How to Make the Desert Bloom: An Ethnographic and Historical Account of Dryland Agriculture Within Palliser's Triangle

Katherine Strand

Department of Anthropology, McGill University Montréal, Québec

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Table of Contents

Table of Figures

ABSTRACT

English

This dissertation is an ethnographic and historical exploration of industrial dryland grain farming in southwestern Saskatchewan. This region encompasses part of Palliser's Triangle, a semi-arid, mixed-grass prairie ecosystem that is known for prolonged and frequent droughts as well as soil erosion ever since it was converted to annual cropland by homesteaders in the early 20th century. To address issues with soil erosion, moisture conservation, and organic matter preservation, grain producers in the region have adopted conservation tillage methods including no-till farming. In most cases, these methods are dependent upon the use of crop inputs such as herbicides and fertilizers. This dissertation traces the development of these methods from the perspectives of farmers but also based on archival and ethnographic research conducted at the Swift Current Research and Development Centre (SCRDC)—a federal agricultural research institution established in 1920 and located in the heart of Palliser's Triangle. Although the relationship between the farming community and the research staff at SCRDC created the dominant system of conservation tillage in the area, that relationship is now mediated through the work of private agribusinesses and crop consultants. This dissertation discusses how conservation tillage has altered the relationship between farmers, public agricultural science and extension services, and private agribusinesses. I also consider how the adoption of conservation tillage systems has shaped the agricultural landscape and communities of Palliser's Triangle. I connect the historical context of conservation tillage to current issues facing industrial grain farmers including land consolidation, data-centric farm management, the appropriation of farm labour by crop consultants, herbicide resistant weeds, crop diseases, and restrictions on the use of glyphosate.

French

Cette thèse est une exploration ethnographique et historique de la culture céréalière industrielle des terres arides dans le sud-ouest de la Saskatchewan. Cette région englobe une partie du Triangle de Palliser, un écosystème de prairie mixte semi-aride qui est connu pour des sécheresses prolongées et fréquentes ainsi que pour l'érosion des sols depuis qu'il a été converti en terres cultivées annuellement par les fermiers au début du 20e siècle. Pour résoudre les problèmes d'érosion des sols, de conservation de l'humidité et de préservation de la matière organique, les producteurs de céréales de la région ont adopté des méthodes de travail du sol de conservation, notamment l'agriculture sans labour. Dans la plupart des cas, ces méthodes dépendent de l'utilisation d'intrants agricoles tels que les herbicides et les engrais. Cette thèse retrace le développement de ces méthodes du point de vue des agriculteurs mais également sur la base de recherches archivistiques et ethnographiques menées au Swift Current Research and Development Center (SCRDC) - une institution fédérale de recherche agricole créée en 1920 et située au cœur du Triangle de Palliser. Bien que la relation entre la communauté agricole et le personnel de recherche du SCRDC ait créé le système dominant de travail du sol de conservation dans la région, cette relation passe maintenant par le travail d'agro-entreprises privées et de consultants en cultures. Cette thèse examine comment le travail du sol de conservation a modifié les relations entre les agriculteurs, les services publics de vulgarisation et de science agricole et les agro-industries privées. Je considère également comment l'adoption de systèmes de travail du sol de conservation a façonné le paysage agricole et les communautés du Triangle de Palliser. Je relie le contexte historique du travail du sol de conservation aux problèmes actuels auxquels sont confrontés les céréaliculteurs industriels, notamment le remembrement des terres, la gestion agricole centrée sur les données, l'appropriation du travail agricole par les consultants en cultures, les mauvaises herbes résistantes aux herbicides, les maladies des cultures et les restrictions sur l'utilisation du glyphosate.

LIST OF ABBREVIATIONS

- AAFC—Agriculture and Agri-Food Canada
- ACTS—Alberta Conservation Tillage Society
- ADF—Agriculture Development Fund
- Chem. Rep.—Chemical Representative
- ERDA—Economic and Regional Development Agreements
- FHB—Fusarium Head Blight
- The Library—The research library located within the Swift Current Research and Development Centre
- LDDS—Low-disturbance direct seeding
- ManDak—Manitoba-North Dakota Zero Tillage Farmers Association
- MII—Matching Investment Initiative
- NDVI—Normalized difference vegetation index
- NPR—National Public Radio
- NSCP—National Soil Conservation Program
- OREI—Organic Research and Extension Initiatives
- P.Ag.s—Professional agrologists
- PAMI—Prairie Agricultural Research Institute
- PFRA—Prairie Farm Rehabilitation Administration
- SCRDC—Swift Current Research and Development Centre (The Station)
- SIA—Saskatchewan Institute of Agrologists
- SSCA—Saskatchewan Soil Conservation Association
- The Station—Swift Current Research and Development Centre, formerly known as the Semiarid Prairie Agricultural Research Centre, The Swift Current Research Station, The Swift Current Research Experimental Station, and The Dominion Experimental Station, Swift Current
- WGRF—Western Grains Research Foundation

PREFACE

Acknowledgements

This research was only made possible through the relationships I formed with friends and acquaintances in the Swift Current region of southwestern Saskatchewan. They generously gave their time helping me understand the many complexities of farming in Palliser's Triangle. The staff and scientists at the Swift Current Research and Development Centre kindly helped me understand the process of agricultural research both historically and in the contemporary Canadian context. Many of the historical documents I cite in this dissertation came from their onsite archival collection.

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CHAPTER ONE

AN ETHNOGRAPHIC JOURNEY INTO PALLISER'S TRIANGLE

Figure 1: Seeding Time. Photo by Katherine Strand.

PROLOGUE

My first introduction to many of the residents of Wymark, Saskatchewan comes in late September 2014, when I receive an invitation from a local, Joe D.,[1] to ride along with both he and his son while they harvest their durum wheat, northeast of town. He suggests we first meet at the ice rink down the road from my house, to join other Wymark residents for their weekly coffee hour. I would eventually become a regular feature at their coffee hour, but for now, I knew only a handful of people in the town. Wymark, with its population of around 130 people, is a small bedroom[2] community located 24 kilometres south of Swift Current, Saskatchewan. At one time it operated independently from Swift Current; it had its own bank, implement dealer, general store, and grain elevators. Now Wymark consists only of a handful of houses, a church, a grade school, a post office operating within a local resident's home, and the ice rink.

I moved to Wymark a couple months before, and lived with a couple in their mid-50s, Doug and Sara; I'll ultimately stay there for 14 months. Doug works in Swift Current but used to be the Saskatchewan Wheat Pool elevator agent at a time when three grain elevators acted as the main focal point of town, extending along the now defunct railway line. Canadian Pacific Railway now uses the track south of Wymark for storing railcars and tanks (See *Figure 2).* Nearly every night of those 14 months, I would discuss all matters farming with Doug over supper. Buying grain from local farmers for over 20 years gave him a long-term perspective on the agricultural community around Wymark I found invaluable. Doug grew up on a farm south

[1] Many of the project participants wanted to remain anonymous, so I decided to use all pseudonyms in this dissertation. I identify those individuals with whom I have interviewed or carried out participant observation with a first name and last initial. I have also changed some place names to preserve anonymity.

[2] Bedroom communities refers to those towns where people own homes but commute to larger, urban centres daily for work and other activities. In this case, Swift Current is the urban centre, which provides all the main services for Wymark residents. Homes tend to be less expensive in Wymark and a well-maintained highway connects the two locations.

of Wymark that was managed for many years by his elder brother but is no longer farmed by any member of his family. As with many small farms in the area, a larger operator now rents the majority of the family land.

Figure 2. Railway Storage. The old rail line south of Wymark. Photo by Katherine Strand.

Doug married Sara after she moved to the community from Manitoba. Every summer, Sara grows the most impressive garden in Wymark, which she uses to supply her four kids, their spouses, and her eight grandchildren with produce for most of the year. Sara uses all organic practices to produce her garden, which struck me as immediately interesting considering the town is completely surrounded by large chemical farms. As well as teaching me about gardening throughout those 14 months, Sara explained many things to me about her and Doug's Mennonite heritage, one they share with most long-term residents in this region. She is a deeply religious woman and taught me a great deal about the role of Christianity in rural prairie life.

The majority of families living in Wymark are multigenerational Mennonites who immigrated to western Canada in two waves. The first wave arrived around the 1870s from Russia, following the implementation of policies that placed increasing pressure on Mennonites to join military forces and educate their children in Russian speaking public schools. This contradicted two key Mennonite values: teaching children in their native German language, and a strict commitment to pacifism. The second wave arrived in the 1920s following the famine and violence wrought by the Bolshevik Revolution. Some immigrated directly to Saskatchewan, while others arrived after first settling in Manitoba or the United States. The Wymark region, which includes other hamlets such as Rosenhof, Blumenhof, and Schoenfeld, is commonly referred to as the "Mennonite Block." This label dates back to homesteading days when families of similar ethnicities or countries of origin often settled together in the same region or hamlet. Several farmers from Wymark explained to me that Mennonite families chose to build hamlet-style communities around their own schools and churches. At one time they even set aside a tract of land near town for common livestock grazing.

The pastor—and retired history teacher—from the Mennonite church located right in Wymark told me that the families from Russia were given this land because the Dominion government believed it had poor soil quality. He said,

> There's two ways of looking at the government's decision. Either they gave the Mennonites the poor quality land because they knew these people made farming work in the Russian Steppe, so they were good farmers, up to the challenge. Or they wanted the Mennonites to fail and move out of this country. I guess it's a cup is half empty or full question (Strand fieldnotes, 2014).

As it turned out, the original appraisal of the land underestimated the quality of soil tremendously, leading many farmers from all over southwestern Saskatchewan to comment on the "good soil" and "nice, flat land."

I walk the short distance from the house I share with Doug and Sara to the ice rink for coffee. In the months to come, Sara often accompanies me on these coffee visits, but for today, I am on my own and feeling slightly intimidated. I push through the heavy metal door on the large, quonset-shaped structure about 20 faces, aged 50 years and older, greet me. In true Mennonite fashion, the women sit on one side of a long table and the men on the other. Most of the building is dark, with the exception of this front room where I notice old photos of community events and a bulletin board on the faded walls of the interior.[3] A look of confusion crosses many faces, so I explain that Joe D. invited me for the coffee hour. There's a slight rumble of laughter before a woman named Hilda says, "Well which one?" A man in overalls and a cap at the end of the table then says, "I'm Joe D. and I didn't invite you." The room erupts into more laughter as I explain, "Well I'm supposed to meet him here so we can go combine some durum." Another man, slight of build with a full beard responds, "Oh you must mean the preacher." He says Joe will be along shortly and offers me a coffee. Hilda gets up and walks into the small kitchen alongside the tables. She comes out coffee steaming in a Saskatchewan Wheat Pool mug. It's at this point that the other Joe D. walks through the front door as the bearded man says, "Joe this young lady is wanting to ride in the combine with you." Joe confirms our plan and urges me to finish my coffee, so we can get to work.

We stay for a few minutes for Joe to make some introductions. I give a few details about my project, but it's only when I tell them that I'm originally from Wyoming that I see a noticeable response. Hilda comments that she wondered why a car with Wyoming plates was parked in front of Doug and Sara's house. Everyone agrees that they also found it odd and were happy to have the mystery solved. I realize that in a town this size, there isn't much that goes unnoticed and wonder if this wasn't the first time my car served as a topic of conversation at coffee hour. We say our goodbyes and Hilda invites me to come back next week.

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[3] Saskatchewan communities larger than 100 people oftentimes maintain ice rinks to serve as community hubs for social gatherings of all types, in addition to housing hockey and curling games. With the slow decay of rural prairie life, ice rinks often outlast schools, Co-op stores, bars, and churches.

As I hop into Joe's red truck out front, he tells me to move the six-pack of Kokanee resting on the seat into the cooler on the floorboards. With the beer in place, we take a few turns out to the edge of town where the road seamlessly transitions from asphalt to dirt, and a canola field creeps into the hedges that surround backyards. The boundary between town and country no longer seems relevant.

OVERTURE

Within a few minutes of driving, Joe explained that we'll take the "grid road northeast" to where Dustin, his son, had already started working. The phrase "grid road" popped up continuously throughout the course of my time in Saskatchewan. Whenever people gave me introductions to their farmyards, they would always use the grid to guide me. Along highways and major gravel roads, the grid roads are labelled. For example, my partner and I live on township road 172 and the sign at our highway junction reads TWP RD 172. Grid roads follow the north-south and east-west lines of the original cadastral grid—more on this later.

As Joe and I continued our drive along the grid road heading north, he pointed out fields owned by other local farmers and various features of the landscape. I asked him why the bearded man called him "the preacher." Joe explained that this man, who also happens to be his brother, gave him the nickname long ago because he tends to "run his mouth around town." As we approached the first east-west road to bisect our north-south trajectory, Joe slowed the truck and directed my attention towards a grove of trees surrounding a collection of decrepit wooden buildings. He referred to it as an "old rundown farmyard" remarking, "Well, we call these trees 'Hollywood' because that's where the young people do their lovemaking." He said probably half the town of Wymark was conceived in those trees. I smiled but found his comment surprising because it contradicted my vision of what being Mennonite is all about. In conversations later that week with Sara, she explained that Mennonite means different things to different people. Some Mennonites, like her family, practice religion in an Evangelical Church but identify their heritage as Mennonite. Others may attend one of the several Mennonite churches in the area that all vary in their practices and beliefs, including one that is considered Mennonite Evangelical. Other self-identifying Mennonite families do not attend church at all, although I found this to be the exception and not the rule. At a hockey game later in the year, Joe told me that he goes to the Mennonite church in town, but he thinks most people only go to see which members of the community failed to show up. I also met farmers who attended the Catholic, Lutheran, and the United Church in Swift Current. Around Wymark, most of the farmers claim Mennonite ancestry. Around Cutbank, region east of Swift Current, farmers have English ancestors and near Stewart Valley to the north, I met farmers with Norwegian roots. South of Wymark is Ponteix, which was originally a French settlement. There are also many Hutterite colonies in Palliser's Triangle (Bennett, 1969; Hostetler and Huntington, 1980). The colonies have German ancestry and like the Mennonites, also immigrated from Russia. On both of the colonies I visited, there was a Preacher within each community who acted as the spiritual and general community leader. The colonies have their own churches and schools and unlike most other farmers, produce almost all of their own food including dairy products, flour, fruit, vegetables, meat, and eggs. The colonies vary in population size but try to keep their numbers below 150 people per colony. By the time they reach 140, the Preacher and other leaders split the colony to start a new settlement on land purchased elsewhere in the Prairies.

Our drive took us past a field that has been farmed for several generations by a Mennonite family who also share the last name D., but as Joe said, "are no relation of mine." Joe slowed the truck again to point out the "sorry state of these fields." As a researcher with several years of experience in farm communities, I knew immediately that Joe was referring to the uneven, chaotic aesthetic of the field, particularly when compared to the land on the other side of the road. The chaos was created by a low-lying crop of lentils bombarded with a variety of weeds including, but not limited to, wild oats, Canada thistle, and narrow-leaved hawk's beard. Joe pointed out the wild oats and told me that around Wymark, he's heard of several farmers with herbicide resistant varieties on their fields. After years of herbicide applications, the plant has developed into strains with the ability to survive after being sprayed. One of the most challenging weeds in this region of Saskatchewan is kochia. Some varieties have developed glyphosate resistance, meaning that farmers can no longer use their favourite weapon to fight this enemy.

The field on the opposite side of the road was also lentils, but it spread out like an even blanket of vegetative life, every plant sharing the same height, and with few weeds to interrupt one's gaze. Joe explained that the chaotic field is owned by an organic farmer who has no regard for how his practices impact the fields of his neighbours. Weed seeds move on the winds which are constant companions to those living on the Prairies. Joe worried that the wind would carry these seeds across property boundaries and onto his fields, adding further to his already problematic weed seed bank—meaning the collection of seeds lying dormant below the surface of his field and awaiting the right conditions to make trouble. In conversations later, Joe referred to this farmer as a "weird guy," who often leaves equipment sitting out in the field all winter long and keeps his farmyard messy. Clearly, Joe was evaluating not only the field but the farmer as well. Burton (2004) refers to the practice of farmers using field evaluations to make judgements about their neighbours as "roadside farming." It's a practice I observed frequently during my drives with other farmers or my attendance at numerous "coffee rows."[4] I continually heard farmers discuss topics such as weedy fields, farmers testing out a new crop, evidence of soil erosion, land sales, and farmers spraying herbicides on windy days. In these conversations, it was easy to identity which farmers had earned respect in the community and which ones attracted unfavourable attention. Rob T., a farmer near the old townsite of Burnham, further north, described farming to me as an act of "public nudity." He explained this with the following quote:

> In farming your neighbours can see all the mistakes you make from the time you put in seed until harvest. They'll see if you didn't drive a straight line seeding and they'll see if you end up with a weedy mess. There's just no way to hide it and you know they're all looking and talking about it on coffee row (Rob T., October 10, 2014).

The above quote highlights a general sense of being under surveillance that I heard from numerous farmers, especially those who grow alternative[5] crops or employ organic practices. Field evaluations by farmers during our conversations typically included judgments of the farmer as being "good," "bad," "lazy," "progressive," "innovative," "old-school," "methodical," and "greedy." Thus, we see a normalizing discourse circulating about fields and how they reflect the moral character of the farmers (Stefanik, 2015). In line with Bourdieu's (1977, p. 72) concept of *habitus,*[6] farmers develop bodily dispositions towards certain practices and conditions on their fields (Burton, 2012). Preference for tidy, weed-free, evenly planted, and perfectly aligned fields

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4 Coffee row is a phrase I often heard used in reference to the regular coffee meetings of farmers and other locals, including the Wymark ice rink gathering. People also use the phrase to refer to gossip. During conversations and interviews I often heard references to "information gathered on coffee row" and "tidbits during coffee row." It can also be used more generally to describe any conversations about farming that occur between farmers.

5 Alternative here refers to the standard three-year rotation of cereals (spring wheat, durum wheat, barley), pulses (lentils and field peas), and oilseeds (canola and flax). Such alternative crops might include hemp, camelina, Kamut, and quinoa.

6 Bourdieu (1998:81) describes the habitus as "a socialized body, a structured body, a body which has incorporated the immanent structures of a world or of a particular sector of that world a field and which structures the perception of that world as well as action within that world."

develops from a young age, through daily practices on the land and constant engagement in roadside farming. These dispositions towards certain conditions are reinforced socially, and through formalized education at agricultural research stations, technology transfer organized by the provincial government, and private technology transfer and consulting. Burton (2012, p. 66) suggests we view farmland as a site of cultural capital generation that inculcates, within "extended periods of socialization in family farming, an aesthetic appreciation of land" that is different from other social groups.

As we approached Joe 's field, I immediately spotted the large combine roaring across the field as it followed the north-south orientation of the bordering grid road. Combines tend to capture my imagination because their unusual shape reminds me of giant insects ingesting plant life and shooting it out their backsides. I spent many hours riding in combines over the course of my fieldwork and came to realize that farmers also use bodily terms to describe the mechanics of operation. The following quote is an excerpt from my fieldnotes but uses terms I collected through conversations with multiple farmers.

> The header, mounted to the front, cuts the crop with sharp teeth. A reel spins along the front to collect the plants with long, nimble, soft plastic fingers. An auger pushes the crop into the belly of the beast where it goes through a series of winnowing and threshing operations to extract the grain. The large glass cab gives a bird's eye view of the cutting and collecting process but the other operations are hidden from view. The extracted grain is visible as it trickles into the hopper mounted on top of the combine. A glass window in the cab allows one to watch the grain pour into the hopper and bounce around in a symphony of chaos. This grain is "dirty" meaning the belly never fully manages to clean out all the chaff, weed seeds, and insects. This affords a new visibility to the diversity of insects and weeds present in the field. As the header cuts and the hopper fills, the combine shits out a steady stream of plant residue from the back and onto the cut field (Strand fieldnotes, 2014) (See *Figures 3 and 4*).

Figure 3. The Header. Pictured above is an example of a combine header with the cutting blade at the bottom, spinning reel towards the top, and auger in the center. Photo by Katherine Strand.

Figure 4. Dusty Work. Pictured above a combine owned by Ronald and Hannah H., near Wymark. Photo by Katherine Strand.

Joe pulled off the grid road and we waited as the combine made its way towards us. Dustin stopped as he neared the end of the field but remained seated in the cab. He waved his dad over, so Joe got out of his truck, and headed over to the combine before climbing the ladder into the cab where they talked for about 10 minutes. Eventually, they both got out and Dustin walked over to the grain truck parked alongside the field. I waved my hand to say hello, but he never looked over or acknowledged presence. Joe grabbed the cooler, climbed into the combine cab, and asked me to join him. “Ready?” Although I didn’t say it, I was thrilled to be taking my first combine ride. When I got inside he apologized for his son. Dustin did not want me to ride with him because as Joe said, he thought it would be a “disloyalty” to his new wife. Later, I would come to understand why Dustin felt uneasy at the prospect; joining someone in the combine is an intimate experience often shared only between family, lovers, and close friends (See *Figure 5 and 6).* Most farmers spent many hours riding in combines with their mothers, fathers, and grandparents before ever driving one alone. During my fieldwork, I spent hours riding in combines, tractors, and sprayers with farmers. Later during the harvest season of 2014, I spent 14 hours riding in a combine with Hannah H., a large-scale chemical farmer and nurse north of Wymark, who shared many fond memories of all three of her kids riding in the cab, sitting on buckets. She said it was a good way “to keep track of them” around all of the heavy equipment. On the day I rode with Hannah, her daughter rode alongside her new husband in a second combine on the field; Hannah said they were still “honeymooning.”

Figure 5. Close Quarters. The inside of Joe's combine cab is pictured above. Photo by Katherine Strand.

Figure 6. The Office. In the photo above, Joe takes a phone call while the combine moves across the field in autodrive. Photo by Katherine Strand.

Riding in the combine is also considered an intimate experience because it affords farmers a commanding view of the fields that can leave them feeling very exposed. As Joe and I got started, he fumbled around with the GPS to get the combine moving. The header teeth gyrated to life and the reel began to spin. Joe stayed silent for about five minutes before launching into a long explanation about why his fields looked weedy. He said he was "embarrassed" and "disgusted" by their appearance, and soon got on the cab radio to tell Dustin, "We need to get the sprayer out here tonight when we're finished with the combine. We've got to get rid of all this green." Joe was referring to a near continuous blanket of bright green weeds that hid beneath the canopy created by the dry, light yellowish-tan durum wheat (See *Figure 5* above). The weeds were small, though, and close to the surface because Joe sprayed earlier in the season to limit their growth. Nevertheless, without another round of spraying his field would likely wind up looking similar to the organic grower's field he chastised. Many herbicides, such as glyphosate, make weeds less noticeable with hours; the plants shrivel, lose their colour, and eventually turn a blackish brown, dying fairly quickly thereafter. Joe said they would also spray the field next spring before seeding it to lentils. He told me that years ago, he always included a summerfallow rotation—meaning a rotation wherein the land is not seeded. Joe explained that for his first 40 years of farming, everyone in the area included summerfallow rotations because in those years, the practice was considered essential for moisture conservation in this dry area of the Prairies. He also said that during summerfallow rotations, he'd come out several times each summer and mechanically destroy weeds with his discers—a tillage implement. Joe pointed out the crop stubble left behind in the passes we already harvested. He said by spraying herbicides, rather than using mechanical implements to kill weeds, that crop stubble will remain on the surface of his field indefinitely. Joe mentioned that over the course of his lifetime, the whole area transformed as people got rid of summerfallow rotations and stopped "working their fields."

As we combined, Joe explained that passenger seats in tractors, combines, and sprayers are technically only to be used for training purposes, because manufacturers claim that passengers distract the operator. I've never heard stories of wrecks because of passengers, but I certainly have heard several about farmers falling asleep at the “wheel” while driving. The increasingly automated driving functions of most farm machinery make that possibility much more likely. The steering capabilities of Joe ’s combine connected to a GPS device with a computer interface (See *Figure 7*). As Joe turned the combine, he raised the header, used the steering wheel to turn, and lined the header up roughly along the borders made by our previous pass. He then hit a button on the joystick and the combine jerked into position, then pushed another button to lower the header to start it spinning. Once the Autodrive was initiated, Joe never touched the steering wheel. The GPS screen showed a small turquoise coloured combine moving forward in a line. The screen highlighted rectangular-shaped sections along the line as we move forward. Joe ’s eyes shifted between the main GPS screen, the small screen next to the joystick, the field, and the auger spinning inside the header. He mostly watched for large stones in the field, as well as swampy or wet patches called sloughs, and weedy areas that are too green and dense for the header to cut. He watched the header to make sure everything spun correctly and to check for plugs in the hole where the auger fed plants into the belly of the combine. On the screens he mostly checked the rpms and the yield monitor. Yield monitors give farmers live updates on the crop yield per acre, something that will also be calculated when farmers empty their hoppers into grain trucks, and again when they empty the grain truck into bins at their farmyard. These calculations typically confirm what farmers already know through doing their own visual assessment of their fields. They know a good crop from a bad crop; they use the yield number for their records—if they keep them—and for coffee row conversations that frequently turn into pissing matches.

Figure 7. Autodrive. Pictured above is Hannah H. and the computer interface in her combine—note the joystick in the lower right corner and the GPS screen in the upper part of the photo. Photo by Katherine Strand.

Most farmers agree that automated GPS driving system technology, which has been available for about 10 years, has had the greatest impact on their experience in the field. Farm technology continues to evolve and make use of robotics and drones, and farm labour shortages push machinery companies like John Deere closer to manufacturing robotic machinery that is operated remotely from the farmyard on a large scale (Gibson, 2019). Farmers enjoy talking about these future possibilities but most agree that there still needs to be a human inside the cab. Joe visually assessed his progress, but also relied heavily on sound, smell, and the detection of vibrations to determine if everything was functioning properly.

After a few passes across the field, Joe asked if I wanted to take over. I felt hesitant at first because of his mention earlier in the day that this particular combine cost $450,000. He reassured me that the basic operation is very simple, and that this field in particular makes harvesting easy. The field was flat with few obstacles, so we switched seats. My first instinct was to grab the wheel, but Joe reminded me not to touch it until we needed to turn. All the main operations to get the combine moving, including the automated drive, relied only on the joystick buttons. While I drove, Joe told me that before GPS, combining was difficult to do all day because it strained his neck and eyes as he tried to keep the header moving straight and avoid overlapping. Seeding was even more difficult because dust made it hard to keep track of the guidelines created by the previous pass. According to Joe , if you seeded a crooked line, you had to live with it all season and everyone "gave you shit" about it.

I ended up driving the combine for about 6 hours, and the only time Joe took over was when we had to empty the hopper into the grain truck. He radioed to Dustin, who pulled the grain truck alongside the moving combine. A long augur extended out from the combine and Joe lined it up visually in order to dump its contents into the grain truck. A few clicks of different buttons on the joystick sent a steady stream of grain pouring out of the auger. We continued moving and collecting grain the whole time, making it very important for Dustin to maintain the correct speed and alignment to avoid a huge crash or the accidental dumping of grain out on the field—something which Joe told me has happened. We dumped three loads into the grain truck before Joe asked if I would be interested in joining him on a trip to Swift Current to sell this load. He wanted to sell immediately because his bin space at the farmyard was limited, and he thought this crop would receive a low grade. His bin space is valuable, so he wanted to sell to make sure there was space to store a higher quality crop he can sell when the price improves after harvest season.

Mid-afternoon we switched places with Dustin and headed into town. Swift Current is a much larger community than Wymark, with a population of around 15,500 people. It provides services for all the smaller towns in the southwest and is also the location of the Swift Current Research and Development Centre (SCRDC). Throughout this dissertation I refer to it as the Station. The Station is one of many federally funded agricultural research institutes in a network that extends across Canada. The Dominion government established the Station in 1920 and at the time of my research between 2014 to 2015, was home to 14 scientists from around the world, as well as lab technicians, PhD students, post-docs, general labourers, and summer students. Located near the southeast edge of town along the railroad tracks, from Highway 4 the Station is barely visible through the large trees that surround the main buildings. As we came to the top of one final hill that overlooks Swift Current and the Station, I asked Joe if he ever visited the Station to attend their field days or presentations. He said he hadn't been there for a long time but mentioned a variety of spring wheat, AC Barrie, that he grew for many years and said that it came from the Station. The program Joe referenced is the wheat breeding division at the Station, which is by far the largest area of research at this branch in Swift Current. Dr. Frank D., a retired cereal breeder at the Station, told me that 50% of the spring wheat and 90% of the durum wheat grown in Canada are cultivars that the wheat breeding division created here in Swift Current. I told Joe about my plans to interview the scientists and learn about the Station for my project as we turned towards the grain terminals on a service road. He thought the plan sounded interesting but also mentioned that he hated attending presentations given by scientists because in the past he has struggled to understand their meaning.

Swift Current, as the largest urban centre in the southwest to run along the main east-west line of the Canadian Pacific Railway, kept the location of its grain elevators the same, but replaced the iconic wooden structures with massive, concrete terminals. Three such terminals currently operate there, helping to move millions of bushels to port terminals located mostly along the eastern coast. Before the cement structures took over, wooden elevators, connected by thousands of miles of secondary rail lines, once linked virtually every hamlet, town, and city in a social, economic, and political network (Barney, 2011). The wooden elevators created focal points in the landscape, towering above towns and endless miles of straight roads and flat prairies. Some elevators still stand as decaying monuments of this now-retired infrastructure, but most were demolished and sold off piece by piece to the highest bidder.[7]

Farmers now drive the network of grid roads to deliver their grain to the concrete terminals, which is considered by federal and provincial governments, as well as private grain handling companies, to be a highly efficient system. For farmers, it means they shoulder more of the financial burden to move grain. As the material network lies in decay, the political network that accompanied the railway lines and elevators also decays. By this, I am referring to the dismantling of the Canadian Wheat Board by Stephen Harper's conservative government and the corporate takeover of the once farmer-owned Saskatchewan Wheat Pool. Both entities gave farmers a competitive edge in the highly monopolized global grain market. Both also provided farmers with an administrative system to organize people across the Prairies and provide their diminishing numbers with a strong voice in Ottawa. According to Doug, my roommate in Wymark and a former grain buyer, the elevators even provided a physical space while waiting in line for farmers to socialize, in another version of the coffee row.

As Joe and I pulled in behind a long line of grain trucks waiting to deliver, I gazed up at the formidable, concrete structures (See *Figure 8*). Joe immediately got frustrated when he noticed the sign above the delivery bay indicating that it was currently only accepting lentils and peas (See *Figure 9*). He drove out of the line and parked in front of a small building next to the looming towers. I followed him into the building and saw a bank of computer screens and a room full of men either working on the computers or talking. This is the control room for the entire elevator, which is run mostly by computers, directing the movement of grain from trucks into the

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[7] A farmer living further north, near a town called Stewart Valley, told me he purchased an entire elevator for a dollar, then used the lumber to build his house and shop.

concrete storage towers, and eventually into railway cars for transport. Joe said hello to a man named Kelly, who he later explained is the manager of the elevator. He told Kelly about his load of low-grade durum that he needed to dump, and after about five minutes of haggling back and forth, Ken finally agreed to buy the grain. As Ken walked away, Joe smiled at me and whispered, “Selling grain is all about who you know.” We waited in the control room while two young men cleared the cereals delivery bay for Joe ’s load. As we waited, I watched as several farmers circulated through the control room to sell their grain. As their trucks sat in the delivery bay, one of the employees took a sample of grain into a private room for grading.[8]

Figure 8. Concrete Towers. Pictured above is one of the grain terminals in Swift Current—note the line of farmers waiting in grain trucks. Photo by Katherine Strand.

[8] The process of grading involves a visual examination of the grain, as well as testing to determine other attributes (Strand fieldnotes, 2014). In the case of durum, the elevator employees look for discolouration, cracks or breakage, shriveling, and sprouting of the kernels. They look for signs of disease, such as fusarium head blight, which causes discolouration. They use machinery to test the durum for protein content, moisture level, and test weight—meaning the weight of a bushel of grain. A higher test weight is desirable. Finally, the elevator employees assess dockage, which is the presence of any other material (e.g. rocks, chaff, and weed seeds) that adds weight to the load. They estimate this dockage by taking a sample and assessing the percentage of other material to make an estimation for the entire load. This allows them to pay for the weight of the grain and not the weight of the grain plus any other materials.

Figure 9. Yellow Means Go. In the above photo, we see the sign indicating what crops the elevator is currently accepting—in this case, peas and lentils. Photo by Katherine Strand.

Most farmers find this grading system highly variable and subjective, making them constantly suspicious of grain handling companies. The grading took about 10 minutes, after which time the manager made the farmers an official hardcopy offer. Every farmer I observed that day signed the paper and dumped their grain. Joe knew most of the people working in the elevator and a few of the farmers passing through. At one point he asked a younger farmer about his grade, which made the man visibly uncomfortable. He eventually said, "Three, but I think it's a two. I'll take it because I just want to get rid of the damn stuff." For farmers who like to play their cards close to the chest, they prefer to keep their grading private from other farmers. Joe eventually received a five for his durum, which is basically livestock feed quality. He never told me how much money they offered him for the load, and I can sense it is a delicate question, better left unasked.

We left the elevator and headed south towards Wymark on Highway Four (See *Figure 10)*. He asked me what I thought about harvesting and how "all this stuff works." I told him that I enjoyed the work and felt respect for farmers and the knowledge required to produce a crop each year. He laughed and said, "Well farmers are pretty much gamblers." He hedges his "bets" with soil testing and crop consulting but never really knows if it will pay. Joe also said that the most any farmer can do is protect the investment, once it's out in the field, through the use of herbicide, fungicides, and other pesticides.

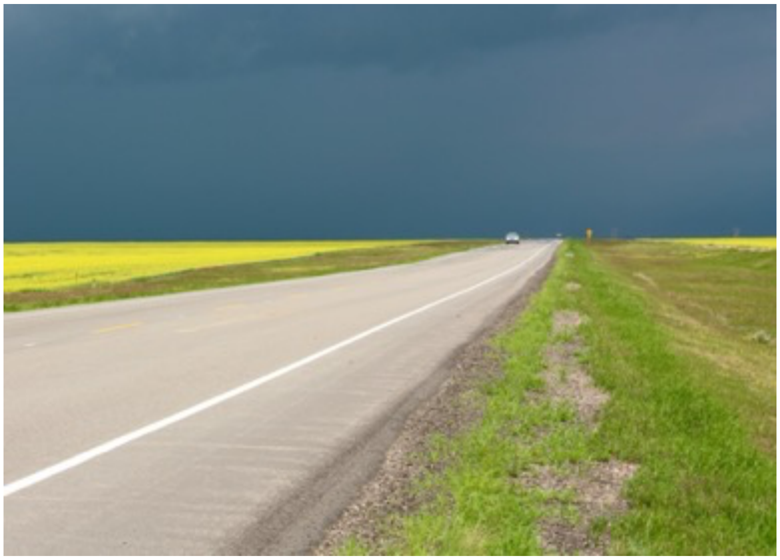

Figure 10. Highway 4. Pictured above is Highway 4, which heads south from Wymark to Cadillac—note the canola in bloom. This photo was taken in the summer of 2015. Photo by Katherine Strand.

As we approached my house in Wymark, I thanked him and we made plans to go again next week. As I took my shoes off at the front door, I felt my phone vibrating and noticed Joe was calling. He said, "You being a Wyoming cowgirl, I want to show you my horse." Having no idea what he meant, I agreed to meet him outside of his house—a short walk to the edge of town. Parked in driveway was a bright red, brand-new Mustang convertible. Joe was sitting in the driver's seat and he waved me over. As soon as I closed the door, he put the car in drive and raced down the road towards Highway 4. When we hit the highway, he quickly accelerated to 178 kilometers per hour. In these moments of sheer terror and excitement, I realized I might need to broaden my whole idea of the prairie farmer.

LIFE IN THE SEMI-ARID DESERT

This dissertation is an historical and ethnographic account of dryland farmers, such as Joe D., and the relationship of the rural community to a public agricultural research station that has been in place for almost as long as the intergenerational family farms. It is also an environmental study of the region known as Palliser's Triangle (See *Figure 11*), which consists of mixed grass prairie, an extensive dune system, a high elevation partially forested park, native and non-native pastureland, and endless fields of annual cropland. The purpose of the dissertation is to answer one primary question, which is intimately connected to the Station, the prairie ecosystem, and the techniques farmers have used throughout the years to produce crops. How did the original desert categorization of the region known as Palliser's Triangle influence the development of farming and agricultural science? I was drawn to this research question because I worked with dryland farmers in the High Plains region of eastern Wyoming and western Nebraska during my master's research project between 2009 to 2010. I left the project with additional questions about dryland agriculture and farming in arid regions without the use of irrigation. Specifically, I left with questions about the value of summerfallowing, the origin of conservation tillage systems, and the obvious conflict between organic and chemical farmers over the best tools for creating resilient farming systems in semi-arid environments. To explore these ongoing questions, I chose a dissertation project in the Prairies of Canada. This choice enabled me to continue a similar vein of research that began within my master's project but fell short in providing a deeper historical account of how certain technological adaptations came about in dryland systems

Figure 11. Palliser's Triangle. The map above shows Palliser's Triangle shaded in bright yellow. Swift Current is in the center of the yellow zone. Wymark, where I lived, is located south of Swift Current. Map from Roussin and Binyamin (2018).

The region known as Palliser's Triangle is considered semi-arid, meaning that it receives less than 400 mm of annual precipitation each year (Welland, 2015) (See *Figure 12)*. Most of the annual crop land, such as where I harvested with Joe D., was a mixed grass prairie ecosystem before it was converted into farmland. In the early 20th century, the mixed grass prairie received many different labels including virgin prairie, buffalo sod, and bald prairie. Dr. Archie Budd, a former forage researcher at the Station, discussed the virgin prairie near Swift Current with the following description:

> In 1910 the Cutbank district, about 15 miles east of here, was principally virgin prairie with a good stand of blue gramma, June grass and buffalo wool or thread leaved sedge, with clumps of bluestem (Andropogon scoparius) on the coulee sides, and, in the more favoured locations, forbal species such as wild rose, wild licorice, prairie bean, milk-vetches, horse mint, and buffalo bean. There were practically no shrubs or trees on the bench lands, the willows etc. which now are found along sloughs and roadside ditches have grown since the country was settled, and it is rather interesting to see fairly good growths of willows where formerly it was all bare prairie. In the coulees and along the creek were several varieties of willow, a few, very few aspens, poplars, choke cherries, saskatoon bushes, wolf willow, and chicken willow (Symphoricarpos occidentalis) (1937, p.1).

Many of the plant species Budd described in the quote above are still present on the Prairies, although mostly in protected regions such as Grasslands National Park. The most common native grasses still present in the southwestern Prairies include spear grass, wheat grass, and blue gramma grass. In terms of the native fauna of the region, there are many species that persist, although in much fewer numbers than were present before European settlement. Some of these include whitetail jackrabbits, pronghorn antelope, ground squirrels, coyotes, badgers, foxes, skunks, black-tailed prairie dogs, whitetail deer, mule deer, grouse, burrowing owls, gray owls, Canada and snow geese, meadowlarks, and sandhill cranes, to name a few (Savage, 2012). Plains bison have been reintroduced to Grasslands National Park in southwestern Saskatchewan, and there is also a herd of Plains bison in Prince Albert National Park, also in Saskatchewan.

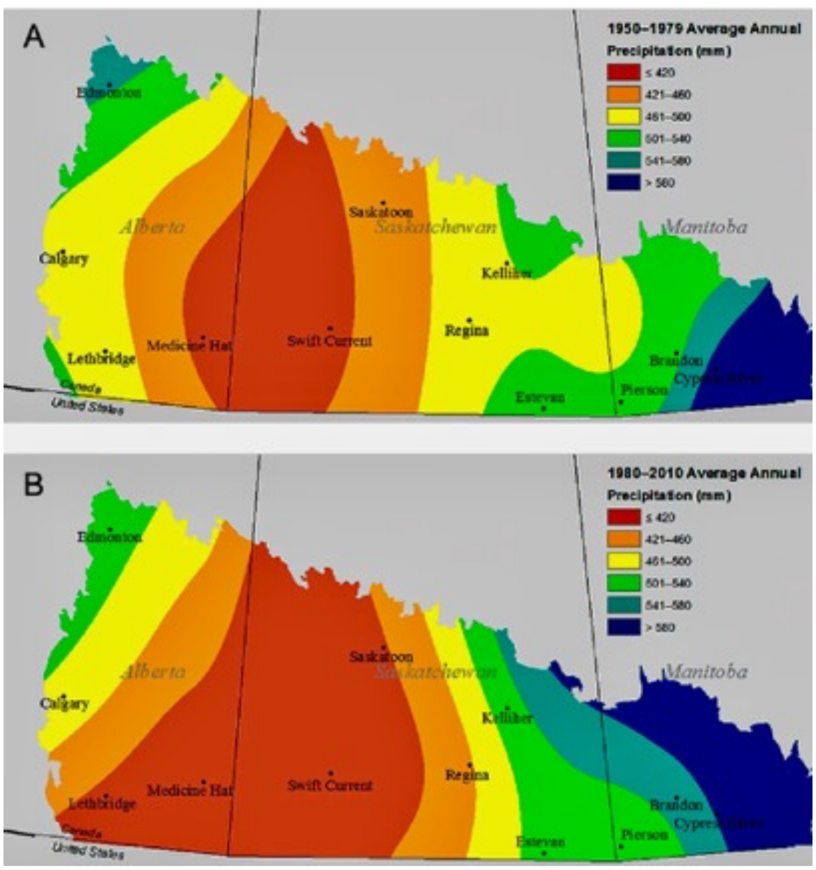

Figure 12. Semi-arid. The above map shows the annual average rainfall in the Prairie provinces. Map from *Roussin and Binyamin (2018).*

The region of Palliser's Triangle roughly aligns with the brown soil zone of Saskatchewan and Alberta (See *Figure 13*). The southern half of Saskatchewan encompasses four main soil zones including brown, dark brown, black, and gray (McKeague and Stobbe, 1978). The colour designation refers to the amount of organic matter in the soil as well as the type of parent material that formed the soils. Brown and dark brown are found in the southwestern semi-arid portions of the province and have between 2.5 -4.5% soil organic matter in cultivated fields (Pennock and Anderson, n.d.). The black zone is more typical in the central and eastern portion of the province these soils have between 4.5 to 5.5% organic matter in cultivated fields.

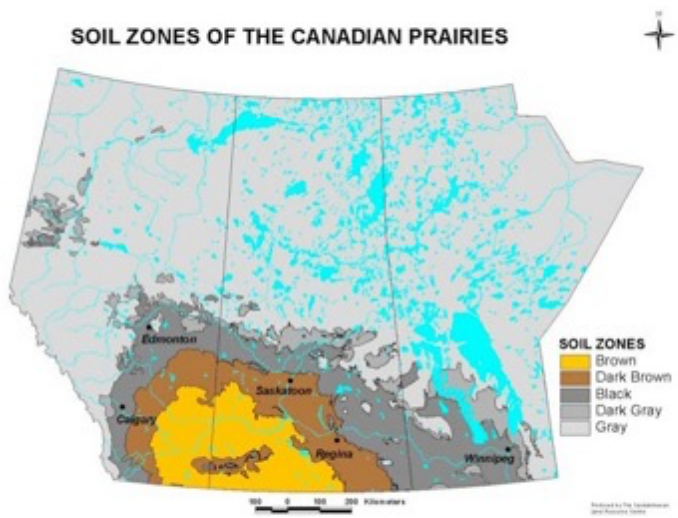

Figure 13. Brown Soil. The map above shows the soil zones of the Prairie provinces. Map from Miheguli et al. (2018).

The soils of Saskatchewan are the result of geologic activity that took place thousands of years ago. As Rennie and Ellis (1978, p. 3) explain:

> The exposed shape and surface features of Saskatchewan are mainly the result of the Wisconsin glaciation…that occurred during the Pleistocene epoch. The last traces of the ice disappeared more than 10,000 years ago leaving a mantle of deposits…consisting of preglacial soils, bedrock, pulverized rock flour, and stones.

This mantle of glacial drift is the foundation for the grassland ecosystem that nurtured humans for thousands of years prior to European settlement. The agricultural resource base in

Saskatchewan primarily consists of Chernozemic soils, meaning those soils "developed under a grassland ecosystem and with few exceptions on parent materials containing free calcium carbonates" (Rennie and Ellis, 1978, p. 9). Chernozemic soils in the agricultural lands include all three categories of brown, dark brown, and black. Patches of Solonetzic soils are also found within the brown and dark brown soil zones and these alkaline patches hinder agricultural production because of their high saline content. The size of saline patches ebbs and flows with changing agricultural practices and levels of soil moisture but are easily identifiable due to their stark white appearance at the surface.

