience to "imagine a color that you've never seen before. And you can't do it because our brains construct things from building blocks of what we've experienced. If you've never experienced it, you can't imagine it" (Raz 2017). Perhaps not a perfect analogy, but there is a general truth in this statement. Our desires are not always logical.

*That actually restricts innovation, especially in a dynamic system where you want to be continually improving something. You have a product like a toaster, that's one thing. You can wait 10 years for the next better toaster. Who cares? But something that needs to be continually iterated and adapted and changed like an application, which really the first time you develop it sucks, and you need to improve it over time.*

OSL 06

This comment exemplifies a problem like implementing networked technology on a small farm. There will surely be a learning curve for the companies developing technologies, but who wants to buy an expensive, faulty toaster that they do not need and cannot afford? This seems to get at another issue, that of finding the spot for technology where it is not too narrow as to be useless to most of the

population, nor too broad that it essentially not helpful in any way that an individual would pay for. Designing technology too broadly, or too narrowly, will lead to problems. The organic farmer in the Southern Willamette Valley noted this (though her farm does not have cell phone or broadband access):

*The biggest thing I think we see is that a lot of ag operations can't pay for the technology by themselves because they don't have a big enough share hold in the business. You can probably sell a smartphone, a specialized smartphone, as an example, to every farmer and it probably doesn't mean a darn thing to Samsung or Apple because they don't have a big enough market share.*

OSL 01

While many people we spoke with did not have many comments about privacy and data sharing, it likely would be a concern if implementation of networked technology were to continue. For example, this was an issue already dealt with by the largest farm in our study, which had implemented a considerable amount of sensor-based technology as well as automation. As the farm manager described:

*We definitely don't want to let them know whatever they want, especially on the accounting side. We host mostly everything except for a few programs that go up to the cloud, but of the data they've got, it's not going to give them a whole bunch. And then we have strong user agreement to where they can't use that data for anything but – you know...a lot of these companies are really data farming, basically, so to speak, so they try to get you – “Here's some free for your software, oh, yeah, but we get to keep your data.”*

OSL 15

It is a problem that is noticed on a corporate level, as well. Comparing two tech companies can demonstrate the potential privacy concerns that smart farming entails. *Farmers Business Network (FBN)* and the startup *Farmobile* both promise to use big data to help grow farm income and increase yields, but they address data sharing and privacy concerns in very different ways, which are readily seen on the home pages of their respective websites. FBN's message is “Strength in Numbers”. Their website promises to “increase your farm's profits with the combined intelligence and buying power of thousands of America's most elite farmers” (farmersbusinessnetwork.com). The company gathers sensor data of the farmers in their network and shares it—anonously—with other members, creating a source of large bank of information. The website of *Farmobile*, by contrast, features in block letters, the statement, “The most resilient farmers own their data outright” (farmobile.com). In a description of their flagship product, a sensor array to collect on-farm information, they state, “we believe data is one of the most valuable things a farmer harvests, and yet too many of our neighbors around the country give their information away for a pittance. No one should ever know more about your farm than you “, continuing, “It's

*time to protect your data like the significant asset it really is. Own your data. Own your relationships. Own your margins.”*

On a broader scale, issues of agricultural data privacy have received increased attention in recent years. Stubbs (2016) discusses the current federal responses to protecting both public data and the massive amounts of data generated by an increasing use of sensor technology. And in Australia, the government convened a panel on smart farming, concluding that “there needs to be agreement between the producer and the equipment manufacturer regarding ownership of, and rights to, (collected) data” (Australia 2016).

IoT, perhaps the techno-fix *du jure*, is promising a world free of the inconveniences we all know and hate. From traffic lights to waiting in line to running out of your favorite product, all these problems will soon be relics of the past. In the agricultural system, IoT and networked technologies are being framed in a similar way to farmers (Stubbs 2016). But what are the costs of engaging with IoT and networked technologies from the perspective of a small landowner? IoT offers both promise and peril in its ability for disruption. A 2014 article in Wired magazine entitled *Why the Internet of Things Will Disrupt Everything* states, “IoT has the potential to create massive disruptions in telecommunications, cable/broadband, cloud computing, and even how we define the internet” (Amyx 2014). The concept of *disruption*, despite the term’s recent popularity, is not necessarily a good thing. While Uber *disrupting* your taxi experience may be a good thing, somebody’s cell phone disrupting the performance at the symphony is less good. And when we ask the question, “good for who?” We see that it is not good for the cabbie who loses his job. And for every dream of a coffeemaker which knows you have awoken based on sensors on its communication with your smart mattress, there is a nightmare scenario, like the refrigerator that sent out hundreds of thousands of spam messages as part of a global botnet (Zolfagharifard 2014), or—much more ominous—the pacemaker that is vulnerable to disruption via remote hacking (Taylor 2016). These stories may provide pause when considering the unforeseen impacts of networked technologies.

Consider again the previous description of the types of applications that are possible with networked technologies. Clearly, there exists an economy of scale concept when considering implementation. Purchasing a drone will be of little use without a device to send information to. And a device will be of equally little use without tools to monitor. A single soil moisture sensor may provide a small benefit in a localized part of a field, but may not be of significant benefit. A field of soil moisture sensors, however, can give a much more complete picture of the moisture levels and efficiency of irrigation equipment.

Coupling these sensors with a networked, micro-drip irrigation controller provides even more benefits. And having a handheld device that can monitor the goings on—and a data plan to cover the massive amounts of data being transferred—increases the advantage further. This must occur to farmers considering implementing new technologies—that the *Internet of Things* will work best when there are many *Things*, each of which will cost money and require a new set of skills to master.

Finally, a resistance to technological solutions may also be rooted in a more general fear and resistance of the unknown. The small farmer near Portland provided her opinion about genetically modified (GM) crops:

*I don't want Roundup Ready corn. I don't. That just seems terrifyingly gross to me. There's a whole variety of corn out there that was developed so that if a certain kind of insect eat it, it causes that insects stomach to explode. What does that do to me?*

OSL 14

Though studies have shown no difference between in terms of human safety between GM and non-GM crops, a fear of this technology has persisted in wide swathes of society (NAS 2016). On the other hand, many farmers use GM crops, assumedly with little concern that their stomach's will explode. This elucidates the fact that what we resist and fear is not always based on a rational examination of scientific evidence, but more likely on assumptions and opinions we have fostered over time. The idea of being at once resistant to, and captivated by new technologies is not a new theme. As Jerry Mander wrote nearly 30 years ago:

*we are now embedded in a system of perceptions that makes us blind and passive when it comes to technology...The deer becomes fixated at oncoming headlights. The fish stares at the face mask of the diver who spears it...we are hypnotized by the newness of the machine, dazzled by its flash and impressed with its promise. We do not have the instinct as yet to be fearful or to doubt. (Mander 1992)*

Literature about technology adoption suggests the issues raised by the above respondents are not unique. Batte and Arnholt surveyed farmers who expressed similar frustrations with the reliability and implementation ability of networked technology implementation, writing that IT technology implementation was “far from a turn-key technology”—at least in 2003 (Batte and Arnholt 2003).

