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Raising Grain in Next Year Country: Dryland Farming, Drought, and Adaptation in the Golden Triangle, Montana

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RAISING GRAIN IN NEXT YEAR COUNTRY:

DRYLAND FARMING, DROUGHT, AND ADAPTATION
IN THE GOLDEN TRIANGLE, MONTANA

by

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THESIS

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Abstract

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Climate change has already and will likely continue to impact agriculture in the Western United States, threatening water supplies for both irrigated and rainfed agriculture (Calzadilla et al. 2010; Chambers and Pellant 2008; MacDonald et al. 2010; Pedersen et al. 2009). In the Golden Triangle, a region in north central Montana, known for its dryland grain production, the same is true. There is a need for in-depth, fine-grained, place-based, and qualitative research about the process of climate change adaptation in agriculture (Miller et al. 2013). Drought challenges farmers in the Triangle, which is semiarid and receives 10-15 inches of annual rainfall. As such, with this study, I use drought as a "research window" into the process of agricultural adaptation to climate extremes (Head et al. 2011). During the 2014 growing season, I conducted 15 in-depth interviews with conventional and organic dryland farmers in the Golden Triangle about how they experienced and responded to drought, as well as how they perceived the current, rapid climate change. In response to drought, farmers have adapted by conserving both fiscal resources and soil moisture in numerous ways, often operating within the lines of "conventional" and "organic," though not always, as this research shows. Many farmers are adopting alternative, sustainable agricultural practices to help build soil organic matter, building their resilience to drought and other climate extremes. Despite these current and evolving changes happening on farms in the Golden Triangle, most farmers do not consider climate change when enacting adaptive changes on their farms.

Acknowledgements

I started this research, in part, to prove to myself that I could see a project that felt as expansive as the prairie itself to the very end. Now that I'm near the finish, it feels like I'm finally getting to the mountains, butting up against the largeness that comes from spending time investigating the particular. I begin my thanks with the research participants themselves. For the leftover pot roast, tomato soup, and the lunch at the Farmer's Daughter Café in Conrad. For Art, who topped off my rig with gas after making the long drive 70 miles on gumbo roads to get to his remote ranch. And for each farmer who opened their homes to me, taking time out of the busy growing season to share their honest perspectives.

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MAP

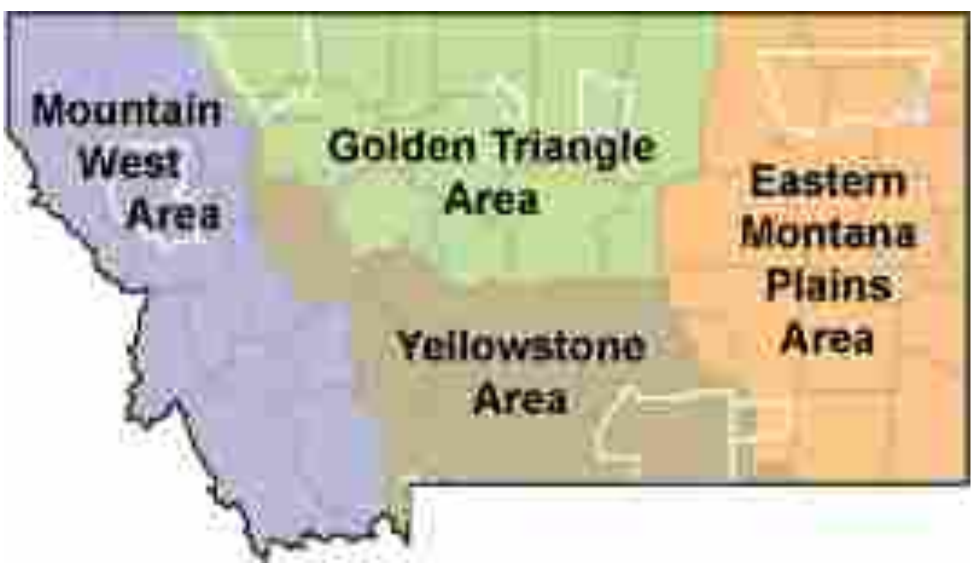

Figure 1. National Resource Conservation Service, Map of Montana Regions Based on Land Use and Resource Concern

True husbandry, as its first strategy of survival, has always striven to fit the farming to the farm and to the field, to the needs and abilities of the farm's family, and to the local economy. Every wild creature is the product of such an adaptive process.

Wendell Berry, "Renewing Husbandry"

The best Montana stories deal with the erratic and unpredictable character of Montana weather.

K. Ross Toole, *Montana: An Uncommon Land*

DRYFARMING ON THE NORTHERN PRAIRIE

In early spring, just as the snow geese were still migrating north, I left the mountains of Western Montana and drove out to the plains. In that long horizon country, golden eagles perched on fence posts surrounding vast fields planted in winter wheat, just greening up with spring moisture. In this country, farmers grow grain crops in a climate where rain falls more in the winter than in the summer, and the annual precipitation amounts to between 10 and 15 inches. Theirs is a semiarid landscape on the thin margin between desert and arable land.

For a century, farmers have raised grain in north central Montana with sparse rain. In recent years, farmers in California have suffered from extreme and exceptional drought. Snowpack in the Sierra Nevada Mountains, which supplies Central Valley agriculture with irrigation, was 12 percent of its average in April of 2015 (National Oceanic and Atmospheric Administration 2015). Such dire drought has occurred in an era of pronounced climatic extremes and global temperature rise. Understanding how farmers persist in dry conditions, how they can make a crop, a profit, and a livelihood despite aridity is what brought me to Montana's north central region, otherwise known as the Golden Triangle.

For all of the peculiarities of its agriculture, I drove my station wagon to the Montana plains to understand how farmers had adapted their agriculture to the drought inherent to their landscape. Over the course of the 2014 growing season, I took four trips to the region, interviewing 15 dryland farmers about drought and adaptation. I sought to understand how farmers experienced drought: how it manifested in their soils, fields, crops, and, perhaps most importantly, their pocketbooks. I also hoped to understand how farmers had responded—or adapted—to drought in both their farm management and production practices. With this research, I hoped to detail the complex process of adaptation as it happens on dryland grain farms in the Triangle. Finally, after gleaning an understanding of drought and adaptation, I wanted to know how farmers' understanding of climate change had informed their adaptive decision-making, if at all. From all of these wonderings, a central research question emerged: how have farmers in Montana's Golden Triangle, having persisted in their harsh landscape, adapted to the economic, political, and ecological trials of the past century? These farmers' experiences in the Golden Triangle, I thought, might reveal more about the nature of agricultural adaptation, essential in this era of more pronounced climatic extremes.

Far from the dry short grass prairie of north central Montana, I grew up in Kentucky where it rains roughly 40 inches a year and the land is green even in winter. After college at a small, liberal arts college in the Bluegrass, I moved back to my hometown of Louisville, and took an apprenticeship at Field Day Family Farm, growing ten acres of vegetables and raising chickens. Field Day leased acreage from an old piece of agricultural land bounded by the suburban development of growing metropolitan Louisville. A major highway bisected the farm. A golf course, parking lot, and mall sprawled just over the fence line. Part of what had drawn me to this urban, yet historically rural, farm was its proximity to my family's old homeplace. My family had farmed, and then gardened, a parcel of land along Beargrass Creek just two miles as the crow flies from Field Day Family Farm. I was the seventh generation to live on the two remaining acres of what had once been a 200-acre farm.

The first year I worked at Field Day, it rained seventy inches. From spring on, it felt like rain was always falling. The spring was the wettest on record. And in December when we added up the inches, the total broke the annual rainfall record for Jefferson County, Kentucky. In a place with an annual average of forty inches, it had rained nearly twice that much. The weeds were prolific that year, because the fields had rarely dried enough for cultivation. Stunted vegetables grew in the shade of pigweed and lamb's quarters, which we cut out in the fall with pruning shears, carting piles of weeds out of the field in a small effort to save next year's crop. The field crew suffered, and two apprentices left unexpectedly in September, before we had brought in the fall harvest. That December, I got hired on to work until the crops were gone, until mid-January. But that winter was unseasonably warm, and cold-hardly greens grew well into February and March, at which point, the next season had already begun.

What I had experienced in that first year farming were two abnormalities for the region and for the farm. Rarely did workers harvest greens through the winter. Rarely did it rain so much. As an apprentice, I knew little of how the unseasonable weather had affected the farmer who cut our paychecks. This experience shaped my interest in how farmers get by in years of excess rain, or in the case of the Golden Triangle, years of scant rain. By way of a deluge, I became interested in how Golden Triangle farmers adapt to unfailing, yet unpredictable drought.

New to the Western landscape, I began this research with the place: its agriculture, its ecology, and its history. This story follows the same trajectory, beginning with the place itself: the concert of prairie bunchgrass swaying in the rain shadow of the northern Rockies, and the history of agriculture that broke the sod and made of it fields of golden wheat.

The Process of Adaptation

Adaptation is as old as life itself. The history of adaptation is written down in stories of human movement and survival, just as it is writ on canyon walls cut open by a river, full of bygone life forms that could not adapt to the climate shifts of the past. Smit and Wandel define adaptation as “a process, action or outcome in a system in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity” (Smit and Wandel 2006: 282). Both human and nonhuman individuals, populations, and communities, and civilizations adapt, altering patterns of habit to fit environmental conditions (Smit and Wandel 2006). Farmers, too, adapt, continuing a ten thousand year old tradition of changing agricultural practices to suit a particular landscape and climate. Adaptation is not, by this description, a straightforward, quiet process. More often it is a dusty, howling process, which it was in the early decades of the 20^{th} century when a swarm of would-be farmers piled into railroad cars in search of their free patch of prairie on the eastern Montana plains.

The coping, managing, and adjustment of a population of people to changing conditions describes the process of adaptation, but not the purpose. What, then, is the aim of adaptation? What does its denouement look like? Good, or "true husbandry," as Wendell Berry put it, the kind that persists in a place, must fit the labor to the field, the family, and the local economy. The exploration of limits, delineations of possibility for a place, people, and economy, Berry names that process adaptation. Doing anything else, with time, will not yield. A prophet and farmer from Kentucky, I use Berry's vision for agriculture to augment Smit and Wandel's definition.

The process of adaptation is evident in north central Montana where farmers—some successful, some not—have tried to eke out a living in a region on the thin margin between desert and arable land. The north central region of Montana is known as the Golden Triangle: golden for the color of the wheat and barley at harvest, and triangle for the shape of the region, which stretches between the three points of Shelby, Havre, and Great Falls. In a land of little rainfall—10 to 15 inches each year—Triangle farmers grow thousands of acres of wheat and barley, among other cereal and pulse crops (Montana Census of Agriculture 2014: 9). Many raise crops without irrigation, dependent on every hundredth of an inch to make yield. Farming has existed in this country for little over a century. In that short time, the farmers who have stayed have adapted to their landscape, and in doing so, have come to understand its character, its drought, its ceaseless wind, and its gumbo soil.

Golden Triangle farmers raise crops and livestock in a land of inherent extremes, where drought is a perennial part of the landscape. Montana Historian Joseph Kinsey Howard explained:

> There have always been drouth and dust on the Great Plains. Averages based upon weather records of thirty-five to fifty years indicate that in most of Montana there are one or two drouth years in every ten, and in the northern portion, two or three (1943: 12).

The Golden Triangle is situated east of the Rocky Mountains, in its rain shadow. Without much precipitation, the land is vast and untreed; its vegetation is comprised of small forbs and grasses, a short grass prairie (Samson et al. 2004). Drought occurs perennially in this country as part of its natural disturbance regime. Historically, drought desiccates prairie bunchgrass, and on this dry, sparsely vegetated ground, soil moves, lifted across the prairie (Clark et al. 2002). "The inherent unpredictability of precipitation among years," Samson et al. (2004: 8) explained, "is an important influence" for this landscape. Most farmers who live and work on the dry northern prairie have done so through many years of drought. With years of accumulated experience, these farmers hold a particular knowledge: in wetter years, how to grow crops with little rain and in dry years, how to get by without it.

The experiences and practices of those who farm despite unpredictable and extreme weather are instructive in a time of contemporary, rapid, global climate change, which some predict could decrease global agricultural production (Calzadilla et al. 2010). Between 1900 and 2005, researchers recorded an increase in the earth's annual average temperature of .74° C (1.33° F) (Pederson et al. 2008: 146). In Western Montana, Pederson et al. (2008: 146) collected a century of meteorological data and found an even larger increase in annual average temperature of 1.33° C (2.39° F) over the same time frame. Changes in precipitation and temperature stand to shift weather patterns across American farmland. Commensurate with changes in precipitation and temperature, researchers have projected an increase in the frequency of extreme weather events such as droughts or floods (Chambers and Pellant 2008). Farmers who wish to remain on their land through extreme climatic shifts must adapt *in situ*—and in a multiplicity of ways—or move elsewhere, either continuing their agricultural traditions in a more hospitable place or leaving agriculture altogether (Head et al. 2011).

In the Golden Triangle, unpredictable and extreme weather has always happened. Farmers who came for free land with the Homestead Act witnessed the most recent century of drought. But previous centuries yielded droughts of similar and even greater magnitude. In fact, "Mounting evidence suggests that the 20th century contains neither the full range of drought conditions that occurred in the recent past nor the potential range of the near future" on the northern plains (Clark et al. 2002: 599). The dust bowls of the early homestead days were unremarkable in the context of this long, ancient history. Prehistoric droughts were repeated and severe. In the Golden Triangle drought was and is as common as the wind, the bunchgrass, and the long, low seam of horizon.

Raising crops and livestock in a particular place is dependent on the predictability of that place's weather and climate. If regional weather—temperature, precipitation, and seasonality—shifts, then the agriculture practiced in that place must also shift, if it is to continue to survive.

The Wheated Plains

Agriculture in the Golden Triangle is built upon the loamy foundations of its soil. The Scobey series characterizes the north central region of Montana. The series "consists of very deep, well-drained soils that formed in till," in the plains, hills, and moraines left in the wake of northbound glaciers (National Cooperative Soil Survey). The region's soils were made during the last glacial epoch, during another great climate change. Scobey soils support native prairie bunchgrass, including bluebunch wheatgrass, western wheatgrass, green needlegrass, and needleandthread (National Cooperative Soil Survey). When tilled, these soils are known for their ability to grow dryland crops, such as wheat and barley.

The dry plains of Montana resemble the climatic and topographical features of ancient agriculture. Ten thousand years ago, early farmers domesticated wheat and barley in Mesopotamia (Montgomery 2007). The fertile land between the Tigris and Euphrates Rivers had been recently glaciated; its soils were rich, its climate cool and dry. In these conditions, farmers domesticated wild grasses, developing domesticated wheat and barley. Farmers in Montana's Golden Triangle grow modern—as well as some heritage—varieties of wheat, bred to produce yields in a cool, arid climate, similar to climatic conditions at the birthplace of agriculture.

The northern prairie of Montana supports few trees and a limited number of grasses and forbs. Perhaps in a similar manner, the Golden Triangle supports a small population of farmers. The early boom years of the Homestead days brought more farmers to the area than now exist in the region.

Homesteaders lured to Montana on the false pretenses of its moist and forgiving climate, staked their claims on 160- and then 320-acre parcels of land. Such small holdings, John Wesley Powell explained in his 1878 report to Congress, would be inadequate for agriculture on the xeric, western plains. After many trying years of persistent drought, homesteaders found that their small homesteads were, in fact, insufficient to support a farm. After the drought years of the late teens and early twenties, many homesteaders busted and left. Many of those who stayed bought and claimed their neighbors' vacated acres, patching together the much larger modern homesteads that characterize the region today. In 1920, the average farm size was 586 acres. By 1950, the average farm size had increased nearly threefold, to 1940 acres (Toole 1959). In 2012, north central Montana supported 5,205 farms with an average farm size of 2,588 acres, covering over 13 million acres (Sommer et al. 2014:13). Most of these millions of acres are dryland cropped, in which crops are unirrigated and farmers rely only on rain and snowfall (Meter 2011). Dryland agriculture is unique with its sole reliance on precipitation, despite a lack of it. Farmers in the Golden Triangle therefore grow crops that thrive in parched conditions, such as wheat.

Wheat is the most prevalent crop in the Golden Triangle. In 2013, farmers there planted 1,156,700 acres of winter wheat and 1,102,000 acres of spring wheat, growing over 51 million and 44 million bushels, respectively (Sommer et al. 2014: 45). Spring wheat is sown in the spring and harvested in the fall. By contrast, winter wheat is sown in the fall and harvested in the spring, capitalizing on winter precipitation. For all those bushels of wheat, the state of Montana ranks fourth in the nation in wheat production (Sommer et al. 2013). While some of Montana's wheat is locally milled, much of it is shipped out of the state to western ports where it is loaded onto ships bound for Asia (Sommer et al. 2013).

Farmers in this region also plant a considerable amount of barley, planting 563,000 acres and harvesting over 27 million bushels in 2013 (Sommer et al. 2014: 49). Several farmers I spoke with peered at me from under the bill of a Coors® or Anheuser-Busch ball cap, companies that contract with farmers to grow malting barley. Many farmers also raise pulse crops, or legumes, such as peas and lentils. In 2013, Golden Triangle farmers planted 135,500 acres of peas, harvesting over 2 million pounds of dry peas (Sommer et al. 2014: 5). Farmers also grow a variety of other cereal, pulse, and oilseed crops for both conventional and organic markets.

Golden Triangle farmers grow both conventionally and organically (without the use of synthetic pesticides and fertilizers). The term organic, as used in this research, refers to organic certification conducted by the United States Department of Agriculture's (USDA) National Organic Program (NOP). Organic farms make up a comparatively small percentage of total farms and acreage in the state of Montana. In 2012, just 148 of the over 28,000 Montana farms recorded sales of organic products, with 90 of those farms recording over 50% of their total sales from organic products (Vilsack and Reilly 2012). Of the nearly 60 million acres of Montana farmland in 2012, 377,598 of those acres were for farms with organic production. In 2012, 24 organic farms grew oilseeds, and 39 grew grains, crops characteristic of the north central region of the state. Organic producers make up a small, but relevant demographic, and are thus included as participants in this research to reflect the diversity of perspectives on adaptation to drought that exist in the region.

Rain Follows the Homesteader's Plow

Crop agriculture has existed in central and eastern Montana for roughly a hundred years. The history of homesteading is written on the landscape. Seen from the highway, abandoned homesteads hide at the bottom of coulees. Wood shacks, weathered and gray, lean with the wind. Down low, where the water sometimes pooled, coulees were a rare place where early homesteaders could find relief from ceaseless prairie wind. Soon after the initial flood of homesteaders had plowed their first fields and sown their first crops, drought hit. The drought busted crops and profit, as the homesteaders had busted the prairie sod.

Agriculture in this region was the result of government prospecting. In the late 1800s, Congress wanted to settle the West. They intended to create an agricultural democracy out of the prairie wilderness, and by doing so, claim it from Native Americans who had lived and hunted there for generations. Through legislation, the Federal government encouraged settlement of the plains states. The Homestead Act of 1862 required an individual making a claim to pay a ten-dollar filing fee and then live, farm, build a home, and make improvements on 160 acres of land for five years. After doing so, he or she could "prove up" on the land and take full ownership of it (Toole 1959). In exchange for labor, homesteaders could own 160 acres of what had been previously federally held public land.

In 1909, Congress approved the Enlarged Homestead Act, otherwise known as the Dryfarming Act. Having settled much of the wetter states of Kansas and Nebraska, homesteaders moved farther west to Montana, near the rain shadow of the Rocky Mountains. To accommodate settlement in this arid country, Congress enlarged the land claims from 160 to 320 acres. In 1912, Congress passed yet another Homestead Act, which shortened the time required to "prove up" a claim from five to three years, and permitting the homesteader's absence for five months of the year (Toole 1959). Such changes were meant to ease the burden of proving up in a landscape so formidable. Moisture and timber were scarce on the semiarid plains, and winters were bitter cold and long. Improving land with so few resources and in a short growing season made farming the northern prairie an endeavor only for the hardiest of homesteaders.

In that era, homesteaders were called "honyockers" or "sodbusters." They came to Montana late, after the turn of the 20th century, and after all the free land had been claimed farther to the east in Kansas and Nebraska where it rained more often and in greater abundance (Carter 2009). A person over the age of 21 who was also the head of a family could file for his or her own homestead. As Carter (2009) notes not only men, but also single women, were among those who filed homestead claims in Montana.

In 1909, more than one million acres were claimed in Montana under the Enlarged Homestead Act. By 1910, five million acres had been claimed, and by 1922, forty percent of Montana had been claimed by individuals trying to prove up on small parcels of prairie (Toole 1959). The first onslaught of homesteaders coincided with favorable wheat prices and above average rainfall. Yields were high, and farmers borrowed money to buy more land and equipment (Toole 1959).

The lure of free land was insufficient to attract prospecting homesteaders to Montana in the early 20th century. Burgeoning western railroads played a significant role, persuading homesteaders to make the long journey north and west into the wild territory. At that time, James J. Hill owned the Great Northern Railway, a long set of tracks that ran along the straight, northern boundary of the United States, a region still known as the Hi-Line. The Hi-Line cuts through Havre and Shelby, cities in the northern reaches of the Golden Triangle. Newly built, the Great Northern Railway relied on traffic for revenue. In such remote and parched country, there was little reason for people and goods to ride Great Northern rails. So Hill crafted a reason for them. He began a settlement program, which promoted the free land made available through the Homestead Acts.

"The Great Northern poured out thousands and thousands of brochures and tracts telling of the richness of Montana's soil and the salubriousness of its climate," and in doing so, brought hordes of homesteaders to the region (Toole 1959: 234). Hill hired an agricultural expert, Professor Thomas Shaw, to evaluate the quality of Montana soil for crop production. Shaw had come from eastern Canada, where it rained more frequently and in greater abundance. With his academic title preceding him, Shaw declared Montana country fit for agriculture. Such agriculture, as he imagined it, included 8,750 farms of 160 acres apiece across 1,400,000 acres of short grass prairie. As in his homeland of eastern Canada, Shaw announced, Montana country contained rich soils on which fell adequate rain, making for plentiful profit (1959).

The notion that Montana could be farmed in the ways of the saturated east persisted in the early homesteading days. Hill's brochures touted the benefits of deep plowing, repeated cultivation of the soil, rotation of crops, and livestock grazing (Howard 1943). While the latter two practices did benefit crop agriculture on the prairie, the former killed vegetation and exposed topsoil, creating prime conditions for soil erosion. Likewise, the myth that "rain followed the plow" persisted in the homestead days, climate misinformation that worsened erosion when drought hit (Liebcap and Hansen 2002). Ceaseless wind and sparse rain taught early homesteaders that frequent, deep plowing would neither harness rain nor hold it.

When they stepped off Hill's railcars, homesteaders began the process of proving up in a treeless landscape. With few trees, fuel and shelter were harder to come by than in the east. Homesteaders made small homes, a box with an arched roof. They tar-papered the outside walls, and pasted newsprint to the inside for insulation. For fuel, homesteaders burned buffalo chips or mats of woven swamp grass and hay. Water was challenging to find, but could be gathered from buffalo wallows, cisterns, or hand-dug wells—some over 100 feet deep (Toole 1959). Towns emerged around towering grain elevators—the tallest structures on the prairie—built along the railroad tracks.

Decades before the great migration of homesteaders to Montana, John Wesley Powell had surveyed the American West. Powell was then director of the U.S. Geologic Survey and in 1878 wrote a social and economic study of the West (Howard 1943). He wrote about its potential for agriculture, based on both its soil quality and climate. Places where annual rainfall amounted to less than 20 inches, Powell deemed unsuitable for crop agriculture (1943). "He warned specifically against exaggeration of the plains' value for crop farming based upon one or several years of better-than-average rainfall" (Howard 1943: 33). Powell likewise warned against the application of the 1862 Homestead Act in the arid West. The 160-acre allotment, he wrote, would be insufficient to support a homestead. As Howard noted, so too would 320 acres. Montana had been over-prospected. Both government and industry had a stake in the success of an agrarian democracy on the northern plains. Both, too, had failed to consider the limits of the land and climate of the northern short grass prairie.

In doing so, they planted on the northern plains an agriculture that would have to change—or adapt—if it were to persist any longer than the wet years that made the early homesteader's boom.

The Busted Prairie

In 1917, after a few years of above-average rainfall, drought hit. Without grass holding the soil, much of it blew. By 1921, half of the homesteaders who had come in the first decades of the 20th century had lost their land. Eleven thousand farms blew off the plains. From 1919-1925, 20,000 farms foreclosed in the state of Montana. The homesteaders "left behind them mute towns with tumbleweeds banked high on the windward side of leaning buildings" (Toole 1959: 8). These early homesteaders did not know the land. Nor did the promoters, the Professor Shaws and the Jim Hills who had boosted Montana's early settlement with false information.

In 1920, at the pinnacle of Montana's crop farming boom, some 57,700 farms sprawled across the landscape; by 2014, nearly a century later, there were 28,000 (Sommer et al. 2014). Those farmers who stayed weathered the 1917 drought, as did many others who came in the decades that followed. Over time, farmers learned to adapt their farms to the drought inherent to their landscape. Those who persisted responded to a multiplicity of forces, not the least of which was the inaccurate information distributed by those who might profit from their settlement. The homesteaders who stayed through the boom and bust years came to understand which farming practices would serve them well on the high, arid plains, and which would mean their ruin at the first gust of hot wind. Many farmers, came to better understand the peculiarities of their local soil and climate. As K. Ross Toole explained it,

> There is a postscript to the story of the honyockers, because…something new rose from the ruins of the old… It was a process of adaptation. No human force can superimpose a theory over the facts of nature, nor, on any appreciable scale, can nature be made to fit a mold of human design. Land cannot be abused without consequence (1959: 239).

Indeed, half of the early homesteaders lost their land and livelihood, and the prairie lost its topsoil.

Fed pamphlets of false ideas about growing crops on the plains, farmers had to unlearn the false information, and instead, consider the limits of the place if they were to continue to farm another year. Those who remain on Montana's northern plains, three, four, and five generations hence have, in many ways, adapted their agriculture to the biophysical place, the drought that characterizes the dry short grass prairie in the rain shadow of the Rocky Mountains. In over a century of agriculture, the homesteaders who stayed also responded to a broad range of other factors, such as the price of wheat, new agricultural technology, and government programs.

The adaptive process Wendell Berry spoke of in "Renewing Husbandry" concerns itself with both the field and the economy. For this research, too, I consider both the biophysical act of farming and the social and economic actions associated with it as part of the adaptive process.

As Berry noted, "true husbandry" honors the limits of the place, adapting an agriculture to the needs of the land, the people, and the economy. By his definition, an adaptation that considers these limits bears the mark of true husbandry. As we shall see, the 15 farmers interviewed for this research represent a diversity of agricultural practices in the Golden Triangle, including both conventional and organic farmers who have responded to the biophysical, social, economic, and political landscapes in which they sow their grain. On the plains of north central Montana, all agricultural adaptation is not cut from the same cloth. Rather, adaptation in this region is as diverse as the many farmers who make their living there. The many versions of agriculture present in the region and in this research, however, are not all true husbandry or, otherwise considered, adaptation that considers the limits of people, place, and economy. In the following chapter, I explore the definition of adaptation more deeply as it relates to agriculture.

Adaptation is not relegated to the historic past, nor does it concern itself solely to the unforeseen future of shifting climate in an era of unparalleled rapid and global change. Adaptation, rather, is a present action, happening in each field and on each farm both in the Golden Triangle and elsewhere. In the next chapter, I also draw from current literature to illustrate the observed and potential future impacts of climate change on Golden Triangle agriculture. How farmers in this region adapt their agriculture to the climate, economy, and the changing structures of industrial agriculture, is relevant in an era of more pronounced climatic extremes.