When the homesteaders arrived in Saskatchewan, they knew very little about the inorganic (or chemical) content of their soils or the deep parent material residing in C horizon. Their arrival predated the first extensive soil survey in Saskatchewan in 1914, but they were aware of the significance of colour variation (brown to black) and could roughly identity the texture of their soils (McKeague and Stobbe, 1978). Texture, as we shall see, is important in Palliser's Triangle and refers to the size of soil particles ranging from large sand granules visible to the naked eye to small clay particles, visible only with high-powered microscopes. When asking contemporary Saskatchewan farmers about their soils, they usually begin with an assessment of rock content (ranging from "not too many rocks" to "a damn gravel pit") and then give one of three basic categories: sand, loam, or clay. Loam consists of sand, clay, and silt particles (the size in between sand and clay) and is generally considered the best by farmers. In the case of Solonetzic soils, the saline parent material or bedrock of C horizon weathers away from exposure to water and various chemical reactions to feed the subsoil above. Unfortunately, this adds additional salinity to the levels above, but in other cases, the C horizon provides essential nutrients for plant growth such as phosphorus, calcium, phosphate, zinc, and many others. Overall, between the parent C horizon and A horizon, the apple does not fall far from the tree. The inorganic nutrient content of A horizon is largely determined by its parent, C horizon, unless the surface is altered by human intervention through fertilizer use.

What interests me about dryland farming is the delicate balance farmers must create between producing crops and maintaining stability in their production systems within an environment that is prone to drought and soil erosion by wind and water. These environments are often called deserts and I have lived within them for the majority of my life. I grew up in southcentral Wyoming on a sheep and cattle ranch within the eastern boundary of the Red Desert. The Red Desert is approximately six million acres of land with sand dunes, badlands, dried alkali lakebeds, deep basins, and high elevation ridges reaching 2300 meters (Proulx, 2008). Although very few people live within the desert, it is home to a wild horse herd of approximately 3,000 animals and the world's largest desert elk herd. The Red Desert is also a region known for its extensive natural resources, which include uranium, oil, and natural gases. There are no farms in the Red Desert, but there are many large ranches like the one where I grew up. This differs from my current home, which includes both farms and ranches. I currently live within Palliser's Triangle near a small community called Fox Valley. The farm that my partner and I own and manage alongside his parents is within 24 kilometers of the Great Sand Hills which are comprised of 1900 square kilometers of active sand dunes. My partner and I fall into the category of organic farmers and we produce organic wheat, lentils, Kamut, peas, flax, spelt, and einkorn. My parents-in-laws also own a herd of approximately 100-head of bison that graze in the pastureland outside my office window. All of Palliser's Triangle falls within the semi-arid category, receiving less than 400mm of moisture annually. During particularly dry growing seasons, such as the one we experienced during 2020, some of our fields received less than 76 mm of moisture between April and August. Although I have experienced wet years in both the Wyoming and Saskatchewan deserts—when the landscape blossoms with green grasses and flowering forbs, in years such as the one we had in 2020, the countryside turns a monotone brown and gray as vegetation shrivels and dust storms coat everything with a layer of dirt.

Dust storms are also something I have experienced my entire life. In Wyoming, persistent winds on our ranch often stirred up dry alkaline soils to create clouds of white dust that hung in the air long after the winds died down. Trailing cattle and sheep on horseback always resulted in thick clouds of dust that made breathing difficult. It is fair to say that I was no stranger to dust storms when I moved onto the farm in Palliser's Triangle with my partner, however I had never experienced a black blizzard until last summer during a fence building project in our bison pasture. In July of 2020, my partner and I, along with his brother and father, began a fence project to create new paddocks within our pastureland. As mentioned above, we received very little moisture that year. As we worked alongside the fence, our footsteps broke down the vegetation. After a few days, even a short walk to get supplies from the truck resulted in mini dust clouds that hung in the air while we worked. On the last day of our project, I grabbed a metal coffee can filled with fencing staples and a hammer and worked my way along the fence—hammering staples into the fenceposts to secure the wire. I worked for about an hour, in which time I had distanced myself from the truck and my fellow fence builders. Around that time, I noticed a drop in the air temperature, along with a slight increase in the wind, so I paused to put the sweatshirt tied around my waist back on. I looked to the southwest, towards a ridge where there is a Hutterite colony about five miles away from our farm, and noticed a strange black cloud further west from the colony. Within 30 seconds of first noticing the cloud, it quickly enveloped the colony and the entire ridge, blocking both from my view. I kept watching the cloud. I could not figure out what it was because it hung so closely to the ground yet expanded vertically to form a massive black wall. Within a few minutes the wall reached the edge of our pastureland and by then, I knew exactly what was headed my way. I began running north towards our truck but within moments the wall hit me with a strong southwesterly wind that nearly knocked me over. Seconds later I was enclosed in a black storm of dust and tumbleweeds that blocked my vision beyond a few feet. I pulled my sweatshirt over my mouth and nose to assist my breathing, but I could not do anything to stop the dust from caking the outer edges of my eyes. I kept moving north towards our truck and felt a slight panic because I could not see it. After about five minutes of moving north, I spotted a small headlight moving towards me from the east. My partner pulled alongside me in our side-by-side ATV. He also had pulled up his t-shirt to block the dirt from entering his nose and mouth. We moved quickly towards the truck, where my father-in-law had turned on the headlights to guide us towards him. With all of us huddled in the truck, we waited for about 30 minutes before the dust storm finally passed.

When the storm was over, we exited the truck to assess the damage. Right away we all noticed the fence line that extends north-south to form the eastern boundary of our property. The fence was completely coated with a wall of tumbleweeds that had collected on its west side during the storm. It looked like a hedgerow without any vegetation. Our bison herd was tucked into the southeast corner of the pasture. They were noticeably dusty but otherwise unharmed. My father-in-law mentioned that the storm could have started 100 kilometers away and built up intensity as it moved across the Prairies, without any significant mountains or hillsides to halt its progress. When we arrived home, I noticed an open window in our bedroom and all of our furnishings coated in dirt. Shortly thereafter, I grabbed my notebook to record my thoughts about the day. The black blizzard that day left a lasting impression on me and has influenced the contents of this dissertation. The blizzard immersed me in a sensorium that brought me closer to understanding the stories of those who lived through the Dust Bowl of the 1930s. It helped me understand why chemical farmers are fearful of returning to a system that relies on mechanical tillage for weed control, which also removes the protective layer of crop stubble from the surfaces of fields. The black blizzard helped me understand why the region was categorized as a desert and the importance of that label to everything that has occurred since settlers moved into Palliser's Triangle. This is not to say that I agree with assessments of the mixed grass prairie that branded the region a wasteland, but it helped me understand the importance of keeping the prairie ecosystem intact—with all of its native plant species—to its overall stability. Unfortunately the intact prairie ecosystem has mostly disappeared, aside from a few protected regions, and the production of annual crops has remade the entire landscape. To stabilize this landscape, without the mixed grass prairie vegetation, requires a form of agriculture entirely dependent on inputs such as herbicides and fertilizers. Of course this creates another set of environmental issues for contemporary dryland farmers, a few of which are discussed in this dissertation.

PALLISER'S TRIANGLE

The man to credit with the region's original designation as a desert is Captain John Palliser, a member of the Irish Gentry in the mid- 19th century (Owram, 2000; Friesen, 1987; Stefanik, 2015). Captain Palliser, with support from the British Royal Geographic Society, was given the task of leading an expedition into Rupert's Land in 1857 to assess the region occupied by fur traders of the Hudson's Bay Company (HBC) and by numerous Indigenous communities including Plains Cree, Assiniboine, Blackfoot, Blood, Peigan, and Saulteaux. A second expedition led by Henry Youle Hind left eastern Canada in the same year and was given a similar task by the Dominion government. These two expeditions presaged the sale of Rupert's Land by HBC to the British government in 1870 for 300,000 pounds. Great Britain then transferred the land to the Dominion government to begin its nation-building enterprise.

During Palliser's 1857 expedition, he travelled through a region of Rupert's Land known as the Northwest Territories—an expanded version of the one today, which included regions that would eventually become the provinces of Saskatchewan, Alberta, and Manitoba. Moving along the southern boundary of these two provinces, Palliser encountered the region that he claimed as his namesake, which he described as "extensive sandy wastes" "forming a triangle, having at its base the 49th parallel from the longitude 100 degrees to 114 degrees w., with its apex reaching the 52 parallel of latitude" (Palliser, 1859, as quoted in Owram, 2000, p. 67). The region formed the tip of the Great American Desert, extending all the way to Oklahoma in the US. Hind corroborated his report adding that the region was "not, in its present condition, fit for the permanent habitation of civilized man" (Hind, 1859, as quoted in Owram, 2000, p. 67). The two men also agreed that in stark contrast to the Triangle and extending out from the Red River Valley, a "fertile belt" of rich soil and dense vegetation swept across the plains and promised the potential to drop "fatness" in the form of wheat.

Many of the people I spoke to around Swift Current seemed fuzzy on the details of European history in Saskatchewan and sometimes unsure of their own families' homesteading stories; however most expressed a full awareness that their home was once designated a wasteland by a man bearing the same name in 1857. Those who did not know this history received an entertaining lesson when a musical titled *The Cypress Hills Would Never Be the Same* came to the Lyric Theater in Swift Current in 2014. The musical was written by Stew Tasche, a local man, and has since been performed for three consecutive years to sold out crowds. The musical takes its audience through the "tumultuous time" in the 19th century when the Cypress Hills—encompassed within Palliser's Triangle— became the meeting ground for First Nations' communities hunting the last of the bison herds, desperado "wolfers" killing all varieties of fur-bearing animals, and permanent trading post inhabitants including European and Métis individuals. The play is a new take on the old homesteading origin story that actually includes part of the Indigenous communities' perspectives. However, where it does not diverge is precisely where it all began, Captain John's triangular desert.

Palliser and Hind upset the Dominion government's applecart with their assessment of the Triangle as a desert (Owram, 2000; Friesen, 1987; McManus, 2011). With the transfer of land completed in 1870, if the Dominion government, land speculators, capitalists, and Prairie boosters ever hoped to attract immigrant settlers, they'd need some magic to transform the desert into the fertile valleys of the Nile Delta (Burrows, 1880). To do this, they embarked on expeditions to contradict Palliser's assessments, and by printing promotional literature including whatever manner of story would be most enticing to their ideal candidate: a young farmer "from environments like the West (e.g., the Ukraine), or where on the basis of the American experience one would be likely to find exceptionally good farmers (e.g., Germany and Scandinavia)" (Bennett 1969, p. 103). They wanted to give the impression that along with keeping his nation's flag, he could retain his way of life because "a move from Yorkshire to Saskatchewan…was hardly more disruptive than one to Dover or London" (Owram, 2000, p. 143). The Dominion government feared US annexation of Rupert's Land, and they needed to recuperate the massive costs associated with the completion of the Canadian Pacific Railway in 1883. In order for the government to fulfill its vision of connecting the coasts with a bridge of people, and create a nation to rival the United States, they needed these immigrants to pour into the west and establish homesteads. And so, they told convenient lies to get start that flow of homesteaders started. However, this little lie became incredibly inconvenient after thousands of people arrived in the Prairies throughout the late 19th and early 20th centuries only to discover that the looming Triangular Desert possessed the power to choke crops, dispossess homesteaders of their land, and kill the Dominion government's nationalist dreams.

Bantjes (2005) explains that if the Dominion government had thought to incorporate knowledge from First Nations' communities into their assessments, they would have discovered that intermittent cycles of drought characterize the life on the Prairies, and these periods are so intense that they can dry sloughs, scorch grasslands, and starve bison (Cunfer, 2005). As Savage (2011, p. 42) explains:

> The special genius of the grassland ecosystem is its ability to ride the extremes of a midcontinental climate—a meteorological rollercoaster of blazing heat, brutal cold, sudden downpours, and decades-long droughts—by storing precious moisture and nutrients in the ground…The power of the soil, the wind, and the rain is concentrated in every leathery shrub and every blade of sun-cured grass.

Needless to say the Dominion government did not incorporate this knowledge, instead setting their homesteaders loose with the advice of dryland farming experts. They were encouraged to follow their U.S. counterparts by plowing their soils deep and with great frequency because as we all know, the rain follows the plough (Wilber as quoted in Smith, 1947).

When the Dominion government had first conceived of its grand plan to build a bridge of people (Owram, 2000) between the coasts, they never envisioned the period of extensive land abandonments that would follow in the 1930s. Friesen (1987) claims that a quarter of a million people left the Prairies between 1931 and 1941, while other estimates place the number closer to 50,000 (McManus, 2011). In the 1930s, newspapers around the country began referring to the region as the "Land of Cain" (Owram, 2000). As Potyondi (1995, p. 6) explains the Prairies, "were the last to be settled and the first to be forsaken." Abandoned land proved particularly disruptive to settlers because, as Gray (1967, p. 188) explains, "the surrendered land seldom contained anything to diminish the force of the wind. When the knolls started to blow it was not long before the sharp sand cut down weeds, polished the fence posts, and drifted over whatever was growing in its path." McManus (2011) explains that Palliser's Triangle was the epicenter of land abandonments, due, in part, to the black blizzards destabilizing the very ground under one's feet.

Not only did the dust storms lead to the widespread abandoning of land, but they buried the very infrastructure that homesteaders had worked hard to build (McManus, 2011). As we will see in the next chapter, this infrastructure of roads, fields, city plans, shelterbelts, hedges, farmyards, fences, irrigation canals, and railways all arose from the striated space of the cadastral grid. Thus, the encroaching desert acted to smooth over the formerly striated space (Deleuze and Guattari, 1987). As Gray (1967) details with great enthusiasm, scientific men needed to intervene to recover this grid of civilization. What is most interesting is that stories of dust storms follow each generation, thus keeping the lingering Desert ever-present in the lives of farmers. Dust storms in the 1950s and the 1980s provided the impetus for provincial and federal governments to launch massive campaigns encouraging farmers to abandon the plough altogether. Grant P., a former provincial extension agent and current organic inspector, recalled for me his experience in the 1980s watching dirt blowing in "thousands of fields" all over Saskatchewan. He told me that a lifelong hobby of collecting arrowheads began in those days because the surface was continually eroding with bare fields and strong winds.

The Prairie Desert of John Gray

After several months of living in Wymark and meeting farmers, scientists at the Station, and other folks working within agriculture, I picked up on an experience that kept repeating itself. Every time I would meet someone, I would explain that I was a PhD student in anthropology studying 21st century farming practices, and the concurrent development of practical and scientific agriculture in southwest Saskatchewan. Additionally, I would make clear that I was looking to study these issues from the perspectives of farmers, and individuals working at the Station. Time and time again, their response would be to remark on the importance of my study, but then express regret that someone had already done this research, and even written a book about it. That book was *Men Against the Desert* by John H. Gray, published in 1967—not quite 21st century, and I was eager to dive into it. Although the book is a bit dated, it has clearly made a lasting impression on people that I suspected might relate to an origin story that aligned with their own vision about how agriculture on the Prairies began. Here is the opening paragraph:

> This is a book with a point of view and a conviction. The conviction is that the conquest of the desert in the Palliser Triangle in the 1930's is the greatest Canadian success story since the completion of the Canadian Pacific Railway. The point of view is that Canada could not have existed without the settling and farming of the Palliser Triangle; and that Canada could not have survived, economically, or politically, if this vast area had been permitted to go back to weed-covered wasteland and short grass cattle range. Would it have gone back to a wind-blown wasteland of sand dunes, buck-brush, and pasture sage without the massive campaign that was mounted to save it? (Gray,1967,VII)

He certainly does not beat around the bush, nor lack a talent for the dramatic. This opening tells a big story, one that speaks to people in southwest Saskatchewan.

To briefly summarize, the book discusses early agriculture on the Prairies with particular emphasis on Palliser's Triangle. It outlines how mistakes made by early farmers, combined with a period of drought beginning in the 1920s and culminating in the 1930s, led to the Prairie Dust

Bowl. It then details how, to avoid having the Prairies disappear under a blanket of dust, the federal government teamed up with provincial officials and farmers to implement scientifically-proven practices—some of which were proven in the hallowed corridors of the Station—in order to restore the land and establish better farming practices for the future. The book is a treasure trove of analysis concerning all manner of topics, including gender, ideas of nature, First Peoples' relations, and their intersections. Gray also describes the looming presence of the desert as a force continually threatening the modernist project of Prairie agriculture. His description of dust storms is particularly compelling:

> Like forest fires, the dust storms built their own gigantic momentum and it was this momentum that spread destruction far and wide…Once this situation got out of hand and the top soil was turned into drifting sand dunes, the most powerful wheeled tractors available sunk to their hubs in the sand (Gray, 1967, p. 153).

Gray gives dirt the full credit it deserves as he explains its power to destroy roads, bury gardens, and seep into windows, turning houses into dust traps. During this period, dirt became an omnipresent force, inescapable for humans and non-humans alike, making life virtually impossible on the Prairies. To conquer the desert, the federal government established the Station in 1920 and the Prairie Farm Rehabilitation Administration in 1935.

The Swift Current Research and Development Centre—the Station—was built in Swift Current because this location is considered the heart of the Palliser's Triangle. It was built to address the needs of farmers in the region and to use science to discover the secrets of the soil, wind, rain, temperature, grass, and alkali in the Triangle to convert the region into a mono-cropped wheat kingdom. Over 100 years of science and farming are structured around the idea that a desert exists in the Prairies, straddling Saskatchewan and Alberta, and is roughly the shape of a triangle. In 1971, Dr. J. B. Campbell—a pasture/forage scientist—wrote a short history of the Station, his fellow scientists, and their research projects between 1920 and 1971. In a prologue for the book, Campbell described the overarching philosophy that guided the scientists from the beginning. He called it their "line-leader" in the following passage taken from that book:

> A history of an industry should tell its accomplishments, the economic and social stresses that have influenced its philosophy, and the ideas of its adventurous people. The 50-year history of the Swift Current Research Station, though necessarily different, is in many ways similar to the story of other successful ventures. Its accomplishments in agricultural research have had an impact on farming practices throughout western Canada and all over the world. The Station has had many people who have had venturesome visions.
>
> A successful business depends on its possession of a line-leader. The Swift Current Research Station has been guided by the need for stabilization of farming throughout the Palliser Triangle. A line-leader may easily be forgotten by those who conceive and use it. It must be improved through research to meet the demands of a challenging market. It must be realistic or it will go to the junk pile. But its basic principles must never be overlooked and, in our case, they are the principles concerned with moisture conservation, soil erosion control, plant improvement, and grazing capacity standards (p. 5).

The line-leader for the Station is the stabilization of the desert with the goal of creating a permanent agricultural economy in Palliser's Triangle.

As mentioned above, the Station was established in 1920 by the Dominion government through their Experimental Farms Service (1939). The origin of this government program dates back to 1886 when the first five branch stations, of what would become a large research network, were established across Canada. The original branch stations were located in Indian Head, Saskatchewan, Nappan, Nova Scotia, Brandon, Manitoba, Agassiz, British Columbia, and Ottawa, Ontario. The branch station in Ottawa is called the Central Station and for many years acted as the administrative hub of the entire network. This responsibility has since shifted to the Agriculture and Agri-food Canada (AAFC) main offices, also located in Ottawa. In the late 19th century, the federal Ministry of Agriculture thought food production in Canada needed revamping:

> In 1884 Canada was facing the need for recasting her agriculture. In the East primitive methods no longer sufficed. The nascent West was presenting fresh problems of its own. Thinkers discerned that Canada's future as a nation depended upon a contented and prosperous people; that such contentment and prosperity were impossible unless agriculture were put upon a permanent, profitable footing; that farming, while the most important industry of the country, was also a mode of living, and hence everything tending to a wider and fuller life on the farm was deserving of the most careful attention (Canada Experimental Farms Service, 1939, p. 19).

The Experimental Farms Service expanded the number of branches in 1911, while also adding illustration stations and branch laboratories. The following quote provides insight into the vision the government had for this network:

> The Dominion Experimental Farms System may be loosely compared to the hub and spokes of a wheel. The hub is the headquarters at the Central Farm. . .The branch farms and stations and branch laboratories of certain divisions are the main spokes, while carrying the influence still further afield are the sub-stations and 195 illustrations stations. The branch farms and other outlying units are in contact with the public continually, co-operate with extension men and serve in many ways. They are close to the farmer and the farmer uses them" (Canada Experimental Farms Service, 1939, pp. 25–6).

The illustration stations were owned and operated by local farmers, who in exchange for compensation, tested crop varieties and farm practices on their land to assist the branch stations with research and extension. In 1959, the network was renamed the Research Branch, and it continually grew throughout the years (Ahara, 2013). By 1993, there were 38 branch stations, such as the one in Swift Current, scattered throughout Canada. However, as part of a restructuring effort, those 38 stations were consolidated to 24 in 1993. All of the illustration and substations have also been closed. As Martel (2013, p.19), explains "If the first 100 years were marked by a continuous expansion of research infrastructure and budget, the ensuing 25 years were characterized by the need to increase efficiency…During the 1990s, the private sector became increasingly involved in priority-setting and the financing of research." In this dissertation, I discuss the involvement of the private sector in research and extension services around Swift Current. In Saskatchewan, only two of the seven branch stations that were established in the province remain independently operational. Some of the stations have been closed completely, while others such as the Indian Head station, have reduced their staff to a handful of people. The Indian Head station technically operates as an outlet centre for the Swift Current scientists, who manage all of the projects carried out there. Interestingly, although not covered in this dissertation, many of the former branch locations in Saskatchewan now serve as farmer-directed demonstration farms, which are financed with provincial, federal, and private funds (Strand, 2019).

Within my first few weeks of arriving in Wymark and visiting the Station, I observed a general atmosphere of apprehension amongst the scientists and technicians about the future of their place of employment. In these early conversations, scientists and technicians both discussed recent layoffs, retirements in which the positions were not refilled, and budgetary cutbacks that limited their ability to travel and attend conferences. Although at this time a major infrastructure project was planned, in which the main building was slated for a remodeling—including updating all of the laboratories—many scientists questioned the intent behind the project. They believed that AAFC intended to eventually sell the building to a company in the private sector who would also purchase all of the research and facilities associated with the wheat breeding division. I can happily report that as of January 2021, the Station remains standing as a public agricultural research station.

During my time at the Station between 2014 and 2015, there were fourteen scientists as part of the permanent research staff and over 100 more employees including technicians and general laborers. There were also many summer students, postdocs, and visiting researchers around the Station. The day-to-day operations of the Station are guided by the Director, Jeremy

L., who was a former researcher at Environment Canada. Jeremy handles many administrative tasks as well as oversees the work of the scientists in terms of making sure they fulfill their grant obligations. He works on the first floor of the main building alongside several desk receptionists and Station secretaries. As I describe in the next section, I conducted interviews with most of the current research scientists at the Station including the following individuals: Dr. Alessandra R.—a plant pathologist who also heads the low-input (organic) research trials, Dr. Camille B.—a microbiologist who specializes in arbuscular mycorrhizal fungi, Dr. Huan G,—a researcher in agroecosystems who heads the alternative crops trials and has contributed significantly to work on lentil research, Dr. Tom N.—a plant geneticist who heads the double haploid wheat breeding work and DNA mapping, Dr. Frank D.—the head of the wheat breeding section who retired in 2015, Dr. Carolyn M.—a researcher specializing in phosphorus nutrient cycles, Dr. Harold R.—a wheat breeder, Dr. Oliver C.—an researcher specializing in agrometeorology, Dr. James A.—a soils researcher who also does environmental metrics work, Dr. Jack M.—a forage researcher specializing in native plant species, and Dr. Adian G.—a rangeland researcher who studies forage mixes for pasture reseeding.

In some of the fieldnotes from my first few visits at the Station, I described it as "disjointed." The Station felt divided into two groups: those affiliated with the wheat breeding program and those not affiliated with the wheat breeding program. Although scientists collaborate on projects and many of the non-wheat breeding scientists joined projects within the breeding section, I never felt like the Station operated with a cohesive research mandate. The majority of the Station's technicians and general laborers worked within the wheat breeding section. The other scientists also worked with technicians and laborers but at a much smaller scale. The technicians were mostly individuals with many years of research experience and/or master's degrees in agriculture-related fields. Some of the technicians I interviewed included the following individuals: Garth K.—the microbiology lab technician who worked closely with Dr. Camille B., Michael H.—a technician in the salinity lab who works closely with the forage scientists, Danny B.—a wheat breeding technician, and Philip J.—the head wheat breeding technician. The technicians serve many roles at the Station. They are in charge of the laboratories such as the one for microbiology and chemistry, they supervise the work of general laborers, and they work closely with the scientists to help them design experiments. I referred to them as "critical translators" in my fieldnotes. By this I meant that the technicians help the scientists translate their research ideas into feasible experiments, which involves many steps. They must identify the type of data that is needed for a project then decide on the best type of experiment or field trial to extract that data. The technicians organize the trial plots to ensure that they get seeded and taken care of according to the experiment protocol. Then, they must collect all of the data and oftentimes help the scientists analyze and interpret the data. In my observations of field days, I also thought that the technicians communicated with the farmers more successfully than did the scientists—more on this below. The general laborers handle most of the physical work involved with taking care of the Station grounds and greenhouses, preparing seed and other materials for the field trials, and carrying out the seasonal labor for field trials—including seeding, weeding, and harvesting. The general laborers also work in the laboratories when needed.

In conversations with the scientists, technicians, and some retired employees from the Station, I found out that the organization of research changed significantly over the years. As I discuss in the upcoming chapters, when the Station was first established and for many years thereafter, it included research divisions on almost every aspect of farm life including field practices, crop testing, forage testing, pasture management, soils, horticulture, engineering—including onsite equipment design and construction, feed production—for turkeys and sheep, and livestock management—for cattle, sheep, turkeys, and chickens. These divisions ebbed and flowed throughout the years in terms of the size of their departments and number of projects. Slowly, many of the divisions disappeared altogether and right before I arrived in 2014, the engineering division—represented by one remaining engineer—was eliminated. On two occasions I toured the shop where the former engineering department used to work. The massive building, with the individual bays—workspaces for each part of the engineering department, remained intact in terms of the equipment, storage cabinets, and lounge areas (See *Figure 14 and 15).* However, with only three people still working in the entire building, including two mechanics and one warehouse manager, the space felt eerie. Although labourers, technicians, and the mechanics still utilize some of the tools and spaces on occasion, on most days the massive building, which sits across from the main offices, is almost entirely empty. Hearing about the fate of the engineering program and observing its former stomping grounds helped me visualize how the other cancelled programs met their demise.

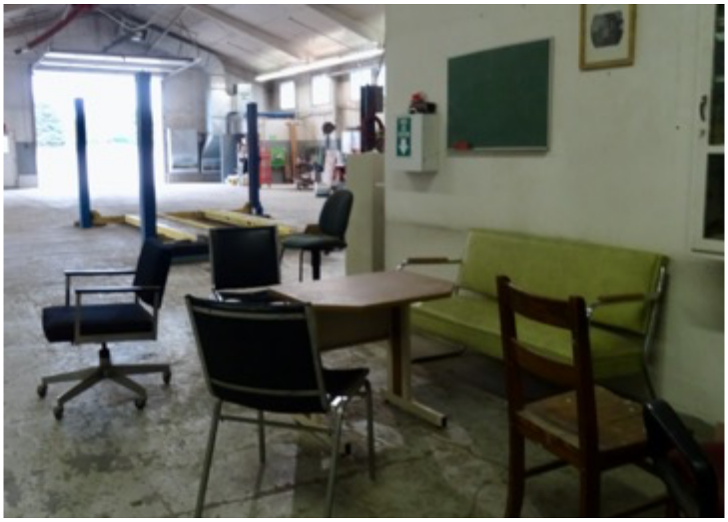

Figure 14. Nobody Home. Picture above is the mechanics/ bay inside Station's shop. Photo by Katherine Strand.

Figure 15. The Shop. Pictured above is one of the bays inside the Station's shop. Photo by Katherine Strand.

The two general areas of research at the Station that feel somewhat safe in terms of persisting as part of the research agenda are the wheat breeding program and the forage research program. These two have been with the Station from the beginning and for many years, the forage researchers outnumbered cereal breeders; however, this began to change in the 1970s with the work of Dr. Frank D. According to many of the Station scientists and technicians, as well as others involved in funding research at the Station, Frank developed a wheat breeding program that is the envy of all others in Canada. The wheat breeders now incorporate double haploid technology in their program, which can reduce the amount of years needed to create a new cultivar from eight to six years. Dr. Frank D., is called the "Billion Dollar Man," because he has been involved—mostly as the head breeder— with the development of 60 new wheat cultivars, which through their growth, have added billions to the Canadian economy. Along with two other scientists at the Station, Frank is an Order of Canada recipient for his contributions to agricultural research.

METHODS: THE STATION

In addition to helping me find a home in Wymark, the organic farmer Stanley W., also introduced me to the Director and several of the scientists from the Station. This first meeting happened in August 2014 when I joined Stanley and Dr. Jeremy L., the Station Director, Dr. Alessandra R., Dr. James A., and Oscar F.—a general labourer—on a tour of the organic test plots in the south field within the Station's grounds. On this first visit to the Station, I learned about the organic—aka low-input—research project, other projects on the south field, and the general organizational structure of the Station. This first meeting led to many more introductions with scientists, field and lab technicians, and general laborers. I ended up conducting twenty recorded interviews with scientists and lab technicians, as well as six additional unrecorded interviews. Of the twenty-six total interviews, fifteen were with scientists, four of whom were retired; nine were with technicians, two retired; and one was with a general laborer. The interviews included questions about their educational backgrounds, research interests, and daily work at the Station. I asked the scientists about their main research projects, sources of funding, and thoughts on how the Station interacted with local farmers. The technicians included people from the microbiology lab, the chemistry lab, the salinity lab, and two of the field technicians from wheat breeding program. The general laborer was also from within the cereals division. Within the category of technician, I also included two AAFC employees based in Regina who run the technology transfer division, as well as two retired individuals from the Station. One of the retried technicians used to run the photography lab and the other was the Information Office for the Station before that position was eliminated in the late 1980s.

The grounds of the Station include a main building with the Scientists' offices and labs, three greenhouses, growth chambers, and an annex off the main building with a conference room (See *Figure 15).* There is also the large shop that is mostly unutilized, aside from an area for the Station mechanics and a parts warehouse. The rest of the shop includes a welding bay, a tinsmith bay, a drafting and engineering area, and an electricians' bay. Engineering and equipment manufacturing used to account for a large division within the Station. Near the shop is another large structure called the Cereals Building. Within this building are the offices for the main cereal technician, as well as other technicians directly under his supervision. There are many large temperature and humidity storage rooms that contain thousands of samples of cereal seed, including all of the spring wheat and durum varieties bred at the Station. The building also includes large rooms where the seed from test plots is cleaned and bagged. The main room of the building is a huge, open workshop where the general laborers and technicians from the cereal division prepare seeding plans and seeding packets for thousands of test plots (See *Figure 16)*.

Figure 16. The Seeding Plan. Pictured above is a worker in the main room of the Cereals Building. He is organizing packets of see that coordinate with hundreds of test plots planted each year. Photo by Katherine Strand.

Other structures on the main Station grounds include several storage buildings for the field equipment including self-propelled seeders, harvesters, and sprayers that are specially designed for test plots. There is also a set of corrals to care for a small herd of cattle, including some fistulated animals. These animals have a small porthole, called a cannula, surgically inserted into the side of their bodies, thus giving scientists and technicians access to their rumens. The primary purpose for keeping fistulated cattle at the Station is to collect their digestive fluids to conduct testing on different types of forages in the artificial rumen lab. In this lab, a large tank is filled with broken-down forage material —to recreate the effect of chewing, water, and the rumen fluids to artificially digest the material. Scientists are mostly interested in measuring the amount of gas, including methane, that is produced by the digestion of specific forages.

Figure 17. The Station. Pictured above is a view of the Station taken from further south and looking northwest. The main building is the higher structure with windows. The shop is located directly behind the main building. Greenhouses are located on the left side of the photograph and the Cereals Building is on the far right. Behind the Cereals Building is a set of corrals for the cattle herd. Photo from SCRDC Archives.

North of the main buildings, there are large, irrigated fields. In the summer of 2015, these fields contained the full family portrait of spring wheat, from its early beginnings as Red Fife and Marquis, to later varieties bred by the Station including AC Barrie. The purpose of these plots is to grow and collect seed for storage in the Cereal Building. In another field, under irrigation, was an area known as the rust nursery. In this area, different varieties of wheat are grown, then inoculated with the fungus that causes wheat stem rust. The plots are irrigated to ensure that the fungus properly colonizes the wheat, which requires moist conditions. Once this has happened, the cereals division scientists evaluate different varieties of wheat to assess levels of resistance to the rust. I spent three hours in the summer of 2015 helping the general laborers and technicians inject rust into the stems of wheat. The process involved drawing water containing the virus up into a syringe and sticking the wheat stems with the needle then pushing the plunger to inject the fungus (See *Figure 18*).

Figure 18. Injecting Rust. Pictured above is the process of rust inoculation at the Station. Photo by Katherine Strand.

The other main part of the Station grounds is the south fields, which are located about one kilometer southeast of the main building. In total, the Station owns 930 hectares of land, including 140 hectares of native pastureland (McCaig et al., 2013). These fields are used for all of the other test plot research done at the Station including more wheat variety testing, lentil variety testing, alternative crop testing—including hemp and quinoa, the organic trials, and long-term rotations that were created in 1966, 1981, and 1987 to assess different strategies for weed control and summerfallowing. The forage division at the Station uses larger plots to test different types of forages while they are grazed by cattle. Finally, the south fields contain an agrometeorology area with multiple instruments that automatically collect data on moisture, temperature, humidity, wind velocity, and solar radiation. Although this is not nearly a complete description of all of the facilities and work done at the Station, it does cover many of the main activities and research projects.

Figure 19. The South Farm. Pictured above are plots of lentils grown in 2015 on the south farm at the Station. The plots are labelled in preparation for an upcoming field day hosted by the Station. Photo by Katherine Strand.

Figure 20. Mini Harvester. Pictured above are workers harvesting test plots of wheat at the south farm. Photo by Katherine Strand.

When I first visited the Station grounds in August of 2014, I was amazed at the beauty of the area around the main building. Large trees surround the building with green stretches of lawn that give the whole space the aesthetic of a park. In my first tour with Oscar F., a general laborer within the cereals division for 20 years, he immediately told me that the Station grounds used to be much more beautiful with a fruit orchard, many flower beds, a horseshoe pit, and multiple spaces for picnics. Oscar told me that the grounds were often the site for wedding photos and that tourists stopped in Swift Current to view the grounds. He said that beginning about ten years ago, these beautification projects became less and less a priority for the Station; regarded as unnecessary projects, and the funds required to sustain them were cut form the Station budget.

In addition to interviews with employees from the Station, I engaged in participant observation during my time at the Station. One of the regular social gatherings I attended was a coffee row held in the Station conference room Thursday mornings every week for retired scientist, technicians, and other employees. I tried to attend this coffee row as much as possible because I found the stories of the retired employees invaluable for my work. These stories, which dated back to the late 1950s, provided important historical context. I also engaged in participant observation with the technicians and laborers while they carried out field operations such as seeding, harvesting, and weeding test plots. As mentioned above, I assisted with rust inoculation and weeks later, accompanied the scientists while they assessed the varieties of wheat. In the spring of 2015, I helped the agrometeorology technician setup an elaborate test plot on the south field, in which he constructed a small greenhouse. The purpose of the test was to assess the growth of a wheat crop within the controlled conditions of the greenhouse—which included irrigation—and compare it with an identical plot alongside but beyond the boundary of the greenhouse conditions. I often accompanied technicians while they checked the plots of various experiments to collect data on weed growth and overall plant health.

In terms of indoor participant observation, I spent a day with a microbiology summer student while she prepared DNA samples of soil fungi for genetic screening. I also assisted the general laborers in the Cereals Building while they prepared seed packets that corresponded to an elaborate seeding plant to test wheat varieties. In the winter of 2015, I spent a day with laborers and technicians affiliated with the wheat breeding program while they emasculated wheat heads. For this operation, we used tweezers to remove the anthers from spikes of wheat to ensure that the plant would not self-pollinate. The breeders at the Station cross-pollinate varieties to develop new strains that include desirable traits, such as rust resistance, from multiple cultivars. Removed anthers can then be used to pollinate a different plant to create a cross. Additionally, I visited the chemistry and artificial rumination labs, although these visits mostly consisted of brief tours.

Most of my time inside the Station was spent on the third floor of the main building in the Station Library. The Library was a central hub for the scientists and technicians. They often visited the Library to borrow books, discuss the acquisition of new reference materials with the librarian, and make copies on several machines. I spent many hours in the Library and was there for at least one day of every week during my 14-month stay in Wymark. The purpose of my work there was to sift through the extensive archival collection stored in a few cabinets in the Library. The archives included Annual Reports written by Station scientists for their supervisors at the Central Farm in Ottawa between 1931 and 1958. Within these reports are updates on research projects within all the main divisions throughout that time period including field husbandry, engineering, cereals, forage crops, animal husbandry, horticulture, and poultry. I also found Annual Reports from the Soil Research Laboratory that was added on to the Station grounds in 1936. The archives included *Weekly Letters* written by the scientists and intended for publication in local newspapers throughout Palliser's Triangle. These letters provided a valuable resource for me in terms of offering a record of the advice given to farmers by the Station between the years 1936 until 2010. I make extensive use of them in this dissertation. I also use the *Seminar Papers,* written by the Scientists about their research and general topics in agriculture, and delivered by them at regular meetings within the Station for all of the researchers. The *Seminar Papers* from the archives were written between the years 1936 and 1955. In many editions of the papers, a summary of the discussion that followed the presentation was also provided. These discussions were fascinating to read, especially when the topic was obviously controversial amongst the scientists. Land use planning, for example, resulted in several heated discussions. In addition to collecting data for the historical portions of my dissertation, the Library also afforded me the opportunity to make small talk with the scientists and technicians on an almost daily basis. A couple of the scientists, Dr. James A. for example, became invested in my research and often stopped by to discuss ideas he thought would be helpful to me.

In terms of other participant observation at the Station, I attended three public field days while living in Wymark and attended one more a year later in 2016, while visiting Doug, Sara, and many of the people I developed close relationships with during my stay in Wymark. The field days were hosted by the Station and all four occurred in either July or August. In the days leading up to these events, the general laborers and technicians worked hard to prepare the south field for a public viewing. This mostly involved mowing the walkways and creating labels for all of the test plots and placing them in the correct location. On the day of the field tours, farmers, professional agrologists, and representatives from private agribusinesses arrived at the conference hall for a quick introductory meeting. Following the quick meeting the tour participants, the Station scientists, postdocs, and technicians drove out to the south field where an organized tour began that included eight to ten stops. At each stop, the scientists, postdocs, or technicians would give a 15-minute presentation to explain the purpose behind the experiment that was being carried out on each test plot. They would also provide any results, if available, and answer questions from their audience members (See *Figure 21).* I observed a wide range in quality of these presentations. Of all my field tours, the salinity lab technician—Michael H.—gave the best presentation. Not only was he well-versed in all the practices that had taken place on his plots, he was also very knowledgeable about saline soils. After his presentation, the farmers and other members of the crowd asked questions for about 20 minutes and he confidently and patiently answered them all. At times, the scientists had difficulties answering questions about the practices that had taken place on the plots, which speaks to their distance from most of the field labour involved in agricultural science. Overall, I found these days very interesting and they helped me understand how the relationship between the farmers and the scientists from the Station has changed significantly over the years.[9]

Figure 21. Field Day. Pictured above are visitors taking part a field day at the Station that occurred in July of 2015. Photo by Katherine Strand.

METHODS: THE FARMERS

As mentioned above, I moved to Wymark in the summer of 2014 and almost immediately began my ethnographic research. Doug and Sara, my roommates, initiated my work with farmers by giving me a list of names and phone numbers of all the people they knew in the area who owned and/or managed industrial farms. Most the people they listed were Mennonite families who farmed near Wymark. To gain a wider perspective, I also established contact with Stanley

[9] For more on field days at the Station, see "From Partner to Consumer: The Changing Role of Farmers in the Public Agricultural Research Process on the Canadian Prairies," in *In Defense of Farmers: The Future of Agriculture in the Shadow of Corporate Power* (Strand, 2019).

and Karen W. who are organic farmers in their mid-60s located about 20 kilometers west of Swift Current. One of my dissertation committee members gave me Stanley's phone number and I called him prior to my arrival to ask for help finding a place to live. Stanley and Karen became two of my closest friends while living in Wymark. They also introduced me to farmers who lived and worked near the Horsham region but also others Stanley had met through his work with the National Farmers Union. As time went on, I met more farmers, as well as professional crop consultants, an organic farm inspector and agricultural representatives from Saskatchewan Agriculture. Through these introductions, I asked many farmers to do interviews with me after signing an informed consent form (see *Appendix One*). The interviews included questions about the history of their farms, their farm operations, and the roles of each family member on the farm. In total, I conducted 24 recorded interviews with organic and chemical farmers and thirteen more unrecorded interviews farmers. For all the farmer interviews, twelve were with individuals identifying as organic farmers and 25 with individuals identifying as chemical farmers. Twenty-five of the famers were men and twelve of the farmers were women. The approximate age range for the farmers was between 20 and 85 with an average age of about 50 years old. One of the unrecorded interviews was with a farm boss on the Swift Current Hutterite Colony.

All of the farmers I interviewed were located within a 200 kilometer radius of Swift Current. The farms ranged in size from 1,500 acres to 20,000 acres with most between 3,500 to 5,000acres. The sizes of the farms are approximate and include both owned and rented land. Based on my previous work in the U.S., I learned that farm size can be a delicate issue for farmers, so I only asked for approximate acreage during the interviews. Only four of the farmers I interviewed raised livestock as well as grew annual crops. There are very few livestock operations near Swift Current, but this number increases closer to the Alberta border. All of the chemical farmers applied the same general structure to their farms. Through the winter, they marketed and hauled grain, purchased seed and chemicals, did maintenance on farmyard buildings and equipment, and created seeding plans—many with the assistance of crop consultants. Two of the chemical farmers also kept livestock, so for these farmers, February and March are spent calving. Beginning in April, although depending on the weather, most did a "spring burnoff," which consisted of spraying their fields prior to seeding to kill all the early spring weeds. All of the chemical farmers seeded with low or zero disturbance seeding implements, with the majority using Bourgault airseeders. These seeders also place fertilizer at the same time as the seed in midrow or side row bands. Depending on the crop, some sprayed herbicides one or twice more while their crops were growing. They all cited occasions when they had used fungicides and insecticides on their crops. If they have fields of alfalfa for haying, this usually starts in July and is finished by August. For chemical farmers, harvest usually begins in August. The majority of those I interviewed desiccated their crops, which means they sprayed either glyphosate or a product called Reglone on the growing crop about one week before combining. The desiccant artificially matures the crop by killing it, so that it can be harvested without moisture issues, which can cause spoilage in the grain bins. Following harvest, all of the chemical farmers I interviewed said that they spray herbicides again after combining if there appear to be significant weed issues on their fields. Chemical farmers generally follow a three-year crop rotation of wheat (either spring wheat or durum)—pulse (peas or lentils)—oilseed (canola, mustard, or flax). Less frequently, they add in rotations of oats, barley, alfalfa and fall rye.

The farm structure of the organic farmers in my project is harder to generalize. Like the chemical farmers, they also market and haul grain in the winter, create seeding plans, do maintenance on farm buildings and equipment, and purchase seed. The start of their growing season varies depending on the weed growth on their fields. Because they use mechanical implements to kill their weeds, the timing is crucial. If they go out too early, then the small weeds will not be killed by their implements or the weeds will grow back before the crop emerges. If they wait too long to kill weeds, the moisture levels on their fields will be depleted by the weed growth. Most of the organic farmers also utilize airseeders, but unlike chemical farmers', their implements are not usually considered zero tillage. The airseeders of organic farmers oftentimes include an additional tillage implement mounted in front of the knife openers for the seed (See *Figure 22)*. This gives the farmers one last shot at killing weeds before the crop is seeded and emerges. Organic farmers cannot spray herbicides, fungicides, or insecticides on their growing crop. Two of my project farmers mentioned spraying problem areas—such as Canada thistle patches—with herbicides to prevent any spread onto the rest of their fields. The patches they sprayed were then sectioned off and any grain grown on those areas for three years could not be sold as organic.

Figure 22. Organic Seeding. Pictured above is a seeding implement in use by an organic farmer. The V-shaped blades are mounted in front of the seed opener and designed to disturb weeds while seeding. Photo by Katherine Strand.

Organic farmers are inspected one time each year by a representative from their certifying agency. This usually takes place during the summer, so that the inspector can examine their fields. During inspections, organic farmers must provide complete histories for each field, crop, bin, load of seed, and any other input that comes onto the farm or leaves the farm. They must give a full accounting of every grain sale made including the amount, price, method of transport, buyer, and location where the grain was trucked after the sale. Beginning in August, organic farmers also begin their harvest season. For most of their crops, they swath the field first, which means they cut the crop down with a swather that also pushes it into windrows. The crop sits on the field in windrows for about one to two weeks. Organic farmers cannot spray their crops with desiccants, so swathing is their primary tool to prepare the grain for harvest. When the crop is ready, they use special headers attached to their combines that are designed to collect the windrows. Occasionally, organic farmers skip the step of swathing and use combine headers similar to those of chemical farmers, which cut the crop and combine it at the same time. This is called direct cut combining. Most of the combining done by chemical farmers is direct cut because they use desiccants. For organic farmers, direct cut usually does not work because there is too much moisture for the crop to cut properly and store without spoilage.