#### 4.2.3 Legal & Regulatory Barriers

There are other barriers to both adopting of new technologies and mandates increasing irrigation efficiency. These barriers lie in within the prior appropriation water laws governing the West. Because of the intricacies of the legal framework, conserved water likely will not translate into new water

for environmental purposes (Molden et al. 2010). It will probably be given to the next farmer in line for water. an example of this is the issue of agricultural “tailwater”. Tailwater refers to the differential between the irrigation water removed from a stream or aquifer, and the amount that seeps into the ground or is taken up by a plant (Ward and Pulido-Velazquez 2008). You can think of it as runoff. The reason tailwater is important to consider is because of the water’s destination. It Eventually either returns to the stream (probably downriver of the collection point) or flows onto another field (though it can also seep into the ground after leaving the field). This water is measured (at least in a crude format) by regulators, and relied on by both other users and for in-stream flows. the water is not “wasted”, but rather runs off and is used by another farmer. Conserving isn’t getting “new” water. switching to drip will not solve the problem, only reducing water for another user. Regulatory barrier—perhaps it is not a regulatory barrier per se, but there is an issue regarding conservation and water law that means saved water, unless it is saved in a very specific manner, will not result in water returning to the stream. Unless use is by a junior user, or is done in conjunction with an agreement to return water to the stream, it will simply be used by a junior user (Molden et al. 2010).

Per Western water law, applying for a change in a water right will not be approved if it is shown to harm the water rights of any other user—junior *or* senior (Goldfarb 1988). Therefore, a change in application from a less efficient irrigation system to a more efficient one (flood irrigation to drip, for example) could be challenged based on this principle. Whether this challenge would occur is less clear, but the fact that any upgrades made by an individual user could be potentially deemed illegal at a later date could give pause to the irrigator. A misunderstanding of water law, even among farmers who rely heavily upon an adequate supply of water—and a disinterest in engaging legally with the water rights system, thus represents a barrier to improvements of irrigation systems.

Two individuals, both ranchers in Eastern Oregon, had participated in water leases, and were not impressed with the results. One rancher from Eastern Oregon professed a skepticism about the end result, saying that the stream condition was worse after the transfer, due to the hydrology in the area, “*which the scientists don’t seem to understand*” (OSL 16). While individual, non-obligatory actions like water leases and transfers may provide a small benefit to specific areas, they are unlikely to see any significant increase in adoption without external pressures to do so (Merrett 2002). The same may be considered true of irrigation upgrades. They are costly and time consuming, and their water-saving



measures mainly provide a benefit to environmental flows. However, even this benefit has been questioned. In a recent study, Batchelor finds that water saving technologies have less effect on improving environmental flows than has been previously thought (Batchelor et al. 2014).

#### 4.3 Future Visions: Water Use, Farming, & Technology Change

The concept of the future was an important theme of this study. As an indefinite concept, the term means different things to all of us. To some the future represents a week from now, while to others it means a year, a decade, or a century hence. We were interested in farmers' and policy makers' views of the future, from whatever perspective they wanted to discuss it, and our conversations ended up encompassing topics as wide ranging as planting decisions, future water availability, their children, technology, changes to government regulations, and the environment.

Following ethnographic practices (Clifford et al. 2010), many questions were broadly framed to allow for the interviewee to interpret it in their own way: *"looking five, and then ten years into the future, do you think your life will be better, about the same, or worse? Why do you feel this way?"*; *"What do you believe are biggest challenges facing humankind today, and in five, ten or twenty years?"*. We also included more pointed questions about certain aspects of the future: *"would you like your children to grow up to be farmers?"*; *"what do you think farming will be like in the future?"*; and *"what is your opinion regarding climate change?"*

The organic pork farmer expressed his fears of the future in socioeconomic terms, and related them back to farming. He did not grow up on a farm, feels that it hard but important work, and supposes that the future of farming will present too many barriers for people like him, who started farming later in life:

*I think that the more young people have been removed from the land, and if only 3% of the population's a farmer, that means a lot of young folks didn't grow up on a farm. And if that's intimidating to them, it might be a hurdle they never want to cross. And we have this cultural understanding, "We'll just hire people from other countries to do our farm work for us." So I fear that young people really won't because of the economic disparity, they're not going to have as easy of a chance, because the land is being consolidated, there's less land, and then, if their only chance is to be labor on a farm setting, it's such a soft labor market, they might do it out of idealism for a few years, but it's going to beat up on them a little too hard, and they're going to look for something else.*

Others, like the rancher near Eugene, considered the question from the perspective of his own family. He was happy that his own daughter, who recently returned from living in the city, would be continuing the farming tradition:

*Part of it's timing-wise, I suppose. But part of it is just interest-wise. And so you never know. So H----- will be the third generation on the place, I guess. Sixth generation in the Valley. Yeah, we were very excited when she decided to come back and continue. You just never know from one generation to the next how it's going to go.*

OSL 13

The small farmer in the Willamette Valley also discussed her the future in terms of herself and her adopted daughter. Her situation was tenuous, and in other parts of the interview she discusses concerns with both water availability and economic solvency:

*Yeah, I have to do this until I die. [LAUGHTER] Or I get crippled up or something... but I'm single. I can risk these things. If you got a family, you can't risk it. You need to have all those medical safeties. And you need to have a constant income. So I'm not sure if this would be possible with a family. With Madison and I, we're getting by. But DHS helps in that too. We're winging it.*

OSL 02

Though focused on her own particular situation, she was aware of her interconnectivity with her community and the climate. The conversation turned to issues of climate change, to which she presented a resilient attitude, and a feeling that she would be able to adapt to future problems. Perhaps mirroring her current financial issues, the future concerns she mentioned were framed in their relation to her own economic situation:

*We may complain when we get 10 days of nothing but rain, but when the summers are this hot and this dry – and the world is changing. I can't change that. So I have to adapt. And you know that is the world adapting. Nothing stays the same. That's the only constant thing in this world, is change. So if I have to change, I'm changing. Maybe I have to give up the trees. Maybe I have to pull up the berries. I don't know. We'll see. And a lot of that is also economy. If gooseberries are bringing in \$10,000, I ain't gonna pull them up. [LAUGHTER] If cherries are only bringing five dollars maybe I'll pull up the cherries.... People in Oregon will buy local stuff, and that's why I'm still here. Because they pay my outrageous prices because they know it's local and it's supporting me.*

OSL 02

A concern for the future is not a new concept in agriculture. According to the FRIS survey, 84 percent of farmers who irrigated expressed an "uncertainty about future water availability" as a barrier

to irrigation system improvements were smaller irrigated farms (USDA 2010). Carey and Zilberman describe the uncertainty of water resources as a significant barrier to technology investment. Discussing uncertainty in relation to potential water markets, they find that potential markets, uncertain legal terrain, uncertainty on recouping costs, and worries about overall access to water all provide roadblocks to implementation of new technologies (Carey and Zilberman 2002).