Figure 2. Abandoned one-room school house found on one farmer's property in the Triangle.

ADAPTATION IN AN ERA OF RAPID CHANGE

Drought has taught farmers who make their living on the high semiarid plains to be hopeful for next year, when another growing season could bring enough rain to make higher yields. Yet such optimism is tempered with a learned humility. As one farmer told me, “We always say, ‘there's always next year,’” the aphorism of crop farmers on the arid plains, a landscape on the edge of desert.

Theirs is a climate of unpredictable extremes, not the least of which is drought. Farmers also experience high wind, hail, and bitter winter cold. In many ways, the unpredictable and extreme climate of the Golden Triangle is akin to what scientists project for western climates as the atmosphere continues to warm. Thus, what farmers out in the Golden Triangle think about their climate and how they respond to it is relevant to understanding adaptation to the extremes that are rendered more likely in an era of rapid, global climate change. In examining the history and current practice of adaptation in north central Montana, this research approaches agricultural adaptation as a process necessary to sustain farms through an uncertain future of climate change. To frame this research on adaptation, I begin with climate change and its observed and predicted effects on agriculture in the American West. From there, I explore existing concepts of agricultural adaptation to climatic extremes, as well as how previous studies have characterized such adaptation.

2.44 Degrees Fahrenheit

Research framed in an atmospheric context ought to begin with the global. On June 11, 2014, I attended a public meeting about Climate Change and Agriculture hosted by the Center for Rural Affairs. A small group of farmers and ranchers from the Flathead Valley in Western Montana met at the Polson Public Library in a small side room where rows of metal foldout chairs had been set up. Jared Oyler, a Ph.D. Candidate in Ecological Climatology at the University of Montana explained climate science to his audience. What he explained about climate change shaped my understanding to such a degree that I pull from his presentation to explain the term, climate change, as it is used in contemporary public discourse and this research.

Climate change, as the International Panel on Climate Change defines it, is “a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades or longer” (IPCC 2013: 126). “The difference between weather and climate is a measure of time” (National Aeronautics and Space Administration 2005). While “weather” describes how the atmosphere acts over a short period of time, “climate” refers to trends, patterns, and averages in the weather measured over longer periods of time (NASS 2005). Climatic changes have occurred throughout the history of the earth. Ice ages, as well as volcanic eruptions, spitting ash into the atmosphere, blocking out the sun, rendering the earth a colder, darker place, are examples of historical climate changes. The most recent climate change—the one that journalists, politicians, environmentalists, and others refer to—is markedly different from the atmospheric upheavals of the past. It differs from these historical climate changes in both its pace and origin.

Oyler began his talk, as many who talk about climate change do, with the Keeling Curve, a zigzag line that sweeps upward through time to the present day. The curve illustrates the increase in atmospheric concentrations of carbon dioxide. Such an increase worries scientists, Oyler said, because of what they know carbon dioxide does in the earth’s atmosphere. Carbon dioxide, like other greenhouse gases, serves the critical function of heating the earth. In many ways, he said, these gases are what have made earth habitable—a reflection of the earth’s ability to photosynthesize large quantities of light energy into food. Greenhouse gases have created the conditions for agriculture across the globe, and on the northern plains in particular, where farmers grow crops in a season shortened by the long presence of winter at the northern temperate latitudes. When solar radiation tears through the atmosphere and touches the earth’s surface, it is re-radiated off of the soil, the sand, the trees, the parking lots, the rooftops up into the atmosphere. Greenhouse gases, such as carbon dioxide, then absorb the re-radiated sunshine, and re-radiate it yet again down onto the earth. If the sun's energy were a pinball, then greenhouse gases would be the bumpers that keep that energy ricocheting off the backboard, racking up points, or here, degrees.

Oyler described the greenhouse effect like a blanket, keeping the earth warm. With more greenhouse gases in greater concentrations in the atmosphere, he said, the earth could become warmer. In fact, it already has. The global average temperature, he explained, already increased 1.62° F (0.90° C) in the past century, from 1895 to 2013. In Montana, the trend was more pronounced; the regional average temperature increased by 2.44° F (1.33° C). In his first five minutes of the presentation, Oyler described what climate scientists understand: that the climate is warming, and such warming is caused by human-borne emissions of carbon dioxide and other greenhouse gases. Such is the scientific theory to which the terms 'climate change' or 'global warming' are referring.

The tandem rise in atmospheric concentration of greenhouse gases and global temperature is relatively straightforward. More complex and difficult for scientists to understand, however, is how this broad scale climate change may affect regional climates. As Oyler explained, low and high-pressure systems can cause regional climatic shifts. Scattered throughout the globe are these periodic oscillations. Such oscillations are naturally variable, and can operate with and against global climate change. Climate scientists experience great difficulty modeling the regional interplay between natural climate variability and global warming. Add to that complexity the way a low or high-pressure system, or global atmospheric gas concentrations, act upon different landscapes, such as the northern Great Plains, situated in the rain shadow of the Rocky Mountains.

He explained the synergy between natural variability and climate change by talking about glaciers. The farmers who participated in this research likewise talked about climatic change in terms of glacial movement. On the high plains due east of Glacier National Park, Golden Triangle farmers needed only to squint to see the frozen peaks on the horizon. When they spoke of climate change, farmers often spoke of glaciers, as we will see.

Natural variability and climate change, Oyler explained, have both contributed to glacial retreat. Regional and global forces have been working in concert, warming the Crown of the Continent, causing glacial melt. If either force was operating in isolation, the glaciers would still retreat, though at a slower pace. In other places across the globe, natural variability and climate change can work in opposition. However, Oyler said, if human populations continue to emit greenhouse gases, it is possible that anthropogenic, global climatic changes could overwhelm natural, regional variability.

Understanding how the climate may change for a particular place reveals potential risks. Understanding the risks associated with a changing climate can inform local, state, and national policymakers who have the ability to manage those risks. Once scientists, like Oyler, can confidently produce projections for a place, then society can make decisions based on those projections. Crafting models to project climate scenarios, however, is further complicated by two unknown variables: (1) human population growth and development, and (2) future greenhouse gas emissions (MacDonald 2010). For climate researchers, "It is difficult to quantify which future scenario is probable" (MacDonald 2010: 271).

Yet, Oyler did offer a forecast for Montana's climate, considering the regional and global, natural and human-caused forces at play in the atmosphere. It's possible, he admitted, that the climate could be very much the same in 50 years, but such a muted scenario is unlikely. A more likely scenario for Montana is a warmer, wetter climate, with drier summers (Pedersen et al. 2008; Qiu and Prato 2011).

Oyler's presentation persisted in my memory because of its clarity about the reality of climatic change. The earth is warming, and Montana even more so. He also admitted, however, the uncertainty that he and other climate scientists must address as they continue to understand the ways in which global atmospheric change, natural variability, and topography interact to produce local climates. Despite the certainty that the earth is warming and anthropogenic greenhouse gas emissions are tied to it, there is much uncertainty in predicting and forecasting how those facts may play out across the many surfaces of the earth. Yet, agriculture is built on the predictability of a place's climate. In the

Golden Triangle, farmers are conscious of the unpredictable nature of precipitation for their region. Drought is part of their climate and agriculture. Still, as weather patterns shift outside of the historic range, farmers may face new hardships navigating the concurrent shift in agricultural practices.

Water and Western Agriculture

Understanding how global climate change could affect a particular place or region is complicated work. Scientists in this field have nonetheless produced a small body of research that details the observed and projected future impacts of climate change on landscapes in the American West and Montana in particular.

Nearly three decades ago, Adams et al. (1988) studied the potential effects of global, atmospheric warming on agriculture in the West. They found that corollary changes in regional temperature and precipitation could impact western agriculture and crop yields in two ways: (1) by altering water supplies, and (2) increasing pressure from pests and pathogens. Furthermore, they noted that climate change could "further weaken an economic base already under pressure from long-term structural changes underway in U.S. agriculture" (1988: 353). Thirty years ago, researchers were already describing the economic ties between climate and agriculture, and how unpredictable and erratic changes in climate could affect farm economies. These findings still stand as a portrait of western agriculture in an era of more pronounced climate change. Since 1988, climate researchers in the West have already documented a marked increase in temperature.

More recently, Pederson et al. (2009) analyzed temperature data from nine meteorological stations scattered throughout the mountainous region of Western Montana. Based on over a century of climate data from 1900 to 2006, they found, "Western Montana has thus far experienced a +1.33°C rise (1900-2006) in annual average temperatures, which is 1.8 times greater than the +.74°C rise in global temperatures" (Pederson et al. 2009: 146). Much like Oyler explained, increases in annual average temperature have been more pronounced in Montana than the average for the entire globe. In addition, the growing season has lengthened; the first frost date has occurred earlier in spring, while the last frost date has occurred later in the fall (Pederson et al. 2009).

By the time Adams et al. published their paper in 1988, the climate had already begun to warm. Since then, it has continued to do so. Pederson et al. (2009) found a three-fold increase in the number of days at or above 32.3°C (90.1° F), considered to be "extremely hot." Early decades of the 20th century were characterized by years with five days of extreme heat. In 2003, however, Montanans experienced 32 days of extreme heat. These extremely hot days also happened over the course of a longer summer season. In the early 20th century, days of extreme summer heat occurred between July 8th and August 11th. By contrast, in the 21st century, the season extended by 24 days, with days of extreme heat occurring between June 29th and August 25th (Pederson et al. 2009).

Commensurate with this increase in warmer days is a decrease in the frequency and magnitude of cool days. Over the course of a century, the annual average number of days below 0°C (32°F) has decreased by 16 days per year. Days of extreme cold, with temperatures below 17.8°C (64°F), have also become less frequent, declining from 20 days in the early 20th century, to 14 days in recent decades (2009). Over the past century, temperature has already shifted, with the greatest change occurring in the past two decades.

To understand whether local or global forces had caused the observed changes in temperature, Pederson and colleagues compared the regional data with temperature data for the entire Northern Hemisphere. Similarities between the data sets indicated, "the same large-scale forcings driving global temperature change may drive a substantial portion of the observed low-frequency change in Western Montana" (2009: 146). In over a century of data collected from Western Montana meteorological stations, temperature changes reflected global, atmospheric changes rather than regional variations. In other words, global climate change, rather than a natural, regional variation—such as El Nino or the Pacific Decadal Oscillation—had caused the temperature change in Western Montana.

A continued increase in temperature could have substantial impacts on Montana agriculture. MacDonald et al. (2010) conducted a study in the St. Mary's River Watershed, researching the effects of climate change on mountain snowpack, which supports water supplies for farmers and ranchers on the Rocky Mountain Front, in the western reaches of the Golden Triangle. Their findings indicated that increases in temperature could greatly affect mountain snowpack, even in scenarios of increased precipitation. In the historical period used in that study, 1961-1990, 70% of precipitation fell as snow. In each of the climate models, however, the percentage decreased, with more precipitation falling as rain.

Furthermore, Chambers and Pellant (2008) found that spring snowmelt had occurred 10-15 days earlier than it did 50 years ago across the Northwest. A particular interaction exists between temperature and precipitation, which is essential to an understanding of how climate change could play out in the American West. In winter, for example, precipitation that falls in tepid temperatures falls as rain. A smaller snowpack accumulates in the mountains. Out on the plains, less snow piles up in between the stubble on dryland farms. In an early and warm spring, the snowpack melts more quickly, depleting reservoirs earlier in the dry summer season. The most conservative model showed that by 2085, complete snowmelt, which had historically occurred between July 19th and September 30th, would likely happen much earlier, between May 5th and 29th. Such a dramatic shift in the timing of complete snowmelt could have significant effects on Montana's irrigated agriculture, dependent on the slow release of plentiful snowpack to ensure a full season's crop. Dryland farmers are likewise dependent on winter snow, which collects in their fallowed fields in between dead stubble and slowly seeps into the soil, replenishing moisture. Temperature, more than precipitation, has the potential to diminish the quantity and melt rate of water stored in the form of snowpack (MacDonald et al. 2010).

Oyler's sketch of Montana's future climate included both increased temperatures and increased precipitation. In addition to diminishing snow accumulation in mountains and on the plains, an increase in temperature has the potential to cause a commensurate increase in the rate of evapotranspiration (Chambers and Pellant 2008). Simply put, even if more rain falls, higher and hotter temperatures could increase the rate at which that moisture is both evaporated and transpired. In a cool, arid climate, such as Montana, an increase in temperature could have a significant effect on soil moisture content, upon which dryland farmers, in particular, depend (Calzadilla et al. 2010).

One study modeled changes in precipitation and irrigation rates for United States agriculture. McDonald and Girvetz (2013) examined the relationship between water deficit and irrigation rate. For arid states like Montana, the research showed that by 2090, more land would need to be irrigated to sustain a crop. With an increased need for irrigation, coupled with its potential lack of availability means that western farmers could face significant challenges (McDonald and Girvetz 2013). As the need for irrigation rises, there may be less water available for it. While an era of climate change may bring with it more precipitation, higher temperatures may alter the timeliness and duration of the rain or snow that does fall.

Many of these studies do not consider how farmers might adapt to a changing climate, how they might buffer their losses in times of drought or flood. Qiu and Prato (2011), however, studied the economic feasibility of agricultural adaptation to a changing climate in the Flathead Valley of Western Montana. The researchers used climate models to test the efficacy of two adaptive techniques: flexible scheduling (adjusting the dates of agricultural production), and irrigation. They measured the success of each adaptive technique in terms of its economic costs and benefits. Their results demonstrated that neither adaptation technique would help farmers adapt to a changing climate. Both adaptive measures were "unlikely to reduce the potential adverse economic impacts of climate change on crop producers in Montana's Flathead Valley" (Qiu and Prato 2011: 223). For all of their models, crop yields decreased both with and without the adaptive techniques. Situated in the mountainous, western region of Montana, the Flathead Valley benefits from both more precipitation as well as more irrigation than does the dry prairie east of the mountains. Without irrigation, dryland farmers in the Golden Triangle are further limited in their adaptive responses.

Compounding problems, increasing temperatures could create more favorable conditions for outbreaks of agricultural pests and pathogens (Adams et al. 1988; Chambers and Pellant 2008; Lal et al. 2011). Increasing temperatures could also favor the proliferation of invasive weeds, such as cheatgrass, which could pose particular problems for organic farmers who farm without synthetic herbicide (Chambers and Pellant 2008; Pederson et al. 2008). Much as Adams et al. posited in 1988, climate change has the potential to challenge agricultural production on farms throughout the American West.

This nearly thirty years of research tells a story of potential hardship on farms in the arid West. As Oyler and others have explained, discerning the future from a range of scenarios is a difficult task (MacDonald et al. 2010). What is clear, however, is that the climate in Montana is already warming, and will likely continue to do so (Adams et al. 1988; Calzadilla et al. 2010; Chambers and Pellant 2008; MacDonald et al. 2010; Pedersen et al. 2009). Changes will be less pronounced in the short term, and more pronounced in the long term (Calzadilla et al. 2010; MacDonald et al. 2010; McDonald and Girvetz 2013; Qiu and Prato 2011).

In north central Montana, rainfall is scarce, and water is made and held in hanging mountain lakes, flowing out over the plains in spring-swollen rivers of green melt. When rainfall amounts to less than 15 inches annually, every eighth of an inch of rain carries great meaning for farmers. Temperature trends already observed and predicted for the future could have significant effects on Montana's agriculture, even if rains do come. Adaptation measures may well center around how to trap and conserve soil moisture, essential to making a crop.

I situate this research in the Golden Triangle, in part, because in a land of inherent aridity, where farmers grow crops with sparse rain, knowledge of how to trap and conserve soil moisture is the foundation upon which this agriculture has been built. That is, those farmers who remain in the Golden Triangle today, have adapted—and will have to continue to adapt—to a climate of certain, but erratic and unpredictable, drought. While their strategies have much to teach us, as we shall see, these farmers are likely to need them even more in the future as temperatures increase, precipitation changes, snow pack diminishes, seasons shift, and new pest problems emerge.

Rural Vulnerability

A decrease in crop yields and farm income not only affects the farm household, but also the rural communities in which those farmers live and work (Johnson and Smith 2003). Successive years of drought reduce farm income and associated agribusiness income, leading to economic hardship in agricultural communities (Johnson and Smith 2003). Public programs, such as crop insurance and disaster assistance, exist to aid farmers in years of drought and decreased yields. Such programs, however, are less effective when the drought years pile up and farmers cannot make up for repeated lost yields (Johnson and Smith 2003). An era of pronounced climate change has the potential to create conditions for more frequent and successive droughts in the Golden Triangle, which could spell economic hardship for the region's rural communities.

Perhaps not surprisingly, researchers consider rural communities to be more vulnerable to climate change than urban areas (Lal et al. 2011). Several factors contribute to such vulnerability: high rates of poverty, high rates of unemployment, a low rate of income growth, high dependence on government transfer payments, more vulnerable populations of very old and very young people, and higher travel costs to healthcare facilities (Lal et al. 2011). In 2010, the population of Montana was 989,415, just shy of a million people (Sommer et al. 2014). The state covers an area of 92,134,579 acres (Sommer et al. 2014). With so few people on a great landmass, Montana is undeniably rural. Much of that rural land—64 percent—is agricultural, held in ranches and farms. In an era of climate change, "States with significant farming dependent counties like Nebraska, Iowa, and Montana could lose agricultural profits" (Lal et al. 2011: 830). Like many places across the globe, the Golden Triangle is rural, agricultural, and vulnerable to climate change.

Adaptation, Adaptive Capacity, and Vulnerability

The farmers who remain in Montana's Golden Triangle have adapted homestead agriculture in the past century to a region far more arid than the former frontiers of Kansas or Nebraska. In that time, Montana farmers either went out of business during the tough times or they adapted, managing their operations to withstand the unpredictable, but sure-to-come drought, as well as the vagaries of markets and government programs. Already in this region there is a history of adaptation. These past strategies for drought adaptation reveal how Golden Triangle farmers might continue to adapt into a future of climate change.

Literature on adaptation developed alongside the emergent study of global, anthropogenic climate change in the 1980s. Adaptation as a term originated in evolutionary biology long before social scientists adopted it. In a social context, adaptation describes transformative change in response to outside social, environmental, or political forces. While biological adaptation is a process for species' survival, cultural adaptation describes cultural survival (Smit and Wandel 2006). The present study examines, in a way, a facet of this cultural adaptation: *agri*cultural adaptation. Considered in this manner, adaptation is manifest in altered human behavior as well as new technology (Smit and Wandel 2006). It is comprised of both social and cultural dimensions, as well as biophysical, economic, and policy dimensions (Risbey et al. 1999, Smit and Wandel 2006). Adaptation has been considered both as a process and as a state of adaptedness (Murhpy et al. 2014). In this study, I consider adaptation a process by which agricultural systems change in response to external stressors, be they environmental, social, economic, or political.

Adaptive change does not happen merely at the farm scale; governments, organizations, and communities likewise participate in the agricultural change evidenced on participating farms. However, in the present study, I interview primary operators of farms in the Golden Triangle, and in doing so, I approach the topic of adaptation from an individual perspective, while acknowledging that adaptive change happens on multiple scales, often simultaneously, both in synergistically and oppositionally. Such a dynamic and varied process I approach from the perspective of the farmer, the individual who must deal firsthand with the effects of drought.

Key dimensions of adaptation are adaptive capacity and vulnerability (Smit and Wandel 2006). “Adaptations,” as Smit and Wandel (2006: 286) explained, “are manifestations of adaptive capacity, and they represent ways of reducing vulnerability.” As mentioned before, adaptation can occur on a multiplicity of scales: at the individual, household, community, or national scale. At each of those scales, vulnerability reflects “the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt, or recover from the effects of those conditions” (Smit and Wandel 2006: 286). Vulnerability, thus, contains two elements. The first is the exposure and sensitivity to a particular external stressor. The second is the system’s ability to respond to stress through coping and adaptation. In this way, measures that increase adaptive capacity can diminish a system’s vulnerability.

Vulnerability reflects biological or physical factors, such as soil type, soil biodiversity, irrigation water availability, and rainfall (Knutson et al. 2011). However, it also reflects social factors, such as the ability and knowledge of the farmer to manage his or her particular land with its particular biophysical challenges. These social facets of vulnerability are less well understood in the literature. By nature of its aridity, biophysical vulnerabilities in the Golden Triangle center on moisture deficiencies, whether in poor snowpack for irrigated producers or in limited, untimely rain for dryland producers. Such vulnerabilities vary across time and space. Timely rainstorms can douse one farmer’s fields, for example, while leaving the neighbor’s dry. Given the harsh biophysical vulnerabilities of the Golden Triangle, with this study, I consider how individual farmers in this landscape have responded to these conditions. In other words, given the considerable biophysical vulnerability of the region’s agriculture, this research centers on the social and economic elements of adaptation.

As such, this research roots itself in farmers’ practical experiences of adaptation. Experiences with drought have been similarly used as a “research window” into the character and quality of adaptation (Head et al. 2011:1094). Adaptation is not restricted merely to future scenarios of climate change; rather, adaptation has happened throughout history and in response to a multiplicity of forces, be they environmental, economic, or political. Adaptation has already happened and is happening both on the northern Great Plains and elsewhere. It already exists in the way those farmers go about their daily work, responding to various environmental risks, such as rain, hail, flood, fire, or drought. Head et al. (2011: 1090) put it well: “Rather than climate change being an entity somehow separable from normal climate, to be responded to in the future, farmers are already in a process of adaptation, whether consciously or not.” Accordingly, Head et al. (2011) used drought as a research window into the process of adaptation for wheat farmers in New South Wales, Australia. Like the Golden Triangle, the landscape of New South Wales is arid, and most farmers grow wheat using dryland techniques. The Golden Triangle bears resemblance to New South Wales in its topography, climate, and its agriculture. Drought is the means through which farmers can talk about the ways in which they respond to extreme environmental forces that come to bear upon their crops. Employing drought as a research window allows the researcher to explore the dynamic and contemporary process of adaptation with farmers.

The Big Climate Coulee

Making use of drought as a window allows the researcher to inquire about adaptation to extreme weather events without the political noise of climate change. Throughout the thirty years that climate change has been a national topic, it has been a polarizing issue (McCright and Dunlap 2011). Liberals and Democrats are more likely to think consistently with the existing scientific consensus on the reality and severity of climate change. Conservatives and Republicans, however, are more likely to contradict the scientific consensus on climate change. Such politicization heightened during the early 1990s, when the global environmental movement began to organize itself on international issues (McCright and Dunlap 2011). For conservatives who value individual freedom, private property rights, limited government, and the free market, "the possibility of an internationally binding treaty to curb greenhouse gas emissions is viewed as a direct threat" (McCright and Dunlap 2011: 160). In response, conservative groups have partnered with "a small number of 'contrarian' scientists" who are willing to challenge the scientific consensus on climate change (McCright and Dunlap 2011: 159). In this manner, conservatives have attempted to balance the dialogue on climate change, which has allowed them to "achieve a level of media visibility incommensurate with the limited scientific credibility of their claims" (McCright and Dunlap 2011: 159). For their efforts, the national dialogue on climate change has become more politicized, with two dire and conflicting arguments. Furthermore, "the American media disproportionately report on the uncertainty and supposed controversy in climate science" (McCright and Dunlap 2011: 161). Both liberals and conservatives seek out news from distinct sources, such as National Public Radio or Fox News, respectively, where they find information that reinforces their personal ideologies. This further politicizes an already divisive issue.

With a focus on drought, I sought to interview farmers about adaptation to climatic extremes apart from the global warming debate. Rather than focusing on the heated issue, I centered my research on adaptation, a concept linked to climate change, but which also stands apart from it, as a way that all living organisms on earth—including humans, including farmers—have persisted in their environments—or not. For the purposes of this study, I used drought as a research window for discussing adaptation outside of the political context of climate change.

At the end of each interview, however, and after having established rapport with the participant, I inquired about the participants' beliefs on climate change. Doing so allowed me to parse out the relationship between adaptation to climatic extremes and farmers' thoughts on the issue of climate change. An interview, as conceived in this research, is not a discussion, but rather an opportunity for the researcher to listen intently, probing for meaning and depth into the perspectives of the farmer participants. The benefits and challenges of interpreting farmers' varied perceptions of climate change is explored more deeply in the Methods Chapter.

Adaptation on the Farm

While an unpredictable future of climate change is the frame for this research, its center is adaptation. Adaptation as a process does not exist in a biological vacuum; dryland farmers in north central Montana do not adapt merely to their particular cloudscape or climate. Adaptation happens in response to climatic and biological forces, as well as in response to economic, political, and social forces (Smit and Skinner 2002). Farmers tend their fields with consideration for both climatic and non-climatic stressors, such as the price of grain or federal crop insurance (Smit and Skinner 2002). Such complexity can be approached through qualitative research, in which the researcher does not isolate climatic and non-climatic variables, but rather, considers both together, as the reality in which farmers sow their livelihoods.

Smit and Skinner (2002) created a typology for the many different agricultural adaptation strategies that exist within scholarly literature. They characterized these different adaptive techniques according to their forms, scales, and participants. Agricultural adaptation is not limited to the farm household, but also happens within other sectors of society. Government, industry, business, and organizations contribute to agricultural adaptation, such as in the scientific development of new crop varieties or chemicals, or as with the development of federal crop insurance policies. Additionally, adaptation can take on different forms, illustrated in the difference between purchasing crop insurance and planting a new, drought-tolerant variety of wheat. Finally, adaptation occurs across different scales, including local, national, or global scales (Smit and Skinner 2002).

The authors characterized adaptations in four ways, including its intent and purposefulness, timing and duration, scale and responsibility, and form. By intent and purposefulness, Smit and Skinner (2002: 93) distinguished between those adaptations that are carried out "spontaneously" or “autonomously,” and those that are adopted in response to a perception of risk in a future of climate change. The authors admitted that identifying the driver for adaptive change is challenging. For example, it is difficult to tell whether a particular adaptation is a response to climate change, or rather is an expression of the general risk management happening annually on a farm. Some growers undertake changes with both climate change and other risks in mind. These drivers of change are also not mutually exclusive. Farmers can take on change, as it were, with both climate and—for example—their financial security in mind.

Smit and Skinner (2002: 93) also characterized agricultural adaptations according to their timing and duration, distinguishing between “anticipatory,” “concurrent,” and “responsive” adaptations. Anticipatory adaptations can otherwise be considered long-term, strategic, proactive changes made within an operation. These kinds of changes take the long view, working towards on-farm resilience over time. Responsive adaptations, by contrast, happen in-season and reactively, in tactical response to unanticipated environmental, social, political, or economic forces. Some adaptations, the authors pointed out, can be both anticipatory and responsive. For example, early homesteaders on the plains experienced drought, prompting them to make long-term proactive changes—even in wet years—to buffer their yields from the losses associated with drought (Smit and Skinner 2002). As we shall see, responses to drought in the Golden Triangle can also be characterized this way, as farmers respond to drought as it happens, but also before it happens, anticipating it, knowing that drought will come to their region as it always has.

In yet a third way, Smit and Skinner characterized adaptation according to scale and the agent responsible for that adaptation. The scales at which adaptations occur can vary between the “plant, plot, field, farm, region, and nation” (Smit and Skinner 2002: 94). The responsibility for those changes can be attributed to the individual farmer, agribusinesses, or governments. While the present study considers changes made at the individual scale, any one farmer’s adaptations are hard to isolate as simply his or her own choices. The responsibility for adaptations made at the scale of the individual farm can reflect influences from actors operating at other scales, such as an extension agent or a salesperson.