Of the organic farmers I interviewed, no two followed the same rotation. They all incorporated cereals, pulses, oilseeds, and perennials, but they grew many different crops within each of those categories. In my interviews the following crops were mentioned: spring wheat, durum, spelt, Kamut, einkorn, barley, purple barley, fall rye, large green lentils, small green lentils, red lentils, peas, camelina, flax, mustard, oats, and alfalfa. Perennial crops such as alfalfa was included in all of their rotations and kept on a single field for three to six years. Alfalfa helps build soil nutrients, but it also outcompetes most weeds. Farmers use it in their rotations to “cleanup” weed issues in their fields. Additionally, all of the organic farmers from my project include green manure crops in their rotations. Green manuring is the process of seeding a crop in the spring that is high in nutrients—including nitrogen, phosphorus, and potassium— and plowing it into the ground in July to add organic matter and nutrients to the soil, which is all contained within the green manure crop. This is one of the few ways organic farmers can fertilize their soils. They cannot use synthetic fertilizer blends, such as those integrated into chemical systems, but there are a few products available including fish emulsions, rock phosphate, compost, and compost tea. Two of the organic farmers I interviewed also raised livestock, which in addition to adding another source of income for them, also added a source of fertilizer through their manure. For these two farmers, they grazed their cattle on their fields after harvest. The cattle foraged the crop stubble, while fertilizing the fields with their manure.

I also engaged in participant observation with farmers for this project. As mentioned above, this included riding alongside farmers in their combines, tractors—while pulling seeding and weeding implements, sprayers, and swathers while they executed imported field practices. These ride-along days were valuable for my understanding of various approaches to weed management, seeding, and harvesting. They were also essential to my understanding of how GPS and other computerized systems are integrated within modern farm machinery. I observed how farmers interacted with their in-cab computers and how these systems assisted in their work. While riding and conversing with farmers in the cabs of machinery, I often learned more about the farm families and the history of the region. Other days of participant observation included the following: seed cleaning, moving grain into bins, trucking grain, driving recreational vehicles, taking farm tours, and joining farmers for social events. As mentioned above, I regularly attended coffee row in Wymark. I also attended potluck dinners hosted by Stanley and Karen W.

These dinners happened one Saturday of each month and I attended almost all of them during my 14-month stay in Wymark. At these dinners, I socialized with other farmers—both organic and chemical—which usually resulted in many stories about farm life in Palliser's Triangle. I attended many social events with Doug and Sarah, including barbeques with their friends and family and church gatherings. In the fall of 2014, I joined the local choir group in Swift Current to meet more people from the region, which opened my social network even further. Overall, by the time I left Wymark in October 2015, I felt like I was leaving a place that had begun to feel like home. I am still in contact with many of the farmers, as well as former roommates, Doug and Sara.

METHODS: OTHER SECTORS OF AGRICULTURAL WORK

In addition to interviews and participant observation with the scientists and farmers around Swift Current, I also carried out this work with individuals engaged in other aspects of agricultural research and labour. I conducted recorded interviews with four professional agrologists, including a specialist in data management employed at the John Deere dealership in Swift Current. I also conducted unrecorded interviews with two additional professional agrologists whom I also accompanied while they did soil testing and field scouting for weeds and crop diseases. I interviewed two agricultural representatives in Swift Current from Saskatchewan Agriculture—the provincial department of agriculture responsible for province-level extension services. I also interviewed the head of a major funding agency called the Western Grains Research Foundation that supports many projects at the Station. This interview helped me understand how the process of funding public research projects, such as those carried out at the Station, has changed significantly since the 1990s—more on this in Chapter Four. I interviewed a farm financial planner who works for MNP, a country-wide accounting, tax, and business consulting firm, based in Swift Current and also met another affiliate of MNP based in Saskatoon who specializes in farm succession planning. I did not interview the second MNP affiliate but spent time with him socially through a mutual friend, which afforded me the opportunity to discuss his work in depth.

Finally, I interviewed an organic inspector, Grant P., who works for the Organic Crop Improvement Association (OCIA) and is based in Swift Current. I refer to our interview and subsequent conversations frequently in this dissertation because I found his thoughts about chemical and organic farmers very insightful. He also provided a long-term perspective of farming on farming in Palliser's Triangle. Before becoming an organic inspector, Grant was employed as an agricultural representative for Saskatchewan Agriculture. He held this position for nearly 30 years before being forced into retirement in the early 2000s when the provincial government dramatically scaled back their extension services. Grant also worked closely with the Station scientists while employed as an agricultural representative, so his thoughts on that relationship helped me understand how the federal research stations are connected to the provincial agricultural services. Additionally, I spent one day with Grant while he carried out an organic inspection on a farm near Tompkins, Saskatchewan. On this inspection, I learned more about organic farming in Palliser's Triangle through both Grant and the farmers who owned the land we inspected.

DISSERTATION CHAPTER OUTLINE

The contents of this dissertation are organized into seven chapters including this introduction. Chapter Two, *A Gridiron Industry in the Desert* provides a theoretical and ethnographic background for my work. This chapter outlines what I mean by "industrial farms" in terms of what I consider to be their most important feature—the proliferation of capitalist commodity species such as wheat. Other attributes of industrial farming include vertical integration and the appropriation of many aspects of farm production by private agribusinesses, which in the case of my dissertation come in the form of private consultants assuming roles in decision making. This chapter delves into how the cadastral grid created the very conditions that make roadside farming possible. The grid created individual partitions within the Prairies that ultimately led to homogenization (Stefanik, 2015). Finally this chapter reviews three main concepts that frame the entire dissertation, which include: the desert, the grid, and surfacing. Drawing on Deleuze and Guattari (1987), I consider how we can use their concepts of smooth and striated space, within capitalist contexts, to understand the complex relationship between the grid and the desert.

Chapter Three, *Surfacing the Grid,* explores farming in Palliser's Triangle between 1908 and the early 1940s. Within this time period, dramatic changes in the landscape were carried out by settlers, as they attempted to "prove up" their land claims, guided by the advice of dryland farming experts such as Angus MacKay and William Motherwell. The advice given by these "experts," resulted in the environmental and social catastrophe that was the 1930s Dust Bowl (McManus, 2011; Jones, 2002). The purpose of this chapter is to provide historical context for understanding why the Scientists began recommending zero tillage farm systems and why farmers eventually adopted these systems. I propose that the main reason the research moved in that direction was that the Scientists focused on remaking the surfaces of annual crop fields to contain the creeping desert sands and preserve the physical manifestations of the grid (e.g. fences, fields, and farmyards).

Chapter Four, *Cracks on the Surface*, picks up this story of surfacing in the early 1940s when the Station first began testing herbicides in the form of 2,4-D. This chapter explains how early trials of 2,4-D led to zero tillage systems that eliminated summerfallow rotations in the 1990s and early 2000s. During this period, private agribusinesses began nurturing close relationships with the rural farming communities of the southwest and also promoted their products as tools for conservation. They began funding research at the Station through the Clusters program, which has dramatically changed the financial structure of the Station. Finally, this chapter describes three examples of cracks that are beginning to form in the dominant zero tillage system of Palliser's Triangle including the crop disease fusarium head blight, herbicide resistant weeds, and herbicide residues.

Chapter Five, *The Soil Test*, traces the development of fertilizer use in Palliser's Triangle through an examination of the *Weekly Letters*. Although Station scientists were reluctant to recommend the use of fertilizers between the 1930s and 1960s, they did begin recommending soil testing to the farmers in their region in the 1960s. Soil testing has become the primary form of field assessment in contemporary Prairie communities, and this service is almost entirely controlled by private consultants called agrologists. I describe the role of private agrologists, P.Ag.s, in Palliser's Triangle to highlight how private industry has largely taken over the role of public agricultural extension services.

Chapter Six, *The Game of Risk and Scale*, follows the story of a big land sale that occurred during my fieldwork to describe the many facets of land concentration on the Canadian Prairies. I describe how other farmers discussed this land sale at coffee row, as well as give an ethnographic description of an equipment auction that took place on the farmyard of Brandon and Diane W., the people who sold their land. I discuss my interview with Brandon and Diane in detail to help explain how land concentration changes rural communities. One aspect of land concentration that I describe in depth is what I call smoothing of the grid, which involves dismantling the farmyards and fences of those who have sold out and left the Prairies.

Chapter Seven, *The Experiment Continues,* wraps up the dissertation by providing my thoughts on an important event that took place at the Station during my fieldwork and how this reflects the state of public agricultural research in Palliser's Triangle. I also delve into two areas of research at the Station that may offer a different vision for agriculture moving forward. I conclude with a section on my thoughts about future research related to this project.

CONCLUSION

The primary purpose of this dissertation is to answer my main research question. How did the original desert categorization of the region known as Palliser's Triangle influence the development of farming and agricultural science? The secondary purpose is to evaluate the relationship between farmers and the Station. This relationship has defined the course of agriculture in Palliser's Triangle since it was established in 1920. Dr. Jack M.—one of the forage scientists, Dr. Camille B.—the microbiologist, and Dr. Carolyn M.—the phosphorus researcher all expressed concern to me about the future of the Prairies in relation to climate change. According to them, and to the Prairie Climate Atlas, within 30 years this region of Canada will have significantly more days above 30° Celsius during the growing season. As the researchers explained to me, this will drastically impact agriculture and the environment of the Prairies, making periods of drought more frequent and longer in duration. As this dissertation will show, during the last major crisis in agriculture, the 1930s Dust Bowl, the Station and other government programs played a crucial role in preventing a complete collapse in the rural communities of Palliser's Triangle. This dissertation will also show that while their solutions to soil erosion and agricultural stability were not systems that we can maintain forever, they assuaged the suffering of many settlers living out on the land. To allow the public research network to collapse, which many of the scientists discussed as a near-future possibility, could have severe social and environmental consequences as we confront the realities of global warming. To preserve this network, the relationship between the Station and the farmers must be rebuilt. The secondary purpose of my dissertation is to discuss factors that weaken this relationship and weaken the overall resilience of farming and farm communities in Palliser's Triangle.

CHAPTER TWO

A GRIDIRON INDUSTRY IN THE DESERT

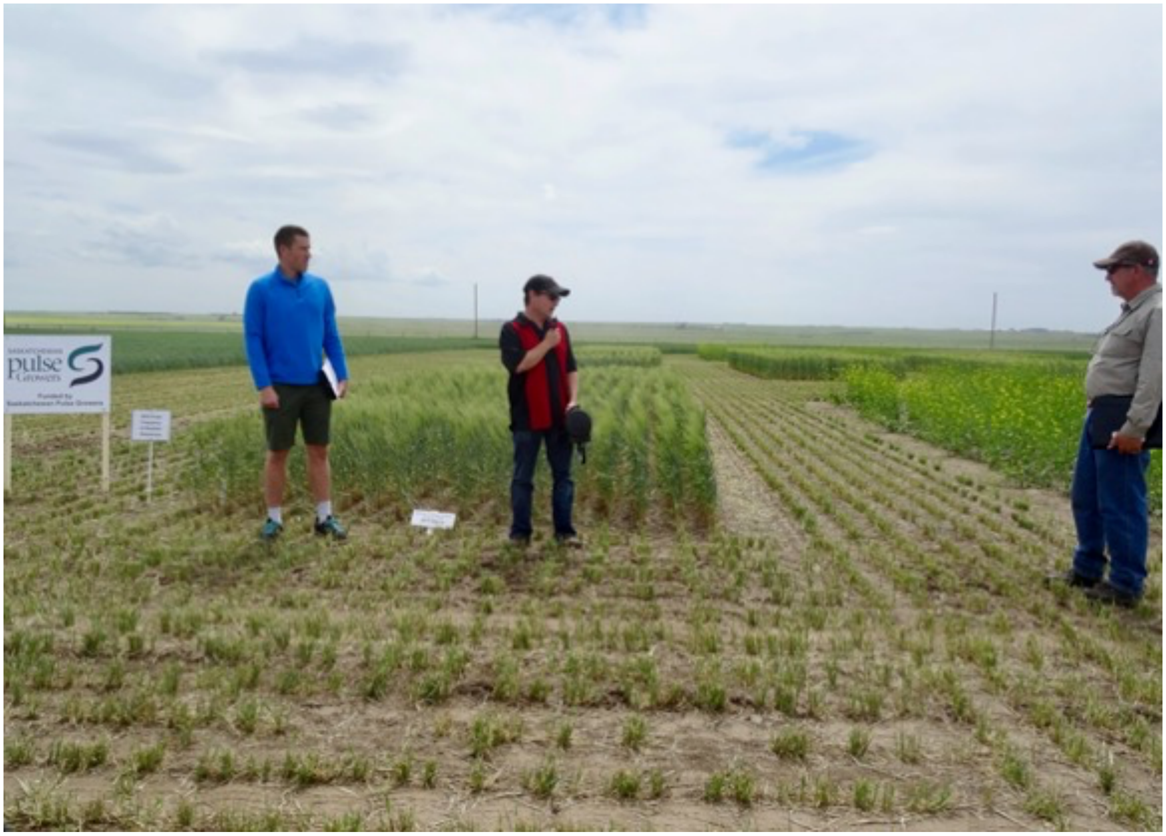

Figure 23: Gridded Field Trials. Photo by Katherine Strand.

INTRODUCTION

My research with farmers of the High Plains began in 2009 when I joined a team of professors at the University of Wyoming on a project funded by the United States Agricultural Department's Organic Research and Extension Initiatives (OREI). The project introduced me to the world of grain farming, as I travelled throughout eastern Wyoming and western Nebraska interviewing organic and chemical dryland farmers to learn about their crop rotations, tillage practices, seeding equipment, seasonal timelines, approaches to harvest and grain storage, marketing strategies, and use of crop inputs, including fertilizers, herbicides, and pesticides. The primary objective of the project was to identify the barriers farmers faced as they transitioned from chemical to organic production, chief among which were challenges associated with marketing, crop production, and insufficient knowledge about organic farming (Strand et al., 2014; Press et al., 2014). However, we also looked at how organic and chemical farmers discussed certain farm practices, such as tilling their soils or spraying herbicides on their land, something we concluded contributed to a process of identity formation: "Organic and chemical farmers manage their soils using different processes that draw on different cultural resources, which in turn, provide distinctive identity formations" (Strand et al., 2014, p. 368-369). For this approach we relied on Burton's (2012) concept of "farmer identity," which recognizes the importance of practice (Bourdieu, 1977) in creating a farmer's habitus. With each farm practice that is engaged in on a field, such as using a moldboard plough to prepare the soil for seeding or spraying herbicides to eliminate weeds, this behaviour becomes "etched" on the landscape (Burton, 2012, p. 54). The altered landscape then serves as a feedback loop for farmer identity as they create "portraits" of themselves on the fields to be observed and judged by their neighbouring farmers (Burton, 2004).

Through this research we recognized the cultural capital of weed-free fields, new equipment, perfectly straight rows of wheat, and tidy farmyards, all of which contributed to the status of farmers as “good” or “bad” within their communities. Burton (2012; 2004) ties this cultural capital to farmers’ embodied dispositions which favour features of productivist agriculture which included maximization of yields and technological innovation (Egoz et al., 2001; McEachern, 1992). Salamon (1992) explains that cultural capital in farm communities translates more tangible capital in the form of increased access to bank loans, rented land, labour during busy seasons, and ability to borrow equipment from neighbours. For this project, we also worked from Burton’s (2004) concept of “roadside farming,” which he describes as the ways in which farmers continuously monitor the fields of their neighbours, driving by slowly to assess the appearance of crops, the presence of soil erosion, and the prevalence of weeds (to name just a few categories of assessment they employ). These visual assessments inform conversations with other farmers as they scrutinize the successes and failures of the fields and of the farmers responsible. Roadside farming results in moral judgments which form a part of identity formation among farmers as they position themselves in opposition to otherness—in this case, organic v. chemical (Ricoeur, 1992). Bennett (1969), who carried out ethnographic research with farmers and ranchers near Maple Creek, SK in the 1960s, also described a version of Burton’s roadside farming:

> The choice of these particular qualities for defining credit [social] status of the men was associated with the public atmosphere in which every man conducted his farming (or ranching) enterprise. The farm is open to the view of all who drive by; the pastures, irrigation ditches, and many other things are visible and the experienced resident can, with little more than a quick glance, provide a remarkably accurate financial balance sheet for the particular farm or ranch (p. 220).

Understanding these behaviours through the lens of roadside farming continues to inform my research, particularly as I participated in this activity myself with many of my farmer collaborators during my time around Swift Current.

Through the process of writing my MA thesis, *Organic Agriculture on the High Plains: Re-contextualizing Symbolic Capital in the Struggle for Legitimacy and Status,* I recognized that many of the elements of cultural capital these farmers used to build their identities in opposition to one another became meaningful within an historical context that began prior to their ancestors' arrivals to the High Plains as settlers in the mid to late 19th century. For example, roadside farming is the visual assessment of fields from a very specific perspective. The very perspective involved in the act of roadside farming is created by the grid of fields and roads that were based on the Public Land Survey System (PLSS) originally established in Wyoming in the 1870s, following the appointment of a Surveyor General for the state by the Department of the Interior (White, 1983). The Dominion Land Survey played a similar role in Canada which we will explore later to as we discuss these important aspects of the grid. In Wyoming, the PLSS, which was originally called the Rectangular Survey System, established townships using a system of meridians and baselines extending north-south and east-west, respectively. Each township was subdivided into 36 sections, each measuring one square mile, for a total of 36 square miles per township. The east-west lines—the baselines—that divided townships are known as "range lines." After I took a summer job with the U.S. Bureau of Land Management as a cadastral survey technician,[10] I became acutely aware of the survey system in Wyoming. For the

10

As the Bureau of Land Management explains, the "Cadastral Survey Program provides one of the oldest and most fundamental functions of the U. S. Government. Originating with the Land Ordinance of 1785, cadastral surveys create, define, mark, and re-establish the boundaries and subdivisions of the public lands of the United States. (The word 'cadastral' is derived from cadaster, meaning a public record, survey, or map of the value, extent, and ownership of land as a basis of taxation.) These surveys provide public land managers and the public with essential information needed to correctly determine ownership rights and privileges and facilitate good land position—which lasted four summers during my early university years—we were required to locate the monuments, usually consisting of stone piles, constructed by the surveyors of the 1870s that marked the locations of townships and sections. With the assistance of Trimble Total Stations—a precise surveying instrument—we spent hours searching for these markers in order to ultimately replace them with new monuments of metal pipe with brass caps marked with the location information. Depending on the project, we oftentimes added new monuments to mark further subdivisions within the original 36 sections. This work took me to the middle of the Red Desert, the dense forests of the Wind River Mountains, and the top of Rendezvous Mountain amid the stunning Teton Range near Jackson Hole. However, it was not until I began my research with farmers in southeastern Wyoming that I fully understood the implications of the Rectangular Survey System.

Unlike other areas of the state that are dominated by ranching and natural resource extraction, southeastern Wyoming primarily consists of dryland grain farms. As we will see later in this chapter, settlers who homesteaded in both Wyoming and Saskatchewan were originally given 40 acres—a sixteenth section within a township—with which to farm and build a home (Bantjes, 2005). Eventually roads to access farmyards and fields were built following the original township and range lines in both places. Unlike the ranching communities in Wyoming (including the south-central part of the state where I grew up), farming regions need this grid system of roads to access their fields without driving across them and potentially damaging crops. This is in contrast with ranch land roads and fenced pastures which tend to follow topography rather than the original survey systems because they require a different type of access to the landscape. A rancher needs a road to a waterhole to check on their livestock, and usually

management decisions" (https://www.blm.gov/programs/lands-and-realty/cadastral-survey, accessed January 31, 2021).

those roads were built for convenient access to those landscape features. In the farm communities of both Saskatchewan and southeastern Wyoming, everyone refers to the system of roads that follows the north-south and east-west township and range lines as the “grid roads.” These grid roads structure the entire landscape, including providing access to farmyards and creating boundaries between fields. This grid system shapes the very perspective of farmers engaged in roadside farming. As they drive the grid roads, following the outer perimeter of fields, they base their judgments on weeds, soil erosion, and the quality of the crops in the context of the grid. This differs significantly from the way ranchers assess views and landscapes[11]. In my own experience, ranchers categorize and assess areas of their ranch based on major topographic features and/or the presence of certain types of vegetation. For farmers, the grid renders topographic features secondary to visual signs of homogeneity, which primarily include an even distribution of crops, and does not include any elements that might disrupt this distribution, such as weeds or empty patches of land. This dissertation examines the grid within Palliser’s Triangle, as well the region's original categorization as a desert, in order to provide a historical context for understanding how certain practices became the preferred system of farming in southwestern Saskatchewan. To support this discussion, this chapter reviews important ethnographic and theoretical contributions from authors across multiple disciplines. These authors have helped me create an analytical lens for my research on agriculture in Palliser’s Triangle.

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[11] Bennett (1969) compares the approaches to landscape management of ranchers in farmers in his ethnographic study of Maple Creek, SK from the 1960s. As he explains, “The farmer was there to establish a civilization and in contrast to the rancher’s attitude, the wilderness was for him something to tame, not to glory in. He had to remove the brush, plow up the ancient sod, pulverize the clods, remove the rocks, and kill the wild animals(…)To the rancher this was a gigantic violation of the natural principles of conservation and the desirability of making-do with minimal disturbance of the original flora and fauna” (p. 206).

This chapter is divided into five main sections. The first section, *Industrial Farming,* outlines the main characteristics of industrial farms that distinguish them from other types of food production systems in North America and around the world. These features include the reliance on a handful of what are referred to as "capitalist species," systems of on-farm data collection, and the scalability of industrial systems. The second section, *Disciplining the Prairies,* begins by explaining how agriculture in the Great Plains of Canada and the U.S. can be viewed through a lens of disturbance ecology, an approach which requires constant interventions by farmers—working under the advice of agricultural scientists—to maintain systems of industrial agriculture. This section also reviews how agricultural science, primarily within the context of government-supported public programs, has shaped the trajectory of farming by serving as a disciplinary force within rural communities. I then draw on the work of Michel Foucault to define how public agricultural science can be viewed through a lens of institutional power. The third section, *Organizing Concepts: The Desert,* reviews the work of philosophers, ecologists, and social scientists as they attempt to define deserts not only as unique ecological environments, but also as conceptual tools. This section includes the work of Povinelli (2016) and her use of the desert as a central figure in the concept of geontopower. I also briefly discuss Deleuze and Guattari's "smooth and striated spaces," which provides a transition to the fourth section, *Organizing Concepts: The Grid.* This section picks up with Stefanik again to describe how the topographic grid acts a powerful tool of governance, establishing the basis for private property law on the Prairies. Through a brief historical discussion of the Dominion Lands Survey, we see how the grid was used to establish private property only after Indigenous Plains communities had been violently removed following the signing of treaties. The fifth and final section, *Organizing Concepts: Surfacing,* draws on the work of Eckbo (2002) and landscape architecture This approach assists me in using the surfacing concept in the agricultural context to describe the work of farmers on their fields as they create particular surfaces that help maintain the striated space of the grid by containing soil and weeds.

INDUSTRIAL FARMING

Popular journalistic books and documentaries about industrial farming and its impact on human health, the environment, farm communities, animal welfare, plant genetics, biodiversity, and food security fill the shelves of bookstores and the Netflix menu, providing the public with important narratives for confronting the realities of contemporary food production.[12] Through this "liberal exposé genre" the authors and commentators "insist that factory farms are so exceptional, and exceptionally bad, that their practices could be corrected if only they were 'exposed' to the public. These factory farm exposés present themselves as radical interventions against power" (Blanchette, 2020, pp. 26-27). Films such as *Kiss the Ground* (Tickell and Tickell, 2020) and *In Our Hands* (Barker, 2017) present visions of alternatives to the highly-mechanized, input-dependent, and environmentally destructive model of industrial agriculture portrayed, in favour of alternative food production systems that include permaculture,[13]

12

Examples of such documentaries include *Food, Inc.* (Kenner, 2008), *Cowspiracy* (Anderson and Kuhn, 2014), and *Seed: The Untold Story* (Betz and Siegel, 2017). Examples of books include *Fast Food Nation* (Schlosser, 2005), *The Omnivores Dilemma: A Natural History of Four Meals* (Pollan, 2006), *The Fatal Harvest Reader: The Tragedy of Industrial Agriculture* (ed. Kimbrell, 2002) and *The Chain: Farm, Factory, and the Fate of Our Food* (Genoways, 2014).

13

Permaculture is a term coined by Bill Mollison and as he explains it is, "the conscious design and maintenance of agriculturally productive systems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of the landscape with people providing their food, energy, shelter, and other material and non-material needs in a sustainable way" (as quoted in Barth, 2016). Permaculture always includes the extensive use of perennial crops in agricultural systems to reduce the need for tilling and to provide soil microorganisms with permanent vegetation. Biodynamic agriculture "is rooted in the work of philosopher and scientist Dr. Rudolf Steiner, whose 1924 lectures to farmers opened a new way to integrate scientific understanding with a recognition of spirit in nature" (Biodynamic Association, 2021, January 31). Biodynamic systems, like permacultures, stress the importance of closed-loop systems or systems that do not rely on outside inputs such as fertilizer and/or weed management. Fertilizer production is integrated within the farm through the use of manure for composting, and through the use of green manure crops or crops that are tilled into the soil rather than harvested so that they can provide soil nutrients and organic matter.

biodynamic, and organic agriculture. These books and films vary greatly in how they define industrial agriculture generally, and industrial grain production specifically. A few key features of these portrayals, however, include: large-scale and corporately-owned; dependent on synthetic fertilizers and other inputs; the use of genetically altered seeds; and rotations of monocultures—a single species of crop on an entire field (Genoways, 2015; Pollan, 2006; Schlosser, 2005; Kimbrell, 2002). While I certainly have observed the presence of everything on this list in farm communities of Palliser's Triangle, I would suggest that these features are symptomatic of one central point that characterizes industrial agriculture. Industrial farms are dependent on a handful of capitalist species of plants and animals that support their livelihoods and structure the day-to-day lives of farmers. Capitalist species are those plant and/or animal species that have been genetically manipulated by humans—across many generations— in ways that streamline their production for national and international markets. In turn, these species have shaped humans or as Scott (2017:19) explains in the context of plant and animal domestication for more than 10,000 years: "what about the 'domesticators in chief,' Homo Sapiens? Were not they domesticated in turn, strapped to the round of ploughing, planting, weeding, reaping, threshing, grinding, all on behalf of their favorite grains and tending to the daily needs of their livestock?" Tsing (2012) discusses a similar process in the context of sugar plantations with her concept of nonsoels—more on this below. Capitalism brought on new requirements for those plant and animal species chosen to support globalized communities.

Wheat, for example, has been bred to succeed in monocrop fields with minimal insect or disease issues. It has been bred in a research environment that includes fertilizers and herbicides, thus making it adapted to input-dependent agriculture. Wheat has also been genetically manipulated to satisfy the demands of grain processors such as millers and bakers who seek consistency in loads of grain, particularly as it relates to protein content, moisture level, milling quality, and colour. Machinery, including seeding implements, has been developed to accommodate particular grain sizes and attributes. Overall, capitalist species such as wheat have been genetically manipulated to accommodate each stage in production, processing, and consumption. As a result, human communities, their landscapes, and technologies are shaped to produce capitalist species and move them into the markets.

This handful of capitalist species began with cattle and Marquis wheat—the first variety of spring wheat seeded— on the Canadian Prairies (Olmstead and Rhode, 2002). It has since evolved into numerous varieties of durum wheat, spring wheat, lentils, canola and other oil seeds, peas, oats, and barley (although wheat and canola continue to dominate) (Government of Saskatchewan, 2021, February 12). Cattle continue to dominate production on the livestock side of things, but species such as bison are also becoming more common. My focus on how a handful of capitalist species define industrial agriculture on the Canadian Prairies is inspired by Blanchette's (2020) study of American hog slaughterhouses and how the industrial pig creates the conditions of existence of small company towns. The example of a small town, that of Dixon in the Midwestern U.S., acts as a case study:

> What distinguishes this company town as a postmodern Porkopolis[14] are the ways that everyday human life and labor have become qualitatively infused with, and organized through, dimensions of the capitalist swine. Dixon [the company town] has been built up, and is now continuously remade, to unlock new forms of value within the hog's body, mind, and behaviour. This town marks a zone where corporations' efforts to manifest a highly uniform version of the porcine species, at a massive scale, have transformed the industrial hog into an omnipresent, world-defining creature (pp. 3-4).

14 *Porkopolis* is the title of Alex Blanchette's ethnographic account of hog slaughterhouses. It is also the name given to Chicago when, by 1863, it had surpassed Cincinnati as the city slaughtering more hogs than any other.

The hog has come to define the small town of Dixon, including the work, bodies, and sociality of its people. Cronon (1991) uses an historical approach to demonstrate how the movement of capitalist species, including wheat and cattle, from rural sites of production to Chicago—the processing and marketing centre of the mid-west—inspired monumental changes in food production, including the creation of feedlots. Cronon's work exemplifies how our production of capitalist species has resulted in unique social, infrastructural, and economic arrangements which organize non-humans and humans for capitalist ends. In both my historical and ethnographic research, I too have witnessed how a capitalist species, such as wheat, have defined the successes and failures of communities and farms in Saskatchewan. It inspired the creation of the Saskatchewan Wheat Pool, a powerful cooperative grain handling and marketing organization, the Canadian Wheat Board, a single-desk marketing board that challenged the obscure forces of the global economy, as well as numerous political organizations such, as the National Farmers Union[15] (Earl, 2019; Fairbairn, 1984; McLaughlin, 2007; Friesen, 1987).

In their quest to improve the likelihood of success for wheat in Palliser's Triangle, researchers from the Station undertook thousands of projects and trials on a large variety of

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[15] John Bennett (1969) describes the creation of cooperative collective political and marketing organizations within Saskatchewan farming communities, such as the Saskatchewan Wheat Pool, Co-operatives, and Credit Unions, as part of farmers' ecological adaptation of "specialized use of refractory natural resources that consequently must be changed or improved in the process. This means relatively high costs and great dependence on these resources, and consequent economic difficulty when variability lowers yields" (p. 308). According to Bennett, who conducted ethnographic research with farmers from Maple Creek in the 1960s, farmers sought out collectivized political and marketing opportunities to help them deal with the extremely variable growing conditions of the area. These collective and cooperative opportunities helped mitigate some of the financial difficulties associated with farming in Palliser's Triangle and represented a low investment in terms of cost. As he explains, "The opportunity costs of innovation [new equipment] were too high—the risk of losing income in these marginal enterprises [farming] was too great. On the other hand, political participation entailed no risks—its opportunity cost was low—and one stood only to gain. In this sense politics can be seen as a resource alternative grasped by farmers when the need arose and the cost was low" (p. 312). In the course of my research, I found that smaller farms and older farmers, over 55 years of age, continued to support these collective structures. Operators of large farms almost all supported the dismantling of the Canadian Wheat Board, citing a desire for market freedom as their primary reason. Bennett might conclude that these larger farms no longer need the collective structures as part of their economic and environmental adaptation.

spring wheat and durum. Just between the years 1986-2011, the breeding program at the Station developed 48 new cereal cultivars (McCaig et al., 2013). Between 1997 and 2007, AC Barrie—a variety of red spring wheat created at the Station—was seeded on 41 million acres in Canada (Germination Magazine, 2007). Throughout my time in the Swift Current area, I observed wheat wreaths decorating homes, wheat berry salad at every potluck event, and many wedding photos taken in fields of wheat. In interviews with older farmers, they referred to certain buildings, houses, equipment, or grain trucks as the result of good wheat harvests in specific years. They also discussed traumatic years when their wheat crops were destroyed by hail, wheat stem rust (a fungal disease), wheat stem sawfly (an insect that targets hollow wheat stems), and grasshoppers. It left an impression that the measure of any given year, good or bad, was often determined by the wheat crop. Overall, it is obvious that the capitalist species of wheat has become "infused with" many aspects of human life and labour within Palliser's Triangle (Blanchett, 2020, p. 3).

In the introductory chapter of Blanchette's ethnography of the industrial pig, he opens the chapter with the following quote from one of his participants: "If it wasn't for the hogs, there'd be nothing here. This would be a ghost town" (2020, p. 1). After reading this remark, from an older man in Dixon, I was immediately reminded of how often I heard similar remarks from my project collaborators about life in southwestern Saskatchewan. Like the residents of Dixon, they live and work within a landscape riddled with the remnants of previously occupied farmyards and towns. They live among ghost towns. Some of these towns may still have inhabitants, but their main streets and downtowns consist primarily of boarded-up, decaying structures, most iconic of which now include grain elevators. Grain elevators continue to disappear at alarming rates, as small towns and private owners struggle to keep up with high costs of maintenance (Vervoort, 2006). As these "sentinels" (p. 196) fall to the ground, rural residents mourn those geometrically pleasing, wood and metal structures that branded Prairie skylines for over a century. As do the residents of Dixon, the rural residents of southwestern Saskatchewan live among the remnants of former Prairie settlements, serving to remind them of the fragility that comes with communities relying on a handful of capitalist species (See *Figure 24)*.

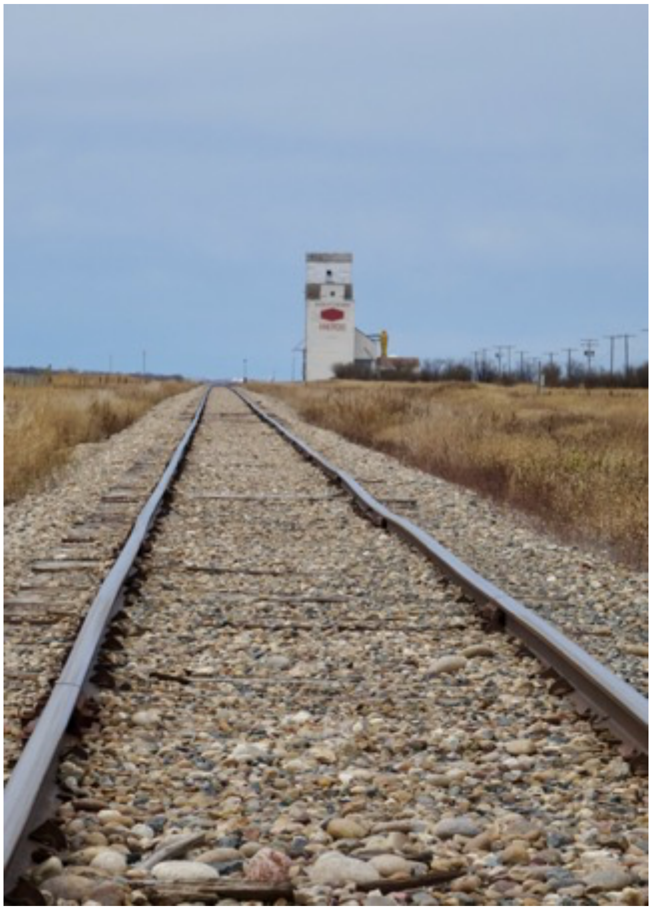

Figure 24. Prairie Sentinel. The Aneroid, Saskatchewan Wheat Pool Elevator. Photo by Katherine Strand.

Another interesting aspect of Blanchette's (2020) ethnography of "the industrial pig" is how he discussed the process of vertical integration within agricultural agribusinesses that continually seeks to control or own every stage of a hog's life from the grain that constitutes its sustenance to the moment it lands on a consumer's plate. Vertical integration basically means that a single company controls multiple aspects or stages of production. In the case of my research, some farmers use Roundup Ready Canola. They purchase the seed and Roundup herbicide from the same company as an integrated system. In some cases, they purchase their seed and inputs from a company such as Southwest Terminal (SWT), then turnaround and sell their crop back to SWT. This vertical integration in the pork industry began in the 1980s, as animal agribusinesses that controlled slaughterhouses began contracting directly with farmers, who were paid to raise and deliver pigs to them following strict contract specifications. Blanchette, through the words of industry representatives, describes the current phase of vertical integration as "the knowledge age of pork" (p. 23). The knowledge age is one in which a single company controls multiple aspects or stages of production and also collects data on each aspect or stage to track a single animal or plant from the beginning of its life, through growth, death, processing, and consumption. The knowledge age is defined by an aspirational "barcode" that agribusinesses hope to create for every package of pork. When the barcode is scanned, a consumer is given specs on "a fully standardized and known life form, which one corporation had carefully overseen through its every expression of life and death" (p. 24). Consumers will pay a premium for this barcode; however, as Blanchette explains, these specs would be for a generic pig because there is no way it can register the day-to-day life of a pig. There is no way it can register "that a key ingredient in those pork chops is workers' breath" (p. 24). Of course this does not deter the aspirations of agribusinesses to achieve total vertical integration and to express that through the barcode.

As we will see in the following chapters, grain farming in southwestern Saskatchewan is also coming into an age of knowledge. In one of my many conversations with John A., a large-scale chemical farmer in his 80s, he expressed his worry about an offer that John Deere had made to him following the purchase of a new combine. They had offered an extended warranty in exchange for access to the data that is collected on the machine's in-cab computer. This data includes crop yield rate, machinery performance, and operator interventions. John worried about the implications of allowing John Deere to collect this data, particularly if they sold that information to grain marketers. He feared that it would give grain marketers, working the futures exchange, the power to control prices before the grain even left the field. The barcode already features largely in organic agriculture, as farmers are required to provide paper trails of their crops for every stage of production. This allows organic food companies to provide consumers with full disclosure on every ingredient in their products. As we will see in Chapter Four and Five, professional agrologists and agribusinesses collect data from farms as part of consulting packages. Farmers can hire professional agrologists to make recommendations on every aspect of their operations and this is made possible through a system of data collection that is fully integrated within farm machinery (Gibson, 2019). Vertical integration is closely connected to Eaton's (2013) concept of appropriationism.

Eaton's (2013) work on appropriationism is connected to her research about Monsanto and their Roundup Ready wheat. Drawing on Goodman et al. (1987), Eaton (2013) explains that, "appropriationism is the process of industrial appropriation of activities related to farm production and practices; industrial capital expands into and takes over rural activities and labor processes" (p.26). She applies this concept of appropriationism to Monsanto's Roundup Ready crops. To access Roundup Ready seed, farmers must agree to a legally binding contract that asks them to pay a per-acre fee and forces them to purchase seed every year, rather than cleaning and saving a portion of their seed from harvest for future use. As Eaton (2013) says, "Monsanto can be understood as engaging in a process of appropriationism, transforming what used to be a farm practice of seed saving into an industrial and fully capitalist process" (p. 28). Many of my project collaborators use patented seed varieties, such as Clearfield Lentils. As we will see in Chapter Five, many also utilized private crop consulting services through professional agrologists. These services appropriate the process of decision-making on farms, and farmers feel compelled to use them because they help farmers navigate the complicated world that has become crop inputs. This complexity is illustrated by the annual *Guide to Crop Production*, distributed online by Saskatchewan Agriculture, and with hardcopies available at provincial offices. The 2020 *Guide* is 692 pages, divided into four main sections including weed control, foliar fungicides, seed treatments, and insect control. It includes information on hundreds of input products, and on the application rates and timing for each product. Thumbing through the 600+ pages of the guide, it is easy to understand why farmers feel overwhelmed by input decision making and defer to the expert help of professional agrologists.

To conclude this section, I turn to Anna Tsing (2012) and her discussion of the 20th century modernist project of scalability. As Tsing explains:

> to scale well is to develop the quality called scalability, this is, the ability to expand—and expand, and expand—without rethinking basic elements…scalability projects banish meaningful diversity, which is to say, diversity that might change things. Scalability is not an ordinary feature of nature. Making projects scalable takes a lot of work (pp. 505-507).

Tsing, drawing from the work of Mintz (1985), suggests that scalability first came into being between the 15th and 17th centuries as European nations established colonial sugarcane plantations. In order for plantations to mass produce sugar to satisfy the insatiable needs of the western world, the entire landscape of islands in the North Atlantic Ocean, such as Madeira, was remade, and an enslaved workforce brought in to gain "tighter control of cane growth" (Tsing, 2012, p. 511). Sugarcane worked well in the plantation environment because cane was a "nonsoel;" Tsing defines nonsoels as "non-social landscape elements" (p. 508). As sugarcane was removed from its origin of domestication and transported to island plantations, it removed the plant from its homeland environmental context of disease, weed pressure, and companion species. Therefore, sugarcane could be propagated on island plantations without significantly altering this remade landscape because it was freed from the long-established entanglements of its homeland environment. The labour of growing sugarcane was also scalable because workers became interchangeable and eventually, beginning in the 18th century, enslaved workers were slowly replaced with a wage labourer workforce (Marx, 1992). Scalability was promoted throughout the 20th century western world, as it became tied to economic, technological, and social progress.

Industrial grain production is a highly scalable project. It relies on a handful of capitalist species that have been bred in the agricultural sciences to propagate in controlled systems without messy entanglements. As Dr. Camille B., a microbiologist from the Station, explained in our interview: "Lots of the wheat selection here [in the Station's cereal breeding program] is done in a greenhouse, with a synthetic medium, to stack plants with more fertilizer to see the potential yield, so nothing that is good for selecting plants with good symbiosis" (Camille B., October 16, 2014). This quote highlights the process agricultural science uses to transform wheat into nonsoels. As Camille explained, early stages of wheat breeding involve a selection process that takes place in highly controlled environments, banishing entanglements with other organisms including weeds, soil microorganisms, and pests, to create "plastic wheat." Plastic wheat is also how a former physiologist from the Station's cereal breeding program described the products of their program. This nonsoel is successful across the great variety of localized environmental contexts where it is grown, as long as specific variables, such as soil nutrients, are controlled through the application of fertilizer and with diminished weed pressure through the application of herbicides. In the conclusion of this dissertation, I return to this topic to address the flipside of Tsing's (2012) description of scalability, which is non-scalability. Tsing compares sugarcane with matsutake mushrooms to highlight all the ways scalability projects fail to remove local entanglements, which will bring us back to a discussion of Dr. Camille B. in the Conclusion.

Tsing's concept of scalability is helpful in my analysis of farmland concentration in Palliser's Triangle. As Tsing (2012) explained, scalability is all about expansion without "rethinking basic elements" (p. 505). As we will see in Chapter Six, the ownership and control of farmland in Canada is becoming concentrated into fewer hands (Qualman et al., 2020). Statistics Canada reported that in Saskatchewan that there were 85,686 farms in 1966. By 2016, there were 34,523 farms in Saskatchewan, representing a loss of 51% in just 50 years (Statistics Canada Table 32-10-0152-01, 2021, January 21). As the number of farms decreases, the size of individual farms increases dramatically. As Qualman et al. report, "We find that 38 percent of the farmland is operated and controlled by just 8 percent of Saskatchewan farms, just 2,433 operations" (2020, p. 8). Labao and Meyer (2001) describe a similar situation in the U.S., "The exodus of Americans from farming is one of the most dramatic changes in the U.S economy and society in the past century. In the early 1900s, more than one of every three Americans lived on farms…At the century's end, the farm population stood at under 2%" (p. 103). The most common explanation for this trend is the technological treadmill on which the farmers who are able to adopt new technology are also able to outperform their neighbours (Cochrane, 1979; Labao and Meyer, 2001; Dudley, 2002). As we will see in Chapter Six, smaller farmers are disadvantaged in many ways including a lower borrowing capacity to purchase new land and equipment. What we can learn from Tsing's scalability concept is that all the elements associated with industrial grain farming lend themselves to this land concentration. As we will see throughout this dissertation, innovations in equipment such as GPS-assisted machinery, the development of larger varieties of other wheat and grains, and the dramatic shift in approaches to dryland farming from intensive tillage to zero tillage, all created conditions which make it possible for a few farmers to manage large acreages. As Tsing also explains: "making projects scalable takes a lot of work" (2012, p. 507). Through my historical research in this dissertation, we will see the process of this work in Palliser's Triangle from the perspective of farmers and Station scientists.

Fitzgerald (2003) explains that the logic of industrial agriculture became part of government agricultural extension programs in the U.S. during the 1920s, as "Taylorism seemed to offer a scientific solution to the mire that farm operations had become, promising instead to unify the disparate elements of crops, climates, economics, and politics into a single industrial unit" (p. 88). Fitzgerald is referring to Fredrick W. Taylor's *Principles of Scientific Management* (1911), the guide used by virtually all industries looking to adopt a factory approach, and it included five main elements: the standardization of products and practices; large-scale production; specialized machines; a focus on efficiency at every stage; and the replacement of craft labour with managerial expertise over unskilled labour. Agricultural extension agents, inspired by Taylorism, attempting to pull U.S. farmers out of poverty advised farmers to think of their farms as factories and themselves as businessmen. Additionally, they encouraged farmers to adopt practices, machinery, seed, and inputs, such as fertilizer and herbicides, that had been scientifically proven by universities to improve efficiency and productivity on farms. In the Canadian context, Laforge and McLachlan (2018) examine the extension work of the Prairie Farm Rehabilitation Administration (PFRA) to highlight how government discourse has continued to shape farmer subjectivities through their recommendations of those farm practices which constitute “good” farming (Burton, 2004):

> The PFRA, as a branch of Agriculture and Agri-Food Canada, continued to change agricultural discourses and practices that solidified soil and water into environmental objects that farmer-subjects were coerced into managing for economic gain. “Good” farmers planted shelterbelts, built dugouts, or used correct crop rotations to ensure soil and water quality remained high, not just for themselves, but for the entire rural community and national economy (Laforge & McLachlan, 2018, p. 370).

In that same vein, I will examine the extension work and information that originated from the Station in an effort to illustrate how they have also influenced farmer subjectivities on what constitutes “good” farming practices. As we will see, most of the work done at the Station has contributed to sustaining industrial grain farming. The Station’s work helped make grain farming on the Prairies scalable. The next section of this chapter delves into a deeper discussion of agricultural science and how experimental stations on the Prairies transformed homesteaders into a “male scientific farmer” (Stefanik, 2015, p.20).