Future uncertainties were related to local issues and regional economic and weather trends. 2015 saw the continuation of a historic drought gripping much of the West, including Oregon (Check Hayden 2015). This drought, and governmental responses both in Oregon and to the south in California clearly affected how farmers viewed their situations, at least in terms of water and harvest potential. As the Eugene rancher described it:

*We had a very average crop this year, but people had quite a bit (of hay) left over. With an average crop, we're sitting pretty good. If we have another year or two of drought, I don't know, you know?*

OSL 13

The Lifestyle farmer, who worked for decades and still maintained connections in the local water policy community, was concerned about climate change and future water availability. She was attuned to both the local and the regional, and expressed a deep concern for the region's economic well-being and the farmers who rely on irrigation water to produce a crop:

*Everybody's worried, but really the irrigators, too. Those that produce a hay crop right now have been pretty worried all year. Now granted, there's only a handful that that's their livelihood, but that's their livelihood. And the rest of us need to be concerned because although I don't produce hay, I buy hay, so what did I buy this year? About 15 tons. So, all of us that have critters need hay. So, the drought would have impacted us. We're lucky that it didn't affect the hay production this year. But, it will potentially, if we don't get some water and fill those reservoirs, next year's hay crop will be impacted. I'll be impacted. Any of us that have critters that buy hay are gonna be impacted. Either in the price or availability.*

OSL 05

Describing the problem in a holistic manner, she focused her attention both on the farmers themselves and on the irrigation districts that supply many local farms with irrigation water in light of a changing climate (Swalley, Tumalo, and North Unit are irrigation districts in the Bend area):

*So what do you do? Normally I buy 15 ton hay, I can't get 15-ton next year? You know, it's like whoa. I can't make them eat less. I need what I need. So, it'll be interesting to see what happens next year. So people are pretty concerned this year.*

*Knowing that if this continues next year, what are we gonna do? A lot of our water, Swalley's doesn't particularly come from storage, but Tumalo does, North Unit does, a lot of them have a storage component to it, and if those reservoirs don't fill, they're not going to be able to serve their people, so how do they decide who gets it and who doesn't?*

OSL 05

The farmer near Portland answered many of our questions from an environmental perspective. She discussed her fears for the future, and cited it as a reason why she started her farm, to set an example for both her child and for her community:

*I think the future...is kind of terrifying...Environmentally for sure because of the way that – climate is changing dramatically because we have more and more people. They're utilizing more and more resources in a less and less sustainable way, especially farming. One of the things about why I grow food is that the most alarming statistic I know about America is that we produce enough food to feed not only everybody in the United States twice, but then some. But we also have starving communities and a crazy level of obesity and also a really ridiculous food waste rate and it should just be – it should not happen. If we're going to be a forward thinking community then we should be doing better. We should be better stewards for the rest of the world.*

OSL 14

While some answered the question in a broader way, thinking about melting ice caps and IPCC reports, the individuals we spoke with by and large talked about the seemingly small changes and trends that they had been seeing in recent years, which, if continued, could end up setting in motion larger problems for the individuals as well as for the region. Discussing the dry, hot summers brought the Eugene rancher into an in-depth discussion about feeding times for cattle, and the wider effects this might have:

*a lot more 90-degree-plus days that just cooks out the grass. It doesn't take long. And so that's been a challenge. So then, in theory, you're going out and you're starting to feed hay a whole lot earlier. I mean, we're feeding some now, and probably feeding less than some people. But if you don't have enough hay put away – you don't need to figure, well, I'll feed a little bit in August and September. And then you'll get some fall rains, and be able to quit doing that for maybe a couple months. Then you get some fall forages that came on. And then by first part – late November, mid-December, you're back to feeding kind of gradually in the full-time. That's all they're going to get until the first of April. Even middle of April, kind of we're kicking them back out, taking them off of hay again. So you know, in a drought, that just gets – the feeding time gets lengthened, you know, fairly significantly. And so then, you know fortunately we had a lot of hay left last year 'cause it was a pretty mild winter. We had a very average crop this year, but people had quite a bit left over. With an average*

*crop, we're sitting pretty good. If we have another year or two of drought, I don't know, you know?*

*OSL 13*

The concept of farmers' perceptions of the future has been explored in extant literature. Sulemana and James connect the concept of farmer identity—as conservationist or productivist—and technology implementation, finding that implementation decisions regarding agricultural, water-saving technology will be viewed within existing ethical and identity frames. Possessing an overall optimistic or pessimistic outlook on the future will also affect technology implementation (Sulemana and James 2014). Other literature on the topic confirms this perspective (Burton and Wilson 2006). While farmers in this study were not specifically identified as possessing an optimist or pessimistic worldview, ethnographically-framed questioning help elucidate the perspectives of individual farmers regarding future perspectives and technology implementation.

## 5. APPLICATIONS OF IWRM & CONCLUSIONS

### 5.1 Barriers to IWRM Implementation

When evaluating a policy framework, it seems logical to attempt to understand its applicability in multiple contexts, and to ask how well it can explain a particular situation. Water policymakers in several states, including Oregon, have implemented or are considering IWRM strategies (AWRA 2012). Therefore, it is worth examining, whether as a framework or a specific tool for problem solving, whether IWRM is compatible with small farmers in Oregon.