Finally, adaptations can be characterized by form. The authors identified and described four forms within Canadian agriculture, where they conducted their research (Smit and Skinner 2002). As with each of the three previous categories, the forms of adaptations are not mutually exclusive. The four types of adaptation characterized by "form" are: "technological developments," "government programs and insurance," "farm production practices," and "farm financial management" (Smit and Skinner 2002: 95). The two first forms "are principally the responsibility of public agencies and agri-business," as well as innovative organic farmers in the Golden Triangle, as I show later. The two latter forms, by contrast, fall primarily under the responsibility of the individual farmer (Smit and Skinner 2002: 95). Delineating responsibility for each of these forms, however, does not always hold. For example, decisions made by agribusinesses and governments that impact the wider agricultural system can and do affect decisions made by individuals on the farm. Understanding these nuances and relationships can elicit a greater understanding of how adaptation works in the Golden Triangle and elsewhere.

Other frameworks for adaptive capacity exist, melding purpose, timing, scale, responsibility, and form together into an altogether different typology. Wall and Marzall (2006: 378) explained community adaptive capacity as "fundamentally dependent on access to resources." Their framework therefore is arranged according to the resources contributing to adaptive capacity. The resources they identified were social, human, institutional, natural, and economic. Social resources describe to the relational linkages present between members of a community. Human, resources, by contrast, are the "skills, education, experiences and general abilities of individuals combined with the availability of 'productive' individuals" (Wall and Marzall 2006: 379). Institutional resources reflect "government-related infrastructure," which provides services, such as electricity and water, as well as healthcare, social support, and communications (Wall and Marzall 2006: 379). Biophysical, or natural resources, include soil and water conditions—in short, nothing less than the sum of ecological goods and services available to a region. Finally, communities can pull from economic resources—capital.

Scholars have framed adaptation and adaptive capacity in more ways than those recorded here. What these frameworks bear in common, however, is their attention to the social dimensions of adaptation. Furthermore, these frameworks, with their lack of mutually exclusive delineations, show the basic interconnectedness of the many drivers of adaptation. Undergirding each social resource for adaptation is the landscape, the soil and water resources of a particular agricultural region. Such interconnectedness, by its very nature, necessitates social research to access the depth of the experience of adaptation.

The present study approaches the adaptation happening in the Golden Triangle of Montana. In the next chapter, I explain the research methods used to approach adaptation. I asked participating farmers about how they have *responded* to the drought events they described. Not all responses to drought, I came to find, are equal. Scholars likewise have distinguished between responses to climatic stress. Murphy et al. (2014) explain the delineations between responses that can be considered "coping," "adaptation," or "maladaptation." Similar to short-term, reactive types of adaptation, the authors describe coping as changes made to withstand the effects of an external stressor, such as drought. Adaptation, rather, is transformative: a wholesale system change that better serves the farmer in their current environmental, social, economic, or political situation. In contrast, maladaptation is a response that "delays the onset of a larger problem, or creates feedbacks that exacerbate the problem further" (Murphy et al. 2014). In addition to the many typologies expanding on the many facets of agricultural adaptation, participating farmers' responses to drought can be better understood with these definitions of adaptation, coping, and maladaptation.

Adaptation Research

Scholars have conducted research on adaptation in a number of ways. Smit and Wandel (2006) provided a typology of four different strands of existing adaptation research. The first approach attempts to predict the effects of adaptation to mitigate the impacts of climate change. The second type of adaptation research uses scientific models to evaluate the efficacy of certain adaptation strategies in diminishing the effects of climate change for a particular system. Qiu and Prato's (2011) study, which used climate scenarios to model the theoretical effectiveness of adaptation to climate change in the Flathead Valley of Western Montana, falls into this latter category. Both types of research use climate modeling to make scientific predictions that factor in expectations for future greenhouse gas emissions, population growth, and development. Smit and Wandel make clear that neither of these two types of research address the process of adaptation nor its practical dimensions (2006). The third type of research assesses adaptive capacity or vulnerability for a particular community in order to prioritize groups most in need of assistance (Smit and Wandel 2006).

The above types of climate change research are common throughout adaptation literature. The last type, however, is more rare. Using in-depth, qualitative methods, this approach—similar to the one used here—endeavors to identify and describe some of the adaptive needs and strategies for a particular people in a particular time and place. With this research, scholars and communities may conduct community-wide, "participatory vulnerability assessments," in which community members and researchers work together to identify potential and observed stressors, adaptive strengths, and strategies for improved adaptation (Smit and Wandel 2006:289). Smit and Wandel (2006) strongly advocate for this kind of research to be conducted in communities across the globe.

Additionally, Miller et al. (2013) note the gap that exists in current climate change literature for bioregion-specific, bottom-up research that explores the potential of certain adaptive strategies to lower risks for diversified agricultural production. Such research, they explain, is of critical importance to ensure food security in an uncertain future of pronounced climate change (Miller et al. 2013). The present research helps fill this gap in the literature with bioregional, bottom-up, and fine-grained research on the complex process of adaptation for dryland farmers in the Golden Triangle, Montana.

A Fine-Grained Approach

While not part of a participatory vulnerability assessment, the present study employs similar methods of inquiry—qualitative, fine-grained, in-depth, and field-based—with the goal of more deeply understanding how particular farmers (dryland farmers) in a particular place (the Golden Triangle) adapt to drought. With their biophysical location on the northern prairie, these farmers have a lived experience of adaptation that has evolved in a land of inherent extremes, where drought occurs perennially, though unpredictably.

Rather than considering adaptation only as a theoretical response to a future stressor, this research considers drought as both a historical and current environmental condition to which farmers have already adapted and are currently adapting. Working with this bottom-up approach, the first question central to the present study is: (1) How have certified organic and conventional farmers in the Golden Triangle experienced drought? With an understanding of how farmers themselves perceive their own environmental conditions, the data and analysis turns to a second and more illustrative question: (2) How have these farmers adapted their farming operations to drought? This question approaches the social dimensions of adaptation as detailed in both Smit and Skinner (2002) and Wall and Marzall's (2006) typologies for adaptation, exploring the many forms of adaptation, the various scales at which those forms occur, as well as the agents responsible for decision making. Underlying this question are inquiries about the structures that both enable and disable farmers' adaptive responses to drought. Finally, this research seeks to understand a third, and more complicated question: (3) What can farmers' responses to drought in the Golden Triangle reveal about the nature of agricultural adaptation to climate change? Considering the history of adaptation in an unforgiving climate, how have farmers in the Golden Triangle been able to persist? How has their adaptive capacity made them more resilient, despite drought, or not?

These questions respond to adaptation literature that calls for place-based and bottom-up qualitative research on the complex process of adaptation. With drought as a research window into ever-present adaptation, this research considers the long-view on adaptation, looking at how it has changed over time—and continues to change—in the century of agriculture on the arid, northern plains of the Golden Triangle, Montana.

Figure 3. Standing stubble in a chem-fallowed field.

APPROACHING THE LIVED EXPERIENCE OF CLIMATE

With much of their labor out-of-doors, farmers experience weather, and over time, climate, firsthand. They witness the elements subjectively, as rain, snow, hail, and wind come to bear on their crops and livelihood. Their lived experience, seemed to me, likely to give them a particular knowledge and perspective on adaptation to climatic and non-climatic forces. In March of 2014, I made my first trip out to the Golden Triangle, traveling east over the last Rocky Mountain pass before the great expanse of prairie. I made three additional trips to the region, following the trajectory of the growing season, visiting the Triangle again in April, June, and September. This chapter details how I went about conducting this research. I begin with data collection, the process of selecting, recruiting, and interviewing the farmer participants. I then introduce the farmers who participated in this study. From there, I explain the data analysis process employed in this research, expanding on the strengths and limitations of qualitative, social research, as applied to this study.

Data Collection

To answer my research questions, I conducted 15 in-depth, semi-structured interviews with growers in the Golden Triangle selected (based on criteria discussed below). I built the interview guide with moderate structure, asking specific questions that would inform my research, while preserving space for unanticipated, but potentially relevant, topics. I wanted to provide direction during the interview, but also leave room for spontaneity. In the months before I set out on my first research trip, for example, Monsanto announced its plans to open a research facility in Great Falls, Montana, at the southern edge of the Golden Triangle (Puckett 2014). The facility chosen, on the outskirts of Great Falls had to be rezoned from commercial to industrial to allow for the storage of chemicals at the site. Three of 15 participants shared their perspectives on the new Monsanto facility despite me not asking after it directly. The spontaneous emergence of information—such as farmers' perspectives on the new Monsanto facility and the development of genetically modified wheat—illustrates the purpose of the semi-structured interview. While this specific information was compelling, it is not included in this research. Rather, it represents an area for further research and inquiry.

With an in-depth, semi-structured approach to qualitative research, I began to refine the selection criteria to reflect the research objectives.

Selection criteria

I limited the research to the Golden Triangle, an agricultural region known for its quality dryland wheat growing conditions. Seven counties east of the Rocky Mountain Front in north central Montana make up the Golden Triangle region, including Glacier, Toole, Liberty, Hill, Chouteau, Teton, and Pondera Counties. With the Golden Triangle as the research site, I selected for farmers of this region. Ranchers represent another sizeable agricultural demographic in this region, but are not included in this study, unless they were also farmers, raising crops in addition to livestock (Meter 2011).

With seven counties as my research area, I further limited the participants to dryland farmers. In 2007, of the 11 million acres of harvested cropland in the Golden Triangle, only 289,000 were irrigated (Meter 2011: 3). Most farmers in the Golden Triangle grow crops using dryland methods, which are reliant wholly on rainfall for moisture. Because climate change projections would affect dryland and irrigated farmers differently, and because each farming method would elicit different adaptive strategies, I limited this study to dryland farmers. As one participant, Innis, described his farm, “It’s all dryland. Really dry sometimes.” Some farmers I interviewed maintained some irrigated acreage. Most farmers, however, worked dryland acres exclusively.

I further narrowed the selection criteria to farmers with an agricultural family history in the Golden Triangle. I inferred that multi-generational farmers would have some historic insight on adaptations to drought in their region. Most farmers fit this mold. When I asked about farmers’ history in the Triangle, many related family history going back nearly a hundred years to the old homesteading days of the early 20th century.

Two farmers, Kip and George, are newcomers to the Triangle and stand as two exceptions to this selection criterion. Kip is a second generation Montanan, and George is a first. These two participants were found based on other farmers' recommendations that they be interviewed. In snowball sampling for additional farmer participants, I did not clearly communicate the entire selection criteria. Therefore, the selection criteria for generational history in the Triangle did not hold for every participant. Most farmers, however, met the selection criteria, and form the bulk of the perspectives in this research. Though Kip and George did not meet this criterion, they nevertheless offered valuable insights on adaptation to drought. George's family had farmed for generations to the east in Minnesota. And Kip's family had been in the Triangle area for roughly fifty years.

Most farmers began their interviews with stories of their family's homesteading history. Cliff began his interview this way, detailing his family's plains history, which precedes that of any other participant. "We are originally here from the Desert Claim days of the 1880s," he said. Cliff's family moved to Montana before it became a state in 1889. All that remains of those early days are long-abandoned and overgrown irrigation ditches that run through his property.

Another grower, Lee, explained how his family had lost their original homestead during the drought years of the 1930s. After World War II, Lee said, his dad came back from the service and took two jobs, working as a mechanic and a bartender. "He saved up enough money to make a down payment on this place here, which was another homestead," he explained. After several years of farming, "He was able to buy the old homestead back." Farmers with history on the northern plains understand that history as it was told to them by their parents and grandparents. The history they know is one of resilience and adaptation, as it was their families who weathered the recurring drought years of the 20th century.

Because I was interested in the many different ways in which farmers adapt to drought on the northern plains, I interviewed five organic growers, five conventional growers, and another five growers who farm both organic and conventional acres. The term, “organic,” in the context of this study, denotes organic certification under the rules established by the United States Department of Agriculture. “Conventional,” by contrast, sometimes denotes the use of synthetic pesticides and fertilizers, which are not permitted under organic regulations. In the Golden Triangle, many conventional farmers manage their soil with a no-till fallow method, referred to in the region as “chem-fallow.” For this practice, farmers leave stubble in the field after harvest and terminate weeds with herbicide, rather than tillage. Chem-fallow is a characteristic practice of conventional agriculture in the region. However, not all conventional growers, as we shall see, farm using the same practices or management. Otis, one of the research participants, while a conventional grower, has not used synthetic fertilizer in eight years. Instead, he uses cover crops to manage his soil fertility. Organic producers, likewise, vary in their farm practices and management.

As this research will show, within the labels “organic” and “conventional” are many different farmers with different ideologies and different methods. Despite such diversity, farmers who grow certified organic grain and those who do not sow their fields under different regulations. The strategies for adaptation are made within the context of a particular agricultural system. In this way, selecting for both organic and conventional producers gives the research richness, as producers respond to drought within the context of organic or conventional, as well as within those systems.

The sampling of both organic and conventional growers does not reflect the demographics of all Golden Triangle farmers. In fact, there are very few organic farms in the Golden Triangle, particularly within the context of the thousands of conventional farms that make up the bulk of the region’s acreage. In 2012, farms with organic sales made up only 148 of the over 28,000 farms in the state of Montana (Vilsack and Reilly 2012). The object of this research, however, is to uncover the many ways in which farmers adapt to drought in the Golden Triangle. Crouch and McKenzie, arguing for small sample sizes, attest to the utility of sampling "variants of a particular social setting" (2006: 493). Rather than sampling representatively from the population for organic and conventional growers, I sampled for the diversity of farmer perspectives that exist in north central Montana. In other words, the sample reflects the many ways in which farmers reckon with drought in the Golden Triangle, whether those ways are widespread or relatively rare. Sampling from such divergent and diverse viewpoints also affords the research a comparative dimension. Holding one viewpoint in the light of another can reveal insights that could not otherwise be seen by evaluating one viewpoint alone. Selecting for diversity of perspectives and experiences creates contrast within the analysis where theory can be generated.

Recruitment

Before I began this research, I knew two individuals who worked in support of Golden Triangle agriculture. Those key informants, David Oien of Timeless Seeds, and Nancy Matheson of the Montana Department of Agriculture, were of particular help to this study, providing names of potential farmer-participants. Per Matheson's suggestion, I sent each farmer a typed letter explaining the research and asking for his or her participation. In the letter, I mentioned that I would follow up in the coming days with a telephone call.

Only one farmer responded to the initial letter. The day after the first round had been postmarked, a farmer whom I'll call Art responded in an email. He explained his experience with drought in a long breath of a paragraph, expressing his eagerness to participate in the research. Every other farmer I had to telephone—often many times—to arrange an interview. In one field note, I wrote, "It took me awhile to get in touch with him—I am now very familiar with his family voicemail, 'Hi, you've reached the…Ranch." I sent out 17 letters over the course of the growing season, and from that effort, interviewed 11 farmers. From there, I used a snowball sampling technique to find additional participants, asking for recommendations of other participants from farmers I had interviewed. Four additional interviews resulted from individual farmers' suggestions, for a total of 15 research participants.

Interviews

Before each interview, I explained the research and described the types of questions I would be asking (Interview Guide, Appendix A). First, I asked participating farmers about their farm and family history. With an understanding of their particular historical and agricultural context, I asked about each farmer's experiences with drought. I wanted to know how they would describe drought, and how drought had affected their farm. Next, I asked farmers how they had responded to drought, in other words, how they had adapted to drought. To gain depth on their adaptive process, I asked what had enabled their ability to adapt to drought, as well as what had hindered it. Finally, after establishing rapport with the interviewee, I asked about their perspectives on climate change, in order to better understand how farmers think about climate change in relation to adaptation to drought.

All interviews were confidential. As I explained to each farmer, their names would never be used in any written reports or presentations. I tried to stress that the participant could skip any question during the interview, and that he or she could terminate the interview at any time. I presented each participant with an Informed Consent Form, which re-iterated in print what I had explained. I then asked for permission to digitally record the interview. All participants signed the Informed Consent Form, and all agreed to have the interview digitally recorded.

To minimize any personal risk farmers might experience by discussing the financial and personal impacts of drought, I assigned each farmer a pseudonym to ensure confidentiality. One farmer, Bob Quinn, refused confidentiality and asked that I use his name in connection to everything he said. Four times during the interview, in fact, he encouraged me to quote him directly. It is important to note that Bob Quinn was a very early adopter of organic agriculture in the Golden Triangle and is recognized nationally and internationally in the organic industry. His interview came about because, more than once, other research participants had told me I ought to interview him and that I would be missing an important perspective if I didn't. It was clear from what other farmers said about Bob Quinn, that they knew his opinions and respected him for his honesty, even if they didn't agree with what he had to say.

The identity of every other participant is confidential information. Pseudonyms are used to protect participants' identities. Direct quotations from participants have been pulled from the interview transcripts, unless otherwise noted.

Farmer Demographics

The participating farmers grew a wide variety of crops apart from the traditional wheat and barley that the region is known for. Participating farmers reported growing wheat, barley, oilseeds (such as flax, canola, safflower, camelina), pulse crops (peas, lentils, chickpeas), as well as many other specialty crops like Kamut®, oats, millet, mustard, fenugreek, emmer, and spelt. Many farmers also grew alfalfa hay or raised some livestock, such as cattle or sheep. Many also incorporated cover crops into their rotations, planting alfalfa, clover, tillage radishes and turnips, vetch, among others, to improve their soil quality.

The interviewees also ranged in age, farm experience, and level of education. All farmers I interviewed were men. In 2012, 85% of principal farm operators were men (National Agricultural Statistics Service 2013). Occasionally, their wives would participate in the interview, but as the men seemed to be the primary operators, they typically answered all questions. Four women participated in the interviews, often clarifying their husbands' perspectives, or adding their own perspective, contributing to this research. However, the overwhelming majority of the perspectives included come from the principal operators, all of whom were male.

Interviewees ranged in age from about 30 to 70 years old, according to my estimation based on dates mentioned as farmers described their personal history. Most farmers I spoke with were in their fifties and sixties, in tune with the average age of principal operators in Montana, which was 58.9 years in 2012 (National Agricultural Statistics Service 2013).

Farmers' experience ranged from just 11 to over 50 years in the field. Many interviewees had been working on the land since they were teenagers, and had helped with farm tasks since they were children. Cliff explained, "I was 14 years old when we [my brother and I] purchased our first little parcel of land. We had a neighbor. He was older and had a few acres. And he said, 'I want to sell that to you guys,' and that's how we got into farming." Many farmers got their start young, either leasing their own ground, or farming with their family of origin.

Some of the farmers I interviewed had college degrees, while others either had some college, or had not gone to college at all. As Barry explained, "I grew up on a farm…I went off to college in Bozeman. Didn't like college. Came back, and I was able to lease a farm…and the next year, I was able to buy it." He was nineteen when he purchased his first 400 acres of farmland. Because he had grown up on a farm, he explained, it was like he had gone to college for 18 years already, learning to grow grain crops. Joe, the youngest farmer I interviewed, leased land while he went to college, farming during the summers. After finishing his degree, he moved home and bought the land he had been leasing. For some farmers, college enhanced their farming experience, introducing them to soil science and agronomy. For others, college was a distraction that they either shirked or endured.

The 15 farmers who participated in this research occupied a range of both age and experience. Their nuanced perspectives and experiences give this research depth and complexity.

Trucks, Grandfather Clocks, and a June Rain

When I set out on the first interview trip, I took the shorter, more direct route. Out of Missoula, I headed northeast on Montana Highway 200, which follows the Blackfoot River towards its headwaters at the Continental Divide. Across Rogers Pass, the mountain road spit me out onto the plains. Tall lodgepole and ponderosa pine dispersed, giving way to a wide, flat, and gold landscape of the plains. My windshield seemed to hold more land and sky, as if it were a magnifying glass. I headed towards Great Falls on plains broken only by buttes, coulees, and rivers, the Marias, Milk, Missouri, and Sun, and Teton Rivers, which snake through the region. Each trip east to the Golden Triangle I took this route, and each time, the change in the landscape was the same.

I took four research trips over the course of the growing season, distributing these trips throughout the spring, summer, and fall so that I could witness the changing prairie landscape. The first trip happened in late March. The gumbo clay side roads were newly thawed. Heading out to a farm up against the Rocky Mountain Front, I drove past a golden eagle, sitting atop a fencepost. I slowed my car to get a good look at it before it lit off, likely to hunt gopher. On this first trip, driving out east of Conrad, I passed a lone cottonwood with two bald eagles alongside one another on a limb. As homogenous as the plains seem at first look, there is much life present there that deserves attention. In spring, the prairie is a wet place. Snow geese pass through on their northern migrations, stopping to shake their wings free of drip. Farmers spend it readying their machinery, waiting for the fields to dry out. Driving up to each farmstead in spring, I found farmers at work in the shop, hands and shirt covered in streaks of black grease.

I took a second trip to Conrad in April. Then, in June, I headed farther east in the Triangle towards Havre, Big Sandy, and Fort Benton. This trip coincided with what farmers call a "June rain"—three days of ceaseless mist and light rain—the kind of rain that sinks deep into prairie loam. During this trip, I interrupted farmers socializing with family and friends in a rare moment of relief. One farmer I interviewed had to reschedule because he was having company over that day. During this trip, I knocked on Joe's door only to be greeted by another member of his family. They were just making lunch, she said, tomato soup and grilled cheese on a rainy afternoon, and she offered me some. I got lucky later that same day, after the interview with Lee, when I got a second lunch of brisket, mashed potatoes, and Brussels sprouts, leftovers from a big family meal the night before.

During this June rain, a celebratory ethos saturated the plains. People gathered to share food and company in the short moment of relief, before the dry part of the summer.

The final trip happened much later, in September. By this time, the winter wheat had already been planted. During this trip, Otis gave me a tour of his fields, showing me the radishes he had intercropped with his wheat. Past another field full of vetch and clover cover crops, he showed me the old schoolhouse where his father had attended as a boy. The door was boarded shut, but I could see through the window: the teacher's old spring mattress, torn apart by mice, covered in varmint droppings, the unpainted wall where the blackboard used to hang, chairs on their sides, the grid of desks askew, evidence of all the people who have left this farm country in its short century of history. On this same trip, another grower gave me a late summer ATV tour of his vegetable test plots. The potatoes had already died back, and the pumpkins were a ripe orange. The season was coming to a close.

The setting was much the same for each of the 15 interviews, with only two exceptions. I interviewed Barry in the gumbo-stained cab of his truck as we drove out to each of his three fields. Bob's interview took place in his kitchen garden. I held the recorder out towards his voice while he replanted his irises. All other interviews happened at a kitchen table. Often the table was made from thick wood, and often, in the corner opposite the table stood a grandfather clock. In many recordings, an hourly toll from these clocks marked the passing of time. The interviews averaged a length of 76 minutes, the longest being 113 minutes, and the shortest, a mere 40. All together, the 15 interviews amounted to a total of 19 hours of tape.

After the interview, some farmers offered to take me on a farm tour. We climbed the significant height up into their mammoth trucks, and drove from field to field, teetering around the potholes, stopping to get out and kneel down to look at the different crops. On one of those drives, Kip taught me how to identify alfalfa. After that, I noticed it everywhere, volunteering along the roadside or in a field where something else was should have been growing. On another trip, Micah drove me out to his fields on top of a knob near the Bear Paw Mountains. From the knob, we could see in all directions. He walked me through one of what he called his “new breaking” fields, prairie sod he had only recently plowed up. The field had taught him the value of organic matter; he had me bend down and feel a clump of the newly tilled prairie loam. It crumbled in my hand. The tilth was so unlike the hard, clay soils of his older fields. On these farm tours, growers showed me firsthand some of the adaptive practices they had been implementing: cover crops, perennial crops in rotation, and with Micah, the value of soil organic matter.

Ecological Embeddedness

I coupled the farmers’ oral narratives of drought adaptation with relevant research on history, ecology, and climate science. This kind of synoptic approach allowed me as researcher to understand the topic—adaptation to drought—through a number of lenses. Particular to this research, I needed to understand the rich, century-old history of adaptation—or the lack of it—for agriculture on the northern plains. Likewise, I needed to more fully understand the science behind climate change, which frames this research. This interdisciplinary approach is necessitated by the nature of adaptation, which is not limited to the farm field or the farmer, but rather is informed by government, politics, and science.

In addition to conducting interviews, I also wrote down observations and reflections that emerged during research in a field journal. These notes informed my perceptions of farmers’ attitudes towards drought, adaptation, and climate change, which in some cases could not be understood based on the raw interview data alone. Field notes also captured interactions that occurred when the recorder was off, such as during field walks and farm tours, as well as during experiences in the Triangle that happened outside of any interview. For example, driving past the Anheuser-Busch grain bins outside of Conrad or through Pendroy, Montana, which marked a major presence on the physical, as well as economic landscape. Or in Pendroy, Montana, where the local insurance agency was a new, white, vinyl building with a neon red open sign, situated on a Main Street otherwise populated by clapboard and cinderblock storefronts, the paint chipping off the old bar and the volunteer fire department. As we shall see, crop insurance also looms large on the plains.

These field notes contributed towards my own "ecological embeddedness" in the Golden Triangle. Ecological embeddedness, Gail Whiteman (2010) argues, helps the researcher to create his or her own narrative in a place. Likewise, field notes facilitated my own interpretation of the landscape and its inhabitants, through writing and reflection.

Data Analysis

After collecting 15 interviews, I transcribed each interview in full. I then began the process of data analysis. I open coded the interview transcripts, searching for recurring themes. I organized these emergent concepts into analytical categories, such as "practices for soil moisture conservation" or "practices minimizing soil erosion." Coding allowed me to rearrange the data into a narrative that would attempt to answer my research questions. I also pulled from field notes to inform and augment transcript data into a more detailed story of how farmers adapt to drought in the Golden Triangle.

During the writing of this research, I pulled quotes from transcripts to illustrate key themes and concepts. I transcribed each interview in full, including false starts to sentences, vocal pauses, as well as repairs to misspoken words. To shorten quotes, however, I omitted some of these vocal idiosyncrasies in places where meaning could be maintained.

The Challenges of Qualitative Research

Interpretive, qualitative research explores social reality through "the perspective of those enmeshed with it" (Hesse-Biber and Leavy 2011: 17). It is within this methodological camp that I frame this research on farmers' experiences of drought and adaptation. With words for data, qualitative research preserves the individual's experience in his or her own vocabulary. The in-depth interview, as a means of gathering social data, "assumes that individuals have unique and important knowledge about the social world" (Hesse-Biber and Leavy 2011: 94).

There exist some limitations to in-depth social research of this nature. With only 15 participants, the perspectives gathered in this research make up only a small fraction of the entire farmer population in north central Montana. The perspectives and experiences contained in this research thus cannot be statistically generalized to the general farmer population in the Golden Triangle, the state of Montana, or even the western United States. Nor does this research measure the efficacy of the adaptive techniques described by the 15 farmer participants. The agricultural techniques contained in this research cannot be considered as necessarily effective for farms and farmers elsewhere.