DISCIPLINING THE PRAIRIES

Historian Geoff Cunfer (2005) provides a unique approach to his environmental and agricultural history of the Great Plains of North America. In combining archival records, census data, and Geographic Information Systems (GIS) maps, Cunfer resisted the temptation to frame his discussion of agriculture on the Great Plains by using either a progressive expansionist story line (Turner, 1972) or one of reckless exploitation (Worster, 1979). Instead, his focused approach relies on interpreting data in the context of disturbance and adaptation. For Cunfer, Great Plains agriculture has been characterized by continual disturbances to the environment, followed by adaptations made by multiple actors—including humans as well as plants, animals, and soil microorganisms—to adjust temporarily to those disturbances. Rather than focusing on a return to equilibrium, Cunfer (2005) suggests that it is more appropriate to think of Great Plains agriculture as an unstable equilibrium, meaning that,

> after a disturbance, succession occurs unpredictably, with uncertain outcomes that are determined by an ever-changing environment(…)Great Plains farming evolved in a similar fashion, with one generation reaching an accommodation between natural imperatives and human that could be sustained for the medium term, but not forever (p. 6).

Tsing (2015; 2014) contributes to this discussion of disturbance as she considers how industrial ruins and blasted landscapes create new possibilities for life on Earth. For Tsing (2015), there is “no single standard for assessing disturbance” however “disturbance refers to an open-ended range of unsettling phenomena(…)disturbance brings us into heterogeneity, a key lens for landscapes” (p. 161). For both Tsing and Cunfer, it is a mistake to categorize disturbance as either a good or bad phenomena; rather, it is more useful to visualize environmental disturbances—both great and small—as beginnings to new arrangements and adaptations. Tsing (2015) recommends a focus on “sites in which human and nonhuman histories of disturbance come together…because such sites allow us to track humans as both vectors and victims of disturbance” (p. 92). Industrial grain farming in Palliser’s Triangle certainly feels like one such site.

Visualizing the agricultural landscapes of southwestern Saskatchewan through this lens of disturbance, allows us to further understand the work of the Station. As we will see in Chapters Three and Four, as soon as settlers broke the native sod and turned it over to decay, the combination of semi-arid conditions and farm practices created innumerable disturbances to Palliser’s Triangle. This is not to suggest that the Prairies were not subject to disturbance events prior to homesteading (Savage, 2011). However, breaking the Prairie sod was a significant event that created powerful dust storms and soil erosion that has been the subject of scientific study at the Station since it opened its doors in 1921. As Henke (2008) explains, agricultural science developed alongside industrial farms and served as a constant force of intervention to keep the capitalist species flowing into national and global markets. He defines industrial agriculture as "an ecology of power, a broad system of social and material production that forms the larger playing field where growers and agricultural scientists work to turn products from local contexts—food, commodities, data, knowledge—into capital that is transferable to other institutions" (p. 6). However, in this ecology of power, there are many disturbances to the system including droughts, changes to international trade agreements, broken transportation systems, and innumerable other environmental, political, and social occurrences. These disturbances disrupt the flow of capitalist species from out of their local context and into global markets. And so, agricultural science—through its many institutions including provincial extension,[16] federal experimental research, private agribusiness, and university outreach—works to repair these disruptions and maintain this ecology of power. Henke calls these interventions by agricultural scientists "repair work" (p. 7). This may include repairs to environmental disturbances, such as farm practices to mitigate drought, as well as repairs to discursive disturbances that question the legitimacy of cultural capital in farm communities, such as creating weed-free fields created through the use of herbicides.

I observed such discursive repair work being undertaken while attending the 2015 CropSphere annual conference held in Saskatoon. CropSphere is hosted by producer groups—more on them in Chapter Five— in Saskatchewan and funded by the federal and provincial

[16] I mention extension services throughout this dissertation. Extension, as defined to me by an extension agent in Wyoming from my previous OREI project, is farmer education, which is usually managed by public services. The main goal of this farmer education is to teach her/him about practices that have been proven to assist in the growth of crops and the health of livestock. On a personal note, the agricultural extension service in my hometown organized the 4-H youth program.

governments as well as private agribusinesses. Farmers and professional agrologists working as crop consultants are the target audience, and based on my conversations with people throughout the day, people from both categories were in attendance. I listened to presentations from marketing strategists, farm consultants, agricultural extension representatives, and agricultural scientists—including one session that featured a cereal breeder from the Station. During the event lunch, Dr. Joe Schwarcz[17] provided the entertainment by discussing the rise of "junk science" and how it fuels the fears of consumers about genetically modified seeds and crop inputs such as herbicides and pesticides. Dr. Schwarcz stated that these fears are not based on science, that they are based on misinformation spread by activists such as Dr. Vandana Shiva who have a political agenda. At one point in the presentation, Dr. Schwarcz downplayed the legitimacy of organic agriculture by stating that it "could not do the job" of feeding the world's population (Strand fieldnotes, 2015). He implored farmers to do a better job of telling people about the farm practices they use and why they use them, before consumer fear results in legislation to prohibit important tools in farming, including fertilizers, herbicides, and genetically modified seeds. Later that afternoon, I attended a workshop hosted by Lyndsey Smith from Realagriculture,[18] in which she gave farmers advice on how to explain their practices to the general public. She described farmers as having "credibility in the public's eyes," and therefore are best positioned to explain why farmers use these tools. Smith offered the workshop groups "talking points" for when they discuss their farm practices with non-farmers and suggested they focus on technological innovations in farming, such as the use of drones. As with Schwarcz's

17 Dr. Joe Schwarcz is the Director of McGill University's Office for Science and Society.

18 Realagriculture is a web-based company with accounts on Facebook, Twitter, YouTube, and LinkedIn. They host radio shows, podcasts, public lectures, and workshops "as a grassroots effort to provide farmers with a new way to access agricultural information" (Realagriculture, 2021, January 21).

presentation, Smith also emphasized the importance of farmers "telling their story" to the general public to counter the negative and or potentially unfounded fears of consumers (Strand and Barney, 2019). CropSphere thus acted as discursive repair work for the industrial grain production system in Saskatchewan. In both presentations, the legitimacy of chemically-based farming was affirmed, while non-chemical systems such as organic farming were delegitimized as viable alternatives to feed the world.

Birgit Müller (2008) addresses this discursive repair work as she draws on Foucault (2009) to demonstrate how turn-of-the-century neoliberal governmentality, expressed through provincial and federal institutions, has permeated farmer subjectivity and resulted in the creation of the farmer-entrepreneur. The farmer-entrepreneur, like Foucault's *Homo oeonomicus,* is a rational individualist who takes risks and interprets success as the result of individual hard work, prudent choices, and technological prowess. As Müller explains, the farmer-entrepreneur subjectivity has opened the floodgates for "the dismantling of collective structures of market protection" (p. 389) by the Canadian government, provincial governments, and private agribusinesses. Even though farmers themselves worked together to create some of these market protections, they no longer view them as necessary. In fact, many view the Canadian Wheat Board and the Saskatchewan Wheat Pool as misaligned with who they are as farmer-entrepreneurs, because they believe collective structures inhibit their freedom in terms of marketing choices and unfairly affect their access to the free market economy. Overall, the farmer entrepreneur fits in nicely with the neoliberal worldview of Canadian politics that supports predominantly the interests of private agribusinesses and the continuation of industrial grain production. However, as Müller illustrates, the farmer-entrepreneur required interventionist discursive work on the part of provincial and federal governments.

To conclude this stream of thought, I now turn to the work of Stefanik (2015) to provide a theoretical analysis of early southwestern Saskatchewan history that demonstrates how governmentality has shaped Palliser's Triangle into a region of industrial grain production and its homesteaders into Prairie individuals. Stefanik (2015) relies almost entirely on Foucault's concept of normalization for his geographic analysis of the Canadian dryland Prairies between the years 1860 and 1940 (Foucault, 1995). To begin, Stefanik frames the process of homesteader settlement in the Prairies as an exercise of power by the Dominion government that ultimately brought a great diversity of people and land into a system of governance that was operated from a distance (Scott, 1998). The Dominion government's primary goal during homesteading was to permanently settle people—non-Indigenous people, that is—on the land and create stabilized agricultural communities that reliably contributed food products to national, and eventually international, markets. This proved a challenging task because settlers came from many countries with diverse types of knowledge and experience with agriculture. Additionally, the Prairie environment is not homogeneous and includes an assortment of soil types, native vegetation, and weather patterns. To make sense of this illegible chaos, the Dominion government exercised power through a process of normalization that made the Prairies and settlers legible—capable of being individually known, assessed, and altered. Stefanik analyzes this process between 1860 and 1940 to demonstrate how the Dominion government achieved homogenization through individualization, thus disciplining the ecology of the Prairies—including the diverse settlers and Indigenous communities—to fulfill the goals of the government.

In Foucault's *Discipline and Punish: The Birth of the Prison* (1995), he examines a variety of situations, including prisons and schools, in order to dissect the regime of disciplinary power that came into being in the 18th century. Rather than relying on the spectacle of torture to control people and reassert the authority of sovereigns, the 18th century brought reforms to this unpredictable system to make discipline more efficient. Rather than relying on singular events of heightened emotion and activity to assert authority, the regime of disciplinary power permeated day-to-day life as it worked through institutions of education, medicine, and imprisonment. Disciplinary power rested on the assumption that all human bodies and minds are "docile" and amenable to change. Foucault uses the example of the soldier to illustrate this docility:

> By the late eighteenth century, the soldier has become something that can be made; out of a formless clay, an inept body, the machine required can be constructed; posture is gradually corrected; a calculated constraint runs slowly through each part of the body, mastering it, making it pliable, ready at all times, turning silently into the automatism of habit; in short, one has "got rid of the peasant" and given him the 'air of a soldier" (ordinance of 20 March 1764) (Foucault, 1995, p. 135).

Stefanik (2015) extends this logic to encompass not only the minds and bodies of Prairie settlers, but the Prairie itself, which the Dominion government thought amenable to change from its original categorization of "desert" to a stable agricultural ecology.

To define the process of regimes of disciplinary power, Foucault explains: "The perpetual penality that traverses all points and supervises every instant in the disciplinary institutions compares, differentiates, hierarchizes, homogenizes, excludes. In short, it *normalizes"* (1995, p. 183). To reiterate a point above, disciplinary power is not concentrated into singular moments of brutal torture and displays of death, rather, it weaves through life, mostly unnoticed, because it works through an individual's compulsion to conform to an ideal form as determined by institutions of power. In the prairies, for Stefanik, the ideal form is the "white male scientific farmer" (2015, p. 20). To create this ideal form, the Dominion government devised a way to individualize farmers to open them up for assessment. This began with the Dominion Lands Survey that divided the Prairies into townships, sections, half-sections, quarter-sections and so on, ad infinitum. Foucault (1995, p. 220) calls this "partitioning" and explains that once something has been partitioned into regular intervals, the individual partitions then can be compared with one another. In this case, each homesteader was given a partition of land that became connected to their name (See Chapter Five). Part of why this original partitioning of land was so effective as a disciplinary tool is that land is highly visible to agents from federal and provincial governments, as well as neighbouring farmers, through roadside farming, as previously discussed (Burton, 2004). The next step in devising "perpetual penality" on the Prairies came when the Dominion government established the Experimental Farms Service in 1886. This ushered in an expert class of individuals to the Prairies whose work was based on two key assumptions. The first was that the Prairies were knowable, meaning that through scientific study the partitions could be analyzed, classified, and defined. The second was that with this knowledge, the partitions were now amenable to change like those soldiers made of clay. As we will see throughout this dissertation, the Station—through its thousands of projects and trials—continually analyzes and reclassifies its own partitions of land, as well as those of farmers to keep redefining what Prairie agriculture should be. The work of scientists at the Station, as well as other players such as professional agrologists, therefore set the norms for Prairie agriculture. As this dissertation will demonstrate, the Station has used a variety of tactics throughout the years to make these norms publicly known; however, it is now the professional agrologists—working as crop consultants—who determine the norms for farmers in southwestern Saskatchewan. As Foucault explains, "The power of the Norm appears through the disciplines. Is this the new law of modern society? Let us say rather that, since the eighteenth century, it has joined other powers—the Law, the Word *(Parole)* and the Text, Tradition—imposing new delimitations upon them." (1995, p. 184). Foucault follows the power of the norm through his studies of clinical medicine, human sexuality, and psychology to illustrate that with every formation of an expert class that makes the human body, human sexuality, and the human mind a knowable object, certain conditions, behaviours, and individuals become classified as beyond the boundaries of the norm (Foucault, 1984, 1990). However, because human bodies are amenable to change, corrective measures can be taken by the individual to bring them back within the boundaries of the norm. The macro trend of these corrective measures is homogenization across the bodies and minds of individuals.

Stefanik (2015) follows this trend of homogenization and concludes that, "laying a continuous grid of property homogenized the land through its individualization. What is most crucial here is that the land and male farmers were the objects organized within a constructed normalizing space, bringing the human and non-human together in a double movement of normalization" (p. 106). The visual analysis of a farmer's land, by government agents and neighbouring farmers, allowed for assessments of a field, the farmer's abilities, and his overall status as a "good" or "bad" farmer (Burton, 2004, 2012; Silvasti, 2003). Stefanik gives many examples of this discourse of good versus bad farmers through his archival research of popular farm periodicals and government bulletins. Midway through Stefanik's manuscript, he makes a connection between his work and that of Foucault's on biopolitics and biopower. Stefanik (2015) argues that because,

> farming is placed where the body, land, and population meet…The individualization of the grid and the norms of scientific farming solved a biopolitical problem of population and food production. The farm becomes a political site where the building of Canada's population and economy overlaps with securing food for Europe (pp. 166-167).

Stefanik argues that through this process of individualization and homogenization, the Dominion government became focused on the population question of how best to provide food production security through the administration of life—both human and non-human—within the Prairies. Stefanik does give ample support to his discourse analysis of good versus bad farmers and farming. However, his analysis falls short in providing examples of how the administration of life actually played out in the context of Palliser's Triangle. Stefanik understood the importance of the Station in terms of establishing norms and promoting a discourse that aligned with these norms for farming. However, he never delves into a discussion of what specific farm practices took hold within Palliser's Triangle and how this continues to affect the entire region, including farms and farm communities. What I hope to add to this discussion is a more thorough examination of this administration of life (read: biopower) in Palliser's Triangle through my analysis of specific practices that maintain the norms of industrial grain production reliant on a handful of capitalist species. However, as we will see in the next section, Foucault's biopower in itself is proving insufficient to the task of understanding governmentality in the Anthropocene epoch. Povinelli (2016) recommends instead that we transition to using what she calls "geontopower" to assess late-liberal governance. The concept of the desert proves essential to understanding geontopower, and so the next section delves into a discussion of deserts, including how Deleuze and Guattari (1987) use them to explain their concepts of smooth and striated space. I use the desert as a central concept to organize my dissertation, as well as the grid and surfacing.

ORGANIZING CONCEPTS: THE DESERT

"How you choose to define a desert depends very much on why you wish to do so in the first place."

Michael Welland, *The Desert: Lands of Lost Borders*

"'Desert' is not an innocent term. Geographically it is defined in terms of rainfall, but unlike other landforms there is, inbuilt in its very name, a sense of foreboding."

Roslynn D. Haynes, *Desert: Nature and Culture*

“It is entirely fitting that there is no simple or self-evident approach, no clear path, to the topic of the desert. We can grasp it as a natural wilderness or as a barren wasteland, as an ecology sometimes unusually rich in life and surprisingly fragile, as an idea of geographical extremity or alterity, as a sacred or accursed site, as a metaphor for nullity, as a subjective or existential terrain, or as an object of sheer aesthetic exultation.”

Aidan Tynan, *The Desert in Modern Literature and Philosophy*

“Deserts have made fools of the wisest people.”

Patricia Limerick, *Desert Passages: Encounters with the American Deserts*

All four quotes from above can be found in the introductory chapters of books about deserts. The Haynes, Limerick, and Tynan quotes are the first sentences of the introductions. Although each book differs slightly in how the authors analyze deserts and the materials they utilize for their studies, all three authors felt inclined to begin the books by emphasizing how deserts are notoriously difficult to define, both in terms of delineating a clear environmental boundary around them and in terms of the wealth of meaning attached to the word desert. Deserts are often defined by their aridity, which can be determined by the use of an equation to determine the aridity index (Welland, 2015). This equation represents the “ratio between average annual precipitation and total annual potential evapotranspiration” (United Nations Environment Program, 2011). These indexes are then used to classify areas into four main dryland sub-habitats: hyper-arid, arid, semi-arid, and sub-humid. However, because many factors are used to determine evapotranspiration—including temperature, wind, and surface cover—this figure is only ever a best estimate. The region of Palliser’s Triangle falls into the semi-arid category, with an aridity index of 0.20-0.50 and average annual rainfall of less than 400 mm (climateatlas.ca). Welland (2015) uses the term “lost borders” to describe the fuzzy ecological boundaries around deserts and to emphasize that deserts are not the end product of desertification but rather “the enduring result of planetary-scale processes” (p. 39) Deserts and their “lost borders surge back and forth over years, decades, and geological eons.” Welland further emphasizes the intangibility of desert borders as he uses satellite imagery of aerosols—tiny particles in our atmosphere—to demonstrate that dust storms are not isolated, local phenomena. Dust particles travel from the Middle East to California, and influence rain and snowfall events in the Golden State: "The soils of the Bahamas and the Florida Keys are composed almost entirely of African dust. The renewal of soils that support the biodiversity and health of the Amazon rainforest is probably driven by the constant supply of dust from the Sahara" (2015, p. 329). Some particles include biological microorganisms such as bacteria, that are deposited in environments far from their deserts of origin. Aerosol mapping helps us visualize how deserts are intimately interconnected with environments all over the planet, and illustrates that although they may not be known for their biodiversity, through dust storms deserts, in fact, support the biodiversity of ecosystems.

Deserts may encompass a wide range of landscape forms, soils, average temperature highs and lows, and wind conditions, all of which contribute to unique plant and animal adaptations. On the ranch where I grew up in the Red Desert, the endangered species *Penstemon haydenii* S. Wats. was found in 1996 on the Ferris Dunes in our summer pastures in Carbon County, southcentral Wyoming (See *Figure 25)*. Commonly known as "blowout penstemon," this species is only found in one other location on Earth, which is 280 km away in the Nebraska Sandhills (Heidel et al., 2018, p. 119). Blowout penstemon has adapted to survive on the surface of continuously shifting sand dunes, with adaptations that include "adventitious roots that maintain the species in shifting sand and a positive growth response to sand abrasion" (Heidel et al., 2018, p. 120; Stubbendieck et al., 1989). Additionally, blowout penstemon survives by extracting nutrients from a soil substrate with no organic matter that is basically comprised of small rock and mineral particles. The plant attracts over 26 species of pollinators and is grazed by herds of antelope, deer, and elk. Having visited these dunes many times, it is astounding to me that anything can survive the aridity and the frequent sand blasts that accompany persistent winds. As Limerick (2001) explains, by studying desert species, we can appreciate these “elegant models of appropriate design” (p. 92) that may serve as critical genetic reservoirs as we adapt to climate change (Welland, 2015).

Figure 25. A Battle of the Wills. Part of the Ferris Dunes in Wyoming. Photo by Katherine Strand.

Deserts carry with them a heavy ideological burden. Perhaps this is because deserts are part of an “ideologico-aesthetic construct of modernity” (Tynan, 2020, p. 6) that contrasts green, seemingly more hospitable nature, with a more colourless nature that is hostile to life. Perhaps it is because deserts are associated with emptiness, which lends malleability to the term and opens it to abstraction. Most definitions of deserts contain an element of absence, emptiness, scarcity, or vacancy (Tynan, 2020; Welland, 2015; Limerick, 2001; Haynes, 2013; Thomas and Middleton, 1994). As John Beck explains:

> The Hebrew word *tohu* can denote an arid wilderness, a desert, and it can refer to chaos. In this latter sense it is usually paired with *bohu,* which signifies emptiness, desolation, formlessness, confusion. *Tohu-bohu,*

> desert and desolation, chaos and confusion, or ”without form and void,” as it is translated in Genesis (2001, p. 63).

As Beck explains, “under the sign of vacancy, the desert cannot be allowed to be left alone” (p.67) as these spaces become national laboratories for experimentation. Thus, the perception of vacancy acts as a “blind” in many cases to hide important movements of capitalist ascendancy. Beck uses the example of weapons testing in the New Mexico and Nevada deserts to demonstrate this point. The designation of “desert” to all empty spaces tends to allow for the development of underground assets including coal, oil, natural gas, diamonds, minerals, and uranium without political resistance (Haynes, 2013). Often denigrated aside as “wastelands,” deserts receive less attention than other ecosystems in terms of environmental conservation. Deserts are often imagined as the end stage of dystopian futures in popular culture à la *Mad Max* (Beck, 2001; Welland, 2015): “Future apocalypse is, then, read in the land itself, the desert revealing the end, pre- and post history” (Beck, 2001, p. 69). Desertification thus has become a yardstick by which we measure our proximity to this dystopian future.

At the 1992 United Nations Earth Summit in Rio de Janeiro, a groups of scientists settled on the following definition of desertification:

> Desertification is land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Desertification affects about one sixth of the world’s population, 70 per cent of all drylands, amounting to 3.6 billion hectares, one quarter of the total land area of the world. The most obvious impact of desertification, in addition to widespread poverty, is the degradation of 3.3 billion hectares of the total area of rangeland…decline in soil fertility and sol structure on about 47 per cent of the dryland areas constituting marginal rainfed cropland (United Nations, 1992, as cited in Welland, 2015, p. 334).

Since 1977 desertification has appeared as an area of concern in the UN's agenda on environmental degradation (Thomas & Middleton, 1994). However, there is some opposition to using desertification as a yardstick for measuring environmental degradation on several grounds. First, as mentioned above, deserts *are not* the end result of desertification, but rather are the result of many planetary processes extending throughout geological time (Welland, 2015). On a geological time scale, deserts are transitory, and their borders are constantly subject to shifts as conditions change (Haynes, 2013). Second, Thomas and Middleton (1994) oppose the term "desertification" because, as they argue, not only does this term resist a clear definition, it also carries with it an evocative image of sandy wastes burying farmyards and small communities. The process of dryland degradation is much more complicated and subtle, and it cannot always be clearly defined as a human-caused phenomenon. Such evocative imagery also fails to recognize the resilience of desert ecosystems and their ability to adapt to disturbances. They further argue that desertification amounts to "little more than hollow political statements used to drum up concern" (p. 59) that are more reflective of colonial-settler fears of a decline in European civilization than ecological concerns. The term has also been used to delegitimize non-European forms of agriculture in many settler communities. Thomas and Middleton fear that because political concerns have been wrapped up in this image of desertification, there is very little thought given to redefining dryland degradation in ways that can positively affect communities living within these environments. Finally, most studies involving desertification measure the severity of the phenomenon in terms of its impact on agricultural, economic systems, rather than assessing its ecological impact (Archer & Stokes, 2000; Thomas & Middleton, 1994). The long-term impact of this narrow focus has been the development of a view that these regions are risky in terms of investments of money, time, and labour. Thus, dryland regions are oftentimes overlooked in terms of their potential to mitigate climate change with increased carbon sequestration as rangelands and croplands are converted into perennial ground cover. Using desertification as a yardstick to measure our proximity to a dystopian future is a political act that Thomas and Middleton connect to settler-colonial governments' attempts to retain control over desert spaces and the humans and non-humans that occupy them.

Deserts are also be used to critique settler-colonial governments and the work of capitalism as it "devastates life and meaning through a homogenising disenchantment space" (Tynan, 2020, p. 7). In Tynan's monumental work, *The Desert in Modern Literature and Philosophy*, he traces the various ways in which Nietzsche, Heidegger, Levinas, Blanchot, Derrida, Deleuze and Guattari, and Baudrillard have "deployed the image of the desert" (p. 7) in their critiques of modernity. In their critiques, the desert is envisioned as a space wherein we can speculate on the collapse of capitalist states through their degradation of environments, depletion of resources, and production of world-destroying nuclear weapons. The desert is thus deployed as a tool for understanding the precariousness of place and the possibility that places will become hostile to human occupation. The desert "provides an aesthetic resource—an affective environment, a *sensorium*—for forms of thinking and feeling that are no longer certain whether they have an environment" (Tynan, 2020, p. 12). As humans recognize their own powerful hand in the demise of life on a planetary scale, this critique is entering a new phase. This is the Anthropocene, a geological epoch in which humans take their place alongside other planetary-scale processes. Through their monumental impact, modern humans have created a recognizable stratigraphic layer in the 4.5 billion-year old Earth, even though we have only been anatomically modern for around 200,000 years. As Tynan explains, "The Anthropocene is the epoch in which Man comes to recognize his own metaphysical depletion in the strata of the Earth…The loss of biodiversity is the violence of a terrifying homogenization before which we stand aghast by our own footprint" (2020, p.224).

As part of the Anthropocene, Tynan argues that we are living in an age "characterized by a transition from biopower to geopower, from a politics of life to a politics of life in relation to non-life at planetary scales. The object of governance is no longer a population in an environment but the Earth as a 'geobiophysical' system" (2020, p. 53). To help us understand this transition, Povinelli (2016) suggests that we focus on three figures—the Desert, the Animist, and the Virus, that are "*diagnostic and symptomatic"* (p. 15) of the form of late liberal governance she calls "geontopower." As Povinelli explains, "geontopower is not a power that is only now emerging to replace biopolitics—biopower (the governance through life and death) has long depended on a subtending geontopower (the difference between the lively and inert)" (p. 5). Geontopower maintains the gap between Life (*bios*)—which is characterized by a cycle of birth, growth, death, finitude—and Non-life (*geos*)—the inert structure in which Life takes place. According to Povinelli, geontopower as a form of governance is now "trembling" (p. 16) as humans come to recognize our homogenizing footprint on the Earth alongside other footprints like meteors and volcanic extinction events, our dependence on Non-life fossil fuels to sustain Life, and our recognition that Life emerged from Non-life—*bios* emerged from *geos* and returns to *geos.* The Desert figure represents a critical tactic and discourse in the maintenance of geontopower because it dramatizes the gap between Life and Non-life. The desert "dramatizes the possibility that Life is always at threat from the creeping, desiccating sands of Non-life. The Desert is the space where life was, is not now, but could be if knowledge, techniques, and resources were properly managed" (p. 16). We will see many examples of this dramatization of the desert throughout this dissertation.

Striated and Smooth Space

Authors Deleuze and Guattari (1987) propose that in order to understand the state apparatus at work in capitalist systems around the globe, we must first understand why space created through these systems is of a very different nature from that which exists in pre-capitalist, nomadic life and in the space created by Earth's planetary processes such as wind and water erosion. In order to visualize the difference between smooth and striated space, Deleuze and Guattari outline various models to contrast these types of space. I find their description of the difference between fabric and felt particularly useful. Fabric is constructed by two sets of parallel threads being interwoven at perpendicular right angles in a regular pattern, with locatable points that can be plotted and fixed. When intersections increase in frequency, striation becomes tighter and the scale of open space, smaller. As we will see in the next section, the grid is an example of striated space. Felt, on the other hand, is not created by the interweaving of threads, but by continuously rubbing together blocks of fibre to create an entanglement that is "in no way homogeneous but nevertheless smooth" (p. 475). Deleuze and Guattari (1987) and Tynan (2020) use deserts as an example of smooth spaces. Colonial governments encountered smooth spaces in deserts, steppes, and mountains. Part of their efforts to expand authority into these smooth spaces involved a process of territorialisation: creating territories by striating the smooth spaces of their conquered lands. As Tynan (2020) explains, "Striated space is segmented, geometric and representational. It is the space of the city…*smooth* spaces are non-metric and non-locational…smooth spaces resist both homogenisation and segmentation" (p. 73).

Capitalism is the entanglement of smooth and striated space, as "the state emerged through intimate contact with smooth spaces," which in agricultural contexts involved division, deracination, and the clearing of land to "facilitate the growth of global trade networks from the fifteenth century onwards" (Tynan, 2020, pp. 179-180). Capitalism brought these two types of space into constant interaction as empires formed and necessitated new types of governance designed to ensure the flow of goods, people, and currency. This governance is structured around striated space and in many cases the grid. As discussed in the previous paragraph, smooth spaces resist homogenisation because they are the result of intensities and aggregates that create emergent phenomena. To illustrate this point, let us briefly return to the Ferris Dunes of Wyoming from my earlier discussion of blowout penstemon. The Ferris Dunes are not the end result of a process, but rather the continuous aggregation of rock and mineral particles as two intensities meet at this particular location. The first intensity is a corridor of high winds in southern Wyoming that carries rock and mineral particles from over 20 km away. The second intensity is the Ferris Mountain Range, extending east-west, that creates a barrier to decrease the "carrying capacity" of the wind (Gaylord, 1982, p. 65). As these two intensities intersect, the sand particles are deposited to form the Ferris Dunes. These dunes resist all attempts at homogenization as they continuously bury all efforts to divide and organize this environment. I can attest to this resistance as my family regularly had to reroute roads and rebuild fences to accommodate the continually shifting dunes. Deleuze and Guattari (1987) might categorize the Ferris Dunes as a force of "deterritorialization"—a force that smooths striated space and leaves us questioning our rooted, sedentary lives.

Deleuze and Guattari suggest that smooth and striated spaces are based on very different aesthetic experiences that can be seen in art and psychophysiological optics. Striated space is characterized by a long-distance view relying solely on optical perception. Striated systems presuppose a larger, ordered structure that creates ambient space which envelops objects. It is based on a constant, centralized perspective, which creates invariant distance through inert points of reference. Smooth space is close range, tactile, and results in a blurring of the subject and object. There is no ambient space to form a higher, logical consistency. There are only aggregates that order differences. Orientations change as the result of these local aggregates (of vegetation, elevation, etc.). Of smooth space Deleuze and Guattari say, “Cezanne spoke of the need to no longer see the wheat field to be close to it, to lose oneself” (p. 493). The sonorous and tactile experience of being *in* a wheat field is very different from viewing a wheat field *from* a distant hill, or planning its future using the abstract space of a map. However, to reiterate a point from above, capitalist modernity is an entanglement of both smooth and striated space. The presence of one does not eliminate the possibility of the other, as the authors explain: “what interests us in the operations of striation and smoothing are precisely the passage or combinations: how the forces at work with space continually striate it, and how in the course of its striation it develops other forces and emits new smooth spaces” (Deleuze & Guattari, 1987, p. 500). This is also what interests me about the development of farming in Palliser’s Triangle. As we will see in the next section, the Dominion Government striated the Canadian Prairies through the Dominion Lands Survey to create a tool of legibility—the grid (Scott, 1998).

ORGANIZING CONCEPTS: THE GRID

If you ever want to open a can of worms or journey into a dark and convoluted rabbit hole, simply ask this very basic question: “what is a grid?” It will set you on a journey deep into human history that includes many surprising and fascinating twists and turns; however, for our purposes I will limit this examination to only those aspects most salient to Palliser’s Triangle. The Dominion Lands Survey began one year after the Hudson’s Bay Company ceded Rupert’s Land in 1867, and was carried out in the Swift Current area between 1880-1884 (Bantjes, 2005; McGowan, 1975). Cadastral survey crews of men traversed the open Prairies with chains (80 chains=1 mile) and a compass to lay out the grid. With a baseline at the 49th parallel (U.S.

border), they established townships as “being a quadrilateral area approximately 6 miles square containing 36 sections, each of 640 acres or 1 square mile, which on being divided into 4 equal parts gives the homestead ‘quarter section’ of 160 acres” (Kitto, 1919). The survey created a “checkerboard style” of land plotting that:

> Enables one to determine the location of a given piece of land, either in the field or on the map, with the dispatch and accuracy that an office record might be looked up by use of a modern cross index system, while its regular north-and-south and east-and-west lines give a succession of regular farms (p.17).

They marked these locations using wood posts mentioned earlier to memorialize designations like this: S.W. 25-36-7-W.3. road allowances were added in and school sections designated on the grid for each township. With the survey off to a good start, the Dominion government used the U.S. Homestead Act of 1862 as a model for their “landmark legislation that introduced the principle of the free homestead”: The Dominion Lands Act of 1872 (Friesen, 1987). It is interesting to note that homesteading around Swift Current did not take off until after 1908 (McManus, 2011; Jones, 2002; McGowan, 1975). Between the 1870s and 1908, most of Palliser’s Triangle was utilized by large ranches raising cattle and sheep. Sir John Lister-Kaye, a Yorkshire Baronet, purchased land from the Canadian Pacific Railway (CPR) stretching from Balgonie, Saskatchewan, to Calgary, Alberta[19] in order to create a ranching empire of cattle, sheep, horses and pigs. In addition to purchasing land from CPR, Lister-Kaye benefited from a policy in 1881, pushed forward by John A. Macdonald, that allowed ranchers to obtain 21-year

19 As part of the Dominion Lands Survey, “many sections of each township were set aside as land grants to non-resident owners. Hudson’s Bay Company received three-quarters of section 26, and, in every fifth township, the whole of section 26. Sections 11 and 29 were set aside for local authorities to sell for financing schools. Throughout much of the North-West Territories railway companies received all the remaining odd-numbered sections. Typically, only the even-numbered sections were available for homesteading. This checkerboard pattern of resident and non-resident ownership ensured that, for a time, enormous spaces intervened between the already isolated settlers” (Bantjes, 2005, p. 25).

grazing leases on up to 100,000 acres of Dominion Lands. Macdonald and his government justified these leases in Palliser's Triangle by claiming that the land was unfit for farming because of desert conditions.

In 1905, Frank Oliver became Minister of the Interior and unlike his conservative predecessor Clifford Sifton, the leftist Oliver "did not like cattlemen" (McManus, 2011, p. 17). According to Oliver, ranchers like Lister-Kaye were too closely affiliated with the conservative party and did not uphold the "emblem of democracy and progress." One year into Oliver's term, during the winter of 1906/07, the Prairie cattle barons were dealt a terrible blow. "Ferocious blizzards and terrible snowfalls lasted long into March" (p. 19) killing between 40,000-50,000 head of cattle in southwestern Saskatchewan. Oliver took advantage of the weakened position of cattle barons and in 1908 created legislation to open land settlement between Moose Jaw and Calgary, and south of North Battleford. Oliver's 1908 amendments to the Dominion Lands Act ended grazing leases and,

> enabled settlers to file on 160 acres of land after paying a small ten-dollar fee. After satisfying the settlement obligations…settlers could then "pre-empt" or have first-right-of-purchase on an adjoining or nearby quarter-section to be sold for three dollars per acre: this was the famous "free homestead" (McManus, 2011, p. 21).

The act stated that "the sole head of a family, or any male over eighteen years old, may homestead one quarter-section of available Dominion land" (Kitto, 1919, p. 141). To permanently secure ownership of the land, men had to perform certain duties:

> Six months' residence upon and cultivating of the land in each of three years. A homesteader may live within nine miles of his homestead on a farm of at least eighty acres, on certain conditions. A habitable house is required except where residence is performed in the vicinity.

Failure to fulfill these duties, would result in the cancellation of title holdings; it was essentially a contract. And thus, the Dominion government guaranteed each homesteader private property if they fulfilled two obligations: manifestation of the grid by constructing homes and cultivating fields, and connection of their property to the larger economy through the flow of grain and livestock. Homesteaders were obliged to release the "wealth of nature" (Cronon, 1991) through their labour, and respect the sacrosanct grid-based property lines. The homesteaders shaped the Prairie within their respective grid squares, and in turn those squares shaped them into "private individuals" (Bantjes, 2005, p. 5). Each private individual, with his own piece of the prairie landscape, could now dedicate his time and labour to producing capitalist species by harnessing the natural wealth of the soil. John Bennett, an American anthropologist who conducted ethnographic fieldwork in Maple Creek, SK in the 1960s, described the "cultural objectives" of Prairie farmers with the following quote:

> The farmer's cultural objectives—to establish a settled countryside—were in harmony with his form of land tenure: the private ownership of small, surveyed plots. He conceived of the land as divided into rectilinear sections, each under the control of a different farm operator, with villages and towns evenly spaced to provide services and the social life he needed. Schools were also spaced to give each neighborhood its educational facilities. The railroad built branch lines to the north and south of the Hills [the Cypress Hills] to serve the new country neighborhoods, and towns were established at about 8-mile intervals along the line, spaced in accordance with the time and distance that wagons loaded with grain would have to drive to the pickup spot (p. 207).

Making the grid manifest was no easy task, however, for as the American novelist Wallace Stegner explained:

> I remember it as it originally was, for my brother and I, aged eight and six, accompanied my father when he went out to make the first "improvements." Except for the four-foot iron post jutting from the prairie just where our wagon track met the trail to Hydro, Montana, and that marked the near corner of our land, there was nothing to distinguish or divide our land from all other, to show which 320 acres of that wind and grass were ours (2000, p. 268).

Stegner's family had homesteaded near a town south of Swift Current called Eastend. He goes on to explain the importance of roads and trails for his life on the Prairie:

> I so loved the trails and paths we made. They were ceremonial, an insistence not only that we had a right to be in sight on the prairie but that we owned and controlled a piece of it. In a country practically without landmarks, as that part of Saskatchewan was, it might have been assumed that any road would comfort the soul (Stegner, 2000, p. 271)

His father broke the soil and cut furrows six inches deep, "as straight as a string and nearly a mile long," following the fence line that ran along their property (p. 275). The grid was made manifest and lived through each turn taken on their cropped land. I experienced the grid during my ethnographic work, spending hours riding in tractors, combines, and sprayers and following these linear patterns originally established by the Dominion survey. With each growing season, and each journey along the highways and roads of rural municipalities, the grid is reinforced. With this context in mind, we can now examine specific attributes of the grid that will be essential for understanding how farmers interact with their land and how Station scientists have influenced these interactions in the interest of increasing the production of capitalist species.

The Grid as a Mathematical Extension of Governance

The grids used in surveying are modelled after Descartes's coordinate system, which utilizes Euclidean geometry[20] to create a system of plotting fixed points within an inert structure (Seigert & Winthrop-Young, 2014; Geyh, 2009). As every schoolchild knows (to adapt a phrase from Gregory Bateson), plotting points on a Cartesian grid was that fun exercise where we traced our fingers across parallel and perpendicular lines to meet at an assigned coordinate such as: (-3,1) or (2, 5). Once located, we marked the point with our pencils and labelled the coordinates near the mark. What we did not realize (or at least *I* failed to realize) is that this exercise in

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20

Euclidean geometry is that which is constructed on a planar surface, as opposed to non-Euclidean hyperbolic or elliptic geometry (Riemann). This allows for linear, parallel lines to extend infinitely without ever moving closer or further from one another. Given the curvature of the Earth's surface, it is a geometry that cannot be found outside of mathematical models. See Bantjes: "Vertical Perspective Does Not Exist": The Scandal of Converging Verticals and the Final Crisis of *Perspectiva Artificialis* (2014).

mathematics represented a powerful encoding and mapping technology. Mumford (1961, p. 192) delves into hundreds of years of human history to decide that the "standard gridiron plan was…an essential part of the kit of tools" for colonists all over the world, especially as a system to organize taxation. Jill Grant (2001) traces it back as far as 8000 years, long before Descartes, and finds extensive use of it by the Greeks who pushed out Indigenous occupants to expand city-states with their own loyal citizens. The power of the grid rests in its ability to simplify the opaque spaces of Indigenous lands and practices and enhance centralized power (Scott, 1998). As Scott explains, most colonial states are,

> "younger" than the societies that they purport to administer. States therefore confront patterns of settlement, social relations, and production, not to mention a natural environment, that have evolved largely independent of state plans. The result is typically a diversity, complexity, and unrepeatability of social forms that are relatively opaque to the state" (pp. 183-184).

Thus, states utilize the grid as a tool of simplification, along with maps and censuses, to simplify this diversity of human and non-human arrangements and inevitably to alter these arrangements for capitalist ends. I reviewed Stefanik's (2015) work in the previous section to provide an example of the power of the grid as a disciplinary structure in the Prairies. Overall, the grid represents what Foucault calls "cellular power," as the homogeneous, segmented, patterned spaces bring individuals under the gaze of the bureaucratic apparatus forming a technique of power (1977, p. 149).

The Grid as Violence

Surveying as a technique has its roots in the countryside of 16th and 17th century England, where it was used to delineate boundaries of possession which corresponded to maps (Blomley, 2003). Blomley sees surveys as a means to order relationships between people, based on coded spaces protected by liberal legalism. Based on these surveys, properties are created and allotted to individuals, thus giving owners the right to benefit from that land, while excluding non-owners from any right to benefit. This forms the basis of property laws under liberalism, and allows governments to use violence when humans and non-humans transgress property boundaries: “The surveyor plays an important role in the inauguration of a particular view of space as detached and alienable and thus is deeply implicated in the ideological creation of property” through their role in creating the grid (Blomley, 2003, p. 135). As Rebecca Solnit (2003) explains, the gaze of the surveyor is also “the gaze of the conqueror” (p. 70). Bantjes described the Canadian land survey as a process that was,

> as much “writing up” the landscape as “writing upon” it, or inscribing on it tangible demarcations of property ownership. “To survey” meant, after all, to view from a commanding perspective or, in usage more common in the nineteenth century, to write a comprehensive inventory of assets of an estate (2005, p. 15).

In the case of the Canadian Prairies, the Dominion government became the owner of this estate, but only after forcibly removing the Prairie occupants who, over the centuries, had developed an elaborate ecological knowledge of the shortgrass plains (Carter, 2019; Oetelaar, 2014; Zarillo & Kooyman, 2006).

Unlike the settlers of the Prairies, the communities of the Blackfoot Confederacy believe that humans are an integral part of the landscape around them:

> Humans play an essential and reciprocal role in helping to maintain an orderly balance in nature through their proper conduct in daily practices, rituals, and ceremonies. Guidance for this role comes not from ecology but from legendary heroes or ancestral beings who travelled across the landscape creating the mountain ranges, the foothills, the precipices, the scattered boulders, the entrenched river valleys, the springs, the cottonwood groves, the bison patches, the berry patches, and the lithic sources. (Oetelaar, 2014, p. 11).

To maintain this reciprocal relationship with non-humans of the Prairies, the Blackfoot people show their respect to sacred spirits who control the availability of resources by visiting places associated with particular ancestors and pausing to tell stories, sing songs, and carry out rituals.

Ancestors such as Beaver gave them instructions on how to construct bison drive lanes made from rock cairns and buffalo chips to guide herds closer to cliffs where they would then be corralled and pushed over. Each stage of this process was also guided by ritual practice and oral narratives that communicated information about the best sites for bison jumps—known as *pis'kun* and literally translating to "deep-blood-kettle" (Grinnell, 1962, as cited in Oetelaar, 2014, p. 21). Although bison hunting was the foundation of Plains communities' subsistence practices, they also moved seasonally to gather plant resources at known patches throughout the Canadian Prairies (Carter, 2019; Zarrillo & Kooyman, 2006). Using archaeological as well as ethnographic and ethnohistoric sources, Zarrillo and Kooyman document how Prairie communities seasonally gathered and processed choke cherries, saskatoon berries, and prairie turnips prior to treaty resettlement. Plains communities such as the Blackfoot, the Plains Cree, and Saulteaux contributed Prairie resources such as bison hides to vast trade networks to acquire resources such as domesticated maize (Zarillo & Kooyman, 2006).

Plains Indigenous communities were long-time occupants of this region and relied on elaborate systems of traditional ecological knowledge to co-exist with their fellow non-human Prairie occupants. R. Grace Morgan (2020) describes these relationships in-depth in her multidisciplinary study of the Northern Plains of Canada using archaeological, historical, and ecological evidence, as well as oral narratives of the Blackfoot and Gros Ventre Nations with a particular focus on the Qu'Appelle River Valley Complex, Cottonwood Creek, and the Moose Jaw River regions of those Nations' traditional territories in southern Saskatchewan. Morgan provides ample evidence to suggest that unlike predominant narratives that credit Indigenous groups with the demise of beaver populations in the region during the fur trade era, her research shows that Northern Plains communities relied on beavers to provide surface water along major and secondary tributaries, especially during droughts. "In an intense drought, without beaver colonies, human occupancy of the plains might not have been possible at all(…)Traditional stories among Plains Peoples portrayed the beaver as a protector of humans and warned against harming, killing or eating it" (p. 54). Morgan's work also highlights how Plains Peoples' complex knowledge of the variable and unevenly distributed resources of this region enabled them to follow a semi-regular seasonal pattern that followed bison populations between winter and summer ranges. This ecological adaptation, on the parts of both humans and bison, "allowed for maximum resource utilization with the least detrimental effect on associated vegetation" (p. 10). Additionally, Plains communities used controlled burns to stimulate the restoration of grasslands and improve the habitat of bison, which consequently also helped them predict bison movements across the Prairies. The Dominion government did not respect these forms of land use because among other things, they did not align with concepts of private property (Asch, 2000).