Whether the focus is within the US, or internationally, it is tempting to remain at a low level of granularity when examining water issues. In fact, a large portion of IWRM literature focuses on trans-boundary issues, relationships between governments, or purely institutional communication rather than on individuals (Baldwin and Hamstead 2015). If any individual needs are discussed, they are in passing. There is no doubt that understanding institutions is important, but a sole focus on institutions at a wide scale can obscure the fact that institutions, the plans that are made within them, and the agents that carry out these plans are all individuals, with their own sets of values and cultural experiences. Additionally, many members of certain institutions, especially in the West, are also farmers or ranchers, and often active members of their communities. For example, I interviewed the head of a SWCD whose full-time job was as a cattle rancher. This man oversaw a small fiefdom in the county. The same is true of a water master, a US Forest Service employee, and the head of a watershed restoration council, all of whom worked either full-time or part-time as farmers or ranchers. The following pages are my attempt to examine the stakeholder in their role as active participants in water policy discussions in Oregon.

This critique is not meant as a blanket criticism of IWRM or its underlying values. Rather, my goal in this section is to demonstrate the difficult task and possible pitfalls of trying to implement a seemingly good idea, without fully considering the perspectives and needs of the individuals involved. Dealing with individuals can become messy very quickly, especially when those individuals are small farmers, and pretending as if all farmers have the same set of needs and desires is unhelpful.

The following discussion will be divided into three sections that each examine an aspect of IWRM through the lens of a rural Oregonian farmer. The first addresses how stakeholder participation is determined—that is, who is and who is not a stakeholder, and how is this decision made. The second portion examines specific methods for engagement and participation between implementers, stakeholders, and

other interested parties, and the logistics therein. The third questions how we can gauge success or failure in the process, and who decides this? Finally, I discuss both the explicit and implicit goals and values that both IWRM and networked technologies represent, through the lens and perspective of the small farmer.

### 5.1.1 Identifying Stakeholders

One of the primary concepts that IWRM is based on is the interconnectivity of individuals and processes previously thought separate (Grigg 1996). Taken from ecology, this concept of interconnectivity has permeated many other fields. This raises a basic question: if we are all connected, is everyone a stakeholder, even if only in a very small way? Practicality and operationality tell us the answer must be *no*, at least in a policy discussion. But this glib question leads to another: if a line must be drawn, between stakeholder and the non-involved, where is it drawn, and by who? It is here that a major tenet of IWRM becomes relevant to this discussion, another concept that has gained wide application, and that is the role of the stakeholder. Most literature cited in this paper does not even define the term, but uses it to mean an individual or group that has some sort of material interest in a certain outcome or process. But this is a vague concept, as interests can be open to interpretation.

Surely some individuals have more at stake than others. Are there classifications of stakeholders in a particular project? Are they identified as major versus minor stakeholders? IWRM literature offers little or no guidance on this point. As an example, consider the water needs of Intel Corporation. Intel manufactures microchips at multiple locations around the state, and requires large amounts of ultra-clean water do so. This process leads to the creation and maintenance of many high-paying jobs and millions of dollars in profit for shareholders. Therefore, it could be argued that Intel has a material interest in the cleanliness of the water they consume. Intel also provides hundreds of millions of dollars in tax revenue to the state, which is relied upon for a great many purposes. Are state agencies, then, considered stakeholders in a project that could affect Intel's water supplies? Also in Hillsboro, perhaps there is a small manufacturer of widgets, which has a water right to a small amount of water. As well, there is a restaurant down the street that uses water to wash dirty plates. And next door to the restaurant, a pastor at a local church who uses water washes dirty feet. Clearly, these individuals all have an interest in clean water, but are they all stakeholders? Is one more important than another? Is Intel a "major stakeholder", while the widget manufacturer a "minor stakeholder"?

Further complicating matters are the legal issues in stakeholder involvement. Consider that in Oregon, federally-designated Indian tribes, like the Klamath in the southern part of the state, have both

an independent legal system and a special set of water rights. Rather than receiving a priority date in the form of a year, their water right states their date as *time immemorial*, representing the ahistorical nature of Indian settlement and their traditional reliance on salmon for sustenance (Colby et al. 2005). This issue was brought to light in the Klamath basin water conflict of the early 21<sup>st</sup> century (Jenkins 2008), which took years of negotiation to reach a resolution and resulted in the violent deaths of a handful farmers and Klamath. Should the Klamath be stakeholders in water issues in Southern Oregon? Will they be represented as a single group, or can individual tribal members be stakeholders, as well? Cases like this are demonstrative of the complexities of water rights negotiations, and the importance of stakeholder identification.

In issues involving water resources conflicts, stakeholders are identified based on their geographic proximity to the project or problem at hand (Lautze 2014). However, due to the water rights system in the West, the geographic aspect of stakeholder involvement is less cogent. Consider Mono Lake, which through complex legal maneuvering, was nearly drained by the city of Los Angeles in the early 1900s, despite lying several hundred miles north (Wood 2014). Those who benefit and those harmed may live many miles away and have no connection or even knowledge of the other.

While it is hopefully clear that many agricultural users have many reasons why they farm, stretching beyond simple economic reasons, Oregon's plan does not differentiate between small and large farming operations, nor does it differentiate the different approaches that may be needed to reduce water consumption on economically productive versus non-productive farms. There was no distinction made between types of farmers, nor was there any commentary within the plan about addressing potential barriers to implementation of new and integrative water saving technologies. The document simply refers to the needs of farmers and the importance of their input and collaboration (OWRD 2012).

The difficulty of stakeholder involvement is not new, nor constrained to the Western US. It has been a hallmark of many projects dealing with natural resources. For example, hydropower development overseas has been frequently cited as an example of a failure to achieve meaningful stakeholder participation that meets the needs of the affected individuals. Scudder (2005), Biswas (2008) and Tilt (2014) all offer critical views on governmental interaction with stakeholders, and shed light on the limits that stakeholder participation can achieve. Other writers (e.g. Vörösmarty et al. 2010) discuss the ecological impacts of hydropower development and how the impacts of a project extend much further than



has been generally acknowledged. These papers discuss forced resettlement and social impacts of hydropower construction, but could be considered an extreme example of the impacts governmental water policy decisions can have on individuals.

### 5.1.2 Meaningful Stakeholder Participation

True stakeholder engagement is framed as both a positive and central feature of IWRM (Snellen and Schrevel 2004) (Biswas 2008). But engagement comes with its own set of risks and costs to the individual. For small farmers in Oregon, engagement with the government may be difficult, if the farmer feels that they are using water illegally, as is the case with at least four individuals in this study. For them, engagement may mean a loss of one of their most cherished assets, their water right. Cancellation of a water right for most irrigators would likely mean the inability to continue farming. This represents a barrier to collaboration that disproportionately affects small users who may be less knowledgeable about water rights and less able to afford legal counseling to advise them on their rights.