Despite the limits to in-depth social research of this sort, findings from the present study may be, however, theoretically generalized to farmers with comparable cropping systems working in xeric conditions. The perspectives held in this research were carefully selected and gathered to represent the diverse array of adaptive strategies and experiences present in the Golden Triangle: from farmers with family and history in the region, from farmers with agricultural backgrounds, and from farmers who operate within the constraints of both organic and conventional agricultural systems. The experiences of the farmers contained in this research are born out of their experiences growing grain in the droughty Golden Triangle. It is likely that these carefully elicited perspectives are not so particular and singular, and, as we shall see, echo ideas and concepts about adaptation and climate change in current literature. The experiences gathered with this research provide more research, more stories, more detailed accounts on how Golden Triangle commodity growers raise grain through times of drought. This research, therefore, adds to a literature on how farmers cope and adapt to drought, a climatic event that may become more common as climate change continues to express itself on farms across America.

This study is designed, rather, for depth of perspective. In giving up some generalizability and breadth, this research approaches the fine-grained and complex lived experience of farming in a drought-prone country and the adaptation to those conditions. All 15 interviews add up to 19 hours of tape (the digital kind). In addition to those recorded hours, I spent many more exploring the region, driving hundreds of miles along its gumbo roads, field walking and farm touring, and sharing meals with the farmers I interviewed. These experiences contribute to a more fine-grained understanding of the experience of raising crops on the dry plains, and adapting to unpredictable, yet recurring drought. Interviewing farmers in-person, often on their farms at their kitchen table, I was able to build rapport, creating space for farmers to share perspectives on sensitive topics, such as climate change and drought. Additionally, I was able to ask questions that clarified the meaning participants were conveying. What this study offers is deep, fine-grained data that approaches the particular, nuanced, lived experience of agricultural adaptation in a land of inherent extremes.

In-depth, qualitative research of this sort also allows the researcher to consider the tension between individual agency and structure. For the purposes of this research, I considered each farmer participant as an individual "doing" in a particular structural context, while also "enduring" that structure (Crouch and McKenzie 2006). While I consider the efforts of the individual farmer carrying out his or her work out on the northern plains, I also consider the social, political, and climatological contexts in which each farmer conducts their business. Crouch and McKenzie explain how qualitative research can be used to witness both the "doing" and "enduring." "It is from within this liminal space," they write, "that our respondents interact with their social environment, and it is this interaction—of the doing with the enduring—that has been the focus of our attention" (Crouch and McKenzie 2006: 494). Analytical, inductive, qualitative research, they posit, is well suited to approach this paradoxical "liminal space."

The middle ground between agency and structure is particularly relevant for this study, as we shall see. Participating farmers are continually adapting to forces outside their locus of control, such as northern plains ecology (e.g. lack of precipitation, soil type), as well as the socio-economic and political structures that determine organic and conventional grain markets. Crouch and McKenzie maintain that research approaching the liminal space between agency and structure is intensive by nature, and as such, "requires small sample sizes so that all the emerging material can be kept in the researcher's mind as a totality under investigation at all stages of the research" (2006: 495). For this research, I gathered a small sample size of 15 farmers, which afforded me both the time and space to conduct in-depth interviews and explore the field sites.

With colloquial, anecdotal data sprawling over hundreds of pages of transcripts, the task of interpreting the perspectives and experiences therein was a daunting one. In addition to the quantity of data, I became uncertain about my ability to interpret it, new as I was to the region and its agriculture. Prior to conducting this research, I had little experience with commodity agriculture or any large-scale farming, be it conventional or organic. Furthermore, being from Kentucky, I had spent little time out on the Great Plains. That first trip, I couldn't tell the barley stubble from the wheat.

What had brought me to this research, however, was an ardent interest in agricultural adaptation and how Montana farmers reckon with the drought that defines the short grass prairie. That interest had been born out my own experience farming in Kentucky on a farm very unlike those I visited, but which had dealt with its own kind of challenges, raising crops in a year of heavy rain. Although I had never farmed in the Golden Triangle, it was perhaps this fact that allowed me to be so curious about what grain farming was like on the xeric plains of eastern Montana.

For these reasons, interviewing grain growers on their farms on the northern plains was nothing short of transformative. Over the course of the four research trips, I gleaned more about conventional, large-scale, commodity agriculture than I had from any book or article. I remember driving from Cliff's ranch on a piece of land on the foothills of the Rocky Mountain Front. He had totaled up his insurance bill for me, out loud, at his kitchen table. The total kept soaring upwards, into the hundreds of thousands of dollars. This was his reality. The cream he took off the top of his crop sales—his net profit—was meager compared to the dollars that moved through his hands each season in the form of insurance, synthetic inputs, and machinery necessary for cultivating all the acres sweeping across his patch of prairie.

The transformation was even more pronounced when farmers expressed views I did not share. At those times, I continued to probe for depth and search their language for meaning. This was most pronounced during the end of each interview, when I asked farmers about climate change. At those times, rather than sharing my perspective, I sat quiet and silent, listening for the meaning held in each farmer's words. In that stillness, I found myself empathizing with foreign ideas and perspectives on climate change, perspectives I had read, but had never heard directly, isolated as I was from the big commodity farms that so characterize agriculture in this country. In another context, I might have disagreed with some of the farmers I interviewed, but in this context where it was my role to listen and understand, I felt myself trying to see the land and the climate with their eyes. This was the most radical part of this research: the act of listening to commodity growers in rural Montana. Now that this research is complete, it is the part I will most remember.

This research has been conducted under the assumption that climate science is replicable, and that there exists a relationship between anthropogenic carbon emissions and the rise in global average temperature. Rapid, global, anthropogenic climate change is a defensible theory that frames this research on adaptation to climatic extremes. When I asked participating farmers about their perspectives on climate change, they had much to say. Some of what they had to say, according to my understanding of climate science, was inaccurate. Several farmers refuted the validity of climate science. One farmer stated that climate change was a political ploy, and another posited that the whole idea was just a way for some people in this country to sell books.

As I reviewed their words in the hopes of analyzing them, I felt like I ought to refute farmers' inaccurate assertions. But I also felt reluctant to do so, as doing so would invert the relationship I had tried to maintain throughout this research, which regards each farmer as the knower, the possessor of experience and perspective. I hesitated to interpret their perspectives on climate change, because in doing so, I had to point out the inaccuracies, the false statements they had made. Interpretation of this kind would reverse the planes on which the participants and I stood, placing me above them as the one informed and knowledgeable.

In reflection, I came to better understand the relationship between the researcher and research participant. Not only is the participant knowledgeable, but I, too, am knowledgeable. As researcher, it is my obligation to interpret the participants' words. Furthermore, the perspectives of participants do not have to be scientifically accurate to reflect their own personal truth. With years of exposure in a landscape prone to extremes, the farmers who participated in this research have significant insight into plains weather and climate, as well as grain farming. Likewise, their opinions on climate change are shaped by the ecological, social, and political contexts in which they live and work. While farmers may speak scientifically inaccurate statements about climate change, what they say is also accurate, a real reflection of their place and history. Rather than consider each farmer's perspective as accurate or inaccurate according to the science undergirding this research, I chose to consider each farmer's words as built from his or her lived experiences farming the dry prairie.

With regard to climate change, I also considered how social contexts influenced participants' beliefs. While each participant shapes his or her beliefs on climate change, their beliefs are also shaped by current trends in national rhetoric on the topic. Farmers' perceptions are not merely their own, but are molded by the political and social contexts in which they live and work. While I consider each farmer's perceptions as his or her individual point of view, I also consider how those perceptions are shaped by social and political contexts.

This research, therefore, approaches the lived experience of drought, adaptation, and climate change on the dry plains of the Golden Triangle. Considering the need for localized, fine-grained qualitative research on the complex process of adaptation, I approach farmers' experience and perspectives with 15 in-depth, semi-structured interviews that took place on growers' farms.

Figure 4. A tractor out in the expansive fields.

RAISING GRAIN THROUGH DRY YEARS

A farmer, who I call Art, was first to respond to my initial wave of letters inviting farmers to participate in this research. The day he received my letter, Art typed out a long email response. More than any other farmer in this study, Art speaks and writes in metaphor. His first email was proof of his poetic way with words. "We live 30 miles from anywhere," he wrote. "When the drought was on in our area we saw meadowlarks in the shadow of power poles with their wings out and their beaks open." He continued, describing in great detail how drought had affected the wildlife on his farm in north central Montana. Before the drought, he had never known that pheasants rub their breast feathers on dew in order to wet their eggs each morning, softening them until their young can peck through the shell. Each generation of pheasant is dependent on the presence of that light moisture at dawn, made scarce in a drought. A fourth-generation farmer in the Golden Triangle, Art's dream is for the fifth and sixth generations to return to the land, continuing the tradition of planting and harvesting grain. His dream—like that of the pheasants—he wrote, depends on the continued presence of moisture. I begin with Art's first email, my first piece of "data," because it illustrates several points. First, Art acknowledged the need for moisture to maintain life in a xeric landscape. Art also gave in his email—early on in this research—a glimpse of what drought looks like on the plains, which is where this study begins.

If I were to study drought and how farmers adapted to it, I knew that I ought to begin with an understanding of what drought looks like, what it feels like, and what it does to a crop, a farm, and a farmer. This story of adaptation begins with growers' experiences of drought, their physical descriptions of what drought looks and feels like on the flat expanse of the short grass prairie. From these growers' experiences of drought, I shift to how drought has impacted their farm operations, and then to how they have adapted to those impacts. From there, I explore the barriers to adaptation, as well as what has enabled, assisted, and supported farmers' adaptation to drought. Finally, I conclude with farmers' perceptions of climate change, as it relates to drought. In a story about drought, I begin with the drama—farmers' windy, desiccated, raw experiences on Montana's central plains.

Blue Wheat and Blow Dirt

Nine of the 15 farmer participants described drought in the Golden Triangle in terms of its effects on their crops and soil. Many farmers said that in a drought, the fields, the windrows, and the roadsides looked—as one might expect—brown. Or, they said that the entire landscape simply looked dry. Innis, a conventional farmer, who raised his family during the droughts of the nineties, said that in their early years, his children hardly knew what a puddle was. Dean described the way the dry, gumbo soil cracks in drought. “It would be cracks this deep, this wide. Ten, twenty feet deep. You lose your pocketknife or wrench—it’s gone. Snakes go in and out,” he said.

A few farmers described stands of wheat and barley turned blue, almost turquoise. I visited Lee, an organic farmer, in the middle of June of 2014. This trip happened to coincide with what the farmers call a June rain, when rain falls over the course of a few days, and farmers divided their days between the shop, working on machinery, and the living room, relaxing in the rare moment of spare time. Driving out to Lee’s farm, my Subaru fishtailed on gumbo roads. Before this June rain, Lee’s spring wheat fields were “starting to look pretty blue.” I caught Lee and other farmers in a moment of rest and relief, their fields green and lush and the soil wet and muddy.

Three farmers described drought in terms of how it moves across a dry prairie. To describe how wind acts upon dry soil, they used a word unfamiliar to me. “Blow dirt” is a term these farmers use for soil erosion by wind—that is, soil particles lifted by wind, carried out of the field, and piled elsewhere on the prairie. “They say it takes a thousand years to make an inch of topsoil,” said Art. “And you can lose that in an afternoon of eighty-mile-an-hour winds. It can all be piled in the fencerow.” From an agricultural perspective, drought affects a field not only in the loss of soil moisture, but also in the loss of the topsoil to wind erosion. If left without vegetative cover, prairie soil dried to dust will blow away. Such a loss, as Art noted, could take generations to replace. Adapting a farm to perennial drought, then, meant managing for both soil moisture and soil cover.

These two concerns, as we shall see later, are fundamental to an understanding of how these grain farmers adapt their farms to drought.

Three farmers described the fire that so often accompanies drought. Their experiences illustrate the critical interplay between heat—high temperatures—and low precipitation. Increasing annual average temperatures have already been observed in Montana (Pederson et al. 2008: 146). As Chambers and Pellant (2008) explained, an increase in temperature can also increase the rate of evapotranspiration, accelerating the loss of soil moisture. Cliff, who farms his family's homestead along the Rocky Mountain Front, described the fires of 1988, the year much of Yellowstone National Park burned. "We had fires. It was always smoke," he said. "The whole front, the whole mountain burned that year. There were several mornings you woke up here, there would be pine needles on your vehicles as ash." Farther east in the Golden Triangle, Joe, an organic farmer, remembered rigging a water tank to the bed of his truck and driving across his and his neighbors' fields, dousing out prairie fires. His community of farmers around Fort Benton turned into a fire brigade, their trucks became fire engines. If the drought's heat didn't spark flame, it nearly boiled Barry's neighbor's flood-irrigated barley field. His neighbor's irrigation hardly cooled his crop in such heat. As Barry observed, increased temperatures can also diminish the effectiveness of irrigating.

Rounding out an understanding of what drought looks like, the farmer participants described the onslaught of pests and weeds that occurs in drought. Fred, a conventional grower, explained how during a drought, the kochia plant—otherwise known as tumbleweed—blows across a gravel road like in an old Western film. Art recalled that grasshoppers always seemed to move in during a drought. He recounted an old homesteader tale of grasshoppers eating a pitchfork handle down to the iron, trying to find the moisture held in the wood.

Sometimes, farmers almost talk about drought as if it were a plague, an ordinary part of a disturbance regime in a semiarid landscape rendered to drama. Some descriptions almost sound uncanny: crops boiling into soup, cracks feet-deep in the earth, blue wheat. Drought manifests itself in low soil moisture, heat, fire, wind, soil erosion, and pest outbreaks. These descriptions make clear the reality of drought on the northern plains. If drought so devastates the landscape and crops, then, does drought affect farmers' livelihoods?

A Century of Adaptation

To temper such dramatic depictions, farmer participants also explained how contemporary farm practices had mitigated the effects of drought. I asked them to compare what they knew about historic drought with their experiences of recent drought. For the purposes of this research, I qualified recent drought as occurring in the past 15 years. It seemed, however, that most farmers considered recent drought to be the drought that had occurred in their generation, during their experience as an operator. For them, historic drought was that of their parents or grandparents' generations. I qualified historic drought as happening before those most recent 15 years. This question, with its malleable time frame, was a tricky one for most farmers to answer. Two farmers said outright, how could they know? Earnest, an organic and conventional grower who farms near Fairfield answered this question thoughtfully. He asked, how could we trust our own memories, or those of our parents or grandparents? To answer my question, he said, he would have to go look at official climate records. Innis, a conventional farmer near Montana's Hi-Line, acknowledged that he tends to only remember the exceptional. It is more rare that he remembers the years of moderate or periodic drought.

Despite the difficulty of this question, six farmers I interviewed said that recent drought had affected them less than historic drought. It wasn't due to any climatological changes, but rather to the improved conservation practices of the farmer. Over the course of the century-old farming history in north central Montana, agricultural practices had changed. Farmers had adapted. Drought had continued to occur, but with practices better adapted to the region, farmers fared better. Micah, an organic farmer, said, "The farming practices are better now. And I think we've seen droughts that severe but you know, people aren't out with the moldboard plow flipping their soil in the middle of summer." The moldboard plow, as Micah alluded, was a deep plow common among the early homesteaders who came to Montana in the early 20th century. It flipped the soil, inverting the soil's structure, creating conditions for soil erosion on the dry, windy prairie.

Kip, another organic farmer, explained that for most conventional farmers, chemical fallow practices—a type of fallowing that uses herbicides to kill or prevent weeds—have improved their ability to minimize erosion and preserve soil moisture. Kip said outright: "We probably would have had a lot better crops in the fifties if we had the farm practices we have today." These farmers' observations are hard to dispute. Most farmers are no longer deep plowing their soil in the dry months of July and August. Many are not tilling it at all. Those who do till do so with caution, with a better understanding of its effects. These farmers clearly acknowledge the adaptation that has already occurred and that will likely continue to occur in the Golden Triangle. The practices farmers cited, strategic tillage and chemical fallow define organic and conventional agriculture respectively, for the area. Such practices will be discussed in greater detail later in this chapter.

What I was trying to understand with this question was how farmers think about weather in the context of climate. Had they observed any changes about the nature of drought over the course of their time spent working in the elements? After all, what first brought me to this research was my own experience farming in a year of record rainfall, a challenging weather extreme opposite in nature to drought. In response to the question, two farmers, Fred, a conventional farmer, and Barry, an organic farmer, both said that they had observed a marked change in the nature of drought over the course of their lifetimes. Fred had observed more consecutive years of drought. Barry, in contrast, described more full-season droughts that persisted through an entire growing season. Still two other farmers said that recent and historical droughts felt the same.

These farmers' perspectives illustrate the difficulty of remembering weather patterns. This challenge is explored in more depth later in the analysis on climate change. Several farmers expressed the challenge of linking observed weather changes to climatic changes. These comparisons between historic and recent drought show how agriculture has adapted over a century of farming on the semiarid plains. Moreover, several participating farmers were aware of this adaptation. Drought has always happened on the plains; while farmers cannot change the climate, what they can change are their agricultural practices. In short, they can adapt.

Low on Cash, Heavy on Humility

When I asked farmers how drought had affected their farm operations, some mentioned diminished yield. Five farmers explained yield losses from drought: fewer tons of hay put up, fewer bushels of grain harvested—if any were harvested at all. Just as many farmers, however, spoke of the corollary effects of diminished yield: its effects on farm finances, long-term farm planning, and the farm family.

Two farmers explained how drought reduces their farm income. “Financially, boy, it hit,” said Fred, a conventional farmer. “There’s a lot of capital that goes into growing a crop. So it’s pretty easy to lose a lot of money.” George, another conventional farmer, remembered the successive droughts of 1996, 1997, and 1998 and how it took him years to revive his farm financially after that. For conventional growers like Fred and George, who use costly chemical inputs to grow a crop, not making yield can cause real hardship, particularly when those inputs are purchased with borrowed money, which they often are. Indeed, organic farmers, or farmers who grow without the use of chemical inputs, also have high some operating costs, usually in the form of more fuel and machinery. Many farmers bear the financial burden of making enough money from a crop to pay back the lender, let alone pay themselves. Successive years of drought only exacerbate this dilemma (Johnson and Smith 2003: 4). As a critical component of adaptation to weather extremes, fiscal management is be explored in more depth in a later chapter.

Four farmers also noted how supply and demand—and also biology—could help alleviate some of the financial stress in a drought year. A lower supply of grain in the market, for instance, can spark an increase in the price of grain. In effect, the few bushels a farmer does harvest in a drought year are sometimes worth more per unit than they would in a year of average rainfall. In a similar manner, low moisture can increase the protein content of wheat, which also improves price in a drought year. "Only benefit…is when the yield is cut, your protein goes up. And there's always a better price for protein…So you can play catch-up a little bit there," Dean, an organic farmer, said. Despite these gains, as Lee, who also farms organically, put it: "My experience in the last 30, 40 years [is that] drought…is a negative influence. I mean the price never makes up for the depressed production." Thus, the benefit of higher prices in a drought year is small, and unlikely to recover financial losses from low yield.

In addition to yield loss and financial stress, drought affects farmers' long-term planning. Three farmers said that drought could set them back on their plan for new varieties or crops, new machinery, or additional land. "Every year we've put it in our self-guide program to try a new crop," Dean, an organic farmer, said. "If there's a drought, we don't do it…you stick with what you know works." Another farmer, Art, explained, "Maybe if there's a piece of ground that come up for sale, there would be no way that you would even think about buying when it's dry." He added, "And if you need a new vehicle, or tractor, or combine…you forget about all of that." Based on these responses, there seem to be two scenarios in which long-term farm planning goals are curtailed in years of drought. First, farmers are unlikely to try a new variety and technique if conditions are unfavorable for success. As Dean said, "It's a bad year to compare it to." Farmers will stick with what they know works. Second, with less cash flow in a drought year, farmers tighten their budgets, and are often unable to make costly changes to their farm operations. Drought, then, could curtail some farmers' efforts to better adapt their operation to drought and, by extension, to long-term climatic changes.

Earnest noted, too, another way drought can affect long-term farm planning. "It's not devastating," he said, "unless you're one of those people who can't pay your bills." He acknowledged that many farmers have debt, borrowing to cover their operating costs from a lender. "If we can't pay it back…we're done as farmers," he said. "Drought does play a major role that way." Drought can put farmers out of business, particularly when it occurs over successive years and debt accumulates.

On a more hopeful note, two farmers felt like drought made them a better operator. That is, it forced them to rethink their operation, and prompted them to make changes to build resilience. Drought demanded adaptation. Kip, an organic grower, said it plainly, "Drought's kind of humbling. You know you don't have control." Similarly, Art described how drought had made him more "conservation aware," and went on to explain the humility that comes with farming in a land of extremes. "You can be really strutting your stuff and then have a year of drought," he said. "Instead of soaring with the eagles, you're kicking shit with the turkeys." While drought—and debt—has put farmers out of business, drought has also forced those who stay to adapt. Those farmers who remain—very few of the thousands who came in the first two decades of the 20th century—have adapted, their resilience borne out of the humility that comes with farming in an unpredictable and extreme landscape.

Drought, Depopulation, and the CRP

As you might expect, one farmer's financial troubles affect others', radiating throughout the agricultural community, and depressing the rural economy. Ten participants (two-thirds) spoke to the fundamental importance of cash, and the challenges that come with the lack of it. More often than tillage, crop varieties, or any topic related to the physical act of farming, money and how farmers manage it was a frequent topic farmers discussed in these interviews. "The ag[riculture] supply companies," said Dean, who had farmed conventionally before he transitioned to organic, years ago. "They won't sell as much fertilizer. And they won't sell quite as much chemicals. But yet," he said, "you've got to apply them, if that's your normal operation. That part will go on. But the fertilizer will be down." In a year of drought, farmers won't spend the kind of money they would typically spend in a year of adequate, timely rain. He went on to say that seed companies, too, would likely see a decline in profits, because farmers would save their own seed. “Saves them a dollar or two,” he said. His observations also described how farmers get by in drought years: with great frugality. George explained how farmers stop spending money when they don’t have any to spend. “When things start getting drier out here,” he said. “You quit seeing people going to town and going out to eat. In drought years, people just tighten up and don't spend money.”

Not surprisingly, the inverse happens in a good year. Fred, a conventional farmer, explained that if “farmers get money, they’re always buying something, whether it’s a new car, a new pickup, a new tractor, or new furniture for the house.” Existing research supports these farmers’ observations of the tandem fluctuations of farm income and rural economic prosperity. Johnson and Smith (2003) observed that drought reduces farm income and, consequentially, reduces income for rural businesses associated with farming.

The farmers I spoke with mentioned other effects of drought on the local community. Five farmers said that drought had contributed to the declining trend in the rural population. Four added that drought—particularly the drought of the 1980s—forced much land into the Conservation Reserve Program (CRP). The CRP is a program administered by the Farm Service Agency, which took sensitive agricultural land out of production in order to prevent soil erosion, improve water quality, and preserve wildlife habitat. In exchange for farmers taking parcels of land out of production, the federal government provided farmers with an annual rental payment. Still another farmer said that drought played a role in farmland consolidation, which also contributed to rural depopulation. Textual data does not always fall into neat categories. These observed effects of drought—rural depopulation, the CRP, and farm consolidation—are difficult to discuss separately.

To illustrate this complexity, I introduce Otis. I met Otis during my final research trip in September 2014, long after the spring wheat crop had been harvested and the winter wheat planted. What is most striking about Otis is that he falls into the conventional farmer category, though his practices are far from conventional. He gave me a field tour in his pickup, and out on his piece of prairie he had tillage radishes growing in his spring wheat, vetch and clover growing in his fallowed fields. For the past eight years, Otis has foregone the use of any chemical fertilizers, though he still uses herbicide to control weeds. More of Otis' story unfolds in a later section. For now, I share some of his perspectives on how drought—among other forces—has affected his community. Otis, as well as four other farmers, discussed how farming has become less profitable, and how younger generations have stopped returning to the family farm.

> The kids were making money somewhere else—and farms weren't big enough to support the son to stay at home…We joke about that when we get together at an auction, where you standing around a bunch of neighbors…the few of us that are left. It will be just a handful of men, but it covered thousands of acres out here that normally would have been maybe twenty farmers. And now it was five.

Otis illustrated farmland consolidation, describing five farmers cultivating a landscape that would once have been worked by twenty farmers.

He continued describing how drought encouraged farmers to put land in the CRP. "Those droughty years caused a lot of people to put their land into the CRP. That was because it wasn't raining in the years that CRP first came out. It wasn't abundant rain and the price of wheat—it was awful. CRP was a good, well, it was a guaranteed income, whether it rained or not." Otis linked the CRP not only to the drought years of the 1980s, but also the poor price of grain. He went on to say how useful the CRP became because a farmer could borrow money against the fact that he or she would have reliable income coming in from the government. He said that he bought more land knowing he had an assured income. "It's not the way you'd like to farm, as a farmer," he said. "To take land out and rent it out to the government was not something that made you feel really good about yourself…but it was a tool." Other farmers also cited the drought as another reason farms went out of business, making land available to those with dependable incomes from CRP-held ground.

Otis' words show the difficulty in ascribing cause and effect to drought, CRP, consolidation, and depopulation. He states that it was not only drought, but also low grain prices, which caused depopulation and consolidation of farmland. And those effects are not separate, but related, as the availability of land from those who moved away allowed those who stayed to pick it up, increasing their economy of scale, helping them make it another generation. Considered together, the strings that make up this complicated knot show the difficulty of making a living as a farmer out on the plains (or in any rural place in America).

As research has shown, adaptation happens not only to the ecological climate, but also to the economic climate: the price of grain, the price of fuel, as well as government assistance programs (Smit and Wandel 2006; Smit and Skinner 2002). As Otis and other farmers have likewise expressed, adaptation to drought does not happen within a vacuum. How farmers adapt extends beyond merely tending to their soil and crops. Adaptation might also mean tending to the fluctuating economic climate, creating a resilience that extends beyond the soil to the bank.

In-Season Adaptation

Central to this study is the question about how farmers adapt to drought. To begin my inquiry into farmers' adaptation, I first asked participants about short-term adaptations to drought. In other words, when drought happened during the growing season, how did farmers respond? This approach allowed me to differentiate between responsive and anticipatory responses to drought, per Smit and Skinner's (2002) temporal characterization of agricultural adaptation. Likewise, such in-season adaptive responses can be even better described as coping, as "simply surviving the disturbance" of drought (Murphy et al. 2014).

Most farmers agreed that there was not much one could do in-season to adapt to drought. Six farmers—all conventional growers—explained, however, that during a drought, they cut down on inputs to better their bottom line. Cliff and George, two conventional farmers, were both staunch proponents of what they called, "split application." As they described it, split application is the practice of spraying fertilizer as it is needed in the field. Rather than spraying out the full amount of fertilizer for a growing season, farmers could apply smaller amounts of fertilizer several times over the course of a season, as needed. If drought came, farmers could choose not to spray. “So when something like that comes up and it quits raining, I quit putting on all the fertilizer,” explained George. “And if it turns on a quick rain in here, then I can put on them last two passes [of fertilizer].” Split application affords these farmers flexibility in a year of untimely or insufficient rain, allowing them to lower their operating costs in a year of low yield.

Innis, another conventional farmer, recounted a story about how he saved money on his herbicide bill. Rather than spending money on expensive weed killers—and the fuel to spray them with—Innis took to his fields weeding the old fashioned way, digging them out one-by-one with a shovel. “I’d do several hundred acres in just a few hours,” he said. What these farmers explained is that in a year of drought, they have to do everything they can—like weed hundreds of acres by hand—to lower operating costs enough to earn a profit. In boom years, or years of adequate, timely rainfall, it seemed, these farmers would spray their usual amount of chemical fertilizer or pesticide, foregoing these drought-year cost-saving measures. In this way, these changes in farming help farmers cope with low yields and low profits in drought years. Such changes, therefore, are not transformative in the way that Murphy et al. (2014) define adaptation.