Homesteads only came into existence as the result of great acts of violence on the part of the Dominion government against Indigenous communities (Daschuk, 2013; Savage, 2012). Even after the sale of land by the HBC in 1870, the Dominion government did not assume control of Saskatchewan until the signing of Treaty 4 with the Cree, Saulteaux, and Assiniboine Nations in 1874, and Treaty 6 with the Cree, Saulteaux, Nakota, and Dene Nations in 1876. Many community leaders feared for what the extinction of their bison herds, as the result of Euro-settler overhunting, would mean for the health and future of their people. They recognized the reality of violence following the Cypress Hills massacre in 1873 and knew that immigrants were flooding into Manitoba, waiting to claim their homesteads. As Daschuk explains:

> The numbered treaties were pivotal to establishment of the new economic and social paradigm in the west. To the Canadian government, completion of the

> treaties was an essential legal precondition to development of the region. First Nations leaders saw treaties first and foremost as a bridge to a future without bison. In exchange to relinquishing their claim on all but a small percentage of land in the region, First Nations leaders sought renewal of the social safety net that they had grown accustomed to during the fur trade and assistance in the conversion to agriculture (2013, p. 183).

The Dominion government looked favourably on treaties because they feared the Plains nations' military prowess, particularly after the Battle of the Little Bighorn in 1876. In negotiations with tribal leaders, men like Sweet Grass demanded, as part of their treaty agreements, guarantees from the government that provisions would be provided in the future to feed their communities. They signed the treaties and for a time, many communities moved into the Cypress Hills to hunt what remained of the Prairie buffalo herds.[21]

The arrangement in the Cypress Hills lasted only a short time because with the completion of the survey and the Canadian Pacific Railway's decision to build its main route through southern Saskatchewan, the Dominion government wanted First Nations to move out of the Cypress Hills and on to distant reserves further east and north. Communities of people, already weakened by starvation and disease, felt the full physical force of the Dominion government as they cut off all provisions and forced them onto the reserves. Reneging on their treaty agreements, the government watched as thousands of people starved to death or died from diseases ravaging their already weakened bodies. Stories of people eating buffalo skins, contaminated carcasses of horses, and moccasin leather to stay alive fill the pages of Daschuk's 2015 work, *Clearing the Plains: Disease, Politics of Starvation, and the Loss of Aboriginal Life.*

21

In *No Surrender, the Land Remains Indigenous* (2019), Krasowski challenges historical research of the numbered treaties and argues that "Canada's treaty commissioners had a common negotiating strategy to discuss only the benefits of a treaty and to ignore its liabilities(…)The texts of the numbered treaties clearly state that the First Nations surrender their 'rights, titles, and privileges to the land.' However, there is no evidence that Alexander Morris or his fellow treaty commissioners discussed the surrender clause during any of the treaty negotiations" (p. 272).

With Indigenous communities tucked away like leper colonies, the grid attempted to stamp out what remained of the trails and camps that had been used by bison hunters for thousands of years. They wanted to create a blank slate for homesteaders to set a revisionist capitalist history of the Prairies in motion (Cronon, 1996).

The Grid as Taxis

Taxis is a cultural technique highlighted in Xenophon's *Oeonomicus* (1938) and used by Siegert and Winthrop-Young (2015, 98) to describe "an order of things in which each and every object is located in a fixed place where it can be found" and retrieved. Xenophon excluded humans from this system because they defy the rules of economy that depend on fixed locations for objects. Seigert and Winthrop-Young argue that gridded spaces extend the rule of *taxis* to humans because grids provide addresses that always exist independently of the humans who occupy them. This system, by virtue of its independent addresses, accepts the possibility of all-encompassing empty space. Humans and non-humans alike, can be in place or out of place. Empty space in farming communities tends to mean fields that remain unseeded during the growing season (fallow) or pastureland (including both native prairie and seeded pasture). As we will see in the next chapter, fallow land became a contentious issue on the Prairies, particularly as it harboured the very conditions conducive to the creeping Desert. The empty space of the pastureland is often what people mean when they enjoy the "open spaces" of the prairies. They seek these locations out for recreational ATV drives, hunting, and walks. One farm family whom I spent time with throughout two growing seasons, they referred to a cropped field surrounded by this empty space as "out in the boonies." As it happens these empty spaces tend to be those areas of more extreme topography (steep hills and valleys) that resist cropping.

These independent addresses (cadastral coordinates) also allow for the accumulation of data through time. The collection of data within the grid is becoming a contentious issue for farmers as machinery, such as combines and tractors, comes equipped with computers with the ability to collect data on individual fields using GPS. Some farmers fear that this accumulation of data will be used by corporations in grain handling to predict and control the world market. Others offer it freely to consulting businesses that use the data to build maps (based on the grid) in ARC GIS with layers of information to assess individual fields.

Siegert and Winthrop-Young (2015) provide a very interesting account of the city planning involved in the Spanish visions for Lima, Peru. Related to the section above, the city planners etched out a grid and assigned names or occupations to locations/addresses before people arrived in the city. As they explain, this was a "fantasy enabled and sustained by the possibility of writing empty space, that is, the ability to literally reserve a space of the unknown" (Siegert & Winthrop-Young, 2015, p. 107). In the Prairies, as in Lima, the writing of empty space depended upon an abstract concept of space and enabled utopian fantasies to flourish quite independently of any lived experience. As we will see in the next chapter, this created many problems in Palliser's Triangle. The Dominion government, the Canadian Pacific Railroad, and land development companies all promoted a fantasy about the productive potential of the Prairies in order to attract settlers to the region (Owarm, 2007; Francis & Kitzan, 2007; Friesen, 1987) Promotional literature created by Prairie boosters described the region as the "land flowing with milk and honey" (Francis & Kitzan, 2007, p. ix). The "Chosen People" lucky enough to leave the Old World and make a new home on the Prairies were promised a life free from indentured labour, industrial cities, and religious persecution (p. x). Francis and Kitzan provide an illustrative poem from a promotional pamphlet that circulated in Europe.

Has ever the smoke of your factories
        Obscured any longing ye had
For a life that gave promise of freedom
        From all the unwholesome and bad,
The smoke, and the din, and the squalor—
        The crowding that God never meant?
If no, ye may listen to Nature—
For to you has her message been sent.
        (Anderson, as quoted in Francis & Kitzan, 2007, p. x).

Promotional literature outlining the supposed conditions of homesteading on the grid, allowed immigrants to imagine themselves leading a different life than that which they had left in the Old World. This imagery was promoted by the Dominion government to attract settlers to a land that only existed in their imaginations, yet this land was already reserved for these Chosen People. Brown (2001) compares the gridded planning of Billings, Montana with that of a prison camp in northern Kazakhstan to conclude that both types of communities carved out a fantasy before the humans arrived to make it a lived reality. These examples underscore that the gridded spaces of surveys "present the world as set before and logically prior to a disembodied viewer" (Mitchell, 1991. The fantasy existed before the lived reality of settlers and papers over the deep history of First Peoples communities. The fantasy made possible with the grid created a seemingly inert structure that structured the dynamic practices and lives of those who chose to settle in this space. Thus, to return to the discussion of Deleuze and Guattari (1987) from above, the grid territorialized the Prairies even before the first settler arrived. However, this grid requires maintenance, particularly because the desert conditions are particularly resistant to this striated space. To maintain the striated space of the Prairies, the Station and other agricultural advisors continuously research and recommend new strategies for farmers for surfacing their fields. The section below outlines the concept of surfacing as the main tool used by farmers to maintain their striated space and to demonstrate their status as a good farmer (Burton, 2004).

ORGANIZING CONCEPTS: SURFACING

To introduce the concept of surfacing, I turn to a quote from the source of inspiration for this concept: *Landscape for Living* by Garrett Eckbo (2002).

> On any piece of land subject to human development—most typically, a house and garden—the first practical problem to solve, once the main construction activities have been completed, is the control of all the ground areas which have been in any way disturbed. This is the problem of *surfacing* [emphasis added], and it is essential to eliminate summer dust and winter mud. The forces of nature are intolerant of bare ground and will, if left to themselves, produce volunteer ground cover on any but the most sterile surface. Such volunteer cover is typically weeds, wild grass or brush, and it is apt to be too rough for average concepts of garden use and beauty (p. 64)

Surfacing is a term from Garrett Eckbo's widely popular guide to landscape architecture, originally published in the 1950s. Surfacing, as part of Eckbo's landscape design, is a "conscious rearrangement of the elements of the landscape" (p. 5) to facilitate the "continuous establishment of relations between man and the land" (p. 6). I find it useful in analyzing the construction of agricultural landscapes because in its simplicity, it condenses significant meaning concerning human relationships to the non-human world. In particular, "surfacing" carries the Western, Cartesian legacy of a critical divide between humans and other animate or inanimate earthly entities. Eckbo's approach presupposes an initial continuity between humans and nature that limited the "savage scratching his way out of the monstrous wilderness" (2002, p. 38). Man[22] has since "emerged from Nature" (p. 29), thus constituting the only being with the ability to endlessly improve on nature through such pursuits as growing an English garden and constructing the Bay Bridge. Thus, from this initial continuity, we have a critical separation between Man and Nature that is bridged through his/her conscious arrangement of Earth's

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22

"Man" is the term Eckbo uses to designate men but kindly extends the term to encompass "women, babies, children, adolescents, old folks, Negroes, Mexicans, Orientals, 'white Caucasians,' Jews, etc."(2002, p. 29).

elements (i.e. soil, rocks, and plants). This critical emancipation from Nature is what grants us modern (and Western) humans the freedom to determine our relationship with the non-human world. Because, from our elevated position, we have altered the conditions of our interactions with it. Thus, Povinelli's geontopower in the Anthropocene maintains the divide between Life and Non-Life, between humans and the inanimate landscape that provides an inert structure for their lives. Surfacing within this context encompasses those physical acts undertaken by humans to maintain these divides.

Through acts of surfacing that facilitate interaction with soils but also contain them we can think about the history of field management in Saskatchewan as a continuous effort to maintain the divide between 'Man and Nature, as well as striated versus smooth spaces. As Eckbo stated, if the forces of nature are left to themselves, bare ground will become populated by wild species of plants that are intolerable to humans (2002). If the forces of the desert are left to themselves, the grid will be destroyed; the smoothing forces of the desert will deterritorialize this space (Deleuze & Guattari, 1987) and leave humans without a rooted place to call home. I include weeds as a smoothing force because they thrive within the disturbed landscapes of agriculture, and like dust and sand, can overcome the physical manifestation of the grid. The following example highlights this point. In the Fall of 1893, the superintendent of the Indian Head Experimental Farm, a sister farm to Swift Current in southeast Saskatchewan, reported the following:

> We were almost buried yesterday with a neighbour's tumble weed. A hurricane blew all day from the North-west, and the edge of the field adjoining the farm is now 10 feet deep with this weed. The trees are full and fences cannot be seen for bank [sic] of weeds. The result of yesterday's blow will be to give us many extra days' work next summer, for millions of seeds have been left on the farm. Looking between here and the town while the weeds were galloping along, the prairie seemed like the ocean with a big storm blowing (MacKay 1983 as cited in Evans, 2002, p. 7).

Weeds can ride the force of strong winds to smooth striated space in ways very similar to those of dirt. Evans (2000) likens the impact of weeds to blowing dirt because in farming systems, both represent matter out of place (Douglas, 2013). Weeds often migrate from distant regions and they thrive in the desert/grid of the Triangle because they like disturbed soil, move freely on the wind, ride on animal fur and feathers, enjoy unobstructed sunshine with the absence of trees, and have few to no pathogens, competitors, or predators to spoil their fun. Weeds propagate quickly because these species produce thousands of seeds that can lie dormant for decades if current conditions do not suit their needs.

Weeds oftentimes mimic monocrop kings like wheat because humans unintentionally select for those strains that closely resemble their growing crop. These cunning strains manage to slip through the control mechanisms of farmers because they hide successfully among the crop and survive to generate new seeds. They possess the ability to "take prevalent possession of soil used for man's purposes, irrespective of his will" (Gray, 1879 as cited in Evans, 2002, p. 13). Weeds do not respect the grid's property lines and species, move across boundaries as tumbleweeds blowing on the desert wind. Weeds also move onto neighbouring fields as stowaways. Weed seeds hide in the hoppers of combines, accompanying grain on its journey during harvest. They stow away in the sleeves of farmers and are transported in the cabs of tractors and trucks. They find safe haven along highways and dirt roads where the land on either side of major roads is unfarmed and only occasionally sprayed with herbicides. Some species of weeds wait in the wings for a truck to drive by and kick up a current of air and dust to carry them into neighbouring fields where fertilizer is abundant. My own Chevy Malibu has no doubt set many of these seeds on their journeys to greener pastures.

Surfacing is important in the agricultural landscape of southwest Saskatchewan because it keeps the smoothing forces of sand and weeds at bay, thus preserving the cadastral grid. However, we can also think of surfacing as an important method for containing the possibility that soils, during periodic dust storms on the Prairies, can—and have—challenged the boundaries between Man and Nature, Life and Non-Life. Western culture characterizes the modern body as unified and "wholly contained within its skin-covered surface" (Taylor, 2005, p. 747).[23] Shildrick explains that this post-Enlightenment discourse on the "clarity of corporeal boundaries is what grounds existential and moral personhood, while the meeting with the other is premised on bodily self-determination and property rights in one's own body" (2001, p. 168). As my own experience of a black blizzard illustrated, dust can invade every crevice and opening of the body to disrupt sight, sound, and breath. And as the next chapter explains, during the Dirty Thirties, the farmers of southwestern Saskatchewan could not escape it either. Dust seeped into every aspect of their lives including their homes, equipment, vehicles, and bodies. These accounts suggest that corporeal boundaries are not solid. The boundaries of our bodies are ambiguous and fluid and always leave open the possibility for a certain degree of leakiness (Shildrick, 2001). Those entities that disrupt boundaries take on negative, "dirty" or "filthy" (Cohen, 2004) connotations that directly relate to Douglas' "matter out of place" from *Purity and Danger*

23

This is of particular interest to psychoanalytical researchers. Please see: Bick, 1987; Anzieu, 1989; LaFrance, 2009. Theorized by such psychoanalytical researchers as Bick (1987) and Ogden (1989), the "skin-as-container is the starting point for the notion of interactive self-sufficiency …self-self interactions depend on a strict boundary between inside and outside. They occur within the realm of clear bounded selves. Interaction is understood here as the encounter between two self-contained entities (human/human or human/object)." Containment is a key factor at any interface that involves humans, for as Bakhin (1984, p. 320) explains, "That which protrudes, bulges, sprouts or branches off….is eliminated, hidden, or moderated. All orifices of the body are closed. The basis of the image is the individual, strictly limited mass, the impenetrable façade." As we shall see, soil proved particularly disruptive of this façade because it infiltrated every orifice of life

(2013), or Shildrick's (2001) "monstrous" beings. Manning (2009), drawing on Esther Bick's psychoanalytic theory, explains:

> To posit skin-as-container as the starting point for the notion of interactive self-sufficiency [in the context of a developing baby] is to begin with the idea that the well-contained human is one who can actively (and protectively) take part in self-self interactions. Self-self interactions depend on a strict boundary between inside and outside (p. 34).

Manning describes leakiness in the body as a risk of "deterritorialization," or the risk of the self not feeling rooted in the body. Of course, this connects to the discussion regarding the risk of smooth spaces deterritorializing the striated space of the grid (Deleuze & Guattari, 1987). Thus, the smoothing forces of the desert can not only disrupt the boundaries between parcels of land, but also the boundaries between self and the outside world. The adds another dimension to the importance of surfacing.

To conclude this discussion, I want to examine one more quote about surfacing from Taylor (2005) in her Annual Review article, *Surfacing the Body Interior.* Taylor explains:

> Surfacing, as we might note, has many senses. It can mean giving something a surface (whether by planning and making it smooth, or by applying a surface layer)(…)but it can also mean coming to the surface (as when a submarine surfaces)(…)or bringing something to the surface (2005, p. 747).

She notes that the term "surface" only entered the English language in the seventeenth century, which "invites us to consider surfaces…as cultural accomplishments, emerging along with the body, the private, and the public, as the sites of both distinction and mediation between them" (p. 746). Taylor proposes the use of surfacing as theoretical framing to understand multiple ethnographic contexts in which the interior/exterior relationship of the human body is in question.[24] Taylor cites many examples of "giving something a surface" on the body using skin, but for this chapter, we rely on Turner's concept of the social skin:

24

> The surface of the body, as the common frontier of society, the social self, and the psychobiological individual; becomes the symbolic stage upon which the drama of socialization is enacted, and bodily adornment (in all its culturally multifarious forms, from body-painting to clothing and from feather head-dresses to cosmetics) becomes the language through which it is expressed (1980 [2012:486]).

I propose thinking about the surface of the field as another social skin, which becomes a moral arena where farmers create a physical manifestation of their skill, dedication, and knowledge, and make judgments of good and bad farming through the process of roadside farming (Burton, 2004). In Chapter One, I included a quote from Rob T., a chemical farmer north of Wymark who described farming as an act similar to public nudity. (Strand fieldnotes, 2014). Farmers notice everything on the grid and it all gets reported back to their respective coffee rows. Thus, the surface of the soil becomes the primary interface through which socialized ideas concerning good/bad farming, the human relationship to non-humans, and private property on the grid are enacted.

CONCLUSION

The primary purpose of this chapter was to review related agricultural research and theoretical concepts that will guide the following chapters. The first section helped to clarify what I mean by industrial agriculture and how the production of a handful of capitalist species such as wheat characterizes industrial grain farming in Palliser's Triangle. Capitalist species are nonsoels—non-social landscape elements. Within agricultural systems, they are not encouraged to form relationships with other landscape elements. They are encouraged to thrive in highly manipulated environments created through the use of agricultural inputs. Other elements that are closely related to the production of capitalist species include on-farm data collection and use, the

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For Janelle Taylor this context is ultrasounds in gynecological medicine and the public circulation of sonograms. Please see Taylor, 2008).

appropriation of on-farm labour by private industry, and scalability—as it is defined by Anna Tsing. The second section delved into an exploration of how agriculture on the Prairies has been disciplined to meet the expectations of agricultural scientists who create norms. As Stefanik explained, this process of normalization created homogeneous fields and the ideal farmer. In the following chapters, I will show how the discourse of what constitutes good farming, and therefore good farmers, changed through the years and is now exemplified by zero tillage, high input systems. Through all these changes in discourse, farmers had to create different portraits of themselves on the fields to reflect their status as a good farmer. The third section reviewed literature related to deserts and the various ways concepts of the desert are used as critiques of modernity, as political tools, as a figure in geontopower, and as a space to envision a post-capitalist world. The section on the desert also included a subsection on smooth and striated space to begin a discussion about how agricultural fields in Palliser's Triangle present a unique opportunity to see entanglements of both types of space. The desert is the first of three organizing concepts I use throughout this dissertation. The forth section reviewed literature about how grids, and in particular those associated with cadastral surveying, are powerful tools used by colonial governments. This section provides a brief historical description of the Dominion Lands Survey and how this survey created the basis for private property law. However, this process was steeped in violent acts against Indigenous communities who occupied Prairie spaces in ways that did not conform to grid-based private property. The grid is the second of three organizing concepts for my dissertation. The fifth and final section introduced the concept of surfacing to the agricultural context of southwestern Saskatchewan. Borrowed from Eckbo (2002), this concept is used to describe the work of farmers, based on recommendations by agricultural scientists, on their fields to maintain the striated space of the grid. This concept is particularly important to the next chapter *Surfacing the Grid.* Surfacing is also used to describe how fields become “social skins” (Turner, 2012) for farmers as they create physical manifestations of their skill and value on their fields. Surfacing is how farmers territorialized the grid. However, the desert resisted this process and continually threatened to deterritorialize the grid and its Prairie individuals.

CHAPTER THREE

SURFACING THE DESERT

Figure 26: Rod Weeder. Photo from SCRDC Archives.

The Plough

What power is this that stands behind the
steel?–
A homely implement of blade and wheel–
Neglected by the margin of the way,
And flashing back the blaze of dying day;
Or dragging slow across the yellow field
In silent prophecy of lavish yield,
It marks the pace of innocence and toil,
And taps the boundless treasure of the soil.

Before you came the red-man rode the plain,
Untitled lord of Nature's great domain;
The shaggy herds, knee-deep in mellow grass,
The lazy summer hours were wont to pass;
The wild-goose nested by the water-side;
The coyote roamed upon the prairie wide;
The black bear trod the woods in solemn might;
The lynx stole through the bushes in the night.

No sound of toil was heard in the land;
No joyous laugh of voice or sharp command;
No cloud of smoke from iron funnels thrown
Was through the autumn hazes gently blown;
No edge of steel tore up the virgin sod;
No church its shining finger turned to God;
No tradesman labored over bench and tool;
No children chattered on their way to school.

But all the land lay desolate and bare,
Its wealth of plain, its forest riches rare
Unguessed by those who saw it through their
tears,
And Nature—miser of a thousand years—
Was adding still to her immense reserve
That shall supply the world with brawn and
nerve:
But all lay silent, useless, and unused,
And useless 'twas because it was unused.

You came. Straightway the silent plain
Grew mellow with the glow of golden grain;
The axes in the solitary wood,
Rang out where stately oak and maple stood;
The land became alive with busy din,

And as the many settled, more came in;
The world looked on in wonder and dismay—
The build of a nation in a day!

By lake and river, rock and barren waste,
A peaceful army toiled in eager haste;
Ten thousand workers sweating in the sun
Pressed on the task so recently begun;
Their outworks every day were forced ahead—
And every day they gave their toll of dead—
Until at length the double lines of steel
Received the streaming steed and whirling wheel!

Where yesterday the lazy bison lay
A city glitters in the sun to-day;
His paths are turned to streets of wood and
stone,
And thousands tread the way he trod alone;
The mighty hum of industry and trade
Fills all the place where once he held parade,
And far away the unheard river's play
Makes joyous night still brighter than the day!

Upon the plains a thousand towns arise,
And quickly each to be a city tries;
The sound of trade is heard on every hand,
And sturdy men rise to possess the land;
Awhile they lingered, thinking it a stream,
But now they flow in a resistless stream
That seems to fill the prairie far and near,
Yet in its vastness soon they disappear.

Where once the silent red-man spurned the
ground,
A land of peace and plenty is now found,
A land by Nature destined to be great,
Where every man is lord of his estate;
Where men may dwell together in accord,
And honest toil receives its due reward;
Where loyal friends and happy homes are made,
And culture follows hard the feet of trade.

This you have made it: Is it vain to hope
The sons of such a land will climb and grope
Along the undiscovered ways of life,
And neither seek nor be founding shunning strife,

But ever, beckoned by a high ideal,
Press onward, upward, till they make it real;
With feet sure planted on their native sod,
And will and aspirations linked with God?

Robert Stead (1908, pp. 64-68) from *The Empire Builders and Other Poems.*

INTRODUCTION

Robert Stead worked as a publicity agent for the Canadian Pacific Railway(CPR) between 1913 to 1919, followed by his appointment as the director for CPR's Department of Immigration and Colonization until 1936 (Kerber, p. 2010). Stead helped construct the discourse which incited thousands of people to leave their homes on the eastern seaboard or in Europe and start over in the Prairies. As Kerber (2010, p. 36) explains, in *The Plough,* Stead suggests that, "there is a higher moral order to which nature must be made to answer, and it is up to the agriculturist…to compel nature to spend her riches…the native prairie is portrayed as degenerate and in need of the edifying model of thrift, ingenuity, and hard work that the settler brings. Only once it has been transformed according to a European agricultural model will the region's true character emerge" In the second half of the poem Stead laments how the "red man spurned the ground," which halted Nature's destiny to be a land "Where every man is lord of his estate" (Stead, 1908, p. 67). This poem tells us many things about how the colonial government, through its hegemonic discourse, justified taking the lands of Indigenous communities, while constructing a narrative that boosted the nationalist project. As Asch (2002) explains, the Canadian government used precedents established within British colonial law to create a dichotomy of "civilized" and "primitive." British law used "primitive" to refer to non-Christian and non-agrarian communities, which implied, in the eyes of the colonial government, the inability to hold land titles or form sovereign nations (Carter, 1999; Furniss, 1999; Savage, 2012; Daschuk, 2013). Stead (1908, p. 64) also taps into this discourse, "Before you [settlers] came the red-man rode the plain; Untitled lord of Nature's great domain." The primitive/civilized dichotomy created a simplified story to give both Indigenous communities and incoming farmers a clear role in the nationalist project, which corresponded to a dichotomy between virgin land and broken fields.

Virgin land (a.k.a. buffalo sod), essentially meant unbroken by the European plough, in disarray with no private ownership, and disconnected from the capitalist economy. However, as we saw above in Stead's (1908, p. 65) poem, because Indigenous communities allowed it to "lay silent," the soil accumulated untold wealth through centuries of continual restoration under a grasslands ecology that created a thick layer of organic matter with abundant soil nutrients. This gave early settlers every hope that with hard work, they could realize their dreams of a private estate in their new Canadian homeland. Professor Thomas Shaw described western Canada in the following words:

> Bewildering, whether viewed from the stand-point of size or resources. In size it is an empire(…)The first foot of soil in the three provinces of Manitoba, Saskatchewan, and Alberta is its greatest natural heritage. It is worth more than all the mines in the mountains from Alaska to Mexico(…)And next in value to this heritage is the three feet of soil which lies underneath the first" (Canadian Pacific Limited, 1909, pp. 12-13).

As we will see in this chapter, after the virgin sod was broken, the soil was quickly depleted of organic matter, which made it susceptible to soil erosion during the intermittent droughts of the 1920s and 1930s. This chapter follows the story of the primary homesteading period in southwestern Saskatchewan between 1908 and the early 1940s. The purpose of the chapter is to consider how the process of surfacing altered the Prairie landscape from its smooth virgin state prior to colonial settlement to the striated grid of agriculture. This process was far from straightforward, as dryland farming advocates underestimated the forces of sand and wind that were always part of the Prairie grassland ecology. Farming experts from the early 20th century, including William Motherwell, Angus MacKay, and Hardy Webster Campbell, advised farmers to dust mulch their fields to create perfectly smooth, vegetation-free surfaces during summerfallow rotations (Jones, 2002; Kilcher, 1986; McManus, 2011). Although their aim in giving this advice was to establish striated spaces with north-south and east-west lines of golden wheat, these perfectly smooth fields expanded the intensity of the desert in Palliser's Triangle. This chapter will examine those farm practices to show how these smooth fields, coupled with prolonged periods of drought and wind, began erasing the striated grid of the Dominion Lands Survey. To contain these surfaces, the Dominion Government invested in scientific research with the establishment of the Station in 1920 and the Soil Research Laboratory in 1936 (Kilcher, 1986). This chapter also includes a brief description of the Station when it was first established and how it operated in coordination with farmer collaborators managing illustration stations. Agricultural research during this early period created a new vision for Prairie surfaces that aimed to retain as much crop stubble on the surfaces of fields as possible to contain unruly soils. The Dominion Government considered this surface conversion a national emergency because Prairie settlers began fleeing their homesteads in the 1920s and into the 1930s to escape their life of economic ruin in a place that was promised as a "land of peace and plenty" (Stead, 1908, p. 67).

The story of surfaces in Palliser's Triangle is broken into two chapters for this dissertation. This chapter follows the story until the early 1940s. The next chapter follows Prairie surfaces from the 1940s through to contemporary farming. However, to begin this chapter, I want to start at the end before taking us back to the beginning. This chapter begins with an ethnographic account of a day I spent zero tillage seeding with John A., a farmer in his 70s who lived through every major stage in Prairie surfacing, aside from its virgin beginnings. Zero tillage seeding, also known as no-till seeding, creates surfaces that are never mechanically disturbed and therefore retain a thick mat of crop stubble on the surface. As we will see in this chapter, agricultural scientists from Saskatchewan and Alberta looked to the virgin Prairies to help guide them in their work to contain soil erosion. Through their observations of the virgin Prairie, they realized that surface coverings in the form of grasses and shrubs obstructed persistent winds to stabilize the surface (Hopkins et al., 1946). Agricultural scientists attempted to emulate the virgin Prairie within cropped fields by developing soil preparation techniques to preserve crop stubble. This eventually led to zero tillage seeding, which is a system maintained through the abundant use of herbicides and fertilizers—a point I will return to in the next chapter. Following my ethnographic account of zero tillage seeding, I take us back to 1908 when Frank Oliver set homesteading in motion within Palliser's Triangle. As a reminder from the previous chapter, when I refer to "surface," I mean the A horizon or "uppermost mineral" (Rennie and Ellis, 1978, p. 9) surface. The A horizon varies in depth but includes the soil particles, water, microorganisms, mineral nutrients, and organic matter that support vegetative life on Earth. The B horizon (subsurface) is immediately below A and contains soil particles and inorganic minerals but very little organic matter. It is a transition zone of "weathered products" (Rennie and Ellis, 1978, p. 9) that is continually fed by the parent material of C horizon.

ZERO TILLAGE SEEDING WITH JOHN

On a cool spring day towards the end of April, I joined John A. for an eight-hour day of seeding with his new Bourgault seeding equipment. I met John at a potluck dinner at Stanley and Karen's house months earlier and always enjoyed his company and unapologetic and freely-offered opinions about farming, politics, health care, education, money, religion, cooking, and just about every other topic under the sun. Unlike most other farmers, our eight-hour day was filled with non-stop conversation, which certainly helped the hours go by. I met John on a field that he rents about ten miles west of Swift Current. As I pulled onto the field, I spotted him alongside his new Bourgault L7800 white air seeder cart hooked on to an 80-foot wide Bourgault 332 XTC red paralink hoe drill implement with both pulled by his one-year old John Deere 9560R four-wheel drive tractor with 600+ horsepower (See *Figure 27*). The air seeder cart included five large tanks for seed and fertilizer and it stood at least 20 feet off the ground. The paralink hoe drill, hooked on behind the air seeder, was a complex tangle of heavy metal beams, plastic hoses, and more than 70 seed knife openers with packer wheels trailing behind (See *Figure 28*). John's equipment represents the latest and greatest in zero tillage seeding technology. As the tractor moves across the field, the tanks of seed and fertilizer in the air seeder cart are fed into a series of plastic hoses that push the seed and fertilizer through the hoses with a steady stream of air. These plastic hoses connect to the knife openers that cut a two-inch row into the ground and carefully place the fertilizer or seed. Directly behind the knife openers are a series of heavy wheels called packers that push soil into the row and pack it down (See *Figure 29*). The air seeder cart and paralink hoe drill are hooked into a hydraulic system powered by the tractor. This setup includes hundreds of sensors throughout the system to detect changes in the topography to automatically lift or drop the hoe drill implement and openers to guarantee that the seed is placed at the same depth throughout the entire field. This is important because if the seed is placed at the same depth, the plants will emerge from the ground at about the same time, which helps the crop mature uniformly for harvest months later.

Figure 27. John's New Bourgault. The zero tillage seeding equipment with the tractor hitched to the white air seeder cart, which is hitched to the red hoe drill seeding implement. Notice the erect crop stubble on the field. Photo by Katherine Strand.

Figure 28. Bourgault Hoe Drill. The view of John's Bourgault red hoe drill seeding implement from on top of the air seeding cart. Photo by Katherine Strand.

Figure 29. The Narrow Knife Opener. The two-inch wide knife openers on the red hoe drill seeding implement with packer wheels behind. The red arrow is pointing to one of the knife openers. Photo by Katherine Strand

After I arrived at the field, I watched as John wiggled his slender almost 80-year old body through every nook and cranny of the hoe drill implement to check that each hose was properly connected within the system (See *Figure 28*). John showed me the knife openers and explained that because these openers cut a row two inches wide, they minimally disturb the crop stubble on the surface (See *Figure 29 and 30*). John and I also climbed the latter to the top of the air seeder cart to open and examine the tanks of seed and fertilizer (See *Figure 31*). We seeded peas that day along with phosphorus and sulphur fertilizers. After re-latching each tank, John and I climbed into the cab to begin our day. The interior of the tractor cab was spacious with two leather seats and three computer screens. One of the screens was the primary interface for John's GPS system that tracked our movement across the field and allowed John to operate his tractor hands-free, except while we made turns at the end of each row. On another screen, John kept track of his seed and fertilizer tanks, which were all set at automatic rates as pounds per acre. These tanks also included sensors to update this information automatically. The third screen kept track of the engine and hydraulic system of the tractor. As we drove along, John continuously checked these screens to make sure that the seed and fertilizer tank levels were slowly decreasing, which indicated to him that the system was placing the seed and fertilizer at a continuous rate. It took one complete pass across the field and several phone calls to his daughter—who was more skilled at the computer programs— before John got everything set in his system for a day of seeding. At this point, while his autosteer guidance system moved us across the next pass, he opened a small blue cooler to offer me a Pilsner.

Figure 30. Zero Tillage Stubble. A two-inch seeded row on our first pass behind the red hoe drill implement. Notice the undisturbed, erect crop stubble beside the row. Photo by Katherine Strand.

Figure 31. Stubble as Far as the Eye Can See. The view from on top of the white air seeder cart with John on the phone. Photo by Katherine Strand.

As John explained, the field we seeded that day was not broken into cropland until the early 1980s and was primarily used as grazing pasture for dairy cattle. As we made our first few passes, I understood why the area remained uncropped for so many years after homesteading. The middle of the field included a series of steep hills that occasionally bogged John's seeding setup down as our tires sank into the moist ground and his tractor ran out of power to pull the heavy equipment up the hill. Although the field was a "pain in the ass" to seed and combine, John said that he always enjoyed working on this field because of the landscape. As we summited the hills, our view opened to miles of fields, farmyards, and small towns in every direction. The work on this particular field would continue after we seeded. John's hired man planned to return in the next couple days to run a roller implement hooked behind a tractor over the field to push any rocks down into the ground to prevent damage to the combine's header at harvest. John's son-in-law would follow with their high-clearance sprayer within the week to apply a mixture of herbicides to the surface before the plants started to emerge. This application helped the pea plants outcompete the weeds by giving them a head start, although John described peas as "poor weed competitors," so by the end of the growing season, he anticipated a messy field that would require a fall herbicide application (Strand fieldnotes, 2015). John's son-in-law had already spent weeks in the sprayer as he prepared the fields for seeding. On some fields, he sprayed about one week before seeding to get a good "burn-off" of weeds and would oftentimes return one to two weeks after seeding to spray again. As John explained, the primary ingredient in their herbicide cocktail is Roundup, but they also mix in other products to address specific weed issues. In the next chapter, I provide an ethnographic account of riding in a high-clearance sprayer.

John and I discussed many topics during our day of seeding including his thoughts on how the landscape of farming and equipment had evolved since his childhood. When John was a child, his father mounted a bucket to their tractor's fender for John and his siblings to ride in during fieldwork. John remembered sitting in the bucket while holding a pail of gopher poison that he ladled out onto the ground as his father drove their tractor across their fields. The tractors at that time did not include enclosed cabs, so his father spent many weeks each spring exposed to the wind, sun, and dust while he prepared their fields for seeding with multiple passes of mechanical tillage to kill weeds, followed by another trip across the field to seed. John estimated that if he were to use his father's equipment to prepare the soil and seed the field that he and I worked on that day, it would take him at least a couple weeks. This same field is sprayed, rolled, seeded, and harvested all within four to five days total with modern equipment. John pointed out the tall crop stubble as we drove along. He proudly directed my attention to the stubble on passes we finished seeding to show me how much stubble remained standing after the land was seeded with his zero tillage equipment (See *Figure 32*). He explained that stubble helped protect his fields from soil erosion, collected moisture, provided a barrier from intense heat and sun, and would eventually improve his soil's organic matter content. After many years of mechanically disturbing his soils to control weeds, John began using herbicides to replace tillage in the 1980s. This eventually led to his adoption of zero tillage farming after he purchased his first air seeder in the early 2000s. John also described his move away from including a summerfallow rotation every second or third year on his fields. I will discuss all of these technological developments in this chapter and the next.

Figure 32. John's View from the Cab. The view from inside the tractor cab with the rearview mirror reflecting the hoe drill implement. Notice the faint line between the perfectly erect stubble on the right and the slightly flattened stubble on the left. The left side has been seeded.

For now, what is important to understand is that for most of John's farming career, the fields did not have the thick layer of crop stubble on the surface as can be seen in Figure 32. As John explained, for the majority of his career, he mechanically tilled his soils in the fall after harvest to kill the weeds before winter freeze-up. When spring rolled around, he brought his tractor and discers out to mechanically work the fields at least two times before seeding. The discers cut into the ground at an angle to disrupt the root systems of weeds and roll the soil over the top. John, and his father before him, used discers and a variety of other tillage implements to kill weeds and create a smooth surface with no vegetation or soil clumps. As John explained, for many years this smooth surface was considered the ideal seedbed for crops. If you take another look at Figure 32, try to imagine seeding this field after it has already been mechanically tilled three or four times. You would not see this crop stubble on the surface. You would see a surface of exposed soil with little to no remnants left of the crop stubble, larger soil clumps, or any other vegetation. During John's childhood, it may have resembled the field in Figure33. John estimated that at least 90% of the farmers in the Swift Current area are either zero tillage or at least minimum tillage. Minimum tillage farmers disturb their soil surfaces slightly more than zero tillage, which usually means that their seeding implement includes some type of mechanical element mounted in front of the seed openers that kills weeds. John also described the fields of organic farmers who cannot use herbicides to kill weeds because of organic certification regulations. As he explained, most organic farmers still pre-work their fields prior to seeding to kill the weeds and most of these farmers use seeding implements that are not categorized as zero disturbance. John said that organic fields are easy to spot in the spring because these fields usually have less crop stubble on the surface because of the mechanical control of weeds. He also said that these fields are more prone to wind erosion, especially in the spring after the weeds have been killed but before the crop emerges. In our conversation in the tractor that day, John admitted that he worries about the impact of herbicides on his health and his land, but he also tries to limit spraying herbicides as much as possible. When I asked if he ever considered converting his farm to organic, he responded with, "god no" (Strand fieldnotes, 2015)! For John, organic was not an option because according to him, it meant disturbing the surface of his fields and risking soil erosion. After years of rebuilding his soils by adding layers of crop stubble to the surface, John could not imagine returning to a time when he used mechanical implements to kill weeds. For John, the risk of soil erosion far outweighed the risk of herbicides. The next two chapters will explain why.

Figure 33.Pre-working the Field. A laborer from the Station driving an open air tractor and pulling a mouldboard plough to pre-work a field prior to seeding. Note the original caption. Photo from SCRDC Archives

BREAKING AND BACKSETTING

As mentioned in Chapter Two, Frank Oliver eliminated long-term grazing leases in 1908 within Palliser's Triangle to force the cattle barons to either purchase Dominion Lands or move out (McManus, 2011; Jones, 2002). Due to the brutal winter of 1906/07, the large ranches lost most of their livestock herds and were not in a position to purchase previously leased lands. As Minister of the Interior, Frank Oliver amended the original homesteading to open a path for settlers to claim 320 acres within six years. Bennett (1969, p.102) describes the homesteading period “not as a slow and silent drift of people westward, but an organized and promoted event taking place over a relatively short period of time.” As McManus (2011, p. 24) explains, “The Dominion Lands offices were not prepared for the massive onrush of humanity that accompanied the amendment [as passed by Frank Oliver]. The Department of the Interior had only one land office in the south in Moose Jaw with which to handle thousands of homestead applications that poured in during the second half of 1908.” The office in Moose Jaw processed 21,154 homestead entries filed in southern Saskatchewan in 1908. To hold up their end of the bargain, homesteaders needed to break 80 acres on their first land claim before they could file for “pre-emption” to claim adjoining lands (Kitto, 1919). Oliver was heavily influenced by Thomas Jefferson’s early 19th century notion of the idealized yeoman farmer settling the American west (Cannavo, 2001). Jefferson envisioned the creation of a utopian society in the west forged through the independent, frugal, and industrious yeoman farmer. The western US and Canada offered opportunities to the landless, poor immigrants who managed to escape the shackles of European aristocracies. Through the abundance of land, yeoman farmers could create an “egalitarian society of small property holders” (Cannavo, 2001, p. 77). Frank Oliver feared that the cattle barons were recreating the landed aristocracy of Europe. He insisted on opening up Palliser’s Triangle to yeoman farmers, which up until 1908, was considered unfit for farming by the Department of the Interior. Oliver aligned himself with dryland farming advocates who insisted that Palliser’s Triangle could produce crops if farmers conserved soil moisture through a practice called summerfallowing. Bracken[25] (1921, p. 167) defined summerfallow as “the name given to that portion of the farm which is left uncropped for a season and the soil managed in such a way that a surplus supply of moisture may be stored in it.” He went on to refer to it as the

[25] The once-president of Manitoba Agricultural College and author of Dry Farming in Western Canada.

"most fundamental practice of dry farming in the northern great plains area" (p. 167). As we will see throughout this chapter and the next, farmers integrated periods of summerfallow into their crop rotations and during the fallow period, farmers utilized intensive methods of tillage to keep the fields weed-free for the entire growing season to prevent weeds from utilizing soil moisture. From the 1920s until the late 1970s and early 80s, most farmers practiced a wheat-fallow rotation. This meant that on a single field, they would seed wheat one year followed by a rotation of summerfallow the next, before returning to wheat. Crops grown after a fallow rotation benefitted from the stored moisture, which amounted to about 26.3% of the total moisture received during the fallow season (Soil Research Laboratory Swift Current, Sask., 1942). Gradually, other crops were added to the rotation, which as we will see in the next chapter, evolved into continuous cropping or the elimination of all fallow rotations. Frank Oliver opened up Palliser's Triangle to homesteading on the basis of dryland farm advocates who claimed that summerfallow could conserve enough moisture to reliably produce crops even during the worst periods of drought (Motherwell, 1910; MacKay, 1909; Campbell, 1909).

One of the most powerful dryland farming advocates was WR Motherwell—the 1909 Saskatchewan Minister of Agriculture and later the Dominion Minister of Agriculture. In 1910, Motherwell (p. 9, 10) stated, "The climate of Saskatchewan is sufficiently dry that until a few years ago it was thought to be impossible to grow cereal crops in the greater portion thereof. Intelligent tillage methods, however, timely applied, have demonstrated in every district that crops can be grown with very much less precipitation than was supposed…The modern summerfallow was introduced in Saskatchewan over twenty-five years ago, not for the purpose of renewing a worn-out soil…but for the purpose of getting the soil in the best condition to absorb moisture." In addition to WR Motherwell, other dryland farming advocates included

Angus MacKay, a prominent farmer in eastern Saskatchewan and the first superintendent at the Indian Head Research Station, and Seager Wheeler who was another well-known farmer in Saskatchewan and wheat breeder (McManus, 2011; Jones, 2002). These three men were united in their belief that the Prairies of Canada, including Palliser's Triangle, could be transformed into a prime crop-growing region if farmers followed their "proven" advice (Wheeler, 1919). A primary source for this advice was written by Angus MacKay and published in 1909. In *Preparing Land for Grain Crops in Saskatchewan,* Mackay offers guidance for farmers on summerfallowing but also on how to prepare the surfaces of their fields for the first time by destroying the native species of grasses and shrubs. MacKay (1909, p. 1-2) calls this practice "breaking and backsetting" using a walking plough:

> Breaking and backsetting is the true way of laying the foundation for future success in the greater number of districts throughout the province…Breaking and backsetting means the ploughing of the sod as shallow as possible before the June or early July rains are over, and in August or September, when the sod will have become thoroughly rotted by the rains and hot sun, ploughing two or three inches deeper in the same direction and then harrowing to make a fine and firm seedbed.

Here we see Mackay advising farmers to cut into the thick mat of vegetated sod to release the hold of subsoil roots, and flip each slice to expose the hidden rhizome. The exposed sod would then dry and loosen, while the native plant material decomposed under the smothering force of its upended foundations (Wheeler, 1919). "Backsetting is merely turning the sod back to its original place, and at the same time bringing up two or three inches of fresh soil to cover it" (MacKay, 1909, p. 2). Wheeler suggests the use of a harrow for backsetting, which should create a "mellow and friable" soil at the surface. He warns that if proper care is not taken, uneven fields will continue to haunt the farmer for seasons to come. To summarize, virgin sod is literally upended and exposed to the elements of wind, sun, and moisture. The settler's plough turned the prairie sod to encourage the land to rot, release the hold of grasslands vegetation on their valuable heritage of soil nutrients and organic matter, and clear the surface in order to plant Red Fife or Marquis wheat. As the "native species" of "blue grama, June grass and buffalo wool or thread leaved sedge, with clumps of bluestem(…)forbal species such as wild rose, wild liquorice, prairie bean, milk vetches, horse-mint, and buffalo bean" (Budd, 1937, p. 1) rotted into a matrix of organic matter, the surface was cleared (See *Figure 34*). The cleared surface provided a clean slate for farmers to begin their work on the grid.

Figure 3 - A thick patch of Rosebush through which the blade has passed. Note long woody roots.

Figure 34: Clearing the Buffalo Sod. Clearing native sod in the 1940s. Photo from 1940 Swift Current Annual Farm Report.

This first section reveals that homesteaders needed to literally reverse the entire order of the native prairie to distinguish themselves from the previous Indigenous inhabitants. This practice marked the land's surface with furrow lines, indicating the land was now under private management. In the first few years of homesteading, crops flourished because as Campbell et al. (1983) explains, this initial breaking of the sod accelerated the decomposition of organic matter, releasing more nitrogen than the seeded crops could ever use. In these early years it seemed as though "unaided muscle" and a "plucky purpose" (Spence, 1881, p. 17) were the only requirements for a man to become "monarch of all he surveys" (Ricou, 1973, p. 37). The broken surface, ploughed into the straight lines of the cadastral survey's square fields, generated a rigid, geometric pattern that contrasted with the native prairie. The pattern enclosed private land and indicated to all who passed by that human labor had released the potential of this soil.