Assume now that whatever individual or agency in charge of organizing and identifying the criteria that makes an individual a stakeholder in a water discussion. The next step is even more challenging. Once stakeholders are identified, an effective mechanism for participation is necessary. Again, IWRM literature offers little guidance regarding what this entails or what form participation with stakeholders should take. Is it in the form of meetings? Are the meetings public, or by invitation to those identified as stakeholders? If there is an agenda, who decides what is a suitable topic for discussion? And are actual binding decisions made, or are the meetings for listening purposes only? The underlying question is, *at what level is proper for stakeholder participation to occur, and who makes this determination?*

Even a seemingly-mundane task, reaching out to stakeholders, may prove very difficult. Determining how, and for how long, this recruitment process would occur, is a challenge. Will a notice be published in a newspaper? While this might meet a legal requirement, individuals living in rural and low-population areas may not be served by a local newspaper. Perhaps an automated telephone service calls every land line in a certain geographic area. But in an era where many individuals no longer maintain a land line, the efficacy of this method may be limited. Similar problems arise with internet and cellular phone access. As the interviews point out, access to communication technologies is not evenly distributed.

The Oregon plan's stakeholder participation consisted partially of 12 meetings, held at various locations around the state. While I could not find a list of the locations, it seems safe to assume that there were many farmers—especially in Eastern Oregon—who would have to have driven 50 or 100

miles one-way to attend a meeting. Perhaps, at some point in the evening, they could stand at a microphone for one or two minutes and express a concern about water use. And then drive another 100 miles back to their farm. Farmers are busy people, as hopefully the interviews elucidated. Many small farmers work second jobs to supplement their on-farm income, and in their remaining time take care of their families. To them, this represents a barrier to participation, especially considering the type of participation—a public meeting—that was available.

In this type of meeting, and others conducted under the auspices of IWRM-style stakeholder participation, who sets the agenda? Will the issues to be discussed be preplanned? If so, when are these determinations made, and who makes them? Inviting stakeholders to participate will surely bring a range of comments and ideas about how to proceed. Whose opinion wins out? As there are no universally accepted models for evaluation, the purpose of an evaluation should be clearly identified and agreed upon with all stakeholders in its planning (Bellamy et al. 2010).

IWRM makes clear that a core value of the concept is environmental protection. But who speaks for the environment? Presumably a state or federal agency would take this role. However, in 2017, it is not as difficult to imagine a situation where a federal agency may abdicate this role, or offer less than desired levels of protection for an environmental issue than a particular interest group may desire. In these cases, who has the final say?

This set of problems mostly revolve around the concept of *equity*, and are not unique to water management. They are core questions at the heart of public policy (Stone 2012), and one that has no easy answer. Lacking a proper framework or a realistic plan for finding, listening to, and implementing the ideas that stakeholders bring, will end up causing a whole new set of problems for water agencies. The impetus for solving these problems will fall to an individual or group of individuals at some level of government. And the success or failure, it seems, of designing and implementing an IWRM plan, without guidance, has much more to do with how well this individual or group's planning and implementation abilities than on any tenet of IWRM.

### 5.1.3 Determining Values and Quantifying Success

Unfortunately for IWRM practitioners, many people and groups have different sets of values, and value water differently. They also use water to promote their own values. Even when two groups ostensibly agree on a particular value, serious conflict may still occur. As an example, consider a meeting where two stakeholder groups advocating specific environmental causes are asked by a water agency to read a statement and determine how much they agree or disagree. The statement is, “concerning water

resources, environmental protection is very important to me". Nearly everyone in the room says that strongly agree. That is a successful outcome, correct?

Maybe not. The two (made up) groups are named "*Friends of the Salmon*" and "*Zero Emissions to Save the Planet*", and the question discussed is regarding how much electrical generation should be allowed at hydropower facilities in the state. The pro-salmon group feels the answer should be zero, because saving an endangered species is the most important goal right now, and *extinction is forever*. The other group's members know that most important task to save the environment is to reduce emissions, and the best possible method is to generate more electricity from dams. At some point, and probably not at that meeting, someone will determine an acceptable level, and it will be based on some evaluation of the importance of some set of factors.

It is easy to see how other types of values could be subsumed by this process. The above example relates to two issues that have legal and regulatory importance, and a large body of law that can be used by regulators in support of whichever choice they eventually decide on. But consider, now, the community and aesthetic values that were so important to the lifestyle farmer near Bend. How do these comparable to the economic value of industrial agricultural production, or the environmental benefit of increasing in-stream flows? Remember, her *inefficient* water use was supporting a non-profit that provides help to abuse victims, and, in her opinion, helping the local economy by beautifying paths used by road cyclists. How can we possibly compare these two uses of water? And who is tasked with doing so?

Aside from these concerns about values, there is another question to consider: That is, *what are the underlying goals, and how do we know if they have been achieved?* To put it blithely, *what's the point?* What is success, and when is it achieved, is in my opinion critical before embarking on any IWRM plan, especially when stakeholder involvement is included. I argue that there will be irreconcilable problems and contradictions with any set of goals, no matter how vague or specific, when working with the underlying assumptions that view all uses of water, and the meeting of the needs of stakeholders, as vitally important.

Does successful implementation mean that we all share water equally? Does it mean that we follow legal dictates and ignore changing social situations? What happens when a legal right is in direct opposition to a spiritual right for water, or a sense of fairness? Being able to say that a process is successful means that you need to have a solution in mind before starting the process. And having a solu-

tion in mind frames and limits the possibilities of what can be accomplished. This is an important question, because, regardless of the answer, one would hope there exists some benchmark, some way to look at the process (either in real time or in retrospect) and answer the question, *was this effective?* and *did it meet or exceed the expectations established at the outset?* Perhaps there are no goals, and it IWRM is purely processual, a set of ideas to pay attention to rather than a strict set of benchmarks. Regardless of which of these is true, or whether the truth lies in the middle, all parties should be clear at the outset what IWRM is and what it is not.

Even seemingly non-objectionable goal can hide underlying problems. One such goal is the overall reduction of water use by agricultural users. Perhaps a farmer can save significant volumes of water by changing her flood irrigation to pivot irrigation and replacing her alfalfa with fruit trees. This may meet an IWRM goal of significant water reductions, but it also represents a *hardening* of demand, as the trees must now be watered every year or they will die. This is also known as *water flexibility*—some uses of land and water are more flexible than others, meaning that they can be changed from one type of use to another more easily (Hileman et al. 2016). While her alfalfa field could be considered wasteful, it could be fallowed for a year when conditions required without resulting in a permanent destruction of assets. Therefore, simply calling for a reduction in overall use could have unforeseen negative consequences in the future.