In addition to cutting costs, three farmers take on additional jobs to maintain cash flow in a drought year. Cliff explained that in drought year, he would custom hay and custom combine for farms over on the Fairfield Bench, many of which are irrigated and tend to fare better in a drought. These jobs would bring in cash to pay his bills. Some farmers explained that when the rain stops in north central Montana, sometimes it falls in torrents in eastern Montana. When central Montana is droughty, they travel to eastern Montana, driving grain trucks or doing custom work, to maintain cash flow.

In past droughts, George, another conventional grower, took jobs off the farm. The last time drought hit, he took a highway heavy construction job, running backhoes and other large machinery. “I make 20-something, 25, 27 bucks an hour,” he said. “Covers my living expense. But in times of drought, you do what you gotta do to survive." By both saving money and finding additional work to make more of it, farmers were able to eke by in a dry year.

With respect to crop management, four farmers explained how they would adjust their planting schedules during drought. Bob, an organic farmer, explained how his nine-year rotation allowed him the flexibility to plant according to available moisture. "If I have fall peas, and if they're not successful, then I will plant spring peas," he said. In the same manner, if his alfalfa is unsuccessful, then he will plant clover, another perennial crop, which will allow him to catch up on his rotations. "If something goes wrong," he said, "you have diversity to make up for whatever's going on." Fred, a conventional farmer, does something similar, though with a much shorter rotation. If the fall is too dry to plant winter wheat, then he'll wait until the following spring and plant spring wheat or barley. "You can be flexible," Fred said. The greater the crop diversity of the farm, it seems, the more flexibility the farmer has to adapt his or her planting to the available moisture.

Farmers' ability to change crops based on a fixed rotation illustrates the difficulty of parsing out short-term from long-term strategies for adaptation. Multi-year crop rotation is a long-term and transformative adaptive strategy that enables farmers to better cope with years of drought. Split application, by contrast, continues a decades-old tradition of reliance on synthetic fertilizer and pesticide. While split application allows the farmer to cope with drought, it continues her reliance on synthetic fertilizer and pesticide. As will be explored in the section on financial adaptation, these inputs are expensive both for the manufacturer to produce and for the farmer to purchase. Thus, the annual purchase of such inputs lowers farmers' profits, and, one could argue, increases the soil's vulnerability to disturbance. Farmers like Bob Quinn, with his nine-year rotation, and to some extent, Fred, with his two-year rotation, are able to cope as well as adapt to drought. These farmers do so with methods that neither require additional capital, nor diminish the soils' inherent resilience.

Preventing Soil Erosion

In contrast to short-term responses, long-term responses are those that anticipate the harmful effects of drought (Smit and Skinner 2002). The two most discussed on-farm management techniques for adapting to drought were preventing soil erosion and conserving soil moisture. Below, I begin with a discussion of how farmers have adapted to prevent erosion during drought. I then explore how farmers have adapted their farms to conserve what little moisture they have. The third most frequently cited way that farmers have adapted to drought is by conserving financial resources, which is discussed at length in a later section. Farmers mentioned other ways in which they better manage their farm in a drought. Those adaptive strategies, such as crop diversification, crop insurance, and in one case—hiring a rainmaker—are discussed towards the end of this section.

Historian K. Ross Toole, among others, has compared the northern Montana prairie to an ocean. "Over this vast, treeless country," he wrote, "the winds are little retarded by friction, and hence they blow with remarkable uniformity and relatively high velocity" (Toole 1959: 14). Those words echoed as I drove up to George's ranch house. In his front yard, a child-size windmill spun so wildly, I thought it might fly off its post. Because of the natural intensity of prairie wind, and the weightlessness of soil wrung dry in drought, erosion was a primary concern for farmers adapting to drought. In order to avoid what they labeled, "blow dirt," farmers noted six strategies. The first and most widespread strategy among the participants in this research was strategic tillage, in which farmers cultivate the soil using particular implements at shallow depths and in certain conditions to maintain soil cover.

Five farmers—all organic—cited this method of erosion prevention. Organic farmers who farm without the use of chemicals cannot eradicate weeds with herbicides, such as glyphosate. Many organic farmers must cultivate or till to remove weeds. Particularly on the Great Plains, where the moldboard plow was the preferred means of opening up prairie soil to crop agriculture, tillage makes soil vulnerable to erosion. To keep the soil from blowing, however, these farmers explained how they till strategically, either with particular implements, at particular depths, or at particular speeds. Kip acknowledged that during drought, "A person is going to have to refrain from tillage practices." "On the other hand," he countered, "sometimes the best thing to do if your ground starts blowing is to work the ground, and it'll bring up clumps." These clumps, he explained, would cover the finer soil particles, holding it in place. He acknowledged the difficulty in determining the best practice in drought: to avoid tillage at all cost, or to till strategically. Such a decision is highly circumstantial, Kip and other farmers explained, dependent on the soil type, soil moisture, as well as what tillage implements are available to the farmer.

Micah, an organic farmer in Hill County, talked at length about his Noble blade, a minimum disturbance cultivator formed in the shape of a V. The Noble blade undercuts the soil, leaving the soil cover intact. "It's kind of like a wave," Micah said. "It [the soil] just kind of comes up and drops down…Say you have a mustard plant, and then the blade comes along, and it just goes *whumpf*, and it sets it back down. By the time you come around on the next round, the top of it's drooping." Tillage implements like the Noble blade give organic farmers, who control weeds through cultivation, an option that enables them to maintain their soil cover.

Rather than till at all, many conventional farmers follow "no till" practices to prevent soil erosion. No till eliminates soil disturbance through cultivation or tillage. In order to avoid tillage, farmers use herbicide to terminate the crop and any weeds before a field lies fallow. Farmers refer to this part of the process as "chem fallow." Chem fallow leaves the dead plant material standing in the field, the roots intact, holding the soil in place. The field lies fallow until the next planting, when the farmer uses an air drill seeder to plant the next crop.

According to the National Resource Conservation Service (NRCS), no till minimizes erosion by "keeping soil in a consolidated condition, which provides additional resistance to the erosive forces of water and wind" (NRCS 2013: 2). No till farming, now in widespread use across the plains, cannot be achieved without the concurrent use of herbicide and air drill seeding. Because chemical fallowing with herbicide is a basic part of this process, chem fallow and no-till were terms often used interchangeably by the farmers I spoke with. “We went to chem fallowing rather than mechanically tilling the ground,” Art, a conventional grower, explained. “And if you have vegetation on the ground, you try to leave it there as long as you can…so that you have something to hold the soil to keep it from blowing.” No till, or chem fallow farming, though mentioned by only two farmers as a means to prevent erosion, was an important adaptation practice for conventional farmers in this research.

Three farmers described using cover crops to maintain soil cover and prevent erosion. Cover crops are “grasses, legumes, and forbs planted for seasonal vegetative cover,” according to the NRCS. The primary purpose for planting cover crops is to “reduce erosion from wind and water.” The farmers I spoke with used a variety of cover crops, such as vetch, clover, buckwheat, sorghum Sudan grass, tillage radishes, turnips, among others. Some farmers used what they called a “cover crop cocktail,” a mix of two or more cover crops planted in the same field. Barry, an organic grower, explained his plan to prevent winter erosion: “My plan is to plant some radishes and turnips and oats as a cover crop. Let that go through the winter. Because most of our erosion comes in the winter months and the early spring months.” Cover crops do just that; they cover the soil, holding it in place.

The different strategies explained here: strategic tillage, no till fallowing, and cover cropping, are more or less useful depending on the farmer’s constraints. Generally, organic farmers cannot adopt no-till practices, although some efforts have been made to develop no till, organic farming techniques. Farmers who have adopted no-till practices would be hard-pressed to till their soil, strategically or not. Cover crops, however, are useful for farmers who subscribe to either agricultural philosophy. Of three farmers who cited the use of cover crops as one strategy for erosion control, two are organic farmers and the third farms conventionally.

Though each of these strategies has its benefits, there are also confounding drawbacks. For example, cover crops provide soil cover in a similar way to no till, however, cover crops are living, while the cover in conventional no till is dead. Driving across the prairie, I learned to tell the difference between a stubble field of just-harvested spring wheat or barley and one that had been fallow for a season. The chem fallow fields took on a gray hue, unlike the bright gold and pale yellow of wheat and barley stubble. An added benefit of chem fallowing, in comparison with cover cropping, is that during the fallow period, no plant is growing and taking up nutrients or subsoil moisture. Rather, the fallow preserves both nutrients and moisture, making them available for the next crop. Still, live cover crops build organic matter, and if the crop is leguminous, add nitrogen to the soil, which will be discussed in a later section.

Conserving Soil Moisture

Conserving soil moisture was another primary concern for the farmers I interviewed. When I asked farmers about their long-term strategies to adapt to drought, eight farmers said that they used cover crops to manage soil moisture. Both conventional and organic growers, as well as those who had both conventional and organic acreage, related the benefits they had seen from using cover crops on their farms. They spoke about many different varieties of cover crops. For Barry, cover crops act as storage tanks for water and nutrients, preserving it through the winter, until the spring, when it can be tilled back into the soil. He, for instance, explained the benefits of radishes for conserving moisture. "With radishes…they actually hold minerals, nutrients, and water, too, in the actual radish. So that it would keep moisture through the winter." Dean, another organic grower, explained the utility of sorghum Sudan grass for trapping moisture in the winter. "You just let it stand there almost all winter, so whatever depth it is, it'll collect that much snow." Sorghum Sudan grass, much like standing stubble in no till farm systems, traps winter snow and holds it in place, allowing greater intake of moisture in the winter and spring.

Yet another way cover crops conserve moisture is by breaking through the hardpan with deep taproots. One farmer, Lee, explained that his soils are heavy, which is to say, laden with clay. Because clay aggregates in stacked plates of layers, it is prone to developing a well-defined hardpan. Alfalfa and safflower, with their long taproots, have the ability, as Lee put it, “open up the soil more so moisture can get down.”

In addition to trapping moisture and breaking through hard-packed clay layers of soil, cover crops also contribute to the concentration of organic matter in soil. Micah remembered breaking virgin prairie sod on his farm in Hill County. In what he called his “new breaking,” he noticed a marked difference in soil quality.

> I had heard it from listening to presenters and readings and things, about the soil that's been depleted and all the natural life that's supposed to be in the soil, from the worms to the nematodes and the bacteria. That's gone from chemical farming. Just in our country, we have a lot of gumbo clay. It gets hard and clumpy. It loses its ability to retain moisture. The moisture winds up running off. Right now, with all this rain that we've had. You can take the pickup and go up on this ground that's only been broke for three years and drive right across it and not have anything stick to the tires. It's like driving across a big sponge. All that humus and everything that's in the soil….Water can percolate down and it just has so many places to go. It's like a diaper almost, it pulls. And then it's there, of course, available for crops, whereas, boy, if you tried to do that in any of our other fields right now, you'd be stuck and you'd have a mess. So yes, we're tilling. But with the cropping systems that we use, with the sweet clover, and the peas, and the green manure crops getting incorporated back into the soil, and using different types of crop rotations, the idea is, as best as we can, to try to get the soil back to how it originally was. And then be able to hold that moisture, just because all of the biomass that is in the soil.

In describing the quality of newly broken field, which had until then been short grass prairie, Micah explains his philosophy on farming. His goal is to build organic matter in a living, diverse soil, full of nutrients and minerals, in order to best absorb the rains that do come. Organic matter in soil increases its water holding capacity. As the NRCS explains, “Soil organic matter holds 10 to 1,000 times more water and nutrients than the same amount of soil minerals” (2014). For Micah, the measure for his agricultural success was the prairie. The farming practices he had developed for his land more closely resembled the natural systems that had evolved for his climate and soils.

Five farmers cited chemical fallow, or no till, as a practice that likewise conserves soil moisture. Because plant matter is allowed to decompose in situ, undisturbed, no till practices also increase soil organic matter, improving water retention. And because no crop is growing on chemically terminated, untilled, fallowed ground, neither is any crop using up existing moisture or nutrients. No till agricultural practices both conserve moisture and create conditions that will absorb more moisture. In studying both no till and cover crop agricultural practices, it becomes clear that both have real, measured similarities with natural systems. A lack of soil disturbance and living, diverse cover would be one way to simply describe the short-grass prairie ecosystem.

The issue, then, is that cover cropping, as the organic farmers practice it, must involve some tillage. And for an organic farmer to practice no till agriculture, as most conventional farmers do, would not be in compliance with organic standards. Organic farmers continue to till. Some of the conventional growers who participated in this study practice both no till and cover cropping. The elephant in the room, then, is something Micah said as he explained his organic practices: "All the natural life that's supposed to be in the soil, from the worms to the nematodes and the bacteria. That's gone from chemical farming." To Micah, conventional farming, with its use of chemical fertilizer and pesticide, does not promote the presence of microbiological fauna in soil.

In my interviews with organic farmers, four farmers explained that part of their motivation to transition to organic agriculture was their concerns about the health effects of agrichemicals. For example, Dean described how his hands would swell after he handled a chemical at the plant where he worked in Great Falls. With swollen hands and a dull headache, he would stay up all night in the blue glow of his computer, researching organic agriculture. Even conventional farmers are wary about the widespread use of agricultural chemicals. George, a conventional grower, explained his sentiment:

> I believe in no-till farming. But I do not like all the chemicals. Our wheat all goes to a flourmill. All of our wheat could be in a bag of flour right here in my house. And you think I want Round-Up all over it? No. Anytime I cut back on Round-Up, that's a good thing.

Both organic and conventional growers—and those who have both production methods within their farms—acknowledge the limits they work within: the limits to no till chemical fallowing, and the limits to organic agriculture that necessitates tillage.

While the organic farmers in this research did not practice organic, no till agriculture, many managed their tillage with care and caution, minimizing its negative effects. While thoughtful tillage can minimize wind erosion, two farmers also explained how it prevents soil moisture loss through evaporation. Both Heath and Bob, organic farmers, explained how the way in which they till helps preserve soil moisture. Heath acknowledged the inherent difficulty in preserving soil moisture through tillage. "Water conservation here is a big one and that is something that organically we're trying to figure out how to do better, because, you have to work the soil to kill the weeds, and every time you work it, you lose moisture," he explained. Because of this loss, Heath explained, a lot of growers have turned to minimal tillage.

The NRCS advocates for minimal tillage that increases plant-available moisture and that maintains at least a 60% cover on the soil surface throughout the year. In addition, they specifically advocate for undercutting tillage implements, such as the Noble blade, because it will "enhance accumulation of organic material in the surface layer" (NRCS 2013: 2-3).

After my interview with Bob, one of the pioneer organic growers in the Triangle region, he gave me a tour of his fields. We climbed aboard his all-terrain vehicle and sped down the hill and onto the gravel road that borders his fields. His was one of my final interviews, and by that time, I was curious about organic growers' use of tillage as a means to conserve soil and soil moisture. West of the road, a large tractor pulled a duck-footed harrow behind it, scraping the soil, tilling. I asked Bob, how does tillage conserve moisture when so many people maintain that it cannot? He responded, explaining how when the tines push through the soil, they push up clumps, covering the smaller soil particles. The soil clumps cap the soil, hampering the evaporation that would normally occur on heavily tilled ground. Minimal tillage, then, stand as real, possible alternatives for organic growers.

Still other farmers concentrated on building soil biodiversity as a means to improve water accumulation and retention. Two farmers described using organic inputs such as soft rock phosphate, or azamite, humic acid, as well as mycorrhizal fungi. Earnest explained his thirty-year-old practice of using what he calls “biological stimulants,” which help the soil break down organic matter, such as straw. The decomposition results in humus, that is, soil organic matter that retains great amounts of moisture, and acts as a kind of “sponge,” which Micah described in his newly broken fields.

Yet another way farmers enhance soil microbiology and build organic matter, as Micah explained, is by incorporating cattle into a cover crop regime. Micah recounted how one of his oldest fields bore the mark of heavy use of nearly a century of agriculture. The field stood hard and clumpy; its yields were poor. He fallowed the field in 2011, and began wintering his cows there. One year, he grew a cover crop mix, or “cocktail” on it, and the cattle grazed on it. Another year, he scattered old barley and millet seed, and grazed that off, too. “It's had three years worth of feeding cows all winter long,” Micah said. “And I figure, it's got to have the equivalent of eight or ten tons to the acre, between the manure from the cattle and what they're leaving behind.” For three, years, he explained, everything he has grown on that field has gone back into the field itself, in the form of nutrient-rich manure. He hopes his strategy has added organic matter, improving the field’s water retention.

Four farmers also explained how early seeding improved their management of soil moisture. If George could get his seed in by St. Patrick’s Day, he said, he would. Early seeding makes use of early season moisture needed to establish a crop. The established crop then grows tall enough to shade the surrounding soil, creating a microclimate at the soil surface that traps moisture and minimizes evaporation. “Come June,” George said, “the chances of a rain out here go down so far. In July, it’s almost nonexistent.” In other words, the summer months in the Triangle are the driest. Because of the limited precipitation in late spring, he said, “Most potential for yield is early seeding.”

What holds these practices together is how each helps edge a farm in the direction of the natural system of the short grass prairie. Avoiding disturbance through tillage, promoting soil biodiversity, planting a diversity of cover crops renders a field more like the prairie. Practices characteristic of sustainable agriculture, which improve soil structure and increase organic matter, mimic the natural system, and are considered to be more resilient to climatic disturbances (Knutson et al. 2011).

In addition to particular adaptive practices, I was interested in how farmers had enacted those practices. In other words, how farmers made change happen on their farms. The most compelling quotes are those in which the farmer explains his thinking behind the transition towards a more adaptive practice. For example, when Micah describes his own curiosity in regards to what intensively integrating his cattle into a cover crop rotation would do for this field. In his case, he had nothing to lose; the field was no longer productive. What he was going for was what he observed when he tilled up the prairie: rich, fertile soil, full of organic matter.

Shedding light on this question, farmers described their experiences transitioning from conventional to sustainable practices. Four farmers offered up their perspectives on how adopting sustainable practices had changed their perspective on farming. This transformation was most evident in Otis, the conventional farmer who has foregone the use of synthetic fertilizer for the past several years.

> Farming, for me in the last five years, has just gone 180 degrees the other way. Cause I was kind of, "Oh man, this farming is just a bummer," because the prices were low, it wasn't raining. And now, well, prices have been high, but these different cover crop rotations and using cows and farming together, those three things just have lit farming on fire for me. I mean, it's just gonna be great. Looking forward to every day, it's just like, what am I gonna do today? To move forward and learn more.

Otis stood up during the interview and walked over to his bookshelf. He started pulling off books, piling up the literature that he had explored during the last several years during his transition away from chemical fertilizer.

Morgan and Murdoch (2000) described organic, or sustainable agriculture as knowledge intensive, rather than input intensive. The authors describe the tacit, localized, and personal knowledge characteristic of sustainable agriculture. For Micah, there was a downside of exploring the complex knowledge of organic agriculture. "It's harder," he said. "It's more complicated, it's more challenging. It's like standing on a beach ball and trying to juggle chainsaws. It very much lacks the simplicity of chemical farming." Perhaps it is within this complexity, that some farmers thrive. As

Dean explained, “It's been just more interesting and more fun than conventional. Of doing my own, on-farm research.” Several other farmers, including conventional growers, had conducted experiments on their own farms, relegating some of their fields to test plots. In these ways, several farmers were making their own knowledge, and with it, adapting their farming practices to their harsh climatic conditions. The use of cover crops to build soil organic matter and improve the soil’s ability to trap and hold moisture stand as transformative means of adapting to drought on the northern plains.

Putting Some Away for a “Not-So-Rainy Day”

Coping with drought often has as much to do with money as with soil. Indeed, many of the 15 farmers discussed the benefits of managing their operating costs conservatively, and they offered up a variety of ways they manage their farm’s finances. Kip explained, “You get a few years under your belt and you try to operate conservative and put some away. They always say put some away for a rainy day but we always say put some away for a not-so-rainy day.” Some farmers spoke to the effect of operating conservatively more generally through years of drought, as well as years of good rainfall. Others, however, spoke more specifically about how they save money.

Two farmers lowered their input costs by saving seed. “I try to only buy varieties that I can keep my own seed. I am not a hybrid seed buyer,” Otis said. He saves all of his own seed, switching varieties every five or six years. “I don’t see the advantage of buying,” he explained. “It’s more money up front.” Saving seed in years of good rainfall lowers input costs for Otis.

George, a conventional grower, stressed the importance of operating conservatively. He was one of the growers who expounded on the virtues of split fertilizer application. In addition to using chemical inputs conservatively, he also purchases them at a lower cost. George explained how his farm produced enough grain to create an economy of scale, which helped him save money on inputs.

> In the drought years, the little guys can’t survive. Cause they can’t buy their inputs as good as I can. We’re getting to the size now where we’re bringing in semi-loads to the yard. If you can start bringing in semi-loads of stuff and bypassing dealers, you’re

> saving yourself money. Kind of like me going right to the flour mill in Great Falls. Most guys don't realize they can do that. They sell to the local elevator. I go right to [the mill].

Because of the quantity of inputs he purchases, George explained, he can get a better price per pound, lowering the cost of those inputs. Using his economy of scale, George is able to minimize his operating costs and maximize his profits. As such, his farm is more secure in years of low rain and low yield.

Another conventional farmer discussed how he had saved money on his input costs by investing in precision agriculture technology, which uses Global Positioning Systems (GPS) to monitor fields and control the amount of chemical sprayed, depending on what is needed. Cliff explained how precision-ag technology enabled him to spend less money on chemical fertilizer, lowering his operating costs.

> The first thing I purchased was a boom controller on my sprayer. As you do your field, it shows where you've gone so your efficiency, your overlap—you're using less chemical…We implemented on that field and we saved like 10,000 dollars just in fertilizer…Early on in 2004, fertilizer prices were here (holds hand up) and now they're astronomical. Every penny counts.

Farmers first adopted precision-ag in the mid-nineties. The government's satellites used during wartime became available to farmers as a means to track and disperse agricultural chemicals. In 1994, a *New York Times* headline read "Satellites Into Plowshares." The article described the early use of wartime technology in farming, which many farmers on the plains have adopted to save money on expensive inputs, which as Cliff notes, are "astronomical." Conventional growers who purchase expensive inputs to increase yield manage those expenses as best they can, by using an economy of scale and/or adopting precision-ag technologies.

Other farmers I spoke with have given up on chemical inputs altogether. Otis, a conventional grower, has foregone the use of chemical fertilizer for the past eight years. While he still uses chemical herbicide and pesticide to manage weed and pest pressure, he has not purchased any chemical fertilizer in almost a decade.

> The stress for me has been a lot less since I quit spending money on fertilizer. It's so much money. I mean that for our farm, it's the difference of 100,000 dollars—and that was back when I used it. Now, I'm guessing it'd be 200,000. That's a huge load off your back that you don't have to have to raise crops to come up with 200,000 dollars worth of income. That monkey off my back has been great.

For Otis, going without chemical fertilizer was a relief. Without it, his operating costs were much lower—100,000 dollars lower—and as such, Otis didn't feel the same kind of stress that such high operating costs put on a farmer to make yield. In lieu of chemical fertilizer, Otis uses nitrogen-fixing cover crops to build soil fertility. He also uses a rare machine that pumps tractor exhaust into his soil. These two systems have enabled Otis to maintain good yields at a lower cost. In those eight years since he quit using chemical fertilizer, Otis has maintained his yields. "We can easily cut 50-60 bushel wheat with no fertilizer," he said. "One year I cut 75 bushel across the whole farm. My neighbors, who use fertilizer—65 was as high as they got."

The organic farmers I spoke with used even fewer chemical inputs. By nature of their certification, organic growers do not use any synthetic, chemical inputs (although certain pesticides are permitted). Several organic farmers spoke to the value of having low input costs. "You can put a lot of money just in chemical and fertilizer into growing a crop of wheat," Kip, an organic grower, explained. "Most of our inputs are machinery and fuel. And our inputs are quite a bit less." While organic growers do have significant operating costs, as Kip explained, those costs are much less than for agriculture reliant on chemical fertilizer and pesticide.

I asked Kip, out of curiosity, why he had transitioned to organic agriculture. "It was purely financial," he said. He went on to explain that what got him interested in organic agriculture was the price premium. "The price was about two dollars a bushel more [for organic wheat]," he said. "Instead of being three bucks a bushel, it was five." For Kip, organic agriculture allowed him to not only lower his operating costs, but also increase his price per pound. The difference between the two, gross sales and operating cost, is what he is able to take home at the end of the season. Last year was a wet year for Kip. Out in his fields, his wheat crop was being out competed by weeds. The men he worked with, he said, were ready to quit organic agriculture and go buy a sprayer and some herbicide to save the crop. Kip told them, “Let's just sit down and look at the bottom line and see what it looks like.” They did some reckoning, tinkering with the books. In the end, he said, “It wasn't really a comparison.” Even in a challenging year, organic agriculture with its higher sale prices and lower input costs would make him a better profit.

Kip insisted that his farm wasn’t organic because he was “wearing a ponytail,” which I took to mean hippie. His farm was organic because it made more financial sense for him. Kip had just recently come into some new land, which he had purchased from his uncle. “My uncle is one of the people who gave me a hard time when I went organic,” he said. “He's always had a snide remark or two.” A few winters ago, however, his uncle had called him up, asking him to buy his conventional farm. When they closed on the deal, Kip said to his uncle. “I said to him, ‘You know? It was an organic farm that bought this conventional farm.’ He says, ‘Yeah, I know.’ He had finally realized over the years what we were doing.” Family banter aside, what this story accentuates is how low-input and high-price farming, oftentimes organic farming, can build financial resilience. Kip did not transition to organic for any other reason than there was more profit in it. Financial stability that extends through both lean and plentiful years is what keeps a farm in business.

Many of the most compelling stories farmers told centered on why they transitioned their land to organic agriculture. Barry explained how he first got into organic farming. “I went broke doing it the other way,” he said. “I actually went broke and I decided to quit farming.” Barry explained how, when he went bankrupt, he sold nearly all of his machinery. All that was left were the oldest tractors and implements, rusting, and barely enough to farm with. He had no capital, no credit for a loan. Without money for any kind of input, his operating budget was little more than an empty ledger. “So I went back to the old ways that they used to do it. I summer fallowed half and cropped half,” he said. “And I actually made more money. Yes, I actually made more money than I did when I was putting all the inputs on it." For Barry, conventional agriculture was not profitable, and drove him to bankruptcy. Organic agriculture was nothing short of his salvation, a way for him to keep farming.

Similarly, Cliff, a conventional grower, sometimes feels the pull to transition away from agricultural practices that rely so heavily on expensive inputs. "I've been thinking about organic for a long time," he said. "You really get pushed when fertilizer prices go up and your chemical prices go up." In 2014, during this study, Cliff was giving organic farming what he called a "gallon effort," putting in 30 acres of organic grain to see what would happen.

What these farmers suggest is that financial frugality, in whatever form it may take, affords the farmer more financial resilience. Operating conservatively in years of plenty can make a farm more resilient in the lean years. Farmers do so primarily by minimizing their input costs, particularly if they are conventional growers, as well as by maximizing their economies of scale. Organic farmers conserve financial resources by eliminating the most expensive input costs—synthetic inputs—almost completely, as well as by selling certified organic products, which typically garner a price premium in the marketplace. These stories undermine any consideration of chemical-reliant agriculture as transformational or adaptive, or otherwise put, resilient to climate extremes. What their stories show is that, for many farmers, organic agriculture both lowers input costs and, as explained in previous sections, improve the soil organic matter, bettering a farmer's resilience in years of drought. Such agriculture need not be organic, as Otis and Earnest show with their own particular versions of conventional agriculture that builds soil organic matter while minimizing reliance on synthetic inputs. These farmers' stories show the transformation and ultimately, adaptation playing out on the plains in response to the place's inherent aridity, as well as an unpredictable future climate.