BLACK IS BEAUTIFUL

With the last traces of native sod rotting into the organic matrix, farmers then needed to mechanically maintain the soil surface with ploughs, harrows, and subsurface packers in order to prevent weeds from taking hold of their freshly disturbed fields. Free from any vegetation, these exposed fields provided a canvas for farmers to display their skill and dedication. During each growing season, they kept at least half of their land unseeded with the practice called summerfallowing. When I asked Leonard W. an 81-year-old—and not yet retired—farmer how, in his early days of management, he could tell a good from bad farmer, he unhesitatingly said, "Well you looked at a guy's summerfallow. If the land was full of weeds and crap and uneven, you knew he didn't know what he was doing…There's no way to hide your mistakes in fallow" (Leonard W., August 19, 2015). Summerfallow literally laid bare a farmer's ability to create the ideal of agricultural surfaces which, in the decades prior to the 1930s, was one that was completely smooth and black (See *Figure 35*).

Fig. 7 - Clean fallow (strip X16) one way disced June 13th, cultivated July 26th. Picture taken September 20th.

Fig. 8 - Dirty fallow (strip X14) single disced May 30th, one way disced June 29th. Picture taken September 20th.

Figure 35: Clean and Dirty Fallow. A page taken from the 1938 Annual Report, Dominion Experimental Station Swift Current. The photo compares a "clean," weed-free fallow with a "dirty" fallow.

As we will see, summerfallowing eventually became a contentious practice in the 1980s and 1990s, but in these early decades, farmers considered it their best form of crop insurance, because of the aforementioned fact that it stored slightly more moisture than its cropped counterpart. The story goes that summerfallow first came into Saskatchewan through a fortuitous set of events that have since attained mythological status (Isern, 1988; McInnis, 2004). W.R. Motherwell recounted the story in his 1909 address to the Dry Farming Congress.

> Owing to the half-breed and Indian rebellion of 1885,[26] many settlers were taken from their homesteads to transport supplies to the soldiers. As a result of this a great deal of land was not sown to crop that spring…This season (1886) was one of the driest in the experience of the country, not over two inches of rain falling during the growing season, and yet on land that was thus summerfallowed or on back-setting well done, there was a crop of from [Sic] fifteen bushels of wheat to the acre (Motherwell, 1910).

In the region around Indian Head, Angus MacKay noticed a difference in yield on those fields left fallow and began promoting the practice publicly after being appointed Superintendent of the Indian Head Experimental Farm in 1886 (Kirk, 1938; Isern 1988). As Jones (2002) explains, MacKay and Motherwell attributed crop failures in these early decades to the improper care of summerfallowing by unskilled farmers, which if done correctly, guaranteed success every year (according to MacKay). Motherwell told the Saskatoon Star in 1918 that, "success or non-success is chiefly, if not entirely due to good or bad farming" regardless of whether drought conditions exist (as quoted in Jones, 2002, p. 6). MacKay and Motherwell based their advice in part on the teachings of H.W. Campbell (Jones, 2002). Prairie historian David C. Jones calls Campbell a "false messiah" (Jones, 2002, p. 31), who promised dryland farmers in the US that "A fine, firm root bed, with a loose surface or *mulch* (emphasis added), is a condition that will withstand the extreme dry periods longest without any injury to the plant" (Campbell, 1909, p. 147). Campbell's work influenced MacKay and Motherwell who then promoted it to farmers in Palliser's Triangle.

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[26] This event is now referred to as the Second Riel Rebellion, the Métis Rebellion, or the North-West Rebellion.

H.W. Campbell, a professor of agriculture in Lincoln, Nebraska, known as the "Father of Dry Farming" promoted a practice known as dust mulching during summerfallow rotations. In his 1907 *Soil Culture Manual,* a publication described by Gray (1967) as required reading in US and Canadian agricultural colleges, he explains that farmers should create "a more scientific condition of the soil" (p. 40) using a series of practices during summerfallow to:

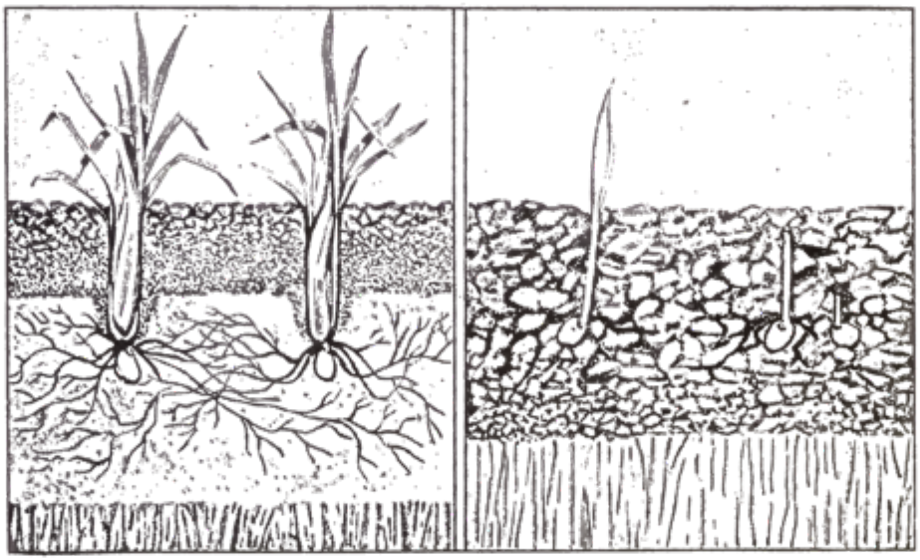
> thoroughly pulverize and loosen the surface for a two-fold purpose. To loosen and form a soil mulch to prevent the loss of moisture by evaporation as well as to break the hard crusted surface to promote a more rapid and complete percolation or soaking into the soil below of the early spring rains (Campbell, 1909, p. 38).

Inspired by the work of Jethro Tull, Campbell suggested the use of a disk harrow, followed by a plough, then followed by a subsurface packer[27], in early spring to kill weeds and create a firm, fine surface—a dust mulch— that disrupted the "capillary attraction" (p. 49) of moisture. In his opinion, evaporation would be prevented by the dust mulch because it produced a buffer between the surface and the moisture reservoir of the subsurface. We can see his vision for the "ideal condition of the soil" in *Figure 36.* Campbell is to credit for writing the manual for the "intelligent and progressive farmer" (p. 13) who was willing to "be saturated with the subject" (p. 17), so that the principles of scientific soil culture become "grounded deep within him" (p. 16) and "part of his being" (p. 17). MacKay and Motherwell promoted his brand of dust mulching and seemed to align themselves with his thoughts on the moral farmer as well.

> Perhaps it is not fair to assert that for the preservation of the morals of people dependence must be placed entirely on the farming class; but it is not going a bit too far to insist that as between good farming and poor farming there is a

[27] Campbell (1909) considered the disk harrow to be the most important tool a farmer could own for generating profit. In 1936, however, Cliff Shirriff gave a lecture to the Swift Current Research Station referring to the disk harrow as the implement chiefly responsible for soil drift in the 1930s. The basic design of a disk harrow included a gang of curved blades mounted on a single beam, which pulverized the soil at a shallow angle when passing (Wendel, 2004). By plow, Campbell primarily means the mouldboard plow, which consists of a wedge-shaped steel cutting edge (single or gang) that slices and rolls the soil completely over. Subsurface packers varied in design but Campbell recommended his own model. It consisted of a series of "sharp wedge-shaped wheels" mounted to a central beam (Campbell, 1909, p. 48). The packer firmed the soil at the bottom of the furrow with a "downward and a lateral pressure" (p. 48).

> difference as wide as the poles are separated in their relation to the morals of the people…. Idleness is next of kin to sin. And idleness is closely associated with poor farming. (Campbell, 1909, p. 294)



Cut No. 8. Germination of Wheat Influenced by Firmness of Soil.

Figure 36: Campbell's Dust Mulch. Campbell's Ideal Condition of the Soil taken from *Campbell's 1907 Soil Culture Manual.* The photo on the left is "ideal" in its fine textured and firm surface. According to Campbell, the photo on the right is not ideal because of the uneven, clumpy texture at the surface.

At the insistence of experts like MacKay, Motherwell, and Seager Wheeler, Saskatchewan farmers adopted dust mulching to create black surfaces during summerfallow rotations. As Campbell highlighted above, these principles became deeply ingrained both on the surface of fields, and in the bodies of farmers. As Gray (1967, p. 72) explains, "It was axiomatic that the summerfallow has to be kept black and the soil could not be allowed to dry into rough chunks. A poorly cultivated summerfallow was a sure indication of a sloppy farmer." Gray goes on to describe farmers' dedication to ploughing their soil as being akin to following a religion. Indeed, the "experts" often promoted Professor W.C. Palmer, of the North Dakota Agricultural College, and his tome *Ten Commandments of the Dry Farmer* (See *Appendix Two*), the first two commandments of which read, "Thou shalt plow deep. Thou shalt keep the surface of the soil loose and level and lower soil compact" (as quoted in Jones, 2002, p. 137). Black summerfallow became a "visible means of displaying your intention to manage well" (Soil at Risk Conference Workshop Ten on Land Degradation, 1985, p. 111), and as farmer Jim McCutcheon explained at the 1994 Direct Seed Conference in Llyodminster, Saskatchewan, farmers became "conditioned to think that black is beautiful (p.199)." He says, "It doesn't feel right to change a system that father and grandfather used with success. It doesn't feel right to use a system that doesn't have black smoke coming out of the stack and black soil coming out the back of the cultivator (p. 199)."

Campbell (1909) claimed that his methods of mechanically maintaining the surface of summerfallow fields through dust mulching could ensure crop growth in even the most arid of environments. Dr. John A. Widtsoe summarized the scientific logic being used during this period in his 1920 publication *Dry-Farming*. As he explains, "The conservation of soil-moisture depends upon the vigorous, unremitting, continuous stirring of the topsoil. Cultivation! cultivation! and more cultivation! must be the war-cry of the dry-farmer who battles against the water thieves of an arid climate" (p. 164). However, while black fallow may have acted to expose the slovenly farmer, it also exposed the soil to the forces of erosion. In 1936 Cliff Shirriff, in a lecture given at the Station, explained that although the "propaganda" of dust mulching "was advocated by leading agriculturalists and almost universally adopted by the best farmers in Canada…it was without a doubt the greatest single contributory cause of soil drifting (p. 4)." Jones (2002, p. 134-135) places the blame for soil erosion squarely with MacKay, Motherwell, Wheeler, and Campbell: "The piffling pedantry preached by the so-called dry farming experts, inflated like blimps with their own importance and accorded rank (…) emblazoned on the sheets of departments of agriculture, the agrarian press, the regional and local papers, the minutebooks of agricultural societies, and the notebooks of careful settlers (…) reckoned they had bared the secrets of taming the 'desert." In all reality, the farmers, operating on the advice of these experts, created the perfect surface conditions to eliminate the striated grid as the desert wind and sand moved across Palliser's Triangle unimpeded by vegetation or even large clumps of soil during summerfallow rotations.

BEST FARMER CREATES THE DUST BOWL

In 1971, Grant Denike, who served as Director of the Station between 1948-1965, related the following story for a publication about the history of the station from 1920-1970.

> A farm a few miles south of Swift Current, on which the dry mulch- fallow method was practiced, was selected as an example of what could be achieved by good farming methods. The farm operator was awarded a Better Farming Certificate by a local service club. There were no weeds, no stones, no trash, and no cultivator furrows anywhere on his half section. Its surface was a smooth as a billiard table. But the day after the farm was so singularly honored, the *west wind* started to blow. It blew for three days, at a velocity as high as 35 miles an hour. When the wind abated, the soil had been swept away to the depth of cultivation (Campbell, 1971, p. 29).

Thus, it was those farmers "who followed the best scientific methods, those who plowed and manicured their summerfallow with infinite care and patience, who were the primary fashioners of the disaster" (Gray, 1967, p. 10). The disaster Gray refers to is the Dust Bowl, which arguably actually began to occur cyclically in the 1920s, but gained national recognition in the 1930s (Jones, 2002; McManus, 2011; Worster, 1979. Cliff Shirriff described the situation around Swift Current with the following:

> As long as the land was in grass, and that which was under cultivation retained its virgin qualities, the destructiveness of winds of high velocity was less apparent…The soils longest farmed have begun to show the effects…In some districts, many acres of wheat land have been denuded of vegetation, practically depopulated, and left a sea of shifting, drifting soil" (1936, p. 1).

In the interest of space, this section cannot delve too deeply into the historical accounts of the Dust Bowl and the dust storms that occurred throughout the 1920s and 1930s; however, I will provide a few accounts taken from the Rural Municipality books of Fox Valley—a community in the heart of Palliser's Triangle.

At this time it would be remiss if no mention was made of the terrible dust storms of the 30's. So severe was the wind that the blowing soil blackened the sky and it became pitch dark at high noon, necessitating the use of the old kerosene wick lamp during the middle of the day. The writer can vividly remember seeing layers of dust settling through the air in the house, like a floating curtain, down to the floor and on to the meager furniture. In many cases all the soil that had been cultivated was completely blown away by the violent wind, leaving only the barren subsoil behind. Evidence of that disaster remains to this day and will be here for many decades to come (Hudec, 2004, p. 658).

By 1937, many, many homesteaders left this area [Fox Valley] for greener pastures leaving many buildings for sale. My folks bought my Uncle John's house and barn and moved them to our place with horses and wagons…. There were still severe dust storms when we lived at our new place. One day in early spring a big electrical dust storm came up suddenly while Esther and I were walking home from school. We had to put our hands by our eyes to protect our faces from blowing sand. We had a hard time seeing the wagon trail we were following to get home. Mom was so glad when we finally reached the house but we were still very concerned about Dad, who was working with the horses on a field one mile south and was not yet home. The horses sensed the electricity from the dust storm and would not go through the gate due to the electrical current or static in the fence wire. Dad had to wait on the south side of the fence until the storm subsided and the horses finally went through the gate (Harold Jackle, 2004, p. 692).

I remember the worst dust storm we had was May 5, 1934. The morning was beautiful. I went out to get the cows and the pasture was quite a distance from the house. There were a lot of hills and I went up one hill and down the other. All of a sudden I saw this big ugly cloud coming so I decided I better high tail it home or I would get lost. I don't think I quite made it to the house before it hit. My mother had made bread dough. There was so much dust in the house we couldn't see. We couldn't light a fire but my mother managed to put the dough in the kitchen oven and had it sitting there all day long. It was about 5:00 or 6:00 o'clock in the evening before the wind went down. First we had to clean up before she could work with the dough and bake bread. The cleaning we had to do. The dust on the windowsills was thick and just so fine. We shovelled out pails of dirt (Mike Weinberger, 2004, p. 1172).

The beginning of the 30s saw the drought return. This drought lasted from 1930 to 1937 and coincided with the Great Depression. Times were tough indeed. Extreme sandstorms would blow for days reducing visibility to near zero. Because it was so dry, friction of dust particles moving in the air caused static electricity to build up on fence wires, while the wires did not actually get hot, they would glow in the same way as northern lights do. You could feel electrical shocks by touching the wire. Some say that sparks could be seen during the daylight jumping fence wires. These 'electric storms' were common even into the 40's (Robert Glass, 2004, p. 551).

Because of the severe drought there was very little vegetation. The soil drifted with the high winds and there were days when it was dark because of the sand storms and we had the lights on during the day. Everything in the house was covered with sand and drifting soil. We had wet clothes on the window sills and doors to trap some of the sand which helped but still it came in. The country side was taking on the appearance of the Sahara Desert. Many of the farmers gave up hope and pulled up stakes and left, looking for greener pastures. 'Anything could be better than this" (Scott Glass, 2004, p. 561).

The final two accounts provided above are from family members of my partner. The final account from Sigmund Glass is about the farm that my partner and I now own. I have often thought about this passage, written by my partner's great-great uncle, while looking out the main window of the old house, which still stands on our farmyard. I try to imagine looking out and seeing the Sahara Desert and it leaves me with an uneasy feeling. McManus (2011) uses settler accounts to describe the sheer terror that accompanied dust storms, and the belief by many farmers that they were punishment for the homesteaders' treatment of the Prairies. Ricou (1973, p. 85) examined the work of Canadian novelist Frederick Phillip Grove, whose prolific writings provide an early example of Prairie realism, to conclude that during this period "the prairie exerts a relentless pressure to return all things to the horizontal. The unending wind…threatens to sweep away everything." McManus and Ricou both describe how repeated dust storms buried fences, farmyards, roads, and every other physical manifestation of the grid that farmers had worked hard to create (See *Figures 37, 38, 39, and 40*). The lurking desert of Palliser's Triangle appeared throughout the 1920s and 30s and exposed the vulnerabilities of Campbell's dust mulch method for summerfallow.

A road closed and impassible on No. 37 highway south of Cabri due to soil drifting from an adjacent field. Furrows being listed to prevent further damage to field and highway.

Figure 37. Road Closed. Note original caption. Photo taken south of Cabri, SK in Palliser's Triangle in 1937. Photo from SCRDC Archives.

Dust blew almost continually over these farm buildings during the growing season of 1937. The farm of Chas. Possehl, Verlo.

Figure 38. Dust Covered Homestead. Note original caption. Photo taken near Verlo, SK in Palliser's Triangle in 1937. Photo from SCRDC Archives.

Figure 39. Drifted Footprints. Drifting soil buries a fence line near Gull Lake, SK in Palliser's Triangle 1938. In the foreground, note wind erosion around footmarks. Photo from SCRDC Archives.

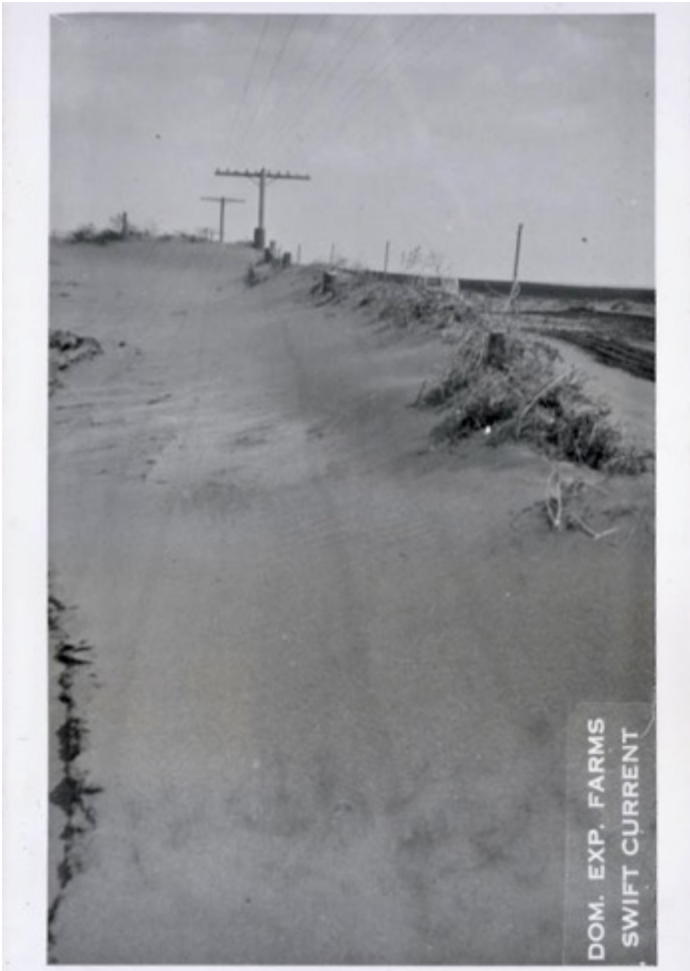


Figure 40. Buried Fences. Another buried fence line from soil drift in Palliser's Triangle. Date unknown. Photo from SCRDC Archives.

In Ricou’s (1973) review of Dust Bowl memoirs and literary realism from authors who experienced the Dust Bowl firsthand such as Sinclair Ross, he concludes that these writers often portrayed the experience as an “internalization” of the prairie: “Man and environment are totally integrated so that adjectives chosen to describe the natural environment could as well apply to character.” Adjectives used to describe both the landscape and its people included “colorless and glum,” “dull and ugly,” “dingy,” and “barren” (Ricou, 1973, p. 87). “The people—they’d be as drab as their homes, as flat as their fields” (Ross as cited in Ricou. 1973, p. 87). Ricou uses the following Stegner quote from *Wolf Willow* to consider how the Dust Bowl exposed the vulnerability of settlers in this environment and threatened to erase the geometric patterns built on the surface of the native prairie. "In its flatness you are a challenging upright thing, as sudden as an exclamation mark, as enigmatic as a question mark" (Stegner, 2000, p.8). However, for Stegner "nature abhors an elevation" and begins eroding it away as soon as it is elevated. Ricou and McManus (2011) describe how the smothering dust necessitated burning lamps for light during the day, holding wet cloths against your face to breath, and remaining indoors during the worst black blizzards. Ricou (1973, p. 86) highlights the following passage from Sinclair Ross's (1957) novel *As For Me and My House.*

> It's been nearly dark today with dust. Everything's gritty, making you shiver and setting your teeth on edge. There's a crunch on the floor like sugar when you walk. We keep the doors and windows closed, and still it works in everywhere. I lay down for a little while after supper, and I could feel it even on the pillow. The air is so dry and choking with it that every few minutes a kind of panic seizes you, and you have an impulse to thresh out against it with your hands (Ross, 1957, p. 62, as cited in Ricou, 1973, p. 86).

The smothering forces of dust challenge the role of farmers as masters of their domain, as well as the corporeal limits of their bodies. It indiscriminately blankets any entity that comes into contact with the energy of its black blizzards: "Grit and grime must be endured in food, in beds, in furniture, and on the floors(…)then it is necessary to clean thick layers of loose soil from everything" (Hopkins et al., 1946, p. 10).

Jones (2002) explains that a new wisdom emerged in the late 1920s and early 30s that focused attention on ways to contain the unruly surface in order to re-establish clear boundaries between man (the upright master) and land (the horizontal subject). Agricultural scientists from the Dominion and provincial governments pursued new tools and techniques for "a containment of the desert" (p. 150). Although, "the region of Saskatchewan…was the epicenter in 1908 of one of the largest mass movements of humanity the world had ever seen when thousands upon thousands of immigrants came to Saskatchewan and Alberta during the last great land rush of modern times…the period between 1917 and 1924, saw an estimated 30,000 men, women, and children flee the south and west plains of Saskatchewan because of drought, crop failure, starvation and destitution" (McManus, 2011, p. 7). At first the Dominion and provincial governments downplayed the severity of the land abandonments in newspapers. Sir Walter Scott, the first Premier of Saskatchewan between 1905-1916, "tried to allay the fears and encourage resiliency" insisting that "good returns [on seeding crops] can be obtained from properly summer fallowed land" (Scott, 1914, as cited in McManus, 2011, p. 38). However, by the early 1920s, it became clear to both the provincial and Dominion governments that unless they intervened, the land abandonments would continue. Thus, not only did they need to devise a plan to contain the blowing soil, they also needed to contain the movement of people fleeing their Prairie homesteads. Part of the solution came in the form of relief packages to assist farmers financially with supplies to ease their suffering. For example, in 1914 the Dominion Government established "relief depots" (McManus, 2011, p. 40) in Swift Current, Maple Creek, Medicine Hat, and Lethbridge to distribute fodder, flour, and coal to struggling farmers. Debt mediation and moratoriums for farmers began in 1914 and remained active for twenty years. The Municipalities Relief Act was passed in 1919, which expanded the responsibility for relief from the Dominion and provincial governments to Rural Municipality governments and included the distribution of seed, flour, fodder, and coal to farmers. McManus (2011) provides many more examples of the relief measures for farmers that began in 1914 and extended through the 1930s. All these relief measures were intended to "prevent the settler from abandoning his land" (p. 40). However, the Dominion and provincial governments knew that relief was only a temporary fix.

To create permanent communities on the Prairies, they needed to devise a system of farming that could address the semi-arid conditions without causing soil erosion.

A STATION IN THE DESERT IS BORN

As Minister of Agriculture in Saskatchewan between 1906 and 1917, Motherwell no doubt felt incredible pressure to make small homesteader farming successful in the Triangle. As Jones (2002, p. 116) explains, "So many of those in power had knelt so long before the gods of expansion and improvement that they viewed the carpers almost as heretics." At the first sign of trouble, Motherwell shifted the blame for crop failures onto bad farmers. As we saw above, this simply was not true. The best farmers, who followed the scientific advice of dryland advocates and dust mulched their fields, created the perfect conditions for surface erosion. As Jones (2002, p. 135) explains, "blowhards" like Motherwell and MacKay "fancied they had disproved the central claim of Captain Palliser about the existence of a forbidding desert on the southern plains." The first decade of homesteading exposed these unfounded claims, yet Motherwell and his ilk never accepted responsibility. Fortunately, Motherwell did begin advocating for a new scientific research station in the Triangle to assist farmers as they struggled to survive on their new homesteads. As early as 1910, Motherwell wrote to Sidney Fisher, the Dominion Minister of Agriculture between 1896-1911, asking that he consider Swift Current for a new Dominion Experimental Farm.

> I respectfully draw your attention to the Swift Current district as one in which an experimental farm could be located to the great advantage of an immense area that is just now passing from the range into general farming operations…thousands of settlers are now and have been for the past two or three years, rushing into the southwestern portion of our province, who stand in need of all the advice and assistance that can be obtained from both Federal and Provincial governments in regard to the best systems of farming necessary to ensure success under semi-arid conditions. If the most modern and approved methods of soil tillage are adopted, success is assured, but if not, then many and serious failures are bound to result" (Motherwell, 1910, p. 1-2).

He followed-up with another letter in 1911, "In discussing the matter with Premier Scott recently I find he is very anxious that Swift Current be selected as the site for one of your experimental farms, as it is in the centre of an immense area with illimitable possibilities, although hitherto looked upon as valueless except for range purposes" (Motherwell, 1910, p. 1-2).

Finally, in 1920 the question of an experimental farm in Swift Current came before the House of Commons as then Dominion Minister of Agriculture, Simon Fraser Tolmie argued in favor of the station and fought to get a start-up fund of $15,000 approved. The following excerpt from the House of Commons debate during fourth session in 1920 reveals how Mr. Tolmie justified the addition of another station in Saskatchewan, where three branch stations already existed and fourteen demonstration farms (illustration stations) had been operational since 1915 (Dominion of Canada, 1920).

> Mr. Tolmie: I may say there is a large territory in the neighbourhood of Swift Current were [sic] farming has been carried on under semi-arid conditions. This runs for a number of miles, east and west of Swift Current, down to the boundary line.
>
> Mr. Lemieux: To the American desert?
>
> Mr. Tolmie: It is on the Canadian side, and it is most important that we establish an experimental station at that point so as to assist the farmers, and to fully inform them as to the best methods of farming under the conditions prevailing in that particular district.
>
> Mr. Lemieux: Is not that territory known as the prolongation of the American desert?
>
> Mr. Tolmie: Yes (Dominion of Canada, 1920, p. 4560).

Tolmie was successful in the debate and $15,000 was allocated to Mr. N.D. McKenzie, the Superintendent of the Indian Head Experimental Farm, to setup operations in Swift Current on "Section 19, Township 15, Range 13, W3M, relinquished from the School Lands Endowment Fund for transfer to the Department of Agriculture" (Campbell, 1971, p. 14).

The first few years of work on the Station resembled any new homestead in Palliser's Triangle.

> Preliminary steps towards establishing an Experimental Station for Southwestern Saskatchewan were taken in 1920. Some fencing was done in the autumn of that year…During the season, 460 acres were broken, 300 acres of which was broken shallow and backset(…)twenty-five acres of the early breaking was seeded to oats for feed. Another forty acres was seeded to two varieties of fall rye(…)The breaking, backsetting and discing were done with a Case 15-27 tractor at an average cost of $8.75 an acre. A house and barn were erected on the farm, a well was sunk, which provides a good supply of water, and all outside fencing was complete (Campbell, 1971, p. 17-19).

Mr. J. Gordon Taggart was appointed Director of the Station in 1921 with the primary goals of providing information to "raise the standard of living in both rural and urban environments throughout Palliser's Triangle…and to show how farmers in the Triangle could cultivate 40 acres as cheaply as 10 acres in Palliser's Triangle" (Campbell, 1971, p. 19). Throughout the 1920s, the Station built on-site housing, barns, and granaries, raised chickens, seeded cereals and forages on their fields, planted gardens and established orchards, kept a herd of Clydesdales, shorthorn and Holstein cattle, and Yorkshire pigs, and tested equipment and fertilizers. In sum, the staff at the Station assumed the life of the farmer in order to collect information in hopes of "giving permanence" to the community of homesteaders in the southwest (Jacobson, 1939, p. 58). This early life on the Station evolved into structured divisions as seen in the Annual Report for 1931, which includes reports from the following sections: Animal Husbandry, Field Husbandry, Cereals, Forage Crops, Farm Machinery, Horticulture, Ornamentals, and Poultry. In these early days, they ran trials on just about every element of farm life to help make it more livable for the settlers who remained in Palliser's Triangle. For example, they tested farming implements on their experimental plots to demonstrate the success of various methods for controlling weeds, while preserving crop stubble. They tested varieties of tulips on the grounds of the Station to demonstrate methods for beautifying the farmyard (See *Figure 41*). They kept a pedigreed flock of poultry and in 1938 reported, “Farmers visit the plant [Station poultry building and range] continually and have shown an unusual interest in improving their own flocks. The Station is now looked upon as the centre for information on poultry improvement” (Dominion Experimental Station Swift Current, Sask., 1938, p. 362). In short, as Gray (1967, p. 31) explains, “Taggart’s purpose was to do no less than reorganize the whole of the agricultural economy within the Palliser Triangle on a scientific basis.”

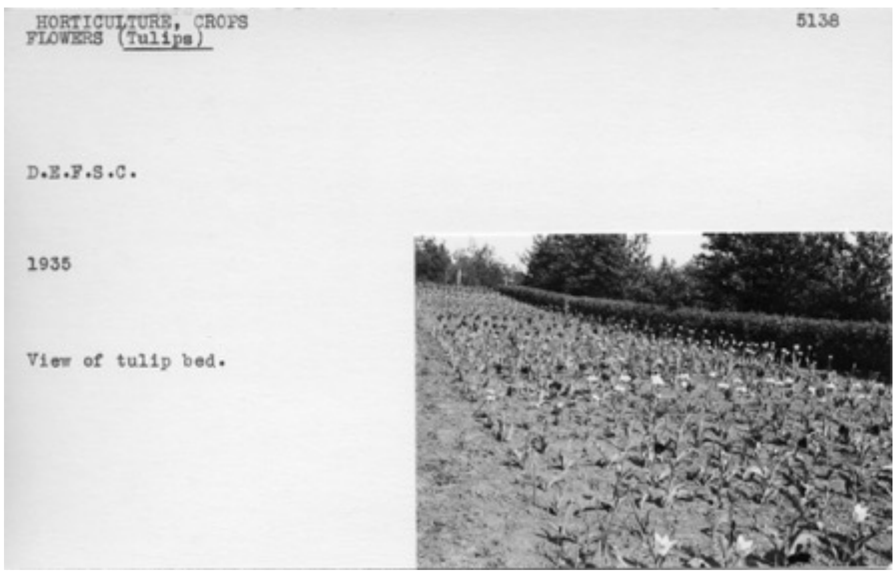


Figure 41. Testing Tulips. An example of the ornamentals research at the Station as part of farm beautification demonstrations. Photo from SCRDC Archives.

In these early days, the Director from the Station, as well as the researchers, kept in close contact with the local agricultural community for the purpose of extending the knowledge they gathered from the Station to assist farmers but to learn from the farmers as well. To use the 1938 Annual Report as an example of this close connection, under the “Extension Activities” section, there is a long list of community events organized and/or hosted by the Station (Dominion Experimental Station Swift Current, Sask., 1938). The Station organized a three-week long farm school for young men between 18 to 30 and many rural day-long courses for all farmers throughout the year on topics including field husbandry, soil drifting control, water conservation, and farm machinery (See *Figure 42*). The Station hosted a “Homemakers’ Cooking School” for “twenty-one ladies(...)and supplied lectures in Horticulture and Poultry” (Dominion Experimental Station Swift Current, Sask., 1938, p. 405). In July of 1938, the Station hosted a field day for farmers and community members to view on-going trials, listen to lectures, watch demonstrations, and visit with the Station scientists and staff. Although this was not the first field day held at the Station (See *Figure 43*), it attracted more people than ever before with 2,500 in attendance (See *Figures 44 and 45*). The Station still hosts field days each summer, although these events are broken down into separate days according to the type of research presented. For example, I attended two low-input (organic) field days, one alternative crops field day, and one forage crops field day. The attendance for all of these events put together was undoubtedly less than the 2,500 people and probably closer to 500 total for all four events that I joined.

Figure 42. A Classroom for Farmers. Note original caption. Students from the 1938 Farm School, directed by the Station and PFRA staff. Photo from Annual Report 1938:399 from SCRDC Archives.

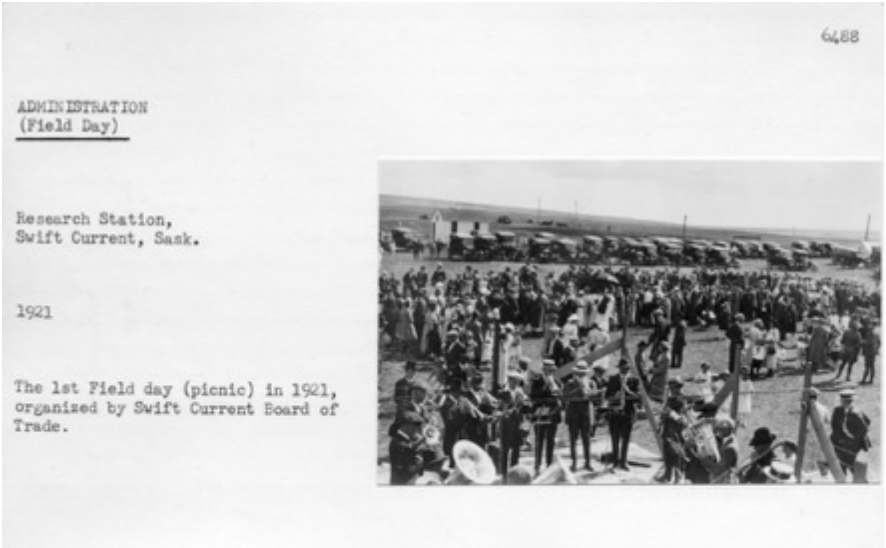


Figure 43. The Very First Field Day. Note original caption. The first field day ever hosted at the Station in 1921. Photo from SCRDC Archives.

Figure 44. A Busy Parking Lot. Note original caption. The parking lot at the Station in 1938 during the summer field day event. Photo from Annual Report 1938:406 from SCRDC Archives.

Figure 45. Another Farmer Classroom. The crowd gathered for lectures and demonstrations during the 1938 field day event at the Station. Photo from Annual Report 1938:407 from SCRDC Archives.

The extension activities mentioned above were only part of the Station's close connection to the agricultural communities in Palliser's Triangle. As mentioned in the Introduction of this dissertation, illustration stations were part of the original research and extension network of the Dominion Government's Experimental Farms Service (Canada Experimental Farms Service, 1939). By 1939, there were 195 illustration stations spread throughout Canada. Illustration stations were located near smaller communities in Saskatchewan and were farmer owned and operated; however, the branch stations—including the one in Swift Current—supervised all of the activities. The farmers at illustration stations tested practices, machinery, and crop varieties on their farms to provide the branch stations with comparative trials on different soil types (Strand, 2019). The farmer-managers received compensation for their work and oftentimes received rent for the land utilized for trials. The farmer-mangers of the illustration stations collected data for the scientists at the branch stations, including data on yield, annual precipitation, machinery testing, crop variety testing, and farm expenses. The farmer-managers submitted reports to the branch stations on all of their trials, as well as updates on their gardens, farm beautification projects, and building upkeep. These illustration stations were located on land near major roadways, "so that a systematic rotation of crops, using suitable seed and judicious cultural methods, might be followed and then to direct the attention of neighbors in the community to this illustration station in the hope that they might emulate the work being done there" (Canada Experimental Farms Service, 1939, p. 25-26). For example, the Mutschler Illustration Farm was located directly alongside Highway 21, the main road between Maple Creek, Leader, and Fox Valley. My partner's grandmother remembers attending events at the Mutschler Farm and most older residents in this area still call it the Experimental Farm. It is no longer owned by the Mutschler's but in conversations with the grandson of the original farmer-manager, I learned that while it was in operation, his grandfather worked hard to keep his fields and farmyard in perfect condition. The grandson believed that this was because everyone in the Fox Valley region constantly observed his grandfather's farm to stay updated on all the new machinery, crop varieties, and practices offered through the Station via the Mutchler Farm. Yearly events were held at the illustration stations, including field days and picnics, which were attended by farmers as well as the scientists from the branch stations. My partner's 93-year old grandmother remembers tasting bananas for the first time while attending an event at the Mutschler Farm. As she recalled, the bananas were baked into a cake and it was the best thing she had ever tasted. Overall, the illustration stations offered another avenue for the Station to collect data on various agricultural trials, offer their recommendations to farmers, and discuss local issues and ideas with farmers to gain their input. The researchers from the Station viewed the illustration stations as an invaluable component of their work. In 1938, W. M. (Bill) Harding—a researcher in the Cereals Division— presented a seminar at the Station. He described his frustrations when applying the experimental process to improving wheat yields on test plots at the Station. He found it almost impossible to isolate any given variable when testing various "treatments," leading him to conclude that the best solution is cooperative experiments:

> Cooperative experiments with farmers would seem like the most satisfactory arrangement for this type of work and it may be best carried out by agricultural improvement associations. Work of this kind would likely be beneficial in a double way. We would, in the first place, obtain a more thorough understanding of the value of our various treatments under different conditions. At the same time we would have at our disposal the advice of individual farmers in respect to various treatments. This phase is most important. In most cases the farmer himself has established the principles by which we conduct our farming activity. By working together both experimentalist and farmer should certainly benefit. (Harding, 1938, p. 16)

Twelve years later, Joe Ficht, from the Field Husbandry Section at the Station expressed a similar sentiment in his seminar paper: "The talent for invention, and the gift of philosophy are never found wanting among farm people. The direct contact with groups of farmers will always be a useful source of guidance and inspiration to the research worker" (Ficht, 1950, p. 6). Thus, we can see how important the close collaboration with farmers was to early research at the Station, which included countless field trials on surfacing and summerfallow rotations to prevent soil erosion that were tested and demonstrated at illustration stations in Palliser's Triangle.

Dr. Frank D., a retired cereal breeder from the Station, explained in our interview that, "the old station Directors like Taggart and Thompson after him, they were visionaries and they had power. If there was a need for something locally, Taggart would tell the scientists, 'go get it done. I'll figure out where to get the money.' This is radically different for us now" (Frank D., January 30, 2015). We will return in Chapter Three to how this power-dynamic shifted within the Station, when in the late 1990s scientists moved from A-base funding—100% AAFC funds—to grant-based funding. However, it was clear through my interviews with Station scientists, both retired and current employees, that from the beginning in 1920 and until the late

90s and early 2000s, the Station Directors, researchers, and laborers operated with great independence from the bureaucracy of Ottawa. In my interviews with retired Station scientists and personnel, many felt that this independence created a family dynamic amongst those who lived and worked within the Station grounds. They discussed parties, dances, picnics, spring plays, and public corn feeds that contributed to this family dynamic. As Campbell (1971) explains, although it was not recorded on the pages of the Annual Reports, right from its beginning in 1921, the Station created its own community in Palliser's Triangle.

> All of the early Station reports were very impersonal, even more so than they are today. The numbers of horses, cattle, sheep, pigs, and chickens were always reported, even the numbers of eggs that the chickens laid. But the people who did the work and the many interesting events were ignored…Not a word is told about the Station picnics…The community dances in the loft of the horse barn are not reported, and not even a note tells of how the last dance was interrupted while the sides of the barn were strengthened with telephone poles to prevent collapse of the building" (Campbell, 1971, p. 21).

In my own perusal of the Annual Reports from the Station, I also noted the lack of personal details about the people who spent their lives giving permanence to the agricultural communities of Palliser's Triangle. What is present in the Annual Reports from the Station and its illustration stations are pages and pages of experimental trials on what constitutes the best surface for protection from soil erosion and for the growth of annual crops. Beginning in the 1920s, the surfacing trials at the Station were heavily influenced by the work of Asael Palmer and his trashy surfaces.

TRASH IS BEAUTIFUL

Dr. Asael Palmer, also known as Trash-Cover Palmer, first came to the Lethbridge Research Station as an assistant superintendent in 1921 (Ellert, 2015). Promoted to Director in 1945, he is best known for his contributions to the exploration and promotion of ploughless summerfallow. In the early 1920s, Palmer consulted with two leading farmers in Alberta, D.W.

Bohannon and T.O. King, regarding their observations concerning the preservation of crop stubble from previous harvests on the soil surface and the subsequent prevention of erosion. He began a series of trials at the Lethbridge Research Station to compare the dust mulch method of summerfallow with methods that did not pulverize the surface and instead, killed weeds while also preserving crop stubble. Palmer noticed that not only did these alternatives to dust mulching prevent soil erosion, they also resulted in comparable yields when crops were rotated in the following season. "He [Palmer] used this as evidence that in fact it was safe to abandon the plough and the plough was not necessary to maintain yield" (Ellert, 2015). Palmer promoted the use of implements such as the duckfoot cultivator, the rod weeder, and the one-way disc in place of the mouldboard plough to undercut weeds at the surface, while leaving the residue of previous crops unaltered. These implements did not cause as much surface disturbance to soils, in contrast to the mouldboard plough which cuts into the soil, lifts it, turns it, and places it back down to bury weeds and bring fresh soil to the surface.

Palmer set in motion a course of research that eventually transformed the entire Prairie landscape. He did this by first identifying soil drift (erosion) as an "injury" to the topsoil caused by "the action of wind upon loose, dry soil unprotected by vegetation. Soil drifting is thus more severe during seasons of drought or severe insect damage when vegetation has been destroyed and the soil has been left bare" (Hopkins et al., 1946, p. 4). Along with his collaborators, including Sidney Barnes of Swift Current Station, he proposed the study of different soil types in the Prairies, along with a comparison of "virgin" soils versus cultivated. Palmer recognized that "newly-broken virgin soil seldom drifts. As long as the fibrous material of the original vegetation is present, this acts as a binder to the soil particles" (Hopkins et al., 1946, p. 6). Palmer ultimately earned his "Trash-Cover" nickname because he promoted practices that kept plant “trash”—usually in the form of the previous rotation’s crop stubble— and dirt clods on the surface in order to break the force of the wind to prevent soil erosion or “drift.” Palmer helped promote the use of the Noble Blade—an implement invented by another Alberta farmer, Charles Noble—as an alternative to existing tillage practices such as the mouldboard plough, and consulted with producers using strip farming to learn about this method of erosion prevention[28]. The Noble Blade cuts into the ground to shear weeds and crop stubble off at the roots, while leaving the surface stubble undisturbed. Palmer also worked with scientists at the Station to develop a “cultural[29]” approach to prevent the problem of soil erosion and improve agriculture in Palliser’s Triangle.

As William Harding of Swift Current explained in a 1937 Station seminar, “The objective of any cultural practice for the control of soil drifting is, shortly speaking, to either conserve or produce (emphasis in original) a type of cover on our soil which will serve as the best possible barrier [to wind]” (p.1). He goes on to explain that farmers can conserve crop stubble using the implements listed in the first paragraph of this section or, when fields lack enough stubble for preservation, to produce a barrier of soil clumps. The first approach was ploughless fallow. The second makes use of the plough to bring moist clumps to the surface from deep below the A

[28] “Strip farming is the growing of crops in narrow, systematic strops or bands to reduce soil erosion from wind and water” (Plant Life, 2021, February 3). I did not encounter farmers in Saskatchewan who engaged in strip farming, however many of my Wyoming and Nebraska farmer collaborators utilized this practice. These farmers divide a field into thirds with strips about 80-100 feet wide. They plant a cereal crop on one strip, a pulse crop on another, and leave the third fallow then rotate the strips each year. These farmers continue the practice of strip farming from its origin—in Wyoming and Nebraska—in the late 1920s and early 30s because they believe it prevents soil erosion from wind by providing intermittent barriers with the strips.

[29] The researchers from the Station often used “cultural” to describe non-input based forms of weed, pest, and disease control as well as methods for preparing soils for seeding and post-harvest weed control. Although I never found a clear definition from the archives on what they meant by “cultural,” I pieced together that in the context of research on soils, this often meant the use of various implements including discers and harrows to prepare the soil for seeding. The term also encompassed the timing, depth of implement in the soil, and the speed of the tractor. In the context of weed, pest, and disease control, “cultural” meant the use of rotations to compete with weeds or break the plant disease cycle, the use of implements to mechanically destroy weeds, and the density of seeding and/or row spacing as this relates to weed competition.