I am not the first to offer criticism of the ideas behind IWRM. The fiercest criticism that I have seen comes from Biswas. In his sweeping critique of IWRM as a concept, he pays close attention to the *meaning* of specific terms. In relation to IWRM's call for an equitable distribution of water, he asks, "What is precisely meant by equitable?" And critiquing the vagueness of the term "economic and social welfare" used in the often-cited GWP definition, Biswas writes:

*What exactly meant by economic and social welfare? Even the economists and the sociologists cannot agree as to what actually constitutes economic and social welfare, except in somewhat general and broad terms. How can the issues related to social and economic welfare be quantified? Can these be even quantified? Are water professionals capable of maximizing economic and social welfare in operational terms, a fact that has mostly eluded even the social scientists thus far? (Biswas 2008)*

Other examples of critiques of the vagueness of IWRM terms come from Cook and Spray (2012), and Jønch-Clausen and Fugl (2001), the latter stating that "to some extent, IWRM degenerated

*into one of these buzz-words that everybody uses but that mean many different things to different people",* claiming that such ambiguity *"obscures the debate and creates unnecessary misunderstandings"*.

Another goal of IWRM is ecosystem improvement (Lankford 2012). Again, what does this mean? It is tempting to think that we can all agree on what an "improved ecosystem" means. But, as interviews with farmers in Oregon show, there are many opinions regarding what a healthy ecosystem looks like. Some farmers and ranchers feel that their irrigation techniques, flooding fields in an uncontrolled fashion, are helpful to the overall environment. As some of the above quotations show, farmers have different ideas about both plans and end goals for ecosystems. If these are the stakeholders, how do we come to terms with their opinions versus the opinion of an ecologist? After all, many of the farmers have spent their entire lives living on and observing the same plot of land, and may feel offended at the idea of a scientist coming on their land for a week and then determining that they know best. The farmers we spoke to generally feel that they are already doing a fine job working with regulators, attaining efficient water use, and protection of aquatic species—all goals of a successful IWRM implementation—without increased oversight of water use or networked technologies.

In a way, IWRM has the seeds of its own destruction sewn within it. IWRM literature makes the claim that we are all connected by water, and all uses are important. However, in order to accomplish something, someone—probably deep within a state or federal water agency—must say that, "yes, all uses are equal. But some uses are *more* equal than others." This is not an easy determination to make, and one that will probably be made far away from a stakeholder meeting. Though it strives to be objective, IWRM possesses several built-in implicit value judgements. By exogenously setting standards for success, but stating that the internal process of stakeholder involvement is important, it becomes both contradictory and perhaps impossible to apply. As Lautze states, "how participatory can a planning process be if the goals are predetermined by IWRM constructs?" (2014). Eventually, one of these two contradictory statements must give way to the other in order to achieve any progress. So far, IWRM has been successful in pretending to be stakeholder driven, while continuing business as usual. Whether this will succeed in the future, as climate change puts more pressure on critical uses, is to be determined. Failing to ask for input from stakeholders is surely bad, but perhaps worse is requesting input, paying lip service to a concept of inclusion and integration, and then summarily ignoring it.

(Author's Note): Our interviews were conducted in the summer of 2015, six months before a very interesting case of stakeholder involvement with government made international news. That was when heavily-armed anti-government militants occupied federal land in the Malheur National Wildlife Refuge, in an apparent protest of federal agencies. In an editorial note, several of the ranchers interviewed for this project expressed views that were very similar to the occupiers, and lived within 50 miles of Burns, Oregon, where this standoff occurred. Events like this should serve as a stark reminder of what is at stake, and the damage that even a small group of individuals can cause when they feel that the government is not listening to them or meeting their needs.

## 5.2 Technology Implementation and IWRM: An Integrated Future?

In the process of researching this paper, I read numerous texts from both the IWRM and the smart farming communities, and noticed several similarities between the two bodies of literature. They were identifying the same list of problems— water scarcity, increased pollution, pressure from other users, insufficient food crop production, climate change). IWRM is arguing that there is *not* a technical solution to these problems, that the solution *must* be integration—with other water users and with the environment, across gender and boundary lines. Technology proponents, on the other hand, are arguing that there *is* a technical solution, but that technical solution is itself an integration—with machines, with data, with sensors. Both approaches, in the end, are calls for greater centralized control, more informed decision-making, and greater integration.

In another sense, however, IWRM and technology adoption are opposites. Networked technologies offer solutions to the problems of water use, pollution and hunger, while demanding little change in the individual. IWRM, on the other hand, asks stakeholders to make sacrifices, and to come together and discuss values, needs, and desires with one another, with the intention of both reaching a comprehensive and workable solution and fomenting a fundamental change in the individual participants' understanding of themselves and each other (Lautze 2014). Whether this is possible, as I pointed out earlier in this section, is an open question. But what they ask of their participants is in this sense quite dissimilar. As Hardin points out in the seminal *Tragedy of the Commons*, some problems have no technical solution, which he defines as "*one that requires a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality*" (Hardin 1968). Smart farming aims to change the techniques, and IWRM aims to change the human values.

Since they both are pushing for integration (albeit in different ways), both end up facing a similar set of barriers, which should be familiar by now. To provide an example from an IWRM implementation effort, Roy discuss the barriers and impediments to developing sustainable management of urban storm water in both the US and Australia. His list of barriers for this project includes “uncertainties in performance and cost, insufficient engineering standards and guidelines, fragmented responsibilities, lack of institutional capacity, lack of legislative mandate, lack of funding and effective market incentives, and resistance to change” (Roy et al. 2008). With a change of just a few words, this list could describe the barriers facing networked technology implementation on small farms in Oregon.

There is one final similarity between IWRM and smart farming that I believe will cause small farmers to resist. That is, both IWRM and smart farming possess a dehumanizing quality. It is hidden below the surface, but you notice it if you pay close enough attention to the messaging from proponents—especially when you think about it from the perspective of a farmer (though, as I readily acknowledge, they are a diverse group).

This quality is easier to see when considering networked technology, which seeks to replace a host of human tasks with automated ones, and human intellect and intuition with a sort of hive-mind of information processing. Rather than an individual, farmers are now *nodes* in a vast network, whose sole goal is to increase efficiency and returns. The methods of determining how and when to plant, used for generations are replaced with an app. The old tractor, which once replaced the plow, is itself replaced by a million dollar GPS-enabled automaton that plows and plants an entire field at the push of a button—and of course you cannot be trusted to work on it, as the software and hardware are proprietary. The data that was once stored on your notepad is now on a server...somewhere, and your water usage and crop production that was once a guarded secret is now “in the cloud”. And the skills you learned from your parents, passed down generation by generation, are now worth little, especially compared to the new set of skills, performed on an iPad, significantly worse than your six-year-old.