Insurance through Diversity

Crop diversity constituted another strategy that farmers had adopted to manage their farms for drought. Crop diversity is considered to spread risk and support sustainable rotational practices (Wall and Smit 2005). Such diversity, four participants explained, functions like built-in insurance. These growers, both organic and conventional, grow crops in a rotation, in which a number of crops are planted in a number of fields, then rotated through fields seasonally. Each crop in the rotation serves a different function, whether to turn a profit or to build soil. Both cash and cover crops are given space in the rotation. Rotation diversity, for these farmers, ensures economic resilience through drought years.

As Cliff put it, "all the eggs in the basket don't work," suggesting that counting on only one crop to perform through both good and bad years wouldn't always turn a profit. For Cliff, a conventional grower, "These other crops, being that they ripen and mature differently, catch the hailstorms differently. I've diversified the risk." Cliff grows a number of crops, including oats, garbanzos, lentils, and camelina, among others. He explained how each of these crops functions in a dry year. "The garbanzo and the lentil, they got a very small flower on them….they're able to take that heat and don't burn." Other crops, such as camelina, do well in drought, but suffer when a wind comes at harvest, knocking dry seed out of the pods. In other words, in any given year, his hope is that if a big weather event were to occur on his fields, at least one crop would be likely to make yield.

Bob, a pioneer organic farmer in the Golden Triangle, explained the value of crop diversity in his nine-year rotation:

> The drought points up very, very, very clearly the importance of rotations. Because even in the drought some crops will work better than others…So we try to have in our rotation now crops that take less water, crops that take more water, early seeded, late seeded, deep rooted, shallow rooted, all those things that lends itself to diversity. And that, I think, is the secret.

In addition to diversity among crops, Bob is also interested in diversity within particular crop varieties. He is working on a project to breed landrace wheat. "Landraces are mixtures of closely related grain," Bob said. "It's how the first farmers farmed." Those first farmers, he explained, would go out into nature, and, finding desirable wild grain, would harvest the best of what they found. "Usually it wasn't a single variety," Bob said. Rather, they gathered a mix of closely related plants.

All of the old heritage wheat grown throughout the United States and the rest of the world was landrace wheat. Sometime after World War II, Bob explained, new breeding programs created distinct varieties, with particular characteristics and qualities desirable for farmers.

> You'd have stuff that was tall and short and sometimes they might ripen at little bit different times. So they didn't like that because everything wanted to be uniform. Completely uniform. And that was the industrial model. The disadvantage of that is that—it has no diversity. So if you have a weather event or an insect event, a disease event that wipes out one particular group of plants in a landrace, you have hopefully the majority of that still left that are resistant to that event. So then, what plants were killed and died can be replaced by the plants that survived. Then you still have a harvest. And those crops that survive can grow bigger and fill out the spaces of the ones that died. What that does and getting into climate change and the diversity is that you can have a diverse mixture of plants with different susceptibilities to cold and wet or disease or hot or drought or whatever.

Bob's farming methods seem to go against the prevailing agricultural habits of the day. What describes his methods perhaps, more than their novelty or innovation, is their conventionality. He is seeking out modes of farming that evolved before the development and use of synthetic agrichemicals, federal crop insurance, or contemporary seed breeding. A commitment to both species diversity, as well as genetic diversity within species, in an agricultural system, for these farmers, is an alternative, ecological form of insurance. With such diversity, farmers manage the basic risk of raising crops in an unpredictable, erratic climate. Crop diversity on both organic and conventional farms likewise represents another way farmers in the Golden Triangle are adapting their agriculture to their particular place.

On Crop Insurance

Still other farmers stressed the importance of investing in good crop insurance. As Otis explained, "You can plan ahead a little bit and make sure that…. should drought hit, the income from those insurance policies would cover your expenses." Two other farmers expressed the value of insurance coverage. But most farmers also acknowledged the difficulty of making enough on crop insurance to really make a living.

Art, my first interviewee, explained to me how insurance worked. He explained that what he considered to be the best crop insurance would cover 70% of the bushels per acre that a farmer has proven he or she can produce. He gave an example, explaining that if he typically got 30 bushels to the acre, in the event of drought or hail or flood, the government would pay him the profit for 21 bushels, or 70% of the proven 30 bushel per acre yield. As Art said, “The 30 percent that you're leaving on the table you call the ‘gravy.’ And that's the part that hurts.”

A few farmers expressed that their proven yields had been determined during drought years. Heath, an organic grower, explained how proven yield works both for and against farmers’ crop insurance. If a farmer has a string of good years, and can prove a high yield, his or her insurance will pay them more, 70% of that proven high yield. “But,” Heath said. “If you have five years of drought, your yields are way down. So say you have 15 bushel proven yield. Well, your crop insurance is 15 bushel. So if you have another drought, even the crop insurance doesn't pay you that much.” Farmers who have suffered years of successive drought will prove a lower yield, furthering their losses. Heath admitted, “My yield's getting better. But it takes a long time to get bad yields better.”

Still, farmers explained the utility of having crop insurance. While five farmers said that Federal crop insurance doesn’t always cover your operating costs, many also acknowledged its essential function for plains agriculture today. Otis put it most simply: “It’s hard to make money with insurance, but you get to farm another year anyway.” I heard the words, “next year country,” several times throughout my research. Farmers explained that if the year is bad, if the rains don’t come when you wish they would, you hope for better next year. Crop insurance, it seems, makes it possible to farm another year. Without crop insurance, Heath said, “We would have been gone a long time ago.”

Only one farmer I spoke with, Bob, said that he completely foregoes Federal crop insurance and self-insures. Another, Heath, explained how he would like to produce excess grain so as to have three years of average crops in storage. Each year, he would sell the previous years’ crop. Either save grain, he said, or keep the equivalent amount of money in the bank. Saving grain or money would give him something to fall back on, to "handle a drought for two years or so."

Both Bob and Heath are organic growers. Bob thinks "chemical" farmers operate with more risk, necessitating more insurance. His farm, in contrast, manages its risk with lowered operating costs and built-in diversity. "If you have a big debt load then you have a big risk," Bob said. Such significant risk might necessitate crop insurance, and make it more feasible for organic or low-input growers to insure themselves through crop diversity and other means.

Moreover, federal crop insurance does not always support growers who use cover crops to build soil on fallow acres, nor those who grow for niche or organic markets. Lee, an organic grower, went into detail explaining all the challenges he had faced as an organic grower with federal crop insurance. His first challenge with crop insurance had to do with managing cover crops on fallowed acres. Lee explained, "So if I have a crop failure on summer fallow winter wheat, I get my insurance based on 31 bushel to the acre. If it's considered re-crop or continuous crop, I only get paid based on 21 bushel." Herein lies the problem. Farmers have to terminate any crop growing on official summer fallowed ground to get the better insurance coverage. This past year, any cover crops on fallowed acres had to be terminated by June 15. Lee's cover crops, planted to build soil on his fallow acres, only started coming up after the first rain, which fell on June 13. "So," Lee said, "if you got a thousand acres and you can only do about 300 acres a day, you got to start a week early." In other words, Lee had to start terminating a crop that had hardly had any time to grow so that he could make sure he would get better insurance coverage in the event of a drought. The logic behind the June 15th termination date for any cover crops on fallow acres makes sense. The purpose of summer fallow, after all, is to conserve moisture and nutrients. Growing crops, rather, uses up moisture and nutrients. A crop grown on acres that have had time to rest, lie fallow, and conserve those resources would theoretically be of higher yield. Cover crops, however, can be managed to conserve moisture and to add nutrients, which is where some growers can get frustrated.

Lee’s wife, who I call Lisa, explained another way in which Federal crop insurance had shorted their farm. They could not get insurance that would cover their contract price for organic winter wheat. They could only insure for twice the price of conventional wheat, even though their contract was for an even higher price. Organic chickpeas were much the same. For chickpeas, Lisa explained, “They said, ‘oh, you can't do those organic.’ So they're only paying us on the conventional price.” Lee continued, relating how he couldn’t even insure 600 acres of Kamut®, a Khorasan wheat. Because he had grown cover crops in the fields where he planted his Kamut®, he couldn’t insure it. He didn’t find that out until after he had already planted it. “And so we really were stressing over this crop coming up,” he said, “Because we weren't getting the rains. And then they're telling us after the fact that we had no crop insurance.” In a variety of ways, Federal crop insurance is a very limited tool for organic systems

Bob, the only farmer who does not buy crop insurance, explained why he gave up on Federal crop insurance, “Because I didn't fit into any of their boxes, they didn’t have time to help me.” Otis, the conventional grower who hasn’t bought chemical fertilizer in eight years, said, about government programs in general:

> I have learned a long time ago that these government programs…you have to farm the way you're told. Doesn't work for me….USDA is under an agribusiness approach. USDA is looking out for the big corporations, the biggest farms, and it has to fit their formula of how things should be done. And it's not necessarily the best plan for the small farmer. And I consider myself still, a family farm. It's not that huge, but those government programs, I think, the information and the rules that are set up in those are coming from that [agribusiness] perspective and they don't fit my way of thinking. And so I just stay away from them.

For growers who don’t farm with the methods supported by government programs, such as crop insurance, alternatives to those programs might be easier to entertain as a feasible way to manage the risk of farming in a land of extremes. Likewise, the lowered risk from farming without high-cost inputs could also persuade a farmer to adopt his or her own insurance mechanisms. Overall, insurance, which worked better for conventional than organic growers, was considered a necessary part of a farm's risk management portfolio. Crop insurance, however, didn't make up for the entire financial losses accrued during drought. Rather than a transformative, adaptive strategy for drought, for most farmers, insurance is one coping mechanism that gets them by enough to farm another year.

The Rainmaker Story

In this land of extremes, a farmer might even try to trick clouds during times of drought. One farmer, the first I interviewed, told me his rainmaker story. Years ago, during the successive years of drought at the turn of the 21st century, he went door-to-door, soliciting funds from nearby farmers, gathering $10,000 to pay a California man, who claimed he could trick clouds into making rain. Art and his wife hosted the rainmaker when he came out to their farm. Art even helped him:

> And he put the pipes in moving water and then pointed them towards the sky. His theory was like a battery charger with positive and negative ions. And it's pretty star-wars-y, but when we were working with the pipes, I could feel it in my body, you know. Your shoulders would be real stiff and sore, and then I get that taste in my mouth, like you'd been at a dentist office. It was just a real funny taste.

When Art hired his rainmaker in February, it did rain briefly, but then the drought returned. Both Art and his wife attested to the rainmaker's effectiveness in making rain. But after that first big shower, the drought came back, and remained the following season. Hiring a rainmaker was only mentioned once as a viable means of addressing drought. Art's story does demonstrate, however, how desperate drought can make a person. As most farmers said, there isn't much one can do when drought hits repeatedly. Hoping for "next year" can only sustain a farmer for so long in this country. Most farmers, however, also acknowledged that they had gotten better at dealing with drought, at least compared with the first half of the 20th century, when farmers were plowing up prairie sod with little concern for soil health.

Neighbors, Pioneers, and YouTube

After listening to farmers talk at length about the many ways they adapt to drought, I asked them where they had learned about these techniques. Where had they gleaned the information they used to devise new crop rotations, soil building practices, or ways to cut down on input spending? Nearly half of the farmers look to their neighbors as a primary resource. Farmers do this in a number of ways. For instance, Heath explained how neighbors share information, but he admitted, that he sometimes feels competitive with others. At the end of the season, however, he “really hopes they do well, and they hope you do well.” Underlying a nagging competition among growers is a somewhat contradictory, but genuine wish for others’ success and sustained existence out on the prairie.

Barry, another grower, said that for him, information exchange happens between close farmer friends. He explained how he has a couple of grower friends who call each other to bounce around ideas, talking through new methods. Other farmers echoed this sentiment, though they also pointed to successful pioneer growers in the region. Organic growers in particular discussed at length how the early adopters of organic agriculture on the plains had been resources for them. Several mentioned mentors who would help with particular questions about organic agriculture. Organic growers Dean and Kip explained how Dave Oien and Bob Quinn had mentored them through their early years of organic agriculture. Formerly an organic grower, Dave Oien is founder and president of Timeless Seeds, a business that markets and sells heritage organic pulse and grain crops grown in Montana (www.timelessfood.com). When Dean was first transitioning to organic agriculture, Dave mentored him through the process. “If I had a question, I’d call him a couple times a day,” Dean said.

Bob Quinn, who I refer to as “Bob” in this research, is the founder of Kamut® International and a successful organic grower who has conducted numerous scientific studies about rotational diversity, ancient grains, and dryland vegetables, among others (www.kamut.com). Kip, another organic grower, as well as many other research participants—organic or conventional—named Bob as a mentor, as someone they look to for advice in both marketing and growing. “Guys like Bob Quinn taught us a lot about the value of legumes. He was in it early,” Kip said. Cliff, a conventional grower, was particularly interested in marketing niche crops, so he closely observes Bob's business acumen, gathering ideas and information that he can use. Pioneers in agriculture like Dave Oien and Bob Quinn took on risk early in their careers, redefining plains agriculture to fit their needs and values.

After the interview, Heath explained that he would like to experiment more with organic agriculture, but felt failure would be too risky. With four kids to take care of, his family has grown, and he cannot afford to take on new crops that lack much history on the plains. The crops he grows and his methods for growing them must be proven. Heath explained how he pays attention to those farmers who choose the risk of experimentation:

> There's a few pioneers that I think get made fun of in farming…. But you have to have some of those people who are just willing. Organic is a little maybe more pioneerish, just in the spirit, than conventional guys are.

In a sense, pioneers who are willing to experiment and risk failure, bear that risk for their community. When they do something that works, such as start businesses that create new markets for regional products, they produce real change in their communities. And when the on-farm successes, a new intercrop or seed variety, work, those new ideas are shared within their community (e.g. at field days).

Adaptation is a way of molding one's work and self to a changed climate—whether that climate is ecological, economic, or social (Smit and Skinner 2002). Situated between biological and cultural adaptation, *agricultural* adaptation deals with the changes happening for people whose livelihood depends on the land and their management of it. Pioneer farmers, who take on risk, then, are drivers of innovation. As climate change becomes more and more pronounced in the coming decades, one way to better prepare rural communities is to create conditions for innovation and information sharing.

Apart from talking to their neighbors, farmers look to other sources of information. Six farmers said that they turn to publications marketed directly to farmers. They read a number of magazines to glean new information and ideas. Earnest, has gathered much of information about farming from *Acres USA*, which "has been a voice for regenerative agriculture for the last 40 years," a voice he has listened to for the past 30. Fred, a conventional farmer, listed off magazines he reads regularly, such as *Pro Farmer* and *Successful Farmer*. “You read what appeals to you,” he said.

Likewise, farmers mentioned several organizations that put forth useful information. Earnest mentioned one organization, the Alternative Energy and Resources Organization (AERO), which he has been loosely linked with for the past 30 years, since his first AERO conference in 1988. There, he met Dave Oien, and first heard him speak. “That put a bug in my ear that I needed to change things,” he said, talking about his eventual transition away from chemicals and towards what he terms “regenerative agriculture.” Micah similarly talked about his involvement with the Montana Organic Association (MOA), where he served a three-year term on the board. MOA conferences, and others, such as the Grass-fed Exchange Conference, were places where Micah and other farmers could share ideas both formally, as well as informally. “Just the phone conversations with people you make contact with,” Micah said, were useful for him, as he was transitioning to organic agriculture. These organized, farmer-directed organizations served a critical role, disseminating adaptive knowledge among growers.

Still other farmers explained how government funded agencies, such as the National Resources Conservation Service (NRCS) and the region’s land-grant university, Montana State, had provided them with useful information about new practices they had adopted.

Five farmers described finding useful information on the Internet. Two farmers, Dean and Otis, spoke about their experience using Internet resources at length. When he was first interested in organic agriculture, Dean would spend nights in front of the blue glow of his computer, doing research about his eventual transition. Otis referenced farmer-made YouTube videos. He said he had been watching those frequently in this past year.

> I don’t know why they do it, but they go out and YouTube themselves, they tell what they’re doing and how they’re doing it. You can just watch those things for hours and hours and hours. They’ll say, ‘This is how we put it in the ground,’ and then they’ll show you pictures of when it’s coming up, different stages, and they’ll show you with

> their cows on it and they'll show you the electric fence that they put around it. They'll just teach you. It's a teaching tool.

In addition to hours of YouTube videos, Otis has watched webinars and films online. To find a book in a library, he explained, could take a long time. But with the Internet, Otis is able to access novel information readily, reading through it or watching it quickly, as he decides whether or not it could be helpful for his farm operation.

Four farmers said that they gather information from chemical, seed, and equipment salesmen who host clinics in town when a new technology comes available. Telling me about this, Fred caught himself, and acknowledged the irony of taking information at face value from someone whose job it is, whose livelihood depends on your purchasing decisions. "Of course," he added, "you have to decide whether it's something that's gonna work for you or not." As with all information, and particularly when it's coming from a input supplier, a farmer has to think for him or herself, deciding whether they want to trust that new information.

Just two farmers mentioned reading books for information. For these two farmers, Otis and Earnest, books served a critical function. Both had stacks of books, and rattled off author names quickly, as if they expected me to know the names. When Otis explained to me all the research he had been doing about cover crops, he started pulling books off of his shelves, piling them up in front of me. "Most of them I've read more than once. It's a little dry, but some of it you just don't want to set it down," he said. In contrast with Internet, magazine, presentation, or conversational information, books offer depth.

Still another two farmers said that the courses they took while in college gave them a useful foundation for understanding agriculture. For instance, Joe took a couple of soil science courses while at the University of Montana. These courses created a foundation of knowledge Joe has been able to revisit as he has farmed over the years.

Only one farmer, Bob, said that he produces his own information and knowledge through the controlled experiments he conducts on his own property. Other farmers mentioned conducting their own experiments, either officially in partnership with Montana State University, or unofficially on their own. These farmers did not, however, mention themselves as knowledge-producers when I asked them to identify where they gathered their information. This suggests that farmers, who are actively producing useable knowledge, do not see themselves as pushing the bounds of agriculture for their region.

The Need for Knowledge-Making

With all of this information available to farmers, what limits them from making changes to better adapt their farms to drought? I asked farmers what barriers, if any, kept them from making adaptive changes. For two farmers, lack of capital kept them from investing in new technologies or techniques. “It all costs money to get into it,” Heath said. He spoke at length about the risk of experimentation, and how some farmers were better suited to take on that risk. “There’s the dream of what we’d like to do,” he said, “and then there’s the reality.” Another farmer suggested lack of time keeps him from making adaptive changes on his farm. Time and money, it seems, keeps farmers from changing their systems.

Still another identified a lack of organic research as a barrier to his own adaptation. An organic grower, Joe, said, “It’d be easy to get frustrated with our extension and public research because it seems like they research for chemical companies at this point. It’s their priority because that’s where the money is.” What would help him on his organic farm, though, is long-term research about crop rotations, answering “biological questions” about what happens in different crop rotations across different soil types over the long term. That kind of long-term research, he said, is expensive. Joe explained that a few years ago, MOA had formed a non-profit with the hopes of funding organic research projects. But, he said, the kind of research they were hoping for was out of their reach. The researchers Joe and others had been talking with told them, “The type of research you’re asking for just needs probably ten times more [money] than you are able to drum up. It came down to money.”

In the fall of 2014, I found myself in the company of several professors from Montana State University, the regional land grant university that conducts research pertaining to the Golden Triangle region, just north of Bozeman where the school is situated. We were all attending a grain conference, put on by the Montana Farmers’ Union. These were professors of agriculture, the kind of scholars who conducted agricultural research for the state. I asked one of those professors about the lack of long-term organic research at Montana State. (I spoke with him off-the-record, and will not mention his name.) What he said surprised me, and I felt it useful to include here. He said that because organic farming is so place-based and site-specific, wholly dependent on the farmer’s local soil and microclimates, research can be challenging. More specifically, organic agriculture is not always compatible with reductionist scientific approaches, which usually form the basis of conventional research. That is, with so many uncontrollable variables in organic agricultural systems, it is challenging to isolate any one particular variable enough to generate replicable studies and generally applicable knowledge. As Micah said of organic agriculture: “It very much lacks the simplicity of chemical farming.” This lack of simplicity, according to the professor I spoke with, makes it hard to understand with controlled, experimental science.

What this perspective both point towards is a need for more knowledge making for organic agriculture that is site-specific and long-term. Several farmers in this study conduct their own experiments in test plots arranged on their farms, placing the field study in the field and the microclimate where its findings will be used.

The Process of Adaptation

About what had enabled them to adapt to drought, farmers had much to say. Participating farmers discussed at length the necessity of financial support for adapting farming techniques and management. Still other farmers described the kind of social environment conducive to adaptive change.

On the subject of financial backing for enacting change, five farmers noted how ready and lucrative markets in organic grain made it possible for them to transition to organic agriculture. Barry, for instance, explained how market demand for peas, chickpeas, and lentils, has made it feasible for more farmers to grow those nitrogen-fixing pulse crops. “You know, the peas—and even conventional now—there’s getting to be more markets. With Dave and Timeless Seeds, with the lentils and the chickpeas, there’s a market for it, as well as a rotation crop, too.” He continued to explain how important the market demand was for farmers. “It all still comes down to money,” he said. “I still have to make money to survive.” As much as farmers might want to adapt their farm management to the vision they have for their own success, they have to be able to market and turn a profit on their crops.

Cliff, a farmer I spoke with who seemed most eager about the potential of up-and-coming niche crops, spoke at length about the potentials he sees in gluten-free grains, such as oats. I remember when we talked for a moment about chickpeas. “The hummus market is like this right now,” and he lifted his hand in the air high up above his head, suggesting the exponential growth of a market for, what was previously in the United States, a relatively obscure legume. Cliff emphasized the market potential for all of the crops in his diverse rotation. His lingering on this subject shows its importance. In some ways, the market demand for crops that diversify rotations is what has made it possible for farmers to extend their rotations beyond the conventional winter wheat and summer fallow cycle.

Bob had the longest rotation of any farmer I interviewed. His rotation extends for nine years. When he first transitioned to organic agriculture, he had buyers asking for organic grain at his mill in Fort Benton. “I had my own market with the flour mill, a ready market. And demand.” Earnest echoed these farmers’ sentiments. “As long as the consumers have confidence in what we’re doing and we change and make the changes that we need to. That’s a major plus,” he said. Consumer confidence in organic crops and other niche crops from the Golden Triangle supports their continued cultivation. Liz Carlisle, who has conducted extensive research on organic agriculture in the Golden Triangle, argued in her 2014 *New York Times* opinion-editorial, that Americans ought to support farmers in rural Montana "Even if you live hundreds of miles away from Montana," she wrote, "eating organic lentils grown there helps farmers responsibly steward their land." Farmers in the Triangle would likely echo her thoughts; market demand builds the economic foundations under their diverse rotations.

Other farmers mentioned a few ways they support themselves financially through change. One farmer mentioned government cost-share programs, such as the Environmental Quality Incentives Program (EQIP), as helping them make important changes to their farm that builds resilience to drought. Many farmers had used EQIP contracts to get financial assistance to improve their farms. Some organic growers had used EQIP's cost-share program to assist them in their transition to chemical-free agriculture. Cliff, a conventional grower, said that EQIP helped "nudge" him into precision agriculture, which helped him save money on his chemical bill. EQIP helped Lee divide his rangeland into smaller parcels he could mob-graze, better managing his pasture. Throughout all of the research, five farmers expressed gratitude for the financial incentives the government had provided them in changing their farming practices with EQIP.

Many farmers also expressed frustration with government programs like EQIP. Joe, a young organic grower, said he was not sure he would get into another EQIP contract, mostly because of the paperwork required for those projects. Likewise, the bureaucracy gets in the way for Kip. The EQIP program required him to use an engineer to build a dike on his property. Kip explained that for his portion of the cost-share, he could have built the dike without the costly consultation of an engineer. "That's the last time I get EQIP money," he said. Despite its benefits, some farmers are averse to using government money to improve their operations, particularly when it comes with so much red tape.

Art, a conventional wheat farmer, expressed his gratitude for banks, which had helped him make changes on his farm over the years. "You go to your lender, [and say] 'what do you think about this crazy or idea or that one,' and if he says 'don't do it,' then you don't do." Art asks for his lender's okay on the financial feasibility for any adaptive project. Financial backing for adaptive changes to drought seems often critical. One farmer said simply that financial stability made it possible to afford new technologies. Whether from a lending institution, the government, or market premiums, farmers need financial support when making adaptive change.

Making on-farm change not only requires capital, but social support. Cliff and Micah described how an existing community of progressive farmers had helped propel them to make changes on their respective farms. Farmers' most-reported reference for adaptive strategies was their neighbor. When I spoke with him, Cliff was in his first year giving organic agriculture "a gallon effort." As a conventional grower experimenting with organic crops, he had visited a little bit with Bob Quinn. "And he said, 'I started the same way. I started with a few acres'." Talking with Bob inspired Cliff and gave him confidence to try something different, prompting him to plant his first 30 acres of organic crops. Micah, new to organic farming, felt the same way about farmers he met at the MOA conference. "Meeting all those incredible people that just, the creativity and the thought that went into everything. It all made so much sense. And I was sold," he said.

Research documents the critical function of social support in encouraging farmers to adopt unconventional or uncommon techniques (Hassanein 1999; Morgan and Murdoch 2000). The present study also shows the important role that social support plays for sustainable and organic agriculture in the Golden Triangle.

Some farmers explained that change had happened on their farms from a mere willingness to try new practices, coupled with a willingness to risk failure. "I've done a lot of experimenting," Otis said. "And probably 75% of what I've experimented with has shown no results." What has worked for Otis, however, has enabled him to completely forego the annual purchase of chemical fertilizer. Any reduction in input costs for farmers has the potential to guard their bottom line from natural fluctuations in profit with drought, flood, or hail. In addition to being willing and able to experiment, two farmers discussed how the changes they had made to better bolster their farm against drought had taken time. Time, mentioned as a barrier to adaptation, was also mentioned as essential to drought adaptation. “Enabling,” Otis said, “is taking it slow. This is my 8th year. I’m not trying to step too far away from traditional (conventional) farming, and risk too much.” While he does experiment, and in doing so, takes on risk, he does so at a measured, deliberate pace. Earnest said much the same. He is transitioning his land one parcel at a time. “I thought it was too much of a financial burden to switch over [everything] at one time,” he said. While he has had many certified organic acres for years, some are just now coming up for certification. His process for change is gradual.

Farmers identified community, willingness to experiment, and slow pacing as essential to their culture. Two farmers with academic backgrounds in agriculture also expressed how their higher education had enabled them to make changes on their farm. Both Innis and Bob, a conventional and an organic grower, explained how their backgrounds in agricultural science gave them the knowledge to better adapt their farm. “I was always just interested,” said Innis. “That’s what I took in college was agronomy. And I still like to try different stuff, just to see how it works.” Bob, who holds a Ph.D. from the University of California-Davis in plant biochemistry, often conducts his own experiments. Before he started farming full-time, conducting experiments was his primary occupation. “I was familiar with the scientific method and how to do experiments,” he said.