Horizon to act as a barrier when there is no stubble —something which frequently was the case in the 1930s as excessive drought prevented vegetation of any type on fields. Palmer's work guided the PFRA's approach to emergency action in the 1930s, as well as the research agenda of the Soil Research Laboratory in Swift Current—both of which will be covered in the next sections. It also inspired the soil survey project in Saskatchewan, which began following the Better Farming Conference[30] in 1920 and resumed with PFRA funding in 1935 (McKeague and Stobbe, 1978). The initial soil survey conducted in 1921 classified all Saskatchewan soils according to a system developed in the US. "It was a hierarchical scheme having 3 levels: soil province—based on general features of surficial geology; soil series—somewhat analogous to a geological formation, based on color, origin of material, and weathering; soil type—based on textural divisions within the series" (McKeague and Stobbe, 1978, p. 6). A series of publications followed the survey to further refine soil maps to include blow-outs—depressed areas where the subsoil is exposed—and alkaline patches—highly saline soils that appear white. The reinstated survey of 1935[31] further refined the scale of soil classification, particularly in highly erodible soils. Through this work, 16,000,000 acres in Saskatchewan became "classed as unfit for cultivation," which eventually led to a "program of land utilization and rehabilitation" (Eisenhauer, 1939, p. 23). Throughout the 1920s and 1930s, the Saskatchewan government

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[30] The Better Farming Conference was held in Swift Current in 1920 and attended by farmers and agricultural scientists (Moss, 1983). It mostly consisted of presentations and discussions about the increasing issue of soil erosion as the result of drought and tillage practices. As a result of the conference, a Royal Commission was established to look into farming conditions and create a soil survey in Saskatchewan. The soil survey began in 1921 under the direction of R. Hansen, the head of the Department of Soils at the University of Saskatchewan (McKeague and Stobbe, 1978).

[31] These early soil surveys eventually led to the 1970 Canadian Soil Classification System that is still utilized today (Ayres et al., 1985). An example of a classification from the Swift Current region is Chernozemic Brown Fox Valley Association. Chernozemic is at the level of Order and refers to "imperfectly drained soils of the grassland region" (p. 14). The next level is called Great Group and in this case is Brown. This level is based on colour as identified on the Munsell Colour Charts, which associate colour with varying levels of organic matter. The next level is Fox Valley Association, "developed from silty glacio-lacustrine deposits parent material is moderately calcaereous" (p. 20). For additional breakdowns in the classification system, see The Soils of the Swift Current Area 72J Saskatchewan (Ayers et al. 1985).

avoided creating an official evacuation plan for settlers because as McManus (2011, p. 143) explains, “The very logistics of an evacuation policy were ‘mind-boggling.’ There were an estimated 30,000 families straddling the drybelt on the western side of the province [Saskatchewan], and a further 100,000 families living in the south plains of Palliser’s Triangle proper. Helping remove, 130,000 families (which could amount to well past 300,000 people) was obviously not a can of worms the province willingly rushed to open.” However, with land labeled unfit for cultivation, the Saskatchewan Government begrudgingly assisted with some evacuations from 1923 until 1940. McManus could not find clear records of the number of families evacuated from Palliser’s Triangle, which he attributed to the provincial government’s intention to forget this unfortunate period in its early history; however, he did find records that showed substantial population increases for towns in the northern portion of the province where some families were relocated. “Between 1921 and 1936, the population of the northern grain belt had increased by ‘no less than 50%” (Matte, 1939, as cited in McManus, 2011, p. 168).

REHAB FOR THE DESERT

In 1935, the Dominion government established the Prairie Farm Rehabilitation Administration, in response to the escalating crisis of crop failures, dust storms, and land abandonments (Canada Department of Agriculture, 1961). As we saw above, efforts to contain the movement of people fleeing their homesteads began around 1914; however, these efforts could not prevent the tide of settlers abandoning the Prairies throughout the 1930s as the drought conditions of the 20s did not let up until the early 1940s. Friesen (1987) estimates that a quarter of a million people left the Prairies between the years 1931 and 1941. Envisioned as an emergency response team, the PFRA set up the base of their operations alongside the Station to quite literally rehabilitate those areas of the Prairies most adversely affected by soil erosion[32] (Canada Department of Agriculture, 1961). Although the PFRA headquarters was established in Regina, regional offices were created at many of the branch station sites including Brandon, Indian Head, Lethbridge, Lacombe, Rosthern, Scott, Morden, Melfort, Manyberries, and Swift Current. The PFRA hired new staff, brought new machinery, and constructed buildings including large shops on the branch stations' grounds. In Swift Current, the new PFRA staff worked closely with the Station scientists and personnel to address local issues in Palliser's Triangle.

On February 10th, 1936, two seminar lectures given at the Station by Dr. S.E. Clarke, the newly appointed head of forages at Swift Current, and Pete Janzen, a director in the illustration stations division and liaison officer for extension projects, outlined the problems both the Station staff and the PFRA faced as they attempted to rehabilitate Palliser's Triangle. Clarke (1936) reported that in Saskatchewan and Alberta, the "brown and light brown soil zone or short grass prairie formation comprises slightly over 30,000,000 acres" (p. 1). Most of the 30,000,000 acres experienced some level of soil erosion, but four to five million acres had been abandoned due to extreme erosion. Janzen (1936) called these areas "small deserts" (p.1) and explained how they "infected" adjacent fields with drifting soil and weeds. Archie Budd, the "self-made botanist" of the Station who started the impressive herbarium (Kilcher, 1986, p. 15), described the issue of weed contamination in a seminar the following year. Budd (1937, p. 5) explained how the empty lands of the Prairie "exodus…grew up into jungles of Russian thistle, tumbling mustard, and other weeds, which blew all over the country" and "polluted our farms." Simply allowing these areas to return to native species was not an option, according to Clarke, because the process

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32 The PFRA eventually expanded into other areas of work such as massive dam and irrigation projects, dug-out projects on farms to develop reliable livestock watering holes, and tree planting to create shelterbelts (Canada Department of Agriculture, 1961).

would take 10 to 25 years and involve “a considerable wastage in land utilization” (p. 1). For Janzen and Clarke, the solution was clear. They had to stabilize the surface of badly eroded fields. Additionally, those fields deemed “unfit for cultivation” (Eisenhauer, 1939, p. 23), needed to be seeded to productive grasses to create pastures for livestock grazing. In other words, they planned to “regrass” some areas that less than 30 years ago were thriving short-grass ecosystems of the Prairies (Canada Department of Agriculture, 1961, p. 8). L. B. Thomson, who took over as the Station Director from Taggart in 1936, presented a seminar paper at the Station in 1938 titled *Economics and Land Utilization*. Thomson urged his fellow researchers to think of this emergency phase as rehabilitation for both the land and the farmer. “The next step(…)is to see that the individual who is rehabilitated is able to maintain a good standard of living and able to make the best use of the natural resource (…) Much concern is expressed over the declining population and the movement out of farmers (…) If they [farmers] are made peasants to begin with, problems similar to what we have now will arise again” (p. 10). Thomson believed that the Dominion Government’s poor planning set farmers up for failure as immigration policy had not properly taken into account the environmental variation in the Prairies. Thomson urged his fellow researchers that day to avoid “condemning the work of the farmer,” (p. 4) as was the tendency of government agencies at that time. Instead, Thomson urged cooperative action to stabilize the Prairies. As Palmer (1939, p. 35) explained, “the nature of damage done by drifting soil were problems of the community as well as of the individual since drifting not only injured the field from which the soil moved.” Palmer believed that containment was only possible if they enlisted the help of the farmers.

The PFRA expanded the federal government’s reach in terms of influencing farmer practices by expanding the operations at illustration stations (Canada Department of Agriculture, 1969). The PFRA expanded the size of some illustration stations to encompass farms up to 640 acres (Moynan and Tinline, 1939). These farms were renamed substations and they became hubs for the researchers from the Station, PFRA personnel, local farmers, and Agricultural Improvement Associations (AIAs) to meet, discuss regional problems, and mobilize the local community to take action (Palmer, 1939). Shorty Kemp, one of the original staff members of the Station, helped establish the AIAs as organized groups of farmers affiliated with each sub-station who helped gather labor for large-scale PFRA projects, organized meetings at the sub-stations, and distributed seed for the establishment of pasture land on badly eroded fields (Gray, 1967). By 1937, there were 109 AIAs across the Prairies with total membership at 14,000 individuals. The large-scale work of stabilizing badly eroded fields mostly involved creating a new type of surface to serve as a barrier for wind and to help collect blowing soil. This process was called corrugating (Kilcher, 1986). "The usual reclamation procedure was to corrugate the land by listing in such a way that clods were brought to the surface. The area was then sown to fall or spring rye by the broadcast method. After a stubble was obtained, the land was sown to grass-legume mixtures" (p. 19). AIAs participated by organizing listing bees in which farmers would gather at a field to contribute their labor and equipment to literally "scoop out troughs" in the soil to reduce wind velocity of at the surface (Dominion Experimental Farm, Swift Current, Sask., 1937, p. 194). The listers, "by means of five six inch spades, spaced twenty inches apart," opened up "furrows which are dammed up every few feet by an attachment following behind each space" (p. 188). (See *Figures 46 and 47*). This created pocketed surfaces.

Fig. 1 - Rear view of machine in operation. Center dammer shown completing a dam. Second dammer from right in act of tripping.

Figure 46: The Lister. A photo showing the John Deere Damming Lister implement. The photo is from the 1937 Annual Report of the Dominion Experimental Station, Swift Current.

Fig. 3 - View showing work done at Gravelbourg Sub-Station. Clay loam soil, free of weed and trash and with good moisture content at time of working. Dams very regular, from 4 to 4½ feet apart.

Figure 47: A Pocketed Surface. The "pocketed" surface after a listing bee. This photo is from the 1937 Annual Report of the Dominion Experimental Station, Swift Current.

The “pocketed land” (Dominion Experimental Farm, Swift Current, Sask., 1937, p. 189) provided immediate protection from spring melt erosion by damming running water. By impeding wind at the surface it prevented drift, while collecting any dirt from neighboring fields in the deep troughs. In the fall, the PFRA and the Station staff distributed seed mixtures of crested wheatgrass, bromegrass, slender wheatgrass, alfalfa, and other leguminous species to AIAs for cooperative seeding (Janzen, 1936). Cooperative seeding involved farmers assisting each other in getting the seed in the ground on their pocketed lands before winter freeze-up. AIAs, sometimes through substations, organized demonstration plots of crested wheatgrass for farmers, where they could observe its success during drought conditions before adopting it for their own land (Murray, 1940). While mixtures, such as the one mentioned above, were desirable from a foraging perspective for the health of livestock, Clarke (1936) described crested wheatgrass as the best forage plant for reseeding (See *Figure 48*). This species is still used by farmers in Saskatchewan because it is “it is an extremely hardy grass, and once established does not kill out. It is a long lived perennial with a deep and extensive root system and short rhizomes” (Clarke, 1936, p. 2-3). Although contemporary scientists at the Station regret the widespread use of crested wheatgrass because it outcompetes most other native and non-native forages, it has become a permanent part of the Saskatchewan pastureland. This species played a key role in the PFRA’s objective of rehabilitating the prairie farmer (Clarke, 1939). They hoped to use crested wheatgrass in their project of “developing a farmer, rancher, or farmer-rancher unit which will be self-supporting throughout drought periods” (Bolton, 1937, p. 1). “Giving permanence” (Canadian Society of Technical Agriculturalists, 1939, p. 2) to agriculture on the prairies required a surface stability that could contain the population “exodus” (Budd, 1937, p. 5) of the 1920s and 30s. Crested wheatgrass gave them this permanence, while outcompeting those "unproductive" native species that survived in all the nooks and crannies of Saskatchewan.

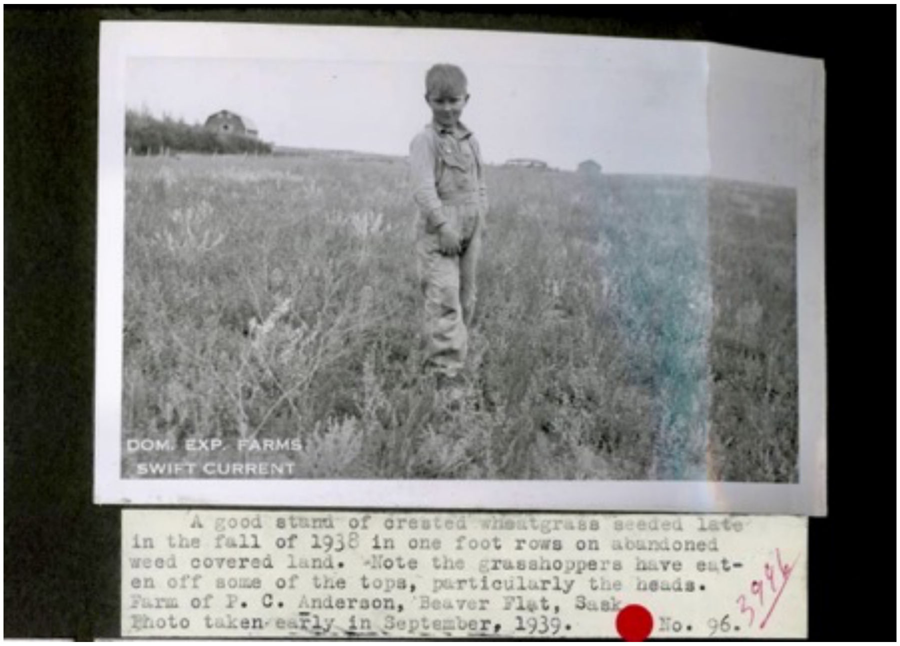

Figure 48. A Boy and Crested Wheat. Note original caption. Crested wheatgrass field seeded on abandoned land in 1939. Photo from SCRDC Archives.

THE SCIENCE OF SOIL

In 1936, the Canada Department of Agriculture established the Soil Research Laboratory at the Station to assist in the ongoing work of improving the practice of summerfallow and of increasing the average yield of wheat crops in Palliser's Triangle. As Campbell (1971, p. 32) explains, the Soil Laboratory was technically a "separate entity under the PFRA cultural program until 1957, when it became a section of this station [the Station at Swift Current]." With PFRA funds, new staff were hired and equipment purchased for the laboratory, as well as facilities constructed including a greenhouse and wind tunnel (Dominion Experimental Station, Swift Current, Sask., 1937). Dr. J. L. Doughty was appointed as supervisor over the Laboratory, and he established three divisions including "Soil Moisture and Wind Structure, Soil Drifting and Weed

Control, and Soil Fertility" (p. 2). As we will see in Chapter Four, the Soil Laboratory began a new phase in soil fertility research at the Station because the Laboratory had the expertise and equipment to chemically test soils for nutrient levels. Before the Soil Laboratory was established, the Station already had a Field Husbandry division that studied summerfallow, as well as different crop rotations and treatments for weeds. Based on my reading of Annual Reports from both the Field Husbandry Division of the Station and the Soil Laboratory, I noticed that although there was overlap in the research interests of both groups, they did different types of projects. The Field Husbandry Division mostly did field-scale testing of practices, implements, and crop rotations and collected data on crop yield, the presence of soil erosion, and presence of weeds. The Soil Laboratory conducted smaller scale experiments to understand the physics and chemistry contributing to some field practices being more successful than others. In other words, "The Laboratory (…) has as its program, the investigation of the fundamental principles underlying soil moisture, soil erosion, and soil fertility" (Experimental Farms Service, 1942, p. 5). These two approaches complemented each other because they shared the same goal. To help establish the Prairies as a prime crop production region, the Station and Soil Laboratory scientists needed to establish a system of field husbandry that kept trash "anchored" (Thomson, p. 1936) to the surface, while providing weed control during the summerfallow rotations and prior to seeding non-fallow rotations. Both groups also needed to investigate the best possible field practices for conserving moisture in the semi-arid Prairies. To find these solutions, the Soil Laboratory staff studied every aspect of the soil, including tank studies to track how much moisture was saved during summerfallow and used by crops. They carried out microscopic studies of the behaviour of soil particles at various velocities of wind. With each study, one solution rang true. In order to conserve more snowfall and annual precipitation, build lost organic matter, prevent soil erosion, and build better soil aggregates (clumps), they needed to conserve crop stubble on the surface. This section takes a brief look at two projects conducted by the staff of the Soil Laboratory that are particularly important to our discussion of summerfallow and surfacing. The first was a project started in 1922 by Sidney Barnes from the Station and carried on until 1942 by the Soil Laboratory (Experimental Farms Service, 1942).

To address the issue of moisture conservation, scientists at the Station and Soil Laboratory assessed which varieties of crops utilized the least amount of moisture, while maintaining a high yield (Experimental Farms Service, 1942). They also assessed which practices during summerfallow conserved the most moisture. To carry out these studies they constructed large tanks, dug them into the ground, filled them with dirt, and farmed them in-situ within a field.

> The tanks were made of galvanized iron, and were 15 inches in diameter and 5 feet deep. They were set in pairs, in pits 5 feet deep so that the soil in the tank was at the same level as the surrounding plot. Each pair of tanks was placed in the center of a 16-foot plot, which was subject to the same cultural treatments as the tanks. The tanks were filled with uniform, well-mixed soil placed in layers corresponding to the original position *in situ* (Experimental Farms Service, 1942, p. 11).

As mentioned in this quote, the tanks were subjected to the same treatments as the surrounding plot including the mechanical control of weeds during summerfallow and seeding different varieties of crops. At various points in the season, the tanks were lifted "using overhead rails and suspended traveling scales" (Kilcher, 1986, p. 13) to weigh the soil to assess moisture lost and conserved. In terms of summerfallow, after twenty years of experiments from 1922 to 1942, the scientists from the Soil Laboratory concluded that on average 26.3 percent of the moisture received over the course of the entire year was conserved during summerfallow (Experimental Farms Service, 1942, p. 12). This percentage did not vary much between different methods of summerfallow. For example, the Soil Laboratory tested the following "cultural treatments" to get a four-year average on moisture conservation in summerfallow: one-way disk and cultivator, cultivator only, ploughed in June and cultivator, surface worked and ploughed in July, and one-way disk only. They did not find much variation between these treatments in terms of moisture conservation and concluded that all treatments were satisfactory to create an ideal surface condition. "An ideal condition would be a long stubble to hold snow during the winter and prevention of all weed growth during the summer" (Experimental Farms Service, 1942, p. 14). Although 26.3 percent moisture conserved may not seem like much, as I mention in the following chapter, this extra moisture was an insurance policy for farmers. If farmers saved 26.3 percent of the moisture from the previous year and if they seeded into the summerfallow fields the following year during a drought with less than 17 inches of precipitation for the entire year—as was the case in 1928 and 1938 for example—this reserve of moisture could save their crop. Overall, as Gray (1967) explains, building on the research of Sidney Barnes—who first constructed the tanks—the scientists at the Soil Laboratory were finally able to put Campbell's dust mulching theories to bed.

> It was weed growth and not capillary action that took the moisture from the soil. It was Barnes' experiments which led to the accurate measurement of moisture loss by weeds and as a result of his experiments the whole basis of summerfallow had to be reversed. Instead of chewing the earth into a fine powder after every rain, the farmers were advised to stay off their summerfallow except to control weed growth (p. 71).

As we will see in the next chapter, this advice of staying off of summerfallow except for weed control eventually led to a full adoption of herbicides by the scientists at the Station.

The second area of research from the Soil Laboratory that I want to discuss briefly is the physics of soil erosion. This discussion will reveal what scientists at the Soil Laboratory discovered when they used a portable wind tunnel to mimic a farmer's greatest nemesis and reveal soil's stunning leap into the atmosphere. Rather than relying on the occasionally fickle, and always unpredictable, winds of the Prairies to conduct experiments on soil movement, researchers at the Soil Lab constructed a portable wind tunnel to uncover the secrets of the phenomenon of soil erosion by wind. They dragged the portable wind tunnel onto fields to test the effect of various cultural practices such as strip farming, cover crops, stubble preservation, and sequences of field preparation techniques or summerfallow treatments (e.g. one-way disc followed by the duckfoot cultivator followed by the rod weeder) on preventing wind erosion (Harding, 1937). They also observed the effect of the tunnel on different soil types, moisture levels, organic matter levels, degrees of "crustiness," as well as looking at the same field throughout various times of the year (Milne, 1937). As explained in the 1937 Soil Laboratory Report, the portable wind tunnel:

> Consists of a propeller mounted on the rear of a car chassis and driven by a 4 cylinder engine. Wind velocities of up to 22 miles per hour can be obtained with the present arrangement. The propeller is set in front of a tunnel with a cross-section area of 3½ x 4 feet. A soil surface of 4 x 8 feet can be exposed to the wind blast. A large tray with adjustable screens is used to collect the soil that is blown off the exposed surface (Soil Research Laboratory, 1937, p. 24) (See *Figures 49 and 50*).

Fig. 6. Complete set-up of portable wind tunnel.

Figure 49: The Wind Tunnel. Note original caption. Photo taken from the 1937 Soil Laboratory Report, Swift Current.

Figure 20. Type and arrangement of catchers used for measuring quantities of soil carried at various heights.

Figure 50: The Soil Catcher. Note original caption. Photo taken from the 1939 Soil Laboratory Report, Swift Current.

In the late 1930s, researchers transported the tunnel all over the barren hillsides and windswept fields around Swift Current to conclude in 1939 that, "the velocity of the wind near the surface of the ground depends entirely on the type of surface" (Soil Research Laboratory, 1939, p. 99). Surface irregularities (i.e. stubble or clumps) create eddies with friction, reducing the velocity of the wind. In the 1939 Report, they used Prandtl's rate of flow formula to quantify this effect[33]. This formula gave them a mechanism whereby they could quantify the surface interface between the atmosphere and the A Horizon in order to compare types of farming treatments. It reinforced what Dr. Palmer knew all along: trash cover reduced the effect of wind on the surfaces of fields. However when they moved the work indoors to the laboratory tunnel and photographed the results, a drama at the microscopic level unfolded (Soil Research Laboratory, 1944).

In the early 1940s, researchers at Swift Current photographed the paths of moving soil particles using a strategically placed lens of sunlight in a darkened wind tunnel (Soil Research Laboratory, 1944). The photos revealed three different types of movement caused by wind: saltation, surface creep, and suspension. The following is a description of saltation:

> After being rolled by the wind the particles suddenly leaped almost vertically to form the initial stage of movement in saltation. Some grains rose only a short distance, others leaped as high as one foot or more…They also gained considerable forward momentum from the pressure of the wind acting upon them…The grains descended in almost a straight line invariably at an angle of 6 and 12 degrees from the horizontal. On striking the surface they either rebounded and continued their movement in saltation, or lost most of their energy by striking other grains causing them to rise upward and themselves sinking into the surface (Soil Research Laboratory, 1944, p. 42) (See *Figure 51*).

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33 "This is expressed by $V_Z = 5.75\sqrt{\frac{V}{P}}Log\ \frac{Z}{K}$, in which Vz is the velocity at any height z, v is the surface drag, p the density of the air, and k corresponds to 1/30 of the height of surface irregularities" (Soil Research Laboratory, 1939, p. 99).

Figure 51: The Vertical Jump. The original caption reads "Soil movement over smooth surfaces of Sceptre heavy clay. This photo clearly shows the vertical ascent of particles in saltation (Soil Research Laboratory, 1944, p. 44).

In saltation, particles began spinning clockwise at speeds between 200 to 1000 rotations per second due to the Bernoulli effect, which lifted them at an angle of between 75 and 90 degrees (See *Figure 52*) (Soil Research Laboratory, 1944). The Bernoulli effect on the semi-circular granules occurs when the "velocity is greater at the top surface than at the bottom" (p. 43). The impact of granules in descent, falling at an accelerating velocity due to gravity, causes the other two types of movement to occur. As particles in saltation fall and strike large granules, they creep horizontally across the surface (surface creep). When they strike smaller granules, such as those that constitute clay soils, this sends the particles flying into the air to be "completely governed by the characteristic movement of the wind (suspension)" (p. 49). Particles in suspension can then be carried miles away from their home field. It was these particles that coated the dining room tables of 1930s Prairie dwellers and coated everyday life with a gritty veneer.

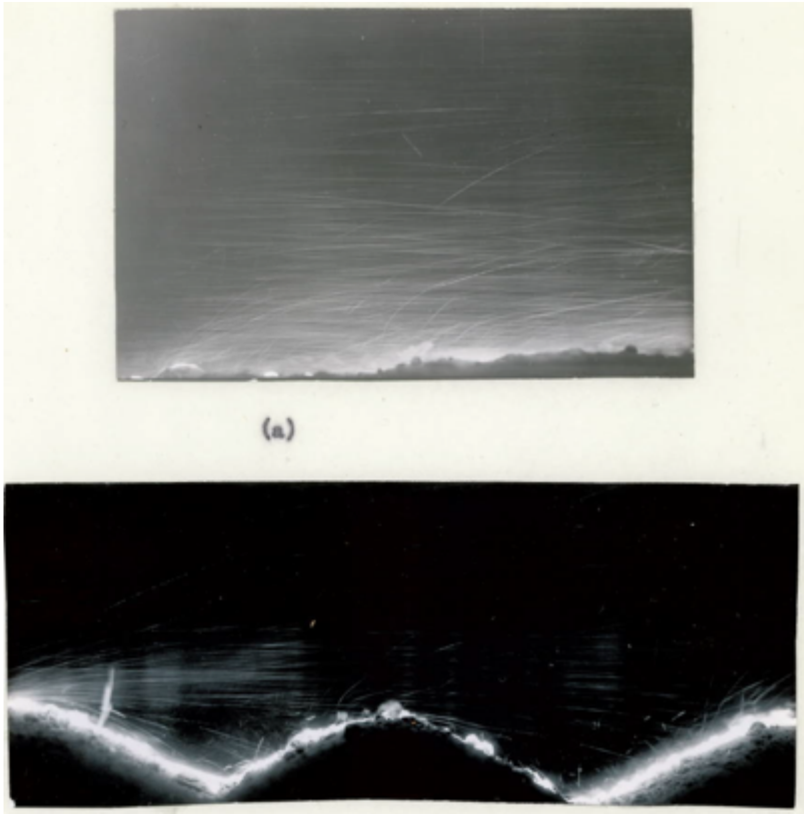

Figure 52: Bumpy V. Smooth. The original caption compares the two photos: "Soil movement over (a) a smooth surface of Hatton fine sandy loam, (b) a ridged surface of Sceptre heavy clay" (Soil Research Laboratory, 1944:45).

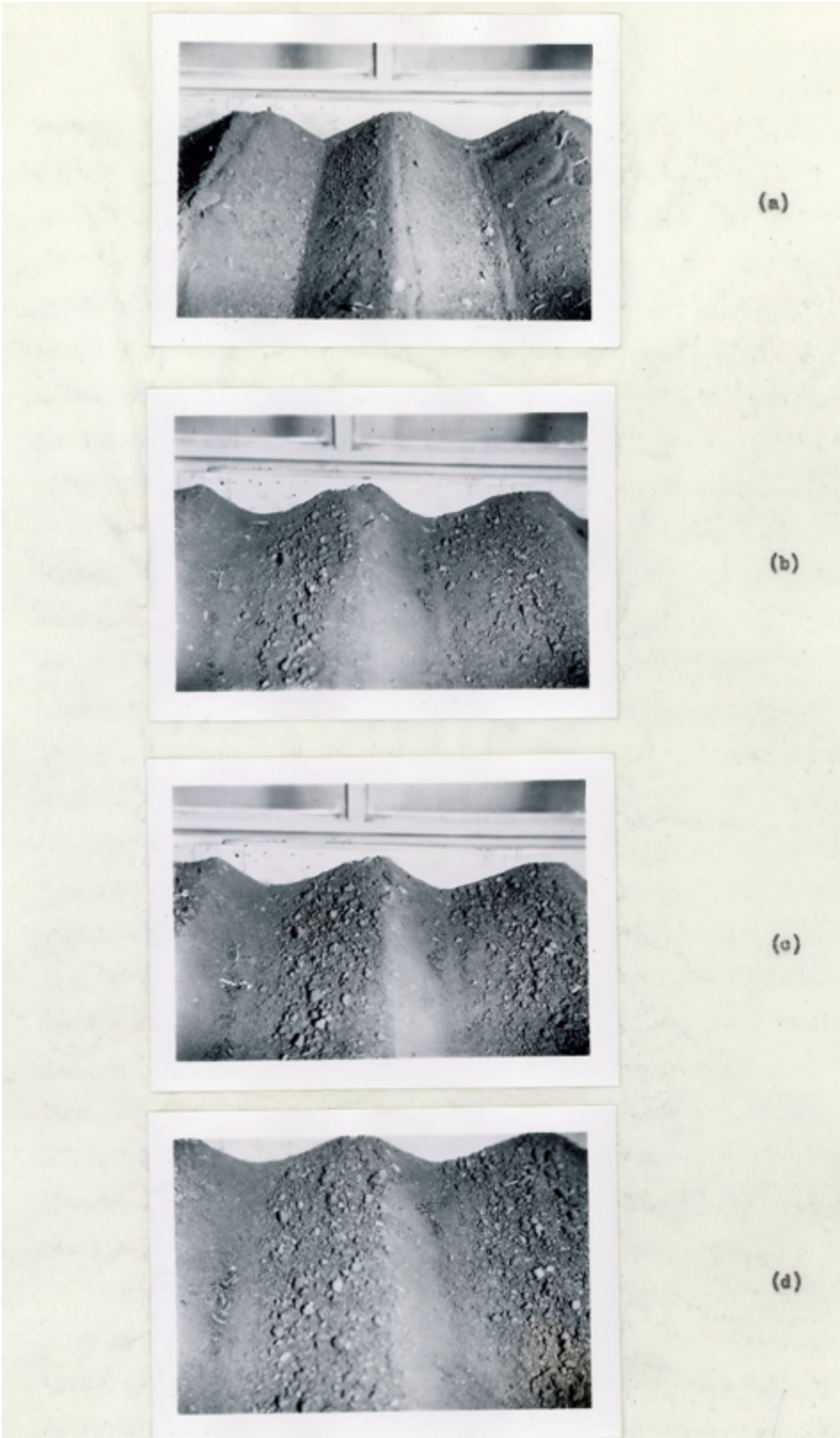

Figure 53: The Leeward Side. The original caption reads "Appearance of soil surface after exposure to different wind velocities: (a) before exposure, (b) after cessation of drifting under

17-m.p.h. wind, (c) under 22-m.p.h. and (d) under 30-m.p.h" (Soil Research Laboratory, 1940, p. 129).

Researchers compared photos taken on smooth surfaces versus ridged or rough surfaces to determine that obstructions lowered the "total rate of soil flow, and virtually eliminated surface creep" (Soil Research Laboratory, 1944, p. 50) (See *Figure 52*). They followed the paths of granules to conclude that wind velocity striking smooth surfaces creates a self-sorting phenomenon whereby particles in saltation (given equal wind velocity) follow a remarkably consistent pattern. Ridged surfaces also self-sort but in more erratic patterns. Most importantly, they found that ridges trapped finer particles on their leeward side (See *Figur*e 53), thus keeping them on the farm. Smooth surfaces offered no obstructions to trap particles. Thus, as Hopkins et al. (1946) explain:

> The action of wind on bare, dry soil is much the same as that of a fanning mill on grain (…) the fine material, such as silt, clay, and much organic matter, is continually sorted out from the coarser sands and blown hundreds of miles away. The best portion is thus removed and lagging sand is left behind (p. 8).

With only sand granules left behind, fields that once consisted of both fine and coarse granules were transformed into shifting dunes with zero stability and little hope for future cultivation. Thus, as the "best farmers" were creating their smooth, black fields, they also unwittingly were creating a surface that systematically carried their most fertile soil particles off the farm.

Surfaces with extreme drift were characterized by their "peculiar pitted appearance," which occurred as thousands of particles in saltation created enough kinetic energy to completely remove the A horizon, thus bringing the subsoil to the surface (Stalwick, 1938, p. 2). Commonly referred to as "blow-outs, slick spots, or scab lands," these exposed subsoils revealed layers of compacted grayish brown soil below the A horizon, and a deeper layer of loose lime containing "gypsum, sodium sulphate, and other soluble salts" (p. 3). The pitted appearance indicated soil conditions had degraded to the point where it no longer sustained life on the surface, thus requiring its occupants to seek assistance and/or vacate the homestead (Beveridge, 1938).

Over 50 years later, at the Lethbridge Research Centre where Palmer worked, two scientists investigated how to restore blown-out soils by adding topsoil, barnyard manure, and synthetic fertilizers (Larney and Janzen, 2012). To simulate conditions like those described above, they mechanically excavated cuts of the A horizon in a process known as "soil scalping" (p. 139). When soil is scalped at a depth of 20 cm, the researchers found a 38.5% yield reduction when compared to their check of non-scalped soils. Farmers in the 1930s learned that 20 centimeters of topsoil determined the "welfare of the community as a whole" (Beveridge, 1938, p. 7). At Lethbridge, Larney and Janzen chronicled all their attempts at rebuilding the scalped soil and came to the conclusion that life on the surface can be restored if manure and organic matter are continually added. The next chapter describes how throughout the next 50 years of research—at Swift Current and other facilities—researchers sought to never again put humans in contact with the subsoil layer. As we shall see, they endeavored to bury the subsurface below a thick mat of organic matter created through the elimination of summerfallow with continuous cropping, and zero-tillage farming which involved eliminating all soil disturbances in order to preserve crop stubble. Before diving into the next phase of this surface story, a brief summary of this first phase is important.

CONCLUSION

To return to an Eckbo (2002) quote from Chapter Two, as part of his methods for landscape design, surfacing is the "conscious rearrangement of the elements of the landscape" (p. 5) to facilitate the "continuous establishment of relations between man and the land" (p. 6). This chapter reviewed several forms of surfacing on the Prairies beginning with a look at zero tillage farming, followed by dust mulching to create black summerfallows, and finally trash covered surfaces created by the preservation of crop stubble on the surface. Each form of surfacing involved unique practices to establish different relationships between the land and farmers. Zero tillage farming, with modern equipment, relies on herbicides to control weeds and precision air-seeders to place seed and fertilizer without disturbing any crop stubble. This type of farming results in a thick mat of crop stubble on the surface, which distances farmers from working on bare soils. Dust mulching created perfectly smooth, trash-free surfaces through the use of invasive tillage implements to pulverize soils. In this scenario, farmers worked closely on bare surfaces, which caused countless dust storms throughout the 1920s and 30s. These dust storms erased the striated grid by burying roads, buildings, fence lines, and fields. The dust challenged the corporeal limits of human bodies. Settlers huddled in the safety of their homes as clouds of dust coated every surface of their belongings, blocked the sunlight, and challenged their every breath. Many settlers fled the Prairies, which initiated relief efforts by the Dominion and provincial governments. The numerous land abandonments also inspired the creation of the Station, the PFRA, and the Soil Research Laboratory. In the 1930s, the PFRA initiated emergency surfacing efforts to rehabilitate those lands most impacted by soil erosion. Emergency surfacing involved pocketing the land to contain soil drift during the worst periods of drought in the late 1930s. Stabilized soils could then be regrassed to create pastureland for livestock. By 1949, the PFRA regrassed 90,000 acres of abandoned land to create new pastures (McKenzie, 1949). Finally, through the work of Dr. Asael Trash-Cover Palmer, as well as the researchers from the Station and Soil Research Laboratory, a new type of field surface came into being in the 1930s. These researchers encouraged farmers to abandon the plough and dust mulching to adopt new implements that preserved crop stubble on the surface. Implements such as the Noble blade cut beneath the surface to shear off weeds without turning the soil. These implements worked well in terms of preserving surface crop stubble; however, weeds continued to cause issues. Through the Soil Research Laboratory, scientists learned that weeds were the primary cause of moisture depletion during summerfallow rotations. Less invasive forms of tillage did not kill all types of weeds and after many passes across a summerfallow rotation during the summer, even implements such as the Noble blade eventually reduced crop stubble on the surface. The next chapter continues this story from the 1940s as researchers from the Station began testing herbicides and eventually replaced all forms of mechanical tillage with chemical weed control.

The primary objective of shifting surfacing practices away from dust mulching and into the preservation of crop stubble was to contain unruly Prairie soils. Resurfacing badly damaged lands helped to contain the spread of the "small deserts" (Janzen 1936:1) that took hold on abandoned land. Resurfacing also helped to contain the alarming flow of settlers fleeing their government claims. Jacobson (1939, p. 2) described the work of the PFRA and affiliated research stations as labor in pursuit of "giving permanence" to agricultural communities in the Prairies.

> The low-rainfall years of the past decade serve to emphasize the fundamental fact that in spite of mechanization, farming on the prairies is a mode of living or a way of life where the home cannot be considered apart from the farm as a whole. The widespread and devastating effects of drought demonstrate the necessity of making the home the central factor in establishing any kind of permanent agriculture on the open plains and in placing farming in this area on a self-sustaining basis (Jacobson, 1939, p. 2).

With Jacobson's quote in mind, it is clear why testing tulips took its place alongside testing implements for summerfallow as part of the Station's research agenda. To give permanence to the farm home gave permanence to the grid because it ensured that people would continue living within the grid and caring for it. It ensured that the small deserts in abandoned land would not continue to spread to reclaim the grid.

In this chapter, I reviewed these early acts of surfacing, including breaking the native sod, to give examples of how farmers territorialized their squares on the grid. The Dominion Government laid the grid before the settlers arrived, but the homesteaders had to manifest the grid on their land through surfacing and building a home. Early dryland experts, such as Motherwell, through their discourse on dust mulching and moral farmers, set the standards for the best possible surface, and therefore the best possible farmer. To achieve this standard, farmers pulverized their soils to create portraits of themselves on the fields that reflected their good moral character as hard workers and astute, scientifically minded individuals. By the 1930s, the Station scientists and the PFRA had shifted the standards of good surfaces, and thereby they changed the qualifications of what constituted a good farmer. In the next chapter, I will show how the standard for surfaces and good farmers continued to change until it landed on zero tillage and zero surface disturbance—such as described with John A. in the first section of this chapter.

The Government Claim
A young man I am, a bachelor of fame
Just trying to prove my government claim
You'll find me out west of the CPR dam
Just wonderin' how I got in this jam.

But hurrah for Saskatchewan, the land of the free
The land of the grasshopper, bedbug and flea
Yet I sing of its praises and tell of its fame
While starving to death on my government claim.

The gay little bedbug so happy and bright
Keeps me up scratching two-thirds of the night
The dishes are scattered all 'round the room,
And the floor has not once caught the sight of a
broom.

Now come to Saskatchewan, there is room for us
    all.
Where the wind never ceases, and the rain never
    falls
Where the sun never sets but will always remain
'Til it burns us all out of our government claims.
    Author unknown (Cutbank RM, 1955, p. 30)

CHAPTER FOUR

CRACKS ON THE SURFACE

Figure 54: Rural Saskatchewan Traffic. Photo by Katherine Strand.

INTRODUCTION

As we saw in the previous chapter, by the 1940s scientists at the Station recognized that by leaving crop stubble on the surface of the soil, they could prevent wind and water erosion because that stubble provided a protective layer. It provided a buffer against the desert conditions of drought, wind, and high heat above 30° Celsius, thus helping to contain the soil within the grid and the flow of homesteaders out of the Prairies. The only problem was that each spring those irritatingly persistent weeds kept appearing, thus necessitating mechanical intervention to prevent them from overtaking crops. This mechanical intervention took many forms including discers, harrows, and cultivators; each approach, however, inevitably pulverised the crop stubble and left the soil surface vulnerable once again. By the 1940s, a miracle arrived at the doorstep of the Station that seemed to resolve all these issues. This miracle was "2,4-D," (dichlorophenoxy acetic acid) a broadleaf herbicide that reduced the need for mechanical weed control. As a plant growth regulator, 2,4-D causes injury by increasing production of the hormone Ethylene (Zimdhal, 2015, p. 92). Once applied, symptoms appear within hours as "epinastic (twisting and bending) responses, stem swelling and splitting, brittleness, short (often swollen) roots, adventitious root formation, and deformed leaves" (Zimdhal, 2015, p. 96). 2, 4-D ushered in a new era in Prairie farming that changed the way farmers interacted with their fields and also transformed the course of soils research at the Station.

The purpose of this chapter is to follow the journey of surfacing in southwest Saskatchewan to its contemporary stage of zero tillage farming. This journey begins in the 1940s with the first section titled *The Miracle of 2,4-D,* which takes us through the 1960s as public research and extension began promoting chemical summerfallow. Unlike farmers' previous approaches to summerfallow, wherein they used mechanical tillage methods from early spring until late fall in order to keep their fields free from weeds and conserve moisture during this fallow rotation, chemical fallow—through its regular applications of herbicides—reduced or even eliminated the need for mechanical intervention.

The second section, *Conservation for Profit,* picks up the timeline in the 1970s as the federal and provincial governments, along with the University of Saskatchewan, began warning farmers that if they continued to till their soils, levels of organic matter would continue to decline, eventually rendering it unproductive. During this period, researchers and extension personnel began discouraging fallow rotations altogether, instead promoting extended rotations or continuous cropping, which basically meant growing a crop every season rather than leaving a field unseeded for a rotation. This campaign challenged summerfallowing, the core tenet of Prairie agriculture which began with Motherwell's work at Indian Head in the 1920s. It rested on the belief that if farmers wanted to grow a crop in the desert, they needed to conserve moisture in a fallow rotation before seeding a crop the following season. I follow this campaign shift through to its crescendo in the 1980s as the Honorable Herbert Sparrow publicized the danger to agriculture in Canada of an encroaching desert. I then highlight how private agrochemical companies such as Hoechst and Monsanto began promoting their products as tools for conservation in the 1980s and 90s. The desert became a conceptual tool used by private agribusinesses, Station scientists, and the PFRA to inspire fear in farmers. They told farmers that if you do not adopt these conservation measures, you will destroy your fields. By the time I conducted my research in 2014-2015, these efforts by public researchers and extension personnel eventually resulted in a near 100% adoption rate of zero tillage and continuous cropping in the Swift Current region. This section also describes the relationships that formed between farmers and private agribusinesses as well as between the Station and new funding agencies in the 1980s and ’90s.

The final section of this chapter, *Zero Tillage Religion,* provides ethnographic accounts based on my participant observation of a young farmer near Swift Current using sprayed herbicides. It also delves into some of the cracks that are beginning to appear in the zero tillage system, including crop diseases such as fusarium head blight, consumer concerns over glyphosate residues, and the emergence of herbicide resistant weeds such as kochia. While researchers at the Station and farmers recognize these dangers, the promotion of zero tillage as a tool to conserve organic matter and protection against soil erosion since the 1970s, resulted in it becoming “locked in, both technologically and cognitively; simply put, at some point in the future zero-tillage will be as hard to dislodge as summerfallow was to dislodge in the 1970s and 1980s” (Fulton, 2010, p. xiii). The purpose of this chapter is to discuss the transition to zero tillage systems that resulted in significant changes to the Prairie agricultural landscape, the relationship between farmers and the Station, and the role of private industry.

THE MIRACLE OF 2,4-D

In 1939, the Swift Current Experimental Farm tested one of the earliest forms of chemical herbicides available to farmers in Canada, called Atlacide (Evans, 2002). Swift Current was relatively late on the scene with testing, as all three provincial governments on the Prairies had begun research trials on Atlacide in the 1920s. By 1929, an advertisement for this sodium chlorate herbicide already included a recommendation by the Saskatchewan and Alberta Departments of Agriculture “to make war on sow thistle” (Evans, 2002, p. 154). Prior to the late 1920s, the use of chlorates was restricted to use by the Canadian Pacific and Canadian National Railways for vegetation control along the tracks. However, by 1934 rural municipalities in the

Prairies had received crates of government-subsidized Atlacide for the control of leafy spurge, field bindweed, hoary cress, Russian knapweed, and multiple varieties of perennial thistle (Evans, 2002, p. 156). Farmers also received sodium chlorate subsidized fully as well as opportunities to purchase sprayers through cost-sharing programs initiated by all three prairie Departments of Agriculture. By 1929, the National Research Council had created the Associate Committee on Weed Control, comprised of delegates from federal research stations, the provincial departments of agriculture, universities, and chemical industry, including Chipman Chemicals Limited, the manufacturer of Atlacide. The primary purpose of the council was to coordinate chemical trials of Atlacide across the Prairies and expand research on weed ecology and biology. This collaborative research on weed control and the search for effective chemical herbicides created a close bond between public agricultural researchers and private chemical companies, one that continues today.

Atlacide, while useful for controlling patches of perennial weeds along roadsides, never became widely adopted as the primary means of weed control by farmers (Evans, 2002). To truly control perennial weeds, Atlacide needed a high application rate, which tended to leave the soil sterile for two or more years. To further complicate matters, it occasionally “burst into flames” while being handled during application when “mixed with dry soil, underclothing or any other dry matter” (p. 156). Thus, as Evans explains, “Chlorate weed killers are significant as a harbinger of the developments that followed, for generating sustained herbicide research, and for strengthening governments’ commitment to chemical warfare” (p. 158). In 1945, the Swift Current Experimental Farm received its first quart of 2,4-D for testing (Doughty, 1955). With trials on Atlacide already underway, an examination of this new herbicide fit seamlessly within the existing research objectives of the Station. Scientists could immediately see its potential because, unlike Atlacide which left the soil sterile because it killed almost all forms of vegetation, 2,4-D is highly selective in its effect and kills only broadleaf weeds.[34] Additionally, 2,4-D was effective at a low price, so farmers could integrate it into their existing systems for less than a dollar an acre, including both the product and application (Evans, 2002).