The dehumanizing quality of IWRM is harder to see, and framed differently, but imagine yourself again as a farmer. IWRM tells you that you are *special*, and your water use is very important. However, the endangered microscopic fish, just discovered on your property, will have to take priority. IWRM says that ecosystems are very important and should be managed holistically—but it turns out you are not doing a very good job at that—though your family has lived on the land continuously since the Civil War. IWRM says, “we know you *think* you understand the landscape, but actually, this scientist has released a study showing that you are a wrong”—never mind that you have been observing your fields and streams

virtually every day for the past sixty years. It is saying that your water use—which you are using completely legally and fulfilling what you see as an important economic and social function—needs to be “balanced” with these other users. In a way, both have the same underlying message to farmers. Perhaps it is spoken in a different voice, but it is the same: *You don't understand what's really going on—you just think that you do. But we can help.*

## 5.3 Recommendations

### 5.3.1 Tech Companies: Develop Tech that Connects & Connect with the Next Generation

My basic suggestion, from getting to know both farmers and technology issues, is to develop technologies that connect and empower farmers to be *farmers*. One of the basic problems for implementing new technologies is that many farmers do not want to give up farming. It is what they do. They are not computer programmers, nor are they IT professionals. They do not want to let a machine do it, even if the machine could do it a little bit better, because then the machine would be doing it. The challenge, then, for tech companies, is to develop technology that is useful to farmers but allows them to continue the parts of farming that are hard but that they enjoy, like being out in nature, touching the soil, and looking at the clouds for signs of rain.

An intriguing possibility for the near-term is for the development of wearable technologies designed specifically for farmers. By incorporating sensor-based technology into clothing, or even having specially-made tools that can be taken out into the field, it would allow farmers to farm—but just a little bit better. Instead of a sensor array that remains in the stream or in the field, the sensor is hand-held, and is taken into the field.

Sensors and automation are clearly appealing for farmers with large properties and who are using monocrop agriculture techniques. While large farms have sizes that make sensor-based equipment very convenient, and their profit is often directly proportional to how efficient they can be, small farms are different. They are often boutique growers, producing specialty crops for farmer's markets or for local production. Creating technologies that bring them closer to their customers, and let the customers get to know the farms better.

Technologists should not only focus on the farmers, but on how smart phones and other technologies can make these experiences better. Consider the following recommendation, from the organic grower in the Southern Willamette Valley.



*If you can find a technology that works for the average consumer but then applies back to farming, then you can probably reap that benefit of having the value where it actually makes sense, but then you're not having to have a farm pay for, it works for everybody...that's where you see a lot of technology. We have to adapt technology that's used for the consumer or the private level and actually make it work on a farm.*

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Imagine you are at the farmer's market, and stop at a booth selling tomatoes. What if you could scan a QR code (you are holding your phone, of course) and instantly view a scene on your phone that explains or promotes certain aspects of the farm itself? An information display could pop up, telling you when it was picked, and who picked it? Perhaps it would even show you the history of the farm, a reminder of the connections to the past that are represented in the product. It could even be a short video of the farmer, teaching their children how to plant. Perhaps an organic farm would choose to show their water use and soil health, in real-time, or what is happening in the nearby stream. Technology for farmers, then, can be a two-way street.

It is difficult to imagine a 65-year old with no technology experience implementing this type of project. But the children growing up on farms will have a particularly interesting mix of skills: many will be digital natives (Prensky 2001) and feel extremely comfortable using and adapting to new types of technology; and they will likely retain the hard work and community values farmers are known for. By investing in this generation, technology companies have a great opportunity to take advantage of the interest in locally-produced agriculture, while creating a market for their products.

### 5.3.2 For IWRM Implementation: True Stakeholder Engagement & Ethnographic Approach

My primary suggestion for strengthening Integrated Water Resources Management as a functional paradigm is to engage in "true" stakeholder engagement with small farmers. Or do not engage at all. I hope to have shown at least two important things in the preceding sections. The first is that farmers are smart people. They are smart, and they know when they are being used or sold a shoddy bill of goods or taken advantage of.

To strengthen its stakeholder involvement potential, IWRM practitioners and authors should consider another conceptual approach used in rural natural resource management that, though recently created, has seen a growing interest. Known as Grass Roots Environmental Management, or GREM (Weber 2003), it shares some similarities with IWRM but starts its analysis at the level of the

stakeholder—in this case, usually farmers or ranchers in the West. While not specifically water resources-based, it could help provide IWRM practitioners with a richer picture of the lived experience, perspective, and worldview, of rural stakeholders, especially in the Western US.

Another question this thesis hopefully raises is, *Can the field of anthropology benefit IWRM?* In my view, and after closely reading IWRM literature, I feel that one of the core tenets of anthropology, ethnographic research, can benefit certain types of IWRM applications. Specifically, ethnographic research methods can help IWRM practitioners in situations where the stakeholder is considered an individual. Ethnographic methods are designed to help understand how individuals live their lives.

One may argue that it would be very difficult to implement an ethnographic approach in a water resources conflict-type situation. This may indeed be true. But, as I hope to have pointed out earlier in this section, implementing *any* system can be difficult, and requires planning and patience to succeed. The Oregon IWRM plan used an 18-member focus group (and thus, claimed to have been stakeholder-driven). Hiring anthropologists or training water resources employees to leave Salem (or whatever city they are in) and go into communities to meet the individuals their policies affect could have beneficial and far-reaching positive consequences. At the very least, it would show stakeholders that there is at least an effort to listen to their perspectives.

Because IWRM is so widely applied and has been used to discuss water resources issues between states or countries, it may not be applicable in cases at that scale. But, as some have suggested, IWRM will function much better when it is thought of as a “toolkit” rather than a comprehensive plan that is readily applicable to any situation.

According to James Clifford, “ethnography is actively situated *between* powerful systems of meaning. It poses its questions at the boundaries of civilizations, cultures, classes, races, and genders. Ethnography decodes and recodes, telling the grounds of collective order and diversity, inclusion and exclusion” (Clifford et al. 2010). At its core, IWRM is interested in the collaboration of disparate entities, of massaging the boundaries that appear permanent but may indeed be permeable. It also desires (at least in its most noble moments) to overcome issues of class, culture, and gender, and find equitable solutions. Ethnographic approaches can also help to understand the underlying mechanisms on which conflict or collaboration is built. While other methods are surely also required, ethnographic interviews that focus on perspectives, values, histories, and relationships to the land deserve consideration as a technique for understanding the complex problems that IWRM plans seek to solve.