Faith and Dollars Per Acre

I asked farmers, towards the end of our conversation, how they make decisions that pertain to drought. Cliff said, off the cuff, “It’s like, ‘Oh shit, now what do we do?’” When drought happens, decision-making was less a deliberate process, and more of a grasping effort to take control of your land, your crops in the face of unpredictable weather extremes like drought. “You can’t predict it,” he said. “Some of it’s a leap of faith.” Other farmers echoed the idea. “I wish there was an exact science to that navigation,” said Micah. The best he could do, he said, was manage moisture, which drives his decision-making. For example, he explained, using cover crops in rotation out on the plains is "kind of a balancing act," he said. "The job is to benefit the soil for next year's crop. Three farmers in total expressed this idea, that soil moisture, capturing it and maintaining it, was what informed their decision-making.

Several other farmers explained how they made decisions. One farmer, Otis, said that soil microbial health drives his decision-making. "I'm working with what's under the ground and then they're [microbes] taking care of my plants…all of our decisions are based on that," he said. Making decisions that benefit his soil, Otis believes, will make his operation more resilient in the face of drought.

Otis, and other farmers, six in all, said that money, most of all, informed their decision-making. "What it cost me per acre to do anything," George said. All throughout our conversation, George sat across from me at the table, legs crossed, nibbling on the banana bread his wife had made, spouting off prices per acre for this or that input. Thinking in terms of cost per acre seemed to help him manage his money. Rather than thinking about the total cost and profit for his entire operation, George broke them down so that he could better see the benefits and drawbacks of each purchase and crop. When I asked Lee what drove his decision making around drought, he said, "I'm almost embarrassed to say that almost 99 percent of those decisions are based financially. I think everybody would like to say that I do everything just for the environment. But we don't. We do it all for the bank." Pounding his fist on the table, Lee expressed to me a clear, hard truth. Farming has to pay for the farmer to continue to farm. Moisture and soil productivity certainly inform the decisions farmers make when it comes to drought. But what informs them most of all, it seems, is: will this change pay?

This idea, that farming—whether it be with chemicals or not—has to pay resounds through this research. Farmers have said, again and again, that to make change happen, they need dollars. An agricultural climate for change, a climate ripe for adaptation, should have, then, built into it, the means for farmers to make a decent living. Resilience, after all, has to do with people, not just plants and soil. These farmers, who know so much about adaptation, having sustained their livelihoods on the prairie for generations, have made it pay. The changes they make—whether they are minimizing their inputs, diversifying their rotation, or turning in a cover crop—have to pay.

This expansive chapter documented the diverse ways that farmers cope with drought. Farmers conserve soil moisture and soil cover using minimal or no till methods. Several farmers, as is shown above, have adopted the use of cover crops to build soil, improving their drought resilience. Coupled with farm practices, many farmers stressed the importance of conserving financial resources. Considering the many adaptive techniques used by these farmers on the semiarid plains, the next chapter explores how they think about their climate.

Figure 5. Tillage radishes intercropped with winter wheat, just coming up in late September.

CLIMATE CHANGE IN A LAND OF EXTREMES

Towards the end of each interview, I asked farmers two questions designed to draw out participants' perceptions of drought and its relationship to climate change (Interview Guide, Appendix A). First, I asked farmers if they perceived climate change as a cause of recent droughts in their area. Second, I asked farmers if they perceived their region as being at risk of more frequent droughts because of climate change. Whether they said yes or no in response to each of these questions, I asked them to elaborate on their response. Many farmers replied with general uncertainty. A third of participating farmers said outright that they didn't know what the future held. How could they know whether this or that drought was a manifestation of recent, rapid climate change? They were farmers, they said, not climate scientists. Many farmers acknowledged that they lived in a land of inherent extremes. How could they tell the difference between this or that extreme? Likewise, how could they predict what future weather would be like? For some farmers, to venture a response to such questions felt akin to soothsaying. Farming in a land of extremes seemed to have taught a kind of humility that hesitated to presume much of anything about the weather.

These questions connect the two dominant themes of this research, drought and climate change. In retrospect, however, these were not the questions I should have asked. What I wanted to learn was how farmers perceived the issue of climate change. Did they consider the climate to be changing, and did they consider that change to be caused by anthropogenic forces? Luckily, farmers' answers shifted away from these particular questions about drought and its relationship to climate change. Rather their answers reflected what I was hoping to get at more broadly: what do these farmers think about climate change? Their responses more generally answered two basic questions: First, what is the relationship between locally observed weather and climate? And second, what is the relationship between human civilization and climate change? Additionally, a few farmers spoke about the challenges of agricultural adaptation to climate change. Others expanded on their own disbelief of climate change, their doubts about the quality of the science or politics behind such a heated issue.

I was apprehensive to ask these farmers about what I perceived to be a sensitive topic. The conversations that ensued, however, were surprisingly frank, honest, and open. During the interview, I spoke little, and listened to what the farmers had to say about such a politicized topic. In this chapter, I categorize the farmers' responses according to the many ways they thought about climate change. First, I discuss how farmers perceived the relationship between extreme weather and climate change. From there, I analyze the many ways participating farmers thought about humanity's relationship to climate change. Finally, I examine the relationship between belief in climate change and participating farmers' adaptations to drought.

A Land of Extremes

In response to the questions about climate change, several farmers spoke of recently experienced extremes. They categorized these extremes as either irregular or regular for their area. Eight of the 15 farmers said that they had experienced irregular weather extremes. The extremes they mentioned were not limited to drought; they also spoke of hail and flood events that had caused commensurate damage to their crops.

Kip explained, for instance, how he had seen more tornados on the northern plains in recent years. "Occasionally we see a tornado in this country," he said. "And I can never remember seeing a tornado as a youngster. There's been a few tornados in the last 20 years. Maybe that's the climate change you're looking at." At times, it seemed like Kip was trying to help me find the answer he thought I was looking for, pointing to possible extremes that could denote climate change. Kip, however, later said that he did not take much stock in climate change. Rather, he sees climate as shifting according to natural cycles. The whole idea of anthropogenic climate change, he considered to be just a "big hype." Several other farmers shared similar perspectives. While some of the farmers had observed odd regional trends in weather, most were hesitant to make any connection between that weather and climate change.

Heath explained how he had been taking out more hail insurance than he ever had before. “We had hail at the end of May,” he said. “And that just never happens.” Because he had been hit with hail more frequently in recent years, he chose to purchase additional insurance. Heath also does not consider climate change when planning for his farm; the idea, for him, is too speculative to be useful in the day-to-day and year-to-year operation of his farm.

Another farmer, Fred, explained that rather than drought, the Golden Triangle had been getting an “unreal amount of precipitation.” Flood can likewise cause significant damage to crops. Too much rain harms a crop. “It would wash this country away,” Lee said. “It truly would wash it away because even in the prairie, there's not the kind of plant population to hold the soils.” Moreover, farmers have selected for crops and crop varieties well suited for semiarid climates. Too much rain at the wrong time could break a wheat crop, dependent on a dry harvest. Fred and Lee also believe that climate changes happen in accord with natural cycles.

Still other farmers discussed the warming trends they had noticed. Art, the poetic conventional farmer, talked about how winter on the plains had felt less severe in recent years:

> I remember the one year that we had snow that was, if you would have set this table out there anyplace, you wouldn't have been able to find it because it was on the level. It was that deep, you know, just unbelievable.

When I interviewed Art in the spring of 2014, it was at the end of a long, cold, winter, with more snowpack than he had seen in recent years. “It's been a long time since we've even had as much snow as we've had this winter,” he said. Bob, an organic grower, explained how he too had experienced warming trends: “I'll show you my 32-pound watermelon that I grew about 80 miles south of the Canadian border on the Montana prairie where it used to get 40 below zero.” For two years in a row, Bob had grown gargantuan watermelon in his kitchen garden. When he was just a boy, he said, he would plant watermelons each year, and each year, they never got to be bigger than a softball. Over the course of his life, coaxing all manner of plants out of the prairie soil, Bob had noticed a change. Later, he added,

> I'll show you what used to be my peach tree. If you told me we could grow a peach tree in Montana—it's completely unreasonable. But five years ago, I planted a peach tree. It went through four summers and three winters without dying. And last summer was its fourth summer and I got 50 peaches off of it.

His short peach tree and record-shattering watermelon were Bob's evidence of warming trends abnormal for his region, as he says, so far north and close to the Canadian border. Referring to plant hardiness zones developed by the United States Department of Agriculture, Bob explained: "We're zone three traditionally. Now we're pretty much zone four. [Zone] three is minus 40 degrees below zero every winter. We haven't had minus 40 for probably 20 years." While the zone classification had not actually changed for this region, based on his experience, Bob felt like it had. When we walked out to his orchard, Bob showed me the bare branches that had been his peach tree, killed when the temperature gauge hit 33 below the previous winter.

Bob and Art described their perceptions of warming trends that scientist have also observed and recorded in some parts of Montana. In 2009, Pederson et al. collected over a century of climate data from nine meteorological stations scattered throughout Western Montana. From 1990-2006, they documented a 1.33° C (2.39° F) rise in average annual temperatures—greater than the global annual average temperature increase of .74°C (1.33° F). Commensurate with this increase in temperature, the researchers also found a decrease in the number of cold days per year. The average number of days below 0°C has decreased by 16 days per year over the course of the century. Likewise, the average number of extremely cold days, below 17.8°C has decreased by four days per year. Mild winters, peach trees, and watermelon grown in a farmer's kitchen garden provide anecdotal evidence of climatic changes happening on the northern plains. It's not surprising, then, that farmers would observe changes on their own land east of the Rocky Mountains.

Three farmers said that they had not observed any extremes outside of the norm for their region. One farmer who had earlier described witnessing tornados on the plains also said, "I don't see any big changes from what I remember as a child." Another grower, George, felt much the same way about climate in the Golden Triangle. He really could not say if recent extremes were any different than the extremes of the past.

> You know, at times, I believe in climate change. At other times, I believe it's just going through a cycle like before. We've been this hot before. We will again. We're gonna have drought again. We're gonna have wet years again. In 20 years, I don't know what an average is. It seems like a land of extremes.

For some farmers, extremes that might seem out-of-the-ordinary elsewhere felt quite normal in north central Montana. The idea of north central Montana as a land of extremes is not new to the area. Both Joseph Kinsey Howard and K. Ross Toole, Montana historians, described the Montana plains in this manner. The boom and bust of early 20th century was marked by years of above average rain followed by dry, hard years of below average rain. The rain gauges of the early homesteaders filled up and then were bare as crops wilted across the plowed prairie. Many farmers echoed this notion of north central Montana as a land of inherent extremes. Farmers' success, in some ways, is built upon their understanding of their landscape, along with an acknowledgement of the limits of their knowledge as cultivators of an unpredictable, unforgiving country. While this idea pervades this research, eight farmers still identified marked changes in their weather patterns, though such observations do not always predicate a belief in climate change.

Bob considered climate change to be a serious threat to agriculture; his adaptive practices reflect his beliefs. One study by Blennow et al. (2012) showed a positive relationship between perception and belief in climate change and adaptation to its effects. However, for many farmers in this research, adaptive measures taken to mitigate climatic extremes had more to do with direct experiences of drought, hail, and other extremes than climate change—even if the farmer also acknowledged the reality of climate change. The converse also seemed to be true for many participants. Adaptive measures taken, it seemed, did not necessarily indicate belief or perception of climate change. For Bob, changes in weather did suggest the reality of climate change. But for many others, their views on climate change stood apart from their observations of weather and from their adaptations to drought.

Weather and Climate Change

Farmers also spoke directly about how they perceive the relationship between weather and climate change. Five participants said that observed irregular weather patterns *could* indicate climate change. This group considered climate change a possible cause of erratic weather, though these farmers did not speak with certainty. Joe, a young organic farmer, said, “I am a believer in good science. And I think climate change is a real thing. If these erratic things are a result of that directly, I’m not sure.” He wonders, when extreme weather happens, if it is an expression of climate change. “But really,” he said, “that’s as far as it goes.” He was not willing to state that any extremes were related to global, rapid climate change. When I asked Art about climate change and its relationship to drought, he said, frankly, “I don’t know.” He thought that climate change could be the cause of recent drought, but it might also be attributed to natural cycles. “I’m not gonna say that climate change hasn’t caused a portion of the drought. I’d be willing to agree on that.” A third of the farmers I spoke with said, “I don’t know,” when I asked them about climate change.

Four farmers, however, said that recent rains led them to think that a climate change was not happening. Fred explained that if I had asked him his thoughts on climate change during the drought years of the early 21st century, he would have said, “‘Yeah, we’re in a climate change.’” But now, he said, with “six, seven years of decent precipitation. You have a little different perspective of it.” His views show a potential limit of this research, which was conducted during a time of relative tranquility after years of decent rainfall. Had I conducted this research in the late 1990s or at the turn of the 21st century, when much of the Golden Triangle was in a stretch of several years of drought, I might have received different answers about the relationship between observed weather and belief in climate change.

Kip shared Fred's perspective. "Last winter, we had some cold. I remember sitting at the grain growers' meeting in Great Falls in early December. That's what killed the winter wheat. We had snow. Wasn't much global warming those days," he said. The heavy snows of the previous winter had colored some perceptions of climate change. Cool weather for any season, it seemed, was in conflict with what they understood to be a linear warming trend across the globe. Such a perception might also be attributed to misinformation about the nature of the global warming associated with climate change.

Bob, one of two farmers with an unfaltering belief in climate change, explained the difference between the terms, global warming and climate change. "I see not so much global warming as I see that the weather patterns are completely erratic." Rather than linear warming, Bob considered climate change to increase the frequency of unpredictable, extreme weather. As a scientist with a Ph.D. in plant biochemistry, Bob's understanding of climate change was consistent with existing literature, which links human carbon dioxide emissions to global temperature rise, and explains the seasonal shifts associated with its effects (Intergovernmental Panel on Climate Change 2013; Pederson et al. 2008). Some farmers' understanding of climate change shows how persistent misinformation on the subject can inform some farmers' perceptions.

Humans and Climate Change

In 2009, the Yale Project on Climate Change and the George Mason Center for Climate Change Communication partnered to conduct a nationwide survey of climate change beliefs and engagement. Their analysis of the survey data found six predominating views on climate change held by American citizens. These "Six Americas," ranged from the "alarmed," "concerned," "cautious," "disengaged," "doubtful," and the "dismissive." Each group represented a different percentage of the American population. They identified 33% of the population as Cautious on climate change. A mere 7% were identified as "dismissive." The researchers also collected demographic data for each group.

This literature helps frame the many ways farmers understood climate change and human civilizations relationship to it.

Seven farmers explained their perspective of climate change as a largely natural phenomenon. Natural shifts in climate, according to these farmers I spoke with, were devoid of human influence. Several farmers used the word, “cycles,” repeatedly throughout their interviews. Explaining his perspective, Otis said, “I think climate change is a cycle. God created the earth and there are cycles in the weather and—it’s just cycles!” He went on to say, “A lot of it is just another cycle.” Then, he added, “I don’t think it’s anything to be concerned about. I think it’s just a cycle.” Otis reiterated, again and again, the idea of climate as a cycle. Fred, a conventional farmer, said much of the same:

> It’s all on cycles, I think. I just think we’re so much into cycles. You go through eight years of drought, well now we’ve gone through quite a few years of good precipitation. I think it’s so much in cycles that it’s just hard to know.

Many farmers expressed this idea of climate change as no more than a natural cycle. They explained themselves in so few words that their responses began to sound like sound bites.

Seven farmers responded to my questions by insisting that the climate changes in cyclical patterns that occur apart from human influence. These farmers, I identified as “doubtful,” according to the Yale Six Americas Study. The “doubtful” includes in equal parts “those who believe that global warming is happening, those who don’t, and those who don’t know” (2009). Many farmers fall into all three categories, with little conviction as to what they believe. “Doubtful” individuals are “more likely to say that global warming is caused by natural changes in the environment.” Over half of the survey’s respondents who were identified as “doubtful” about climate change said that, “the earth’s climate is random and unpredictable.” Living and farming on the dry northern Great Plains, it’s easy to see how farmers might think this way about climate. Individuals in the “doubtful” category are, demographically speaking, “male, older, better-educated, higher income, and white.” According to the study, “They also tended to be Republicans.” Such a demographic description would seem to fit some of the farmers I spoke with, although I did not ask farmers explicitly about their political beliefs.

When I spoke with Lee, he expanded on the idea that current conditions reflected natural climate cycles. When I asked him my first question about climate change, he sighed and began a long, eloquent explanation of how he understood it to be. Living up against the Rocky Mountain Front, just east of Glacier National Park, Lee—like many other farmers—spoke about climate in terms of glaciers:

> I'll back up a little bit. Okay, when was the last ice age? 10,000 years ago? Okay, so we've been—I don't care who you talk to—we've been in an earth-warming situation ever since the glaciers stopped growing. The earth was warming when the glacier quit moving forward…The glaciers create a refrigeration effect. So the smaller the glaciers are, the more the glaciers recede, the less of a refrigeration effect it has on the temperature of the earth. And so 10,000 years ago—uninfluenced by man—the glaciers started receding.

Then, Lee helped me understand his perspective by asking me to imagine a 3x3x3 cube of ice, placed in the middle of the kitchen table where we were sitting. As the ice melted, he explained, at first, you might not really notice it. After a couple of days, he said, you might see some water, some small sign of melting. But then, all of sudden, the whole thing will have significantly diminished in size overnight. Early on, when the ice block was at its apex size, if you stood close to it, he said, you could have felt cold air moving off of it. Later, after it had melted, you wouldn't have felt any cooling effect. "That's how I kind of look at the earth," he said. According to Lee, the warming trends that we observed today reflected changes that had been occurring for a long time, as that ice slowly melted.

After his glacier allegory, Lee paused, and then began again, cautiously. "Okay, I'll say something that hopefully won't offend you. Maybe it'll offend other people," he said. "But, how can we be so arrogant?" He continued:

> How can we be so arrogant?... I think a lot of people.…their thought process is influenced too significantly.…by their arrogance.…And I don't think we're really that important.…I'll give you an example. When Mount Saint Helens erupted.…I heard them say that the amount of emission.…was more than all of the world's emissions for something like a year... And I thought, holy smokes, we think we're significant?...At different times during the earth's existence, the sun was blocked out for hundreds of years....which cooled the earth, blocked out the sun, destroyed the plant populations, created ice ages.…Are we that significant? I'm not sure we really are.

In so many words, Lee explained how he considered humanity in relationship to something as imposing and enduring as climate. What struck me most about Lee's perspective was how agreeable it was to my own sensibilities about the human relationship with nonhuman nature. What he was speaking of was his humility, cultivated from a life spent farming on the dry Montana prairie. Lee's perspective sheds light on the common ground that could exist between farmers and climate change activists. Listening to his explanation, I found myself agreeing with him. I accept the scientific reality of climate change and I believe that farmers and others ought to adapt and mitigate. My perspective, like Lee's, evolved because of the humility I feel in comparison to a great, unknowable, and unpredictable climate. Although Lee is "doubtful" about anthropogenic climate change, he nonetheless has complex and thoughtful beliefs to share about climate and humanity's relationship to it.

Later in the interview, Lee contradicted himself, acknowledging some human influence on the climate. "There's all kinds of reasons," he said. "Natural and influenced by humans and influenced by all kinds of everything that we can fear," suggesting that he can also fathom some way in which humans could influence something as great as climate. Another farmer, George, acknowledged that humans have had some kind of influence on climate. "I think it's all tied together," he said. "You can't just keep spewing all your pollutants into the air and expect not to affect Mother Nature somehow." Though skeptical of the veracity of rapid, global, and anthropogenic climate change, these two farmers could conceive of the potential impact humans could have on the environment. On the relationship between humans and climate, however, most farmers conceived of climatic change as a reflection of natural cycles, operating outside the influence of human emissions.

The Origins of Disbelief

In addition to speaking about the relationship between humans and climate, three farmers said that they did not believe that the climate was changing at all. The rise in national attention to climate change, these farmers claimed, had nothing to do with its scientific validity. Heath and Otis insisted that much of the science that linked human carbon emissions to an increase in global temperature was inconclusive. “There are scientists that are saying it’s just a bunch of bunk and there are scientists that are saying it’s real. But they’re both scientists. They’re coming up with two different answers,” Otis said. Otis perceived climate change as a scientific dialogue between those who believe it is happening and linked to carbon emissions, and those who don’t.

Heath explained it another way; he believes that because climate projections give a range of scenarios with different degrees of severity, the science must not be good. “It just seems to me,” he said, “like the climatologists have been, well, it’s gonna be this way, well, maybe it won’t be that bad, maybe it’ll be more like this.” Climate projections depend on both population growth and economic growth. In short, they depend on the rate of continued carbon emissions. Such speculative projections with a wide range of possible effects don’t impart much confidence in the science, for Heath. “I’m not gonna pay attention to it,” he said. “There’s a lot of speculation there, and I don’t have respect for that.”

During our conversation about climate change, Heath vowed that he actually loved science. “It’s my favorite thing to read,” he said. “My one problem with it is who’s sponsored the scientific discovery?” he said. “Where’s his money from?” He continued, saying that what made him wary of science was muddy funding, backing from someone with a vested stake in the outcome. What Heath suggested was that if someone wanted a particular scientific outcome, he or she could tinker with the many complex variables often at play in experiments, and finagle the results.

He went on, “We all sort of have a bias. You search for information that you agree with, and you don’t look for the information that’s wrong.” Here, his argument shifted to a critique of the nature of scientific experiments. Deductive research must isolate variables, which as Heath pointed out, is difficult to do. Likewise, any objectivity a researcher can claim is nothing but a veil, behind which is an inherently subjective human conducting an experiment.

Farmers critiqued climate science from many angles, pointing out its great weaknesses. Part of Heath's critique had to do with the speculative nature of climate science, which must reckon with the unknowns of population growth and continued emissions, if scientists are to make any reasonable projections. Part of his critique also had to do with the inherently subjective nature of humanity, even humanity conducting scientific experiments.

Farmers' critiques are not lost on leading scientists, for instance, Steven E. Koonin, wrote in the *Wall Street Journal*, wrote, "There is little doubt in the scientific community that continually growing amounts of greenhouse gases in the atmosphere, due largely to carbon-dioxide emissions from the conventional use of fossil fuels, are influencing the climate" (Koonin 2014). While scientists do have consensus about the current state of the climate, the future is less clear (Intergovernmental Panel on Climate Change 2013). Koonin's statement refutes Otis' assertion that climate science is unclear about the rise in global temperature and the climatic effects of human carbon pollution. Koonin went on, explaining that, "The crucial, unsettled scientific question for policy is, 'How will the climate change over the next century under both natural and human influences?'" Those kinds of questions, Koonin wrote, "are the hardest ones to answer" (Koonin 2014). In many ways, Heath was right to critique climate science for its many divergent projections. Likewise, Otis' assertion that climate science was lacking in a clear consensus was also partly accurate, at least in reference to what the future climate holds. Farmers' critiques of climate change, then, are not far off from mainstream, scientific critiques.

Otis continued with a more biting critique of climate change. For him, the popular idea of climate change was no more than a means for the government to increase taxes.

> They're looking for a way to tax us, somehow….That's the way climate change and the government's perspective and that's my take on this buzzword of climate change….They're just looking for some way to generate money. It's just what they do….Because we're burning gas, and we're putting these emissions in, we're causing climate control or climate change, then let's tax people so we can control the climate.

Otis' worries about the increasing size of the government and its bureaucratic hold on ordinary constituents is a common one for conservatives in America, who generally support a smaller government. Conservatives are also more likely to be uncertain of climate change and its link to burned carbon (McCright and Dunlap 2011). Republicans represent citizens for all state legislative districts encompassed in the Golden Triangle. Of all Golden Triangle counties, only two, Hill and Glacier Counties, were a democratic blue in 2012 after the United States Presidential election, with the majority of those citizens voting for Democratic candidate Barack Obama. Citizens in all other Triangle counties voted Republican. One could infer that Otis' views on climate change are a reflection of his political context out on the plains of Montana.

Belief and Practice

For all of these farmers who refute the reality of climate change, their perspectives appear to remain distinct from the adaptive practices on their farms. Both Kip and Heath farm organically, employing practices that do not rely on fossil-fuel-based agrichemicals. Otis, while not an organic farmer, has foregone the use of chemical fertilizer for eight years for financial reasons, and has instead taken to building his soil with green manure cover crops. Otis also uses an implement that pumps tractor exhaust into his soil as he drives across his field, seeding a crop. This system, he said, builds his soil. "There's a little bit of nitrogen that comes out of your exhaust," he said, "along with the CO_2 and the carbon that feeds the [soil] microbes." When he seeds, Otis essentially pumps carbon emissions, which would otherwise go into the atmosphere, back into his soil. "I'm not saying that the exhaust does it all, but it's a little part of the puzzle," he said, referring to his soil fertility. The exhaust, as well as his soil building with cover crops, has maintained his soil fertility without the use of expensive, fossil-fuel-based chemical fertilizers.

His practices have the effect of limiting his farm's carbon emissions, doing some small part to mitigate climate change. He is also adapting to it as he builds his soil's fertility and its ability to catch and hold moisture. Such mitigative and adaptive practices would seem to come from a farmer concerned with the state of the climate and his contribution to it. But as Otis' tells it, climate mitigation and adaptation are not his aim. To him, climate change is a political ploy built on the shaky foundations of conflicting science, and a government he perceives as primarily interested in increased taxation.

With Otis most profoundly, as well as with organic farmers who did not consider climate change a pressing reality, there was a dissonance between belief and practice. For some farmers, Bob, Barry, and Earnest, their certainty about rapid, global climate change parallels their farming practices, which work to both mitigate and adapt to a changing climate. But for many farmers, their doubt in climate change stands in contrast to their largely adaptive practices. For Heath, Joe, Kip, Lee, and Otis, this is the case. To some extent, George and Cliff also represent this dissonance, as conventional farmers who have started to transition their farm operations to more diversified cropping systems. Seven farmers—nearly a majority in this research—fit into this category. For these farmers, their subscription to alternative, adaptive farming practices has more to do with the financial benefits of those practices, rather than their ecological benefits for a future of climate uncertainty.

The relationship between drought and climate change on the plains, for many farmers, had little to do with the weather. Many farmers had witnessed some changes in the severity, duration, or frequency of weather extremes. But when asked if these changes were an expression of climate change, most farmers hesitated. Only two of the eight farmers who had noticed pronounced changes in weather patterns, linked those changes to their belief in climate change. Many farmers were less sure, and echoed the century-old refrain of the plains farmer, about a life lived in a landscape of inherent extremes. "It seems like it is a land of extremes," George said. This sentiment resounded through the research. Even Joe, who believed in good science and the reality of climate change, said, "If these erratic things are a result of that [climate change] directly, I'm not sure."

This sentiment illustrates the ambivalence farmers expressed on the topic of climate change. "I guess I don't feel like I have a reason to believe that that's the case or not the case. It's not something I worry about," Micah, an organic grower, said. Art, Dean, and Innis expressed similar views. Organic and conventional growers alike expressed ambivalence. Art and Innis, conventional farmers, were as uncertain about climate change as Dean and Micah, organic farmers whose practices could be considered adaptive and mitigative. As Art said, "You can blame anything for being the cause of something else." None of these four farmers was ready to commit to one particular message about climate change: that it existed or it didn't, that it was caused by fossil fuel emissions or wasn't. To them, it didn't matter. What mattered, rather, was their bottom line and the continued success of their farm operations. Or, for Micah and Dean, what mattered was their health. Both farmers transitioned to organic agriculture because of health concerns they had with the conventional use of chemicals.