## 5.4 Conclusion

Small farmers today stand at a crossroads. Trends in farming in the West and worldwide point to a future with fewer productive small farms and greater consolidation of farmland (Murphy 2012). Large, high-intensity and monocrop farms are swallowing up more farmland with each passing year. And changing demographics mean that the average farmer qualifies for social security, and their children—if they have any—may be less interested in agriculture than living a comfortable life in town or city (Schai-ble and Aillery 2012). The younger farmers desire to instill a value in the land in their children, but many also want them to choose their own paths in life independent of their parents' decisions.

Society is changing, too. Children who used to play outside on a sunny day now spend their time glued to a screen. People with a connection to the land now think their food comes from the supermarket. With record numbers of people living in cities and working in high tech jobs, many small farmers feel that they have been forgotten about and passed over, being noticed only long enough to blame for the environmental problem *de jure*. Receiving little notice of the beneficial job they are doing, many feel as though they are treated unfairly by an ungrateful and disconnected society more intent on finding a scapegoat than finding sustainable solutions.

On small farms in Oregon and throughout the West, neither water nor technology are distributed equally (Stubbs 2016). Water availability is contingent on a combination of legal, historical, and hydrological factors that have resulted uses that in many cases no longer match evolving societal needs (Molden 2009). This can be especially true of irrigators, whose water use in some cases has changed little in the past century. Current water trends, exacerbated by climate change, have increased pressure on farmers and water policy professionals to find sustainable solutions that are acceptable to all users (Steduto et al. 2012). Like water, technology implementation is contingent on historical, and societal factors. Adoption of certain types of technology, including networked technologies, faces numerous barriers.

This thesis examined the perspectives and perceptions of a range of individuals involved in Oregon agriculture. Unlike many discussions of farming and water use, this paper attempted to approach the question with an explicit understanding of the individuality of farmers, and the value in their perspectives regarding water resources and technology adoption. By interviewing a range of individuals using an ethnographic perspective, this project sought to understand these individuals from the perspective of their values, their communities, and their perspectives of themselves.

By gaining an understanding the individual this project also attempted to learn about the barriers standing between small farmers and networked technology implementation. This was accomplished by examining larger trends in agriculture, water resources, and technology. How these farmers choose to proceed will likely be affected by a blend of these issues, as well as their own visions of the future, for themselves, their families, their communities, and even the planet.

Armed with this richer understanding of the multidimensionality of small farmers in Oregon, this paper then examined the concept of Integrated Water Resources Management, specifically its approach to the individual—referred to by IWRM as the *stakeholder*. By providing a critique of IWRM, the goal of this thesis was at to use the lessons presented in that framework to better understand the issues facing small farmers in the state. Accompanying this critique was a contrast between the implicit values underlying the seemingly contradictory concepts of IWRM and technology implementation, showing that the differences—and similarities, point to a similar future and a stark choice for farmers in the West.

### Epilogue—A Farmer’s Field, The Near Future

He takes a deep breath of the warm, late October air, and stares at the box. Yesterday the drone’s infrared detector went down. And now the evapotranspiration sensor array. The metal box looks just the same as yesterday, but he knows that sometime in between then and now it had broken—the alert on his phone told him so. He looks down at the plain —but quite expensive—metal box, housing the malfunctioning sensor array’s electric brain. *Everything’s breaking down.*

Standing there, he’s suddenly unsure of himself. *Did I say that out loud, or just think it?* he can’t be certain, and this worries him. He listens, as if for an answer, but the quiet evening offers no clues. The only distinctive sound is the *whirr* of the drone, hovering above the neighbor’s field. *No matter, true either way,* he says, out loud for sure this time. He swears, once, for good measure. He stares at his neighbor’s drone following its predetermined path. Concentric circle after concentric circle. Electric brain functioning normal.

Finally pulling his eyes away, he gazes at his land. Twenty-five acres, settled by his mostly-forgotten, likely-illiterate great-something grandfather. It seems empty now, but for the unpicked summer crop—and the fancy irrigation system. The fancy *useless* irrigation system, he thinks. *Control it from your phone,* the saleskid said. Apparently still needs water to operate, though.

*Not much of that these days.* He glances at the sky, a darkening blue emblazoned with a fading streak of crimson. *Here it comes.* He doesn’t need a notification sent from the expensive sensor array to

tell him this—his old-fashioned, biological humidity sensor is working just fine. For the past hour, it has been rhythmically bashing out the weather report like Morse code: “RAIN! 100% CHANCE!” What a decade ago had been a sometimes-dull ache in his right knee had been ceding ground for some time to a sharper, more permanent pain, which seemed less concerned with measuring the humidity and more with reminding him what seventy years in the field does to a body. But he’s not the type to complain. After all, who would listen? Probably not that grandson. He’s too busy with his VR. *Pretending to be a robot soldier.* And who else is there?

*There’s nobody else.*

He gives the sensor box a hard kick and immediately regrets it. The uprooted sensor goes clanking along a row of what were once watermelon. The tapping in his knee increases and he swears again.

He walks to pick up the now certainly-broken box. Almost to it, he feels—too late—the desiccated watermelon root catch his ankle, and the ground coming towards him. His reflexes kick in and he catches himself so his weathered hands take the brunt of the fall. He is unhurt, but he doesn’t get up. He lies there, face near the ground, hands pressed into the dirt, in the darkening field. Closing his eyes, he is silent, listening to the *whirr* above him. The sensor box is forgotten. So is his knee. His mind is racing.

The memory comes vivid and sudden and feels like the time he tried his grandson’s VR. Except he knows immediately that this is real. *Was real.* It’s the same field and he’s still on the ground, only it’s a lifetime ago. He gazes up at the tree-like form standing over him, blocking the bright sunlight. It’s his grandfather. He smiles and bends down, and scoops a handful of dirt in his big weathered hands. *You hold it in your palm and you make a ball and squeeze it—there you go, boy, just like that.* He watches his own hands as they imitate his grandfather’s. *Go ahead now. Listen to that water. Can you hear it? This is how you get to know your soil.* He gives a tentative squeeze and the soil begins to crumble through his hands. *That’s ok, boy. That’s the soil telling you it’s thirsty. We got to give it some water...*

And the scene dissolves, and he is back in the field, still on the ground. Looking down, he realizes that he clutching a clump of dry dirt. He unclenches his fist and watches it crumble to the ground. Drops begin to fall, and are swallowed up by the darkness.

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