For all of these farmers' differing viewpoints about climate change, what seemed clear is that belief, disbelief, or ambivalence about climate change did not necessarily inform one's farming practices. As Wolf and Moser noted, "Knowledge of climate change alone is commonly considered a desirable but insufficient condition for mitigating GHG (greenhouse gas)" (2011: 551). For the farmers in this research, something else informed their adaptive farm practices. Considering the previous chapter, farmers made adaptive changes in response to direct experiences on their farms, such as drought. Farmers manage for soil moisture, soil cover, and financial resilience, which buffer their farms from extremes that are seen and felt firsthand, rather than extremes predicted for an unknown future of climate change.

Solutions to Climate Change

Tied up in their responses to questions about the relationship between drought and climate change, some farmers expressed concerns about potential solutions to climate change. Two said plainly that farmers could only respond to what happened in the near future. To plan for multi-year projections was not feasible for many farmers.

“My response right now is I have to just look at it on a year-to-year basis,” said Heath, a skeptic of climate change. “I have to just think about it that way. I can’t think about, well, how am I gonna farm in ten years?” Another farmer, Joe, shared his sentiment, and said, “It's not something that I think too much about.” For these farmers, to think about projected future climate scenarios was not reasonable. They could only respond, rather, to what they observe within their own climate, happening in real-time, on their own farms. While the perennial drought in their climate may encourage these farmers to embrace adaptive practices, those changes are based on direct experience with recurring drought, rather to some theoretical model projecting a range of climatic scenarios. They respond to what they see and feel, rather than to what scientists project for their region.

Two farmers also said that giving up fossil fuels would be a real challenge for most American farmers. Heath explained the dependence on fossil fuels on his farm.

> There's not much I can do about it right now… you just have to have horsepower. So you hope everybody else who doesn't need horsepower stops using it. We just get to be the lucky ones who can still burn fuel.

About fossil fuels, George said, “We gotta have it.” These farmers understood their own reliance on fossil fuels to power their machinery to plant, cultivate, and harvest crops on their thousand-acre farms. George, however, was optimistic about the ability for farmers to further adapt to an increase in the frequency, duration, or severity of extremes. He said,

> We need to be clean. We need to keep addressing this and that [and not just] assume it's just gonna fix itself… We can't keep burning fossil fuels. We need to be looking at alternative energies… We can't drag our feet and say this is the way dad always did it.

Farmers’ perspectives on drought and climate change were difficult to parse out. For example, farmers spoke not only about the relationship between their weather and climate change, but also about the relationship between humans and climate change. Others spoke about the nature of science, and still others, about humility. The thread that holds throughout the analysis of farmers’ perspectives on climate change, however, is that belief or disbelief does not necessarily correlate with action. The adaptive practices present on Golden Triangle farms are in place to build resilience against real, experienced weather extremes, rather than projected, anticipated ones. Farmers are better, perhaps, at responding to what they know will happen, or what they can reasonably assume will happen, based on years of experience working on the same ground, in the same climate.

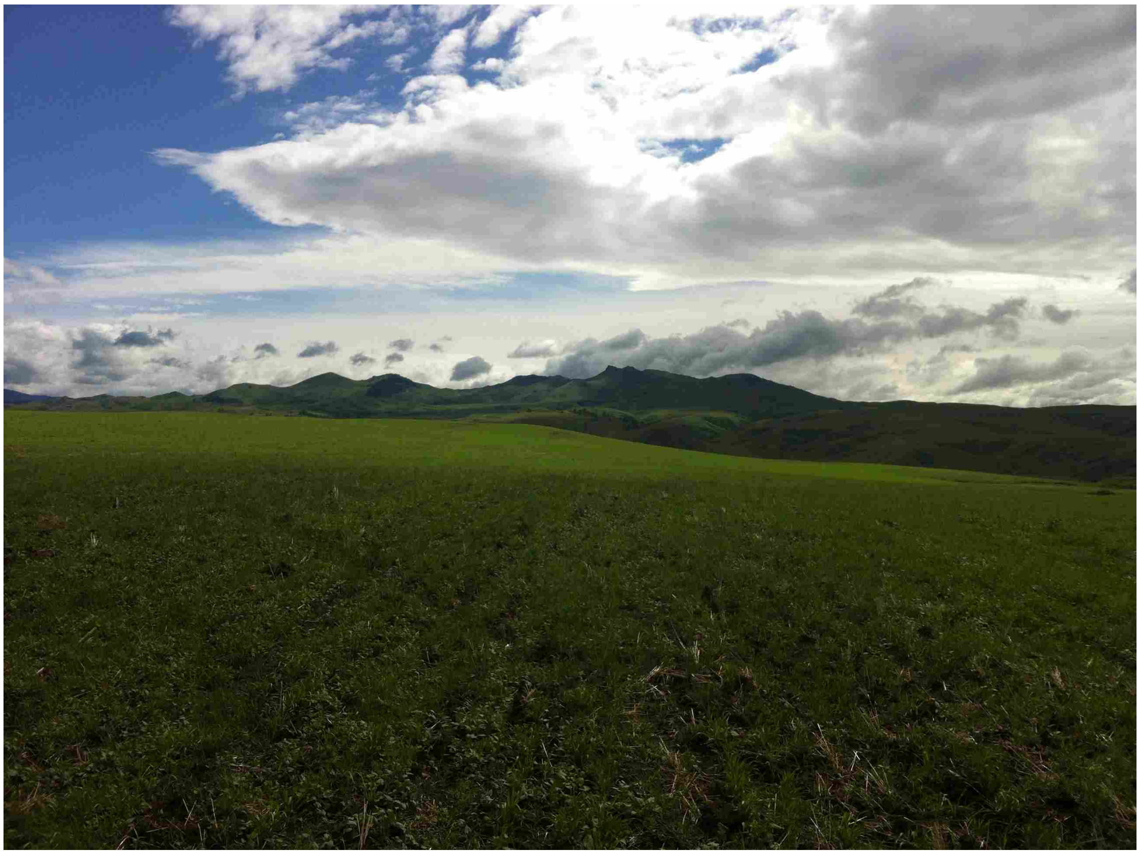

Figure 6. A view of the Bear Paw Mountains east of Havre, Montana.

An Agricultural Climate for Change

Some would argue that no agriculture at all should have ever torn up the deep-rooted sod eastern Montana. But it has, and what now blankets the former prairies are vast monocultures of wheat and barley and farther south, corn, that arc over the curve of the earth in this long horizon country. But look more closely at Otis' fall fields and coming up between his neat rows of wheat are tillage radishes, meant to hold moisture and nutrients through the winter for spring growth. In this landscape known for both its grain and its drought, some farmers are doing agriculture differently, as evidenced by the stories held in this research. Some are using crop diversity and rotation and cover crops, and a few are foregoing the synthetic fertilizers and pesticides that so deplete farmers' bank accounts. A transformation is happening on the northern plains of Montana. Slowly, more and more farmers are adopting adaptive practices that will better buffer their operations against the drought so inherent to their landscape.

Rapid, global climate change, many researchers suggest, could decrease global agricultural production (Calzadilla et al. 2010). In Montana, where the annual average temperature has already increased 1.33° C (2.39° F) in the western part of the state, climatic change impacts have already happened and are likely to continue to happen (Pederson et al. 2008). Global climate change could cause changes in temperature and precipitation, as well as the frequency and duration of extreme weather events (Chambers and Pellant 2008). To ensure global food security, as well as rural, agricultural livelihoods, farmers must adapt to—and mitigate—climate change. In the Golden Triangle, just east of the Rocky Mountain Front, farmers sow their livelihoods in a climate of inherent and unpredictable extremes, such as drought, hail, and wind.

Dependent on the predictability of regional weather, agriculture must adapt if it is to persist. Dryland agriculture in the Golden Triangle has evolved over the course of its century-long history to better suit its landscape. Farmer participants in this study evidenced this evolution, noting how agriculture has changed since the dusty early homesteading days. On the semiarid short grass prairie, dryland farmers grow crops with 10-15 inches of annual precipitation. Drought is a regular part of the disturbance regime for this landscape (Samson et al. 2004). In the present era, farmers participating in this study continue to alter their operations to better suit their environmental conditions. Some of the changes these farmers have made allow them to better cope with drought as it happens. Other changes are cut from a more transformative cloth, as farmers alter the basic structure of their farm systems to build resilience to erratic, unpredictable drought. These transformations are adaptation, and are occurring presently out on the plains, albeit slowly, as farmers devise novel crop rotations, develop new crops and crop varieties, and find ways to build soil without breaking the bank.

Scholars have expressed the need for qualitative research that investigates the adaptive capacities of agricultural communities across the globe. The present study thus uses fine-grained, in-depth, bottom-up methods to better understand the process of adaptation as it happens out on the plains of north central Montana. During the 2014 growing season, I interviewed 15 organic and conventional farmers in the Golden Triangle. Sitting down at their kitchen tables, I asked farmers about how they experienced and responded to drought, as well as how they had adapted to drought. Likewise, I asked farmers about the process of adaptation: what had informed their decision-making to drought, what had enabled their adaptation, and what had hindered it. Finally, I asked farmers about their perceptions of climate change in order to elucidate the relationship between their perceptions of and their adaptations to climate extremes.

The farmers who participated in this study expressed a diversity of perspectives on adaptation and drought, raising a diversity of dryland crops on the northern Great Plains. These 15 organic and conventional growers explained how they experienced drought, as well as how they managed their farms for it, both coping with and adapting to annual moisture deficits. In this chapter, I summarize the research findings for both farmers' adaptations to drought and their perceptions of climate change, and I consider these findings in light of current scholarship. From these findings, I make recommendations for further research and suggestions for the application of this study to the work of building a more adaptive—and more resilient—agriculture on the northern Great Plains.

Responsive Adaptations

Farmers who participated in this study were aware of how their farm practices had changed over more than a century of farming history in the Triangle. Six said that recent droughts had not affected them to the same degree, as had those that happened during the homestead days. Both organic and conventional farmers explained how farming techniques on the plains had changed over time, making farms more resilient to drought. Most cited the use of chemical fallow and no-till methods as better preventing erosion and conserving soil moisture. Yet drought still affects farmers in the Golden Triangle. It lowers yields and increases financial stress. Some farmers also explained how years of drought had diminished their ability to experiment with new crops and crop varieties. The financial stress that accompanies drought made purchasing new equipment or land difficult for some of the farmer-participants. A few farmers said that they also take on extra jobs to make enough money to farm again next year in this "next year country."

Despite the halt in some farmers' long-term planning, drought also makes them more conservative and cautious operators. One farmer, Art, explained how drought had made him more aware of the need for erosion control, specifically, managing soil to prevent "blow dirt." While drought diminished their ability to make changes, it also showed these farmers the necessity of enacting those adaptive changes to conserve soil cover and soil moisture.

In the short-term, farmers explained that when drought occurred, there was little they could do. Common coping strategies included lowering input expenses, spraying less fertilizer and herbicide, and lowering labor costs. Flexibility with planting schedules also helped to minimize the effects of drought. Farmers with longer rotations—five or nine-year rotations, rather than a two-year rotation—benefitted from greater flexibility with these more transformative adaptations. Conventional farmers who grew wheat and barley also mentioned the benefits of flexible scheduling (e.g., fall versus spring seeding) as a short-term adaptive technique.

Anticipatory Adaptations

The farmers in this study had much more to say about long-term adaptation to drought. Clearly, conserving soil and moisture is critical to farming on the dry, windy plains. However, conventional and organic growers managed for soil moisture and cover in different ways. Five organic farmers explained how they used “strategic” tillage to maintain soil cover and maintain soil moisture. Organic farmers used a variety of tillage implements, such as the noble blade, which undercuts weeds, preserving soil cover and keeping the soil horizon intact. Several conventional farmers, by contrast, employed no-till, chemical-fallow practices to preserve soil cover and moisture. The use of cover crops to conserve both soil and moisture was the method most often discussed by both organic and conventional farmers. Not only organic, but also conventional growers, as evidence by this study, make use of cover crops, crops that are tilled back into the soil and never taken to harvest. Moreover, farmers in this study grew a diversity of cover crops, from Sorghum Sudan grass to tillage radishes, each of which had its own soil-benefitting properties. Growers who participated in this research used a variety of techniques to manage their farms in a drought-prone landscape.

Not only organic, but also conventional farmers in this study had adopted sustainable techniques so often associated with climate resilience (Wall and Smit 2005). The delineations so often drawn between organic and conventional agriculture, at least for those farmers I spoke with, do not always stand. There were several conventional farms with more diversity than organic farms. Otis and Cliff, for example, are conventional growers who raise a diversity of crops in various rotations. Otis most clearly defies his conventional label, as he does not use any chemical fertilizer, having abandoned that practice eight years ago for cover cropping and other alternative, sustainable methods of maintaining soil fertility. Building climate resilience in agriculture may not need to be entrenched in one agricultural camp, such as organic or conventional. Rather, discrete agricultural practices that build resilience have the potential to transcend particular types of agriculture, and find application on a greater diversity of farms.

In addition to production techniques, participating farmers talked at length about conserving financial resources, in both wet and dry years. Farmers conserved their financial resources in a number of ways, and many emphasized the importance of lowering operating costs to increase profits. Several producers participating in this study explained how organic production had enabled them to minimize their inputs. Not only organic growers, but also conventional growers, had enacted changes on their farm to minimize their dependence on expensive chemical inputs. Otis most clearly shows how a conventional producer can enact such radical change, as mentioned before, having rid his farm of synthetic fertilizer eight years ago.

Additionally, organic growers explained how market demand and high premiums for organic products had also benefitted their farms financially, improving the resilience of their operations to drought. Some conventional producers also explained how raising niche crops, such as garbanzo beans, oats, and camelina had enabled them to achieve higher premiums. Cliff, for example, had his eye set on the gluten-free markets. Many organic growers I spoke with grew for Timeless Seeds, which aggregates, packages, and markets organic heritage grains and legumes.

Several participating conventional growers explained how they also tried to minimize their input costs through both wet and dry years. For those farmers who do use expensive inputs, many explained techniques they use to conserve chemicals and save money on their operating costs. Some, for example, apply fertilizer in succession, called “split-application.” One farmer had increased his farm size for economy of scale, which had given him the ability to purchase bulk chemicals at lower prices. Another farmer explained how he had adopted precision agriculture technology to save money on input costs, though such technologies bring an additional cost to the grower. Such methods might be better considered as means of coping with both drought and the reliance on chemical fertilizer and pesticide. While such technologies and practices do conserve those chemicals, farmers are still paying for expensive chemicals, which lower their profits both through years of drought and years of plenty. And as Liz Carlisle (2014) pointed out in her New York Times editorial, manufacturing synthetic nitrogen itself uses fossil fuels and emits carbon, a greenhouse gas that contributes to the current climate change. Such practices that maintain the use of synthetic fertilizers and herbicides, for many reasons, might be best considered as maladaptive, as they contribute to the cause of recent, rapid climate change. As such, they contrast with those practices that build resilience without huge capital investment on part of the farmer. Strategies such as cover cropping, crop diversification, which require the mindful and strategic use of tillage, are better adaptive, as they build resilience without a huge capital investment and without further exacerbating climate change.

Financial Resilience

Many farmers resoundingly explained the critical role of financial resilience for agriculture on the plains. Several farmers explained how crop insurance allowed them to cope with drought. The benefit of crop insurance, many farmers explained, is that it can carry a farmer through to the next year. In "next year country," if the current year yields drought or hail or untimely rain, then farmers can hope for better growing conditions next year. Many farmers, however, spoke about the inadequacy of the existing federal crop insurance in supporting them through years of drought.

Several organic farmers explained how crop insurance regulations required farmers to terminate cover crops by June 15th—early in the short northern plains growing season—if the ground is to be considered fallow. Crops planted on fallowed fields garner better insurance coverage than those crops planted on continuously cropped fields. This requirement cost organic farmers money and kept them from adequately building soil with cover crops. For example, my second visit to the region coincided with a June rain, and fell right before the June 15th deadline. Many farmers explained that before this June rain, their cover crops had not yet germinated. Because they had to terminate those cover crops by June 15th, just days after the June rain, such timing had not allowed them to receive any of the benefits from planting the cover crop on their field. As Smit and Wall (2005) noted, agricultural policies and programs should be flexible to the needs of farmers in diverse production systems and biophysical environments.

Only one farmer, Bob Quinn, did not buy any crop insurance. Instead, the Quinn farm has both saved money and built diversity into the production system. In this way, Bob has created cropping scenarios that are lower-risk. His growing strategies, in short, avoid the sort of coping strategies other farmers use to get by, and instead, build a resilience inherent to the farm. Bob's crop diversity and nine-year rotation was one of the most transformative and adaptive practices that I witnessed talking with growers out on the plains. His farm has for years been a model for transformative agriculture, and likewise, Bob, a true pioneer, has provided critical social support to others developing and adopting their own adaptive techniques.

These growers in the Triangle—conventional and organic—who minimize inputs, use crop diversity, build soil with cover crops, and minimize soil disturbance, manage for drought primarily with their production practices. While crop insurance allows them to get by in drought years, their agricultural systems build resilience inherent to their soil and climate. Theirs is an agriculture that has transformed their parcels of prairie, and which shows how adaptation is not static, is not historical, but is dynamic, and contemporary, as many farmers continue to think up and enact adaptive changes on their farms.

The Process of Adaptation

Consistent with previous studies on sustainable agriculture, most farmers—nearly half—said that they learned about farming techniques from other growers, particularly those growers who are early adopters of novel technologies or techniques. Personal connections, particularly with well-known farmers in the region such as Bob Quinn, had greatly informed some farmers' adaptive strategies. Additionally, participating farmers gleaned information from farmer-specific publications, organizational meetings and publications, and the Internet. Several farmers spoke about the role of social support in encouraging them to enact adaptive changes on their farms, particularly for farmers using organic or sustainable methods. There is well-documented research that shows the role of social support in encouraging farmers to adopt unconventional techniques (Hassanein 1999; Morgan and Murdoch 2000). Likewise, a raw willingness to try new practices and risk failure, farmers explained, had also helped them enact changes on their farms.

When I asked farmers about what had enabled them to make adaptive changes on their farms, many talked about the importance of financial resources to cover the cost of implementing new strategies. Farmers in this study described several ways they pay for adaptive changes on their farms. Some of the producers described how demand for organic or niche crops, which often receive a higher price in the marketplace, had provided them the financial support necessary to grow new crops. Others mentioned government cost-share programs, such as EQIP, as helpful in pursuing new changes. A few farmers mentioned lending institutions, which had helped them finance previous changes.

Perceptions of Climate Change

In addition to adaptation, I asked participating farmers about their perceptions of climate change. Seven farmers explained climatic change as a natural phenomenon characterized by cycles. While their viewpoints could be a reflection of the political and religious beliefs the farmers held, they also might reflect another worldview, that of the plains farmer, who considers weather and climate as erratic and unpredictable, completely outside the realm of human influence or understanding. On the plains, where weather is fickle and often extreme, such a worldview seems reasonable.

More than half of the 15 farmers said that they had observed recent, irregular weather extremes, including hail, tornados, flood, and generally warmer seasons. Such observations did not, however, necessarily predicate a recognition of rapid, anthropogenic, and global climate change. Of the eight farmers who had recognized irregular extremes, only two said that those changes could be a reflection of climate change.

In their research with forest managers in Sweden, Germany, and Portugal, Blennow et al. (2012) found a relationship between belief and perception of climate change and adaptation. Such a correlation between experience, belief, and adaptation was not apparent among the farmers I spoke with in the Golden Triangle. Several farmers in the present study employed what are considered to be more resilient farming techniques, such as crop diversification or cover cropping (Wall and Smit 2005). Yet, the degree to which farmers had adopted those adaptive techniques did not necessarily reflect a belief in climate change. Only one farmer, Bob, acknowledged climate change and was devising adaptive strategies to improve his farm's resilience. His newest project, for example, is developing a wheat landrace, which will increase the genetic diversity *within* his wheat crop.

Five farmers also expressed an uncertainty about the topic of climate change and were unwilling to say whether or not climate change was happening or would affect their farms. In addition, three growers expressed doubt about the validity of climate science, which they perceived as inconclusive and speculative.

For many farmers I spoke with, their perceptions of climate change were distinct from their adaptive practices. Some farmers explained that their practices had evolved in response to direct experiences of weather—such as drought, rain, or hail—rather than in response to an uncertain and unknown future of climate change. Moreover, several farmers expressed disdain for the uncertainty inherent to scientific projections for regional climates. Both farmers' experiences and climate science make climate change a hard thing for farmers to adapt to.

As such, many farmers' adaptive techniques reflected the local need to preserve both soil cover and soil moisture. On dryland farms, where yields are generally lower than on irrigated farms, many farmers were motivated to make adaptive changes to improve their financial resilience. For most farmers, climate change had not informed the decision-making about adaptive changes on their farms.

The farmers I spoke with are doggedly practical. They grow crops in a dry climate with little rain, and farm through years of plenty as well as years of drought. To manage their farms for drought, these 15 farmers pay particular attention to their soil, managing to prevent erosion and conserve moisture. Just as important as their production practices, many farmers operate frugally through both wet and dry years. In the Triangle, the network of farmers who adopt unconventional techniques seems to be growing and expanding, with several conventional farmers adopting what are often considered sustainable practices, including cover cropping and crop diversification. In speaking with both conventional and organic growers, it is clear that a spectrum of practices exist in the Triangle.

What only hindsight could have uncovered with such clarity, I have found through this research that farmers in the Golden Triangle manage for two things first: money and moisture. These two guideposts are central to successful farming in the dry Golden Triangle. Few farmers—just one in this study—managed his farm for climate change. That farmer, Bob Quinn, is an anomaly in this region, and likely in the region as a whole, as he is in a minority of organic farmers in the grain growing Golden Triangle. That is not to say, however, that other farmers do not employ sustainable practices on their farms that could benefit them should the climate shift to a wetter or drier and surely a hotter place. Many farmers who participated in this study are building soil with cover crops, foregoing the use of fossil-fuel intensive chemical fertilizers and pesticides, and are diversifying their crop rotations. Most of those employing these practices are organic farmers, but not all are. Some are transforming and adapting their operations in a conventional agricultural context. The bulk of these farmers are adapting their operations to the experiences they have firsthand, rather than to a future of uncertainty with climate change.

Responding to a future range of climate scenarios, dependent on unknown variables of future population growth and development is a tough row to hoe for a farmer on the plains. Rather, many farmers respond to what they experience directly, watching the clouds build on the low horizon across the wheat field and witnessing the rise and fall of wheat prices in both conventional and organic markets. Policymakers and organizers should continue to empower farmers with the knowledge and skills to build resilience—both financial and ecological—on their farms in response to contemporary climatic and economic challenges. In short, organizers might, as so many are already doing, to help create a climate for change, in which farmers have the social and financial support they need to enact transformative, adaptive changes on their farms.

At times I have wondered why belief in climate change ought to predicate action. For many people, this might be true. Certainly for Bob Quinn, one farmer in this study, his scientific consideration of climate change and his personal observation have pushed him towards developing landrace wheat, improving the genetic resilience of his crop. But for most people, the trajectory of belief, then action, is a logical farce. Change is not always linear, and out on the plains, it seems to have taken a whorled approach, as farmers here, then there, begin to adopt sustainable practices, moving away from first the deep moldboard plowing of their grandparents and then from the chemical reliance of their parents, making changes slowly and gradually. Climate change, which so necessitates adaptation and transformation in agriculture, is not the agent of change for many of the farmers I spoke with. Something else moves them: like Otis, who abandoned his chemical fertilizer and fell back in love with farming. For Otis, and other farmers trying to make good with the land and their bank account, change happens slowly as it is tinkered together in the shop, at the conference, on YouTube, and in the NRCS office. What if the tinkering came first, if the reorganizing, reconstruction, and retooling came first? Would then, the understanding and belief follow? Perhaps an emphasis on resilience and action, not necessarily climate science, would trace a better path towards transformative change out on the Montana plains.

Figure 7. Bob Quinn’s sunflower crop, bowing at the close of the season.

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APPENDIX A

Interview Guide

Before the interview. Be sure to check the recorder before the interview. Bring back-up batteries. Record the subject code into the recorder, for example "Farmer A."

Introduction. Thanks so much for taking time out of your day for this interview. This is part of a larger study about farmers in Montana's Golden Triangle and how you've responded to drought. I appreciate the opportunity to sit down with you and talk a little about your experiences here on your farm.

In this interview, I'll be asking you questions about how you've experienced drought in the past as well as more recently. I'll also ask about how you deal with drought in the day-to-day, and how you make long-term planning decisions about drought. Towards the end of the interview, I'll be asking you a few questions about drought and its relationship with climate change.

Before we get started, I want to let you know that your participation in this study will be confidential, and that your name will not be used in any written reports or presentations. You're welcome to speak freely on these topics.

If it is okay with you, I'd like to tape-record this interview. This helps me focus on what you're saying, and makes sure that your words are most accurate. Is that okay with you?

If yes, turn on the recorder.

Farm Background.

1. First, I'd like to hear a little about your history on this farm. When did your family start farming here?

2. Please tell me a little about your farming operation.

Drought. Thanks, now I'd like to talk about your experiences with drought here on your farm.

3. What have drought conditions in this area been like in the past 15 years?

4. Being from Kentucky, which gets a lot of rain, I'm not very familiar with drought, especially drought here in Montana. What does drought *look* like on your farm, physically? In other words, how would you describe it to someone who had never been here before?

5. How has drought affected your farming operation in the past 15 years?

Probe: Are there any other ways drought affected your farm? If so, how?

6. In what ways, if any, does drought affect your *community*?

7. When you think about recent drought, how does it compare with drought that occurred here in the past? In other words, what is similar or different about drought in the past and drought in recent decades?

Adaptation. Thanks. Now let's talk more about how you've responded to drought on your farm, in terms of your farming practices and management in the last 15 years or so.

8. When drought occurs during the growing season, do you make any changes in farm practices?

Probe: If so, what kinds of changes have you made? E.g. change in crops, crop varieties, timing of planting.

Probe: If not, why didn't you make any changes? What are the barriers, if any, that keep you from making changes in response to drought?

9. When you think about the changes you made in response to drought, what enabled you to make those changes? E.g. Government programs or other financial resources.

Follow up: Were there any changes you wanted to make, but couldn't? Why?

10. I'm also interested in long-term farm planning in response to drought. Have you made any major changes in your farming practices or management as a result of drought?

11. Now I'd like to talk about the decision-making practices on your farm. How you go about making decisions on how to respond to drought either in the short or long term?

12. Where do you *learn* about the farming practices that you use in response to drought?

13. How do government programs related to farming impact your decisions about responding to drought?

Probe: (Organic farmers) What about the National Organic Program?

Climate Change. Now we're going to shift and talk more about drought and its relationship to climate change. Climate change is a hot topic right now, and I'm interested in *your* perspective on this issue.

14. Do you see climate change as one of the causes of recent droughts in your area? Why or why not?

15. Do you think this area is at risk of having more frequent droughts in future years *because* of climate change?

16. What do you think would help farmers cope and respond to future drought?

Closing.

Is there anything else you'd like to say about drought or climate change or any of the topics we covered?

Is there anyone else you think I should talk to? (If yes,) would you mind if I mention that you recommended that I talk with them?

Would you mind showing me around your farm? Ask for a farm tour and field walk.

Also, if I need clarification on anything you said today in the interview, would you mind if I contacted you? What would be the best way for me to do that?

Thank you again for taking time out of your day to sit down and share your thoughts.

Turn off the recorder. Make sure the recording is saved.

Remember to record on paper:

Date, time
Place and farmer's name
Length of interview
Observations and descriptions of farm and farmer
Diagram of interview

Remember to take photos if allowed.