For farmers in the Swift Current area, 2,4-D was miraculous. As Stanley, an organic farmer near Horsham in his late 60s, explained to me while we rode in his tractor seeding lentils, 2,4-D changed the way his dad farmed:

> My dad loved chemicals and I can understand why. When you fight your whole life to control these weeds and something like 2,4-D comes along and works—you spray it and the weeds shrivel up and die—well why wouldn't you use it? He could finally get control of his stinkweed and wild mustard and that made all the difference some years.

One can imagine the satisfaction Stanley's dad felt as 2,4-D took effect on the stinkweed plaguing his fields. Five years after it was first tested in Swift Current, 23 companies were manufacturing 2,4-D and approximately 13,566,000 acres of Prairie crop land were treated with the chemical (Evans, 2002, p. 164).

In 1947, because the volume of research on 2,4-D had become so immense, the Associate Committee on Weed Control organized the first Western Canadian Weed Control Conference to discuss research findings. Joe Ficht, an agronomist within the Field Husbandry Division of the Station, attended the third of these conferences, held in Edmonton, Alberta. At a seminar at the Swift Current station on February 23, 1950, Ficht summarized the meeting in a paper for his fellow scientists. He described the event proceedings as having been dominated by the "contagious enthusiasm for weed control by selective herbicides" (p. 4). With 255 delegates

[34] Grasses, such as wild oats and wheat, are unaffected by 2,4-D. This meant that it could be sprayed in late fall or early spring and have no impact on the cereal crops. 2,4-D is a plant growth regulator, which means that it alters the hormone auxin to cause uncontrollable growth like a cancer (Zimdhal, 2015). The plant cannot keep up with this growth causing split stems and deformed leaves.

attending, 133 represented commercial interests, 30 the Dominion Government, 19 rural municipalities, 17 the prairie provincial governments, 4 prairie universities, 2 were from the press, 4 farmers, and 45 other members fell under the "miscellaneous" category (p. 1). Of the 28 papers presented, 17 were summarizing various 2,4-D trials or concerned research on other herbicides. Ficht felt that this represented "a much better balance of the programme than we had at the first conference [Western Weed Control Conference in 1947]" (p. 4) because the 11 other papers dealt with topics such as the cultural control of weeds, weed surveys, and weed germination studies. Another attendee of the 1950 conference, A.M. Wilson, remarked that herbicide research on weeds was easier to conduct because as he said, "Tillage, cropping, and cultural control studies are complicated by the need to consider a wide range of variables (variations in weather, soils, weed populations, timing of tillage operations, etc.) and may take years to bear meaningful results" (p. 4, as cited in Evans, 2002, p. 159, 258). Ficht acknowledged this research potential as well as the enthusiasm he witnessed at the conference for 2,4-D as a replacement for tillage in summerfallow in the seminar he gave at the Station

Conference attendees, such as Henry Wood of the Manitoba Weeds Commission believed that 2,4-D could solve soil drifting issues on the Prairies because it could help farmers reduce or eliminate their need to mechanically destroy weeds with various tillage implements. At the Station, one such research trial was already underway with the primary goal of assessing if 2,4-D could completely replace mechanical weed control (Dominion Experimental Station, Swift Current, Sask., 1947). Researchers within the Field Husbandry Division tested three formulations of 2,4-D, but they concluded that tillage could not be replaced at that time for two reasons: "First, the cost of the chemical is considerably higher than the cost of tillage, and secondly because of the selectivity of the chemical, it does not destroy all types of weeds present, which means that the land will have to be worked any way [sic]" (p. 32). The results of the Swift Current trial did not dissuade industry representatives at the Weed Control Conferences, however, who believed that with additional experimental work, chemical fallow would eventually replace traditional summerfallow. Ficht (1950) voiced his concern over the direction of this research fearing that the enthusiasm for 2,4-D might overshadow the need for continued work towards understanding weed biology. He also "doubted the desirability of having research projects partly financed by the companies which are selling the products under investigation" (p. 4).

By 1956, with 2,4-D use on the Prairies becoming "almost universal" (Evans, 2002, 1996), the Dominion Experimental Farms in Swift Current, Regina, Indian Head, Lacombe, and Brandon all began a research project "designed to determine the minimum amount of tillage required to provide satisfactory weed control during the summerfallow year and to test the usefulness of herbicides as a substitute for tillage in different localities" (Anderson, 1969, p. 34). This came at a time when soil scientist K. W. Hill (1956), of the Field Husbandry Division at Ottawa, created a pamphlet for farmers on the Prairies that included a warning: "Constant vigilance must replace complacency if the challenge of soil drifting is to be met" (Hill, 1956, p. 3). Hill explained that although farmers throughout the 1940s and early 50s had managed to avoid large-scale wind erosion like that seen in the 1930s, "localized erosion is insidious. Every year newly seeded crops are blown out, roads, fence lines and shelterbelts are damaged, borrow pits filled, and precious topsoil carried away" (Hill, 1956, p. 3). The multi-sited project called "10.01.08 "was carried out from 1956 to 1961 and laid the groundwork for a transition to chemical fallow on the Prairies as a response to the erosion referenced above. However, the biggest obstacle researchers at Swift Current and the other stations confronted was the persistence of grassy weeds such as wild oats, green foxtail, and wild buckwheat (Anderson, 1969, p. 34). 2,4-D had no effect on them, and other herbicides on the market including TCA, dalapon, and amitorl "gave inadequate control and toxic residues from some of these chemicals injured the succeeding crop."

Chipman Chemicals Ltd. stepped up to the task once again and along with their associates Plant Protection Ltd. of Great Britain, developed Gramoxone—a broad spectrum herbicide whose primary ingredient was Paraquat, or bipyridinium dichloride (Anderson, 1969; McConkey, 2010). Gramoxone is non-selective in its herbicidal action, meaning that it can kill broadleaf species of weeds as well as the troublesome grassy species listed above. In 1964, the Swift Current Experimental Farm began project "10.01.13" with the primary goal of testing Gramoxone as a replacement for tillage (See *Figure 55 and 56).* In their conclusions, Anderson (1969, p. 36) explains: the results of experiments conducted at several locations strongly suggest that tillage is not a prerequisite for maximum moisture conservation. In other words, where weeds are effectively controlled by chemicals, the moisture conserved is equal to that conserved under a total tillage program. Chipman Chemicals Ltd. followed up the Swift Current research with trials of their own across the Prairies. Hank Anderson, the lead scientist in chemical research at the Field Husbandry Division at the Station in Swift Current, toured the Chipman Gramoxone trials in 1969 and described the study as the result of close collaboration between Chipman and the Station. As Anderson explained, "At the outset it should be emphasized that this study in Western Canada grew out of the minimum tillage and chemical summerfallow programs developed at our Research Stations" (1969, p. 37). Results revealed that Gramoxone did not provide a satisfactory method of controlling volunteer grain[35] and Canada thistle, therefore Chipman and Plant Protection Ltd. shifted their efforts towards developing tank mixtures with other chemicals to address this issue. Additionally, although it was “obvious that a chemical fallow system or minimum tillage would benefit these soils” (p. 38), “prices of such products as Gramoxone must be sharply reduced before they can be used economically.”

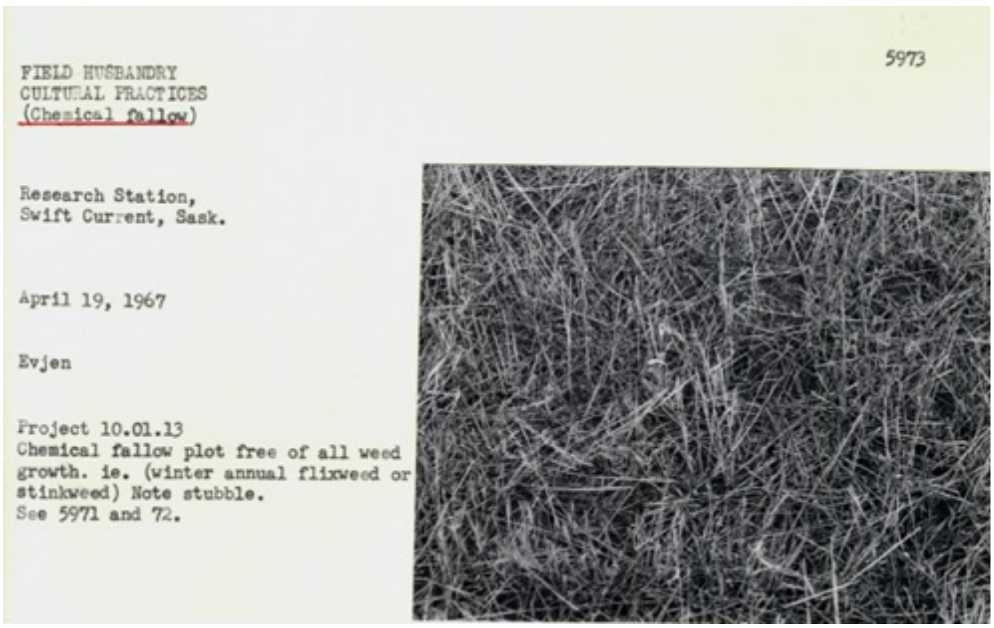

Figure 55. Chemical Fallow. Note the original caption. Photo from SCRDC Archives.

[35] When farmers and scientists refer to volunteer grain, they mean plants that have self-seeded from previous crops and are now considered weeds. For example, volunteer wheat are wheat plants from the previous year that self-seed and grow in the next rotation.

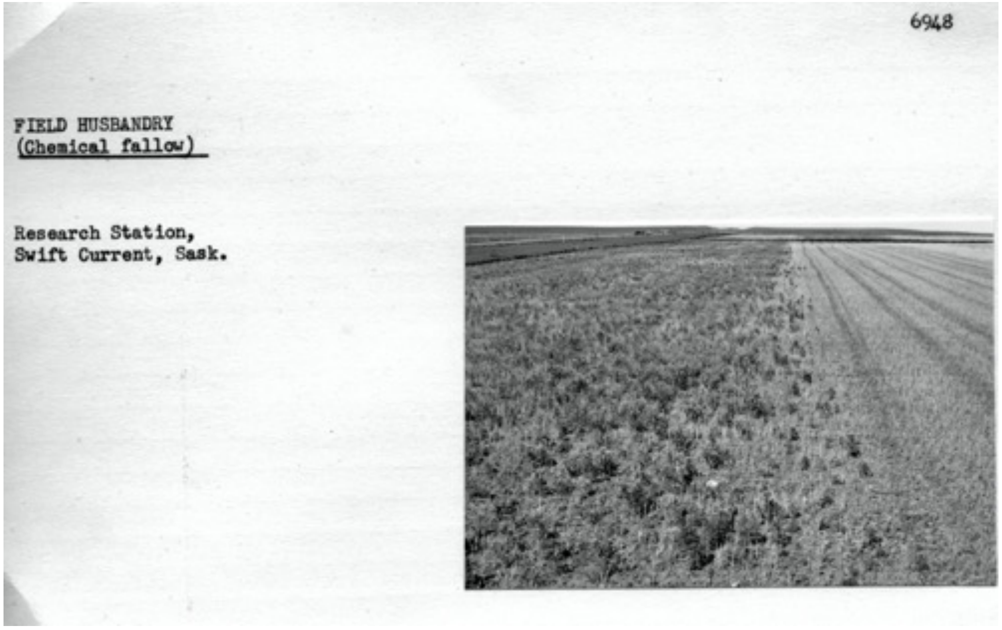

Figure 56. My Best Photo. Note original caption. The Station photographer described the above photo as the best of his career because it clearly shows the impact of herbicides sprayed on the right side of the photograph. Photo from SCRDC Archives.

In collaboration with Hank Anderson, Rick J. worked with other engineers at the Station in the early 1970s to develop new seeding equipment that could penetrate the surface with minimum disturbance to the soil and complete soil preparation and seeding using just one implement and a single pass across the field, a process known as low-disturbance direct seeding (LDDS)[36] (McConkey, 2010). The primary goal of LDDS was to limit soil disturbance and preserve organic matter on the surface by using implements that killed weeds and seeded the crop simultaneously, while not turning or pulverizing the soil. In my interview with Rick, he described his motivation to work in the field of minimum tillage.

36

McConkey (2010) and McInnis (2004) explain that in the 1940s, the discer seeder was the first implement designed to seed and prepare the soil in a single pass. However, it was also high disturbance for weed control, meaning that it still disrupted the surface of the soil and pulverized crop stubble. Additionally, it broadcasted the seed rather than precisely placing it. As herbicides became available, single pass seeding technology no longer required the use of intensive disturbance implements such as the discer for weed control.

> Boy I recall when we moved to our farm in Neville [SK] at 19 in the spring of 1949, which was a very dry year and a very windy spring. In the process of moving we drove through two bad dust storms and couldn't grow a crop that year. So that whole conservation tillage area was sort of ingrained in my upbringing [laughing] (Rick J., September 17, 2015).

Rick's work focused on "getting seed placement into untilled soil through the stubble…it evolved from disc openers, which had more soil disturbance to hoe openers which penetrated the soil a little easier and gave more uniform seed placement" (Interview). He also described how most of the innovations in seeding equipment that made reduced tillage possible came from the farmers themselves. As he said:

> I think a lot of the motivation came from the men that were familiar or were farmers themselves that saw the need for new and better equipment to do the job at hand. I think all the Prairie manufacturers that were involved like Friggstad, Flexi-Coil, Morris, Conserva Pak, Bourgault all originally had their roots on the farm(…)With farm boys it was a very, very good marriage between what really needed to be done and how to do it[37] (Rick J., September 17, 2015).

Rick was responsible for numerous equipment developments at the Station throughout the 1970s and '80s, some of which are still used by technical staff today, including models of his self-propelled plot seeder.[38] In a directory published in 1993, of the 64 entries listed of research equipment developed at the Station, Rick had his hand in designing or refining 43 of them, units that aided research staff in seeding plots, cleaning grain, and collecting data—among other things. When I asked him if he had ever patented any of his designs, Rick replied laughing,

> I did get involved in attempting to patent some of my seed opener work, but I wasn't the type of individual that really pushed that and one of my weak areas was always publication(…)One of my later developments that I really felt was worth patenting, by the time I got around to writing the application, there was another application that beat me to the patent office, so nothing came of it (Rick J., September 17, 2015).

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37 For detailed description of equipment development for conservation tillage and low- disturbance direct seeding, see: McInnis 2004 and *Landscapes Transformed: The History of Conservation Tillage and Direct Seeding* 2010 edited by Lindwall and Sonntag.

38 A self-propelled plot seeder is one that is independently powered and guided without the use of a tractor. Plot seeders are specialized research equipment used to seed small acreages at the Station.

I found Rick's modesty about his incredible contributions to the Station and the development of low-disturbance seeding equipment, especially endearing.

Along with Hank Anderson, Rick had travelled the Prairies throughout the '60s and '70s to give talks about adopting conservation tillage methods assisted with chemical herbicides. He remembered those times fondly; however, concluded our interview by voicing concerns:

> It may appear right at the moment that we sort of reached a plateau where we have solved a lot of problems but uh, are seemingly developing into new areas of problems. With zero tillage we're very dependent on the use of chemicals for weed control and whether that is sustainable is in question(…)Maybe we haven't researched adequately the effect of chemicals on our environment and food supply and potential health concerns (Interview).

We will return to Rick's concern, along with a discussion of modern seeding technology later in the chapter.

This section reviewed the period from the late 1930s until the late 1960s, which laid the groundwork for on-farm adoption of reduced tillage farming with herbicides such as Gramoxone and 2,4-D. Herbicides for weed control offered a solution to the continual threat of the creeping desert because farmers could reduce their need for mechanical weed control with tillage. Scientists at the Swift Current Station collaborated with private industry to test products, refine seasonal field preparation activities, and promote herbicides as a tool for soil conservation. As we will see in the next section, private industry played an increasingly important role in the adoption of conservation tillage, particularly when Monsanto developed the herbicide Roundup.

CONSERVATION FOR PROFIT

Referred to as "our Bible" by a former Information Officer from the Swift Current station, the *Guide to Farm Practice in Saskatchewan*, was a yearly publication created by researchers and extension personnel from the research stations, the provincial government, and prairie universities that provided basic agronomic advice for farmers. In the 1975 edition a section concerning the decline of soil organic matter and its direct correlation to the practice of summerfallowing challenged a “belief system” in the Prairies (Fulton, 2010, p. xi), and became a highly controversial topic of discussion amongst the farming community (Awada et al., 2014; Gray, 2010). Summerfallowing as a method had been nurtured on the Prairies since Angus McKay happened upon this moisture conservation technique in the late 1800s. Dr. Donald A. Rennie, a professor of soil science and the future Dean of the College of Agriculture at the University of Saskatchewan, was primarily responsible for including this warning about soil organic matter in the aforementioned Guide. Rennie went as far as calling the practice of summerfallowing “the most singular mismanagement practice that has been in vogue since this country was opened up” (Fairbairn, 1984, p. 30). Rennie believed that by 1975, he had finally collected enough data to make a strong case against the practice as a moisture conservation technique, explaining that only 26% of the precipitation received during a summerfallowing year was conserved for the subsequent growing season. Additionally, with the loss of soil organic matter, “a 30-40% decrease in native [soil] productivity has been estimated” which, “appears to be a direct result of this overuse of the summerfallowing practice, the excessive tillage associated with this practice, or both” (Rennie & Ellis, 1978, p. 52). In close collaboration with Rennie, Con Campbell (1983, p. 2) from the Swift Current Station explained that summerfallowing caused the decline in organic matter because it “enhanced decomposition” through increased oxidation, it tended to “facilitate erosion of the soil, thus resulting in its physical loss,” and lead to “smaller carbon inputs” because crops are only grown every other year. Rennie (1976) recommended extending crop rotations to greatly reduce summerfallowing and minimizing tillage operations as much as possible. This required “a significant conceptual change by farmers” and “a radical change in soil management practices…where inputs such as fertilizers and herbicides are a must" (Rennie & Ellis, 1978, p. 59).

By the late 1970s and early '80s, farmers were aware of Rennie's suggestions for continuous cropping and tillage reduction; however, they were slow to be adopted on the Prairies for multiple reasons, including the high cost of herbicides and inadequate seeding equipment (Zentner, 1977; Lindwall, 2010). Agrochemical companies listened carefully to Rennie's suggestions and began advertising campaigns promoting herbicides as a tool for conservation. For example, Hoechst released a 73-page booklet in 1984 titled *Conservation for Profit* (CFP). I found a copy of the booklet in the Station library and immediately noticed the frequency with which the authors cited research originating from the Swift Current Station and many other Prairie research facilities. Rennie, Campbell, and Anderson featured prominently, with Hoechst publishing graphs and charts taken directly from their papers, as well as many others. Within the pages of *CFP,* the research is used to promote a reduction in tillage-based summerfallowing through the use of continuous cropping and yearly applications of herbicides, including Hoe-Grass, for the control of wild oats. Hoe-Grass was a new product for Hoechst in 1984, and as they explained represented "one of the easiest and simplest ways a farmer can begin the transition into the CFP system" (Hoechst, 1984, p. 65).

CFP states that, "Summerfallow is the most unnatural state land can be placed in. It exists nowhere in nature except in environments which cannot support vegetation, such as deserts" (1984, p. 10). Hoechst issued a warning to farmers that if they failed to subdue the "dust-ravaged landscapes" (p. 45) and halt soil degradation, "it is reasonable to expect that their freedom to choose farm practices will be severely curtailed by 'public' persuasion" (p. 67). Thus, "CONSERVATION FOR PROFIT is a land management system that takes the farmer's short-term concern for high yields and bridges it with society's long-term need for soil conservation" (Hoechst, 1984, p. 2, emphasis in original). Hoe-Grass, along with other herbicides such as 2,4-D were described as critical components of CFP because these products have "the work-efficiency of 100 hoe-hands in a cropped field" (p. 40). New products such as Hoe-Grass had an additional advantage because this herbicide could be sprayed on weeds at early emergence to "burn off" the weeds a few days prior to seeding. Unlike herbicides like Avadex—one of the most commonly used broad-spectrum products of the early '80s—Hoe-Grass did not require any incorporation into the soil in order to take effect.[39]

Hoechst was not the only agrochemical company promoting their products as being beneficial for soil conservation. In 1976, Monsanto made Roundup commercially available to farmers in Canada (Bayer Crop Science, 2020, December 15). Roundup, with its main ingredient glyphosate, is a broad spectrum herbicide that kills broadleaf weeds as well as grasses. It inhibits the enzyme primarily responsible for the production of several amino acids. By 1978, Monsanto was "looking into integrated chemical and tillage systems"(Mitchell, 1984, p. 129) with research trials in the brown soil zone of the Prairies comparing "Conservation Fallow" (p. 130) systems including chemical only testing with zero tillage and chemical combined with minimum tillage. The results of Monsanto's study showed that chemical only systems conserved 7.5% more moisture than chemical combined with tillage systems. The chemical only systems also had a yield advantage of 2.5 bushels per acre. However, a 1984 cost analysis revealed that tillage costs averaged about $9.50 per acre, while chemical-only systems using Roundup averaged $22.58 per

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39 Hoechst (1984, p. 41) explains that Hoe-Grass and 2,4-D are called post-emergence herbicides that can be sprayed directly on weeds. Avadex is considered a preplant or preseeding incorporated herbicide because it must be placed below the surface where weeds germinate in order to take effect. This requires disturbing the soil, so post-emergence herbicides work better for CFP systems.

acre (p. 132). Thus, even though Roundup proved to be a much more effective broad-spectrum herbicide than anything else on the market, the cost prohibited most farmers from integrating it as their main herbicide. We return to a discussion of Roundup in the next section. By the late 1970s, the research stations and private industry demonstrated that chemical herbicides could replace tillage as the primary mechanism for weed control. However, the farmers needed more incentive to adopt herbicides as well as give up their summerfallow rotations. In the early 1980s, the federal government attempted to deliver that incentive by once again changing the definition of what constituted good farm practices.

The Sparrow Report

In 1982, the Honorable Herb O. Sparrow, then chair of the Senate Standing Committee on Agriculture, Fisheries, and Forestry, took a trip across Saskatchewan in a small, low-flying airplane (Sparrow, 1984). Raised on a farm near Vanscoy, SK, Sparrow immediately noticed the widespread presence of one of the telltale signs of soil degradation[40] on the Prairies: white, saline patches of alkaline soil marring the "breadbasket" of Canada (Sparrow, 1984, p. vii). This airplane trip inspired Sparrow to launch a two-year investigation of soil degradation all across Canada, which culminated in *Soil at Risk: Canada's Eroding Future*, also known as the "Sparrow Report" (Sparrow, 1984). Delivered before the Senate on February 7, 1984, Sparrow called soil degradation "the most serious agricultural crisis in its [Canada's] history" (p. 1) and cited "the wheat-fallow rotation cropping system" (p. 45) as being responsible for losses of soil

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40 Alkaline soils contain a high concentration of soluble salts, which inhibit plant growth (Henry et al., 1987; Stepphun & Curtain, 1992). Although alkaline soils are the result of salt accumulation from the long-term weathering of rocks and minerals and evaporation of ancient seas, farmers also contribute to this accumulation, as salts move up from lower soil horizons to the surface. Deep tillage brings salts to the surface, but more importantly summerfallowing also contributes to this process. It results in a rise in the underground water table that goes unutilized by plants during the fallow season. As the water table rises, salts move to the surface and are deposited, thus causing "white spots where nothing grows" (Henry et al., p. 3).

organic matter and declining productivity within the Prairies. To reverse soil degradation on the Prairies, Sparrow recommended incorporating practices already in use by "committed conservationists" (p. 28) including conservation tillage, the use of herbicides rather than tillage for weed control, and minimizing fallow rotations in favor of continuous cropping. Sparrow considered zero- or no-till systems the "ultimate form" (p. 47) of conservation tillage because these systems maintained a permanent cover of crops or stubble on the surface at all times, therefore limiting soil erosion and reducing water runoff by trapping snowmelt.

Sparrow's report concluded with 20 recommendations for all levels of government to begin a nationwide soil conservation project. He called for a campaign designed to increase public awareness of soil degradation including environmental courses for primary and secondary schools, as well as through public education initiatives such as "running 30-second conservation advertisements instead of beer commercials during hockey games" (p. 32). He emphasized the need for more applied research on conservation tillage and herbicides through the federal Experimental Farms and Research Stations and asked for these federal lands to become "conservation showcases for the nation" (p. 13). Sparrow highlighted to importance of "providing financial incentives…to farmers…to help defray the costs of conservation practices," including tax credits for the purchase of conservation tillage machinery, fertilizers, and herbicides. Finally, Sparrow called on provincial departments of agriculture, federal Research Stations, universities, farm organizations (e.g. Manitoba-North Dakota Zero Tillage Farmers' Association), and the Prairie Farm Rehabilitation Administration (PFRA) to provide more information transfer about soil conservation through meetings, on-farm equipment demonstrations, and on-farm research trials.

The Sparrow Report brought nationwide attention to soil degradation with 50,000 copies printed for use in Canada and around the world (Saskatoon StarPhoenix, 2012). In my interview with Samantha G. and Charlie A., two employees within the Agriculture and Agri-Food Canada (AAFC) communications and technology transfer division in Regina, both agreed that the Sparrow Report represented the turning point in the shift towards conservation tillage systems. Charlie worked for the PRFA from the early ’80s until he took this job at the AAFC in 2004. As he explained, after the report, soil conservation became “politically and scientifically in vogue” (Samantha A. and Charlie P., October 7, 2014). Additional funding provided by the federal government for research and extension activities on soil conservation work was funneled into the core budgets of the research stations, provincial governments, PFRA, and farm organizations (Sonntag & Lindwall, 2010). Some provincial funding through the Economic Regional Development Agreements (ERDA) was given to farmers to purchase Roundup for experimental use on their fields (Ward et al., 2010). ERDA evolved into the National Soil Conservation Program (NSCP), administered by the PFRA. This program funded the general operations of farmer organizations such as the Manitoba-North Dakota Zero Tillage Farmers Association (ManDak), the Saskatchewan Soil Conservation Association (SSCA), and the Alberta Conservation Tillage Society (ACTS)—all established in the late ’70s and ’80s. The PFRA, along with scientists at the Research Stations, worked closely with farmer organizations to host farmers for field days, informational meetings, and equipment demonstrations. Dr. Jeff A., a former research scientist at the Station, explained in our interview:

> When I arrived in '86 it was quite an exciting time. There was a lot of keen interest in the community in our work on cropping systems, well particularly direct seeding and no till systems(…)We’d hold field days at that time and you’d get hundreds of people and over a thousand at the big meetings(…)At some point though we realized that it’s best to work on getting the early adopters to give anecdotal stories of their experience. ‘You know in my experience this is best’ sort of anecdotal

> stories work better than all the scientific evidence-based stuff we presented (September 10, 2014).

Indeed, within the pages of conference proceedings, titles such as *Soil Conservation: A Resource Worth Saving* (Swift Current, 1986), *Soil At Risk* (Hanna, 1985), *The Optimum Tillage Challenge* (Saskatoon, 1984), *Risks and Rewards of Several Tillage Reducing Technologies* (Saskatoon, 1986), and *The Saskatchewan Direct Seeding Workshop* (Lloydminster, 1994) farmer testimonies were always included, along with workshops for farmers to discuss practices with the early adopters. Some of the testimonials from early adopters, including those from Jim McCutcheon and Robert McNabb, came from key individuals involved in creating and leading ManDak, SSCA, and other farmer-run soil conservation organizations. These farmers circulated the soil conservation technology transfer scene of meetings and field days as much as scientists and extension personnel from research stations and the PFRA. They proved "invaluable with their 'across the fence' discussions at these meetings and with neighbors at home" (Samantha G. and Charles A., October 7, 2014). Farmers like Jim Halford not only designed machinery to make zero-tillage farming possible (like the Conserva Pak air drill), but also gave presentations at meetings and helped scientists, extension workers, and equipment manufacturers identify issues that were preventing farmers from adopting conservation tillage. In Halford's 1984 presentation given at *The Optimum Tillage Challenge* meeting, he highlighted issues he confronted during his own shift to conservation tillage which included concerns over economics, availability of parts, efficiency and timeliness, and seeding machinery. Additionally, Halford gave attention to the "psychology" or "human side" (p. 9) of the issue, including the appearance of fields, the level of patience required to adopt new technology, the color of machinery paint,[41] and the fear of a

41 Most farmers from this project demonstrated a clear preference for specific brands of farm machinery for example John Deere and Case IH. Each brand has a signature colour (e.g. John Deere Green). At times, the colour is used in place of the brand name in conversations amongst farmers. "If it isn't Red [Case IH], leave it in the shed."

neighbor's gaze. In fact, he recommended the formation of therapy-style groups in the form of tillage clubs to help farmers navigate these psychological issues, and was partly responsible for the creation of SSCA in 1987. He worked closely with scientists such as Guy Lafond at the Indian Head Research Station in the 1980s developing and researching zero tillage practices, thus creating a "hotbed of zero-till activity" (Willerth, 2010, p. 98) at Indian Head that radiated out across the Prairies. The scientists from the Swift Current Station and from the Indian Head Station, along with early adopters, worked in coordination with the PFRA to help inform prairie farmers on the advantages of conservation tillage.

Another Round of Prairie Farm Rehabilitation

As we saw in Chapter Three, the PFRA played a pivotal role in stabilizing the unruly soils of the Prairies. In the 1980s, they worked closely with farmers to assist them as they adopted herbicides and conservation tillage practices. Charles A., formerly of the PFRA and now working for AAFC, explained in our interview that part of his tactic for making farmers aware of soil conservation issues was to "guilt people." As he said:

> First off we guilted people (laughing). We'd say "look what you're doing to your soils" and "it's a matter of time," and we had the hourglass graphic. "It's a matter of time and your soils will erode away." We had commercials and TV venues. We did a lot for creating awareness around the issue of the day and that practices you were doing were not sustainable or appropriate for day and time(…),We even did things for school kids because kids are sponges that take the stuff home and tell their parent, so we're making the connection between generations(…),So we had numerous programs from '85 to the last program I ran was green cover, so that was 25 years of programming to adopt the beneficial management practices with a big push on soil conservation (Samantha P. and Charles A., October 7, 2014).

The programming Charles is referring to was various cost-share initiatives for equipment purchases as well as numerous informational meetings and equipment demonstrations to teach farmers about conservation tillage. Even with all the guilting and programming, farmers were slow to adopt conservation tillage. In 1995, less than 10% of Prairie farmland was seeded using zero tillage systems (Awada et al., 2016). In addition to the aforementioned psychological hang-ups, people like Kent P.—who currently works for Western Grains Research Foundation but from 1990-1995 worked as a Regional Conservationist for the Saskatchewan Soil Conservation Association—described the perceived risks associated with converting in this excerpt from our interview:

> Katie S.: What, in your opinion, was holding them back from switching to zero-tillage technologies?
>
> Kent P.: Well of course there was the risk of changing and failing and then losing your farm.
>
> Katie S.: Yeah well that's huge.
>
> Kent P.: And I know of people that it happened to. Whether it was too early and the equipment wasn't as good or because things were so expensive or because interest rates were higher, people were losing their farms. It was real.
>
> Katie S.: The '80s were certainly hard times for U.S. farmers.
>
> Kent P.: Here too. It was dry, dry times. Interest rates were at 18%. Oh yeah these weren't good times…The farming community was so negative about farming. Basically saying, "We don't want our sons and daughters to go into agriculture—anything but agriculture"(…)So what we were doing and what the federal researchers were doing was trying to help reduce the risk for farmers. If they were going to lay out 100,000 for a new piece of equipment, then we would have all kinds of field demonstrations to help them make the best decision, with seeding equipment in particular.

Having farmed through at least two multi-year droughts—the first in the '60s and the second in the '80s—John A. described his choice to use summerfallow as an insurance policy. John, the zero tillage farmer from Chapter Three, works with his daughter and son-in-law and is highly regarded by other chemical farmers in the area. However, during those decades, he felt very negative about the future of farming:

> Our land, it just blew like crazy. We had days in the ’60s and ’80s when you couldn’t see the shop sitting across the yard from the house. But we felt like summerfallowing was the only way to get a crop in this drought land. At least you’d get something, ya know. You’d have some moisture stored from fallow to get a crop the next year. It was our only insurance in those years (John A., October 24, 2014).

A few things changed in the mid to late ’90s that led to a dramatic increase in the use of zero tillage technology. First, drought-resistant varieties of lentils and canola became available during this time that helped farmers diversify their crops from cereal-fallow rotations, to cereal-pulse-oilseed rotations (Huan L., May 15, 2015). Lentils and canola became profitable crops that helped farmers make the financial leap from seeding land in alternating years, to seeding their land every year. Research led by agriculture economist Robert Zentner from the Station, conducted cost-benefit analysis to confirm continuous cropping with conservation tillage was profitable for farmers in the brown and dark brown soil zones (Zentner et al., 1991). Farmers needed this economic reassurance because to shift from wheat-fallow rotations with very few inputs to wheat-lentil-canola rotations with herbicides and fertilizers required more money. Additionally, to purchase sprayers and conservation tillage seeding equipment necessitated large capital investments, so farmers needed to know that they could recuperate their costs. This economic reassurance, combined with consistent meetings and demonstrations from the PFRA and the Station to prove the feasibility of conservation tillage, helped convince farmers that an alternative system was possible on their farms. Second, seeding technology improved, which allowed farmers to maintain all their stubble on the surface, while still getting accurate and uniform seeding, as well as fertilizer placement, with single-pass operations (Rick J., September 17, 2015). And finally, as the patent on Roundup was due to expire in 2001, Monsanto made a clever move that ensured their product would remain a critical component of conservation tillage systems indefinitely; the company decreased the price by about 50% in the mid-1990s before the patent expired (Gray, 2010). In my interview with Leonard W., a chemical farmer in his late 70s, he cited all of the above reasons (machinery developments, lentils, and Roundup) as contributing factors to his own conversion to 100% zero tillage. As he explained:

> The most difficult part was getting a machine that would seed into the residue that you had…When I first started questioning our fallow rotation, we had a Noble hoe drill that I was going to alter myself to minimize soil disturbance by changing the tips where the seed comes out from a round pipe to a narrow point, but then in '82 or '83 a tax incentive came through for machinery for soil conservation. Swift Current had a demo on a Flexicoil drill and I thought, "This makes more sense." That tax credit came through and I bought a Flexicoil(…)Early on we didn't use chemicals. The Flexicoil had shovels on it for weeding so it was a weeder/seeder. Then I don't know if you know Peter Moore, but he worked at the Swift Current Station. He helped me a lot. He worked for us and ran machinery and did tests out here. Well he was the first guy to try glyphosate out here. He had a bit of Roundup and wanted a place to try it out. Well it worked great but at that time it was 28, 29 dollars a liter, expensive(…)We tried a few different things pre-seeding like blades, cultivators, and rod weeders but nothing worked nearly as well as a glyphosate burnoff and direct seeding. Once those prices came down, it became pretty critical for our operation. It's pretty critical that we don't lose the ability to use these chemicals(…)The pulses or lentils actually came in the '70s as I was trying to extend my rotation(…)I went to conferences on all this stuff. I remember one in North Battleford very well. It was a tipping point for me. People were telling us, "It [conservation tillage] will work." It may have been there that I heard Bob Zentner's presentation on the most profitable rotation. It was lentils-durum, so that's been critical ever since (Leonard W., August 19, 2015).

Many of my discussions with farmers around Swift Current, revealed similar experiences of gradual transitions into zero tillage that started with chemical fallow and evolved into continuous cropping with lentils:

> So when I was younger and growing up, you know the methods of farming were basically you would summerfallow half of your land and seed half of it. And the thought behind that was it was too dry here to continuous farm, and so of course you had to conserve some moisture, so we spent all summer trying to kill weeds. We were tilling, yeah four or five times through every summer, and so we were only utilizing half of our acres. So since I would say early '90s, I got into farming with different machinery like air drills

> instead of old-style discers and that drastically changed farming(…)Within five years we were completely no till and around 2000, we moved ourselves right off of summerfallow. My dad thought the chemicals were too expensive, but when we introduced the pulse crops like lentils, it started to pay the bills and there weren't too many questions asked anymore (Ronald H., August 25, 2014)

In this quote, Ronald H. describes the shift in tillage and seeding practices from his childhood when summerfallow was kept tilled all season to zero tillage with an air seeder and herbicides. Ronald H. is a large chemical farmer near Wymark who currently farms with his son, daughter, and son-in-law. Ronald's father did not support his son's decision to get rid of summerfallow rotations because he thought continuous cropping would strain the farm financially. As soon as Ronald proved the system to his father with financial success, his father accepted continuous cropping and the zero tillage system. In the next quotes, Brian F. describes a similar transition to conservation tillage.

> Dad would cultivate the land, make it all black. In our summerfallow like the ground was always black, black, black kind of thing. My dad never changed farming practices from the time he started until he quit. When I did start, probably in about '98 or something like that, I rented land and switched to zero tillage right away. Dad disagreed because, like, he always used discers and summerfallow every year, every year, every year kind of thing(…)Dad was basically organic, but one year his wild oats just got way out of control, so he went to town and rented a sprayer that year. I had never sprayed in my life of course, so I filled up the sprayer and then what do you do? Like what do these gauges mean kind of thing [laughing]. Well as soon as we started direct seeding with a Flexicoil air seeder, well then you always pre-burn Roundup before seeding and now you can use chemical while it's growing with lentils and canola (Brian F., August 22, 2014).

Brian farms east of Wymark with his five sons. They also raise beef cattle, dairy cattle, and chickens. In this quote, Brian is referring to Roundup Ready canola, which became available to Canadian farmers in 1995 (Holm & Johnson, 2009). Roundup Ready canola has been genetically modified to be resistant to Roundup, thus it can be sprayed even after it emerges from the soil for in-crop weed control. Similarly, Clearfield lentils bred by the University of Saskatchewan's Crop Development Centre (CDC) first became commercially available to farmers in 2006 (Saskatchewan Pulse Growers, 2012). Marketed through BASF, Clearfield lentils are bred to include a trait for tolerance to imidazolinone herbicides such as Odyssey—also a BASF product (Barker, 2020). As with Roundup Ready canola, Clearfield lentils can be sprayed with products such as Odyssey for broad-spectrum weed control while the crop is growing. With herbicide-tolerant crop varieties, agrochemical companies like Monsanto created production systems in which farmers purchase seed and chemical from a handful of companies and are required to sign commitment forms. For example, for Clearfield lentils, when a farmer purchases lentil seed from BASF, they must sign a form with a number of conditions attached to its growing (BASF, 2020, December 15). Among other things, farmers are only permitted to use BASF herbicide products, like Odyssey, on these lentils, and they must submit to audits and inspections of their farms (including crop sampling and providing access to all business records that relate to Clearfield lentils). Further, if they clean[42] and resell seed to other farmers or use the cleaned seed themselves, that sale must be reported and the lentils submitted for testing at BASF to make sure no other herbicide products were used. For Clearfield canola, there is also an additional yearly fee of $70.00 attached to every 22.7KG bag of canola seed purchased (Corteva agriscience, 2020, December 3), and farmers are not allowed to clean their seed to grow or sell beyond the

42 Seed cleaning refers to the process of sorting the seed out from all other materials that are picked up with the combine. These other materials include weed seeds, rocks, grain chaff, and insects. Some farmers have the equipment to clean their own seed, while others pay seed cleaners for their services. Seed cleaners have either mobile or stationary seed cleaning plants. Of the seed cleaners I have met, they both own mobile plants that are hauled to farmers' yards throughout the winter.

first year of purchase. As with Roundup Ready canola, Clearfield Canola seed must be purchased by an authorized dealer every year.

From Farm Kid to Chem. Rep.

One might ask why farmers like as Brian are willing to submit to these restrictions when their families have been able to clean and regrow spring wheat and durum seed on the Prairies for several generations. One possible explanation that occurred to me during my research, is that companies like Monsanto have been nurturing their relationships with farm communities and research establishments like the Swift Current Station since the 1970s. Private companies have been conducting research trials on conservation tillage alongside public researchers from the Stations, provincial governments, and Prairie Universities and have forged relationships with farmer organizations like MANDAK and the SSCA by sponsoring their events, technology demonstrations, and publications. For example, in the 1993 SSCA audit report, they list Monsanto Canada as having contributed $19,450 of their total $93,081 total cash revenue for previous year. Additionally, the audit reports that, "SSCA has formed a partnership and signed agreements with TransAlta Utilities and Monsanto Canada for $1.15 million over 3 years. These agreements will enable the SSCA to continue its Direct Seeding Programs…These agreements and proposal (if approved) will be the largest private sector financial commitment to soil conservation programming ever made in Canada" (SSCA, 1993, p. 9).

According to SSCA researchers McClinton and Polegi (n.d.), the project with TransAlta and Monsanto was approved, although Monsanto only contributed $400,000. In *Saskatchewan Soil Conservation Association (SSCA)-History*, McClinton and Polegi explain that prior to the agreement:

> Monsanto had noticed that Roundup sales were growing in Saskatchewan, but not other provinces. They identified SSCA as a key driver behind direct seeding in Saskatchewan and wanted to ensure SSCA's programs continued(…)There were concerns that SSCA's independence, real or perceived, would be lost due to the large corporate funding component (pp. 8-9).

In the 1994 Lloydminster *Saskatchewan Direct Seeding Workshop* hosted by SSCA, the conference proceedings booklet included a description of a competition for best "Farmer Modified Direct Seeding Equipment," organized by SSCA and sponsored—in big bold letters—by Monsanto (p. 2). Also included in the booklet, is a form to order a *Direct Seeding Manual* written by SSCA and the Prairie Agricultural Machinery Institute (PAMI) and "supported in part" by Monsanto (p. 3). The conference booklet also includes a 14-page fully colored and illustrated pamphlet titled *Roundup Herbicide: A Farmers Guide for Controlling Annual and Perennial Weeds in Reduced Tillage.* Within the guide, Dr. Guy Lafond, research scientist from the Indian Head Research Station, is quoted as saying, "With weed control, as tillage decreases, you must depend on herbicides for weed control. Generally speaking, we always encourage a fall spraying to control winter annuals" (p. 3). *Roundup Herbicide* includes farmer anecdotes about using Roundup in zero tillage systems, a chart showing weeds controlled by Roundup, and a short guide on application instructions. The guide also clearly states, "Roundup is an extremely safe herbicide, both for the environment and for the applicator. Roundup has very low toxicity and is unlikely to harm humans, domestic animals, wildlife, or the environment, when used according to label instructions" (Monsanto 1994, p. 5). In 1997, MANDAK released a guide of their own titled, *Zero Tillage: Advancing the Art* and sponsored in part by Monsanto and Ducks Unlimited Canada—strange bedfellows indeed. In *Advancing the Art,* zero tillage as a practice is promoted as a method for improving the environment because it preserves and builds organic matter, which then "reduces the amount of CO_2 in the atmosphere where greenhouse gases may already be excessive" (p. 4). We will return to this idea of zero tillage creating carbon sinks in the final section of this chapter. "Soil erosion has reduced the capacity of people to feed themselves and civilizations have collapsed as a result" (p. 4). They promote zero tillage as "the perfect system" (p. 4) and explain that, "Without doubt less expensive glyphosate, the non-selective herbicide used in place of tillage to control weeds, gave farmers the means to adopt zero tillage" (p. 4).

In addition to these types of partnerships, Monsanto and other agrochemical companies built trust within the community through providing employment opportunities for the children of farmers. I came across numerous examples of this throughout my time in Swift Current, but one experience stood out in my mind-perhaps because it involved Monsanto. In February of 2015, I attended the annual Pulse Winter Meeting in Swift Current. The meeting had over 100 attendees, and featured speakers from the Swift Current Research Station, as well as the provincial government, prairie universities, and private companies. Topics of discussion included new lentil varieties, disease issues in pulse crops, and marketing opportunities. I spotted Christy S., the professional agrologist who taught me all about soil testing earlier that fall, and took a seat next to her. She introduced me to everyone at the table, which included two other P.Ag.s, as well as Jason, a "chem rep from Monsanto." I immediately felt curious about the chem rep because he was the first person I had ever met who worked for this infamous agrochemical company. We sat and listened to the presentations all morning, but at lunch there was finally an opportunity to talk more with Jason. He asked numerous questions about my research and life prior to living in Wymark and seemed genuinely interested in the conversation, particularly in my stories about Wyoming. As it turns out, Jason grew up on a small farm near Assiniboia, SK. He explained how his family sold the farm because they could not keep up with costs of production. Jason now lives on a small acreage outside of Swift Current with his wife and three kids. He described the acreage as a substitute for living on the farm but lamented not being able to give his kids a childhood on his family farm like he had. The other P.Ag.s at the table agreed when Jason spoke to the near impossibility of small farmers surviving these days, but they all felt thankful for their jobs in agriculture, which are mostly supported by the larger farmers in the area. This is undoubtedly a brilliant strategy on Monsanto's part, but what seemed to matter the most on that particular February day was Jason's thankfulness for being able to give his children a rural upbringing.

This was not the first time I had heard about small family farms succumbing to the financial burdens of 21st century agriculture, but it felt like an interesting moment because Monsanto provided Jason with an opportunity to continue living in southwest Saskatchewan and working alongside farmers. Jason was not a well-polished corporate guy giving me a rehearsed company line. Rather, he was a farm kid who grew up never feeling like Monsanto was the enemy, and was thankful for the lifestyle his job made possible. Arguably companies like Monsanto are at least partially responsible for the demise of small family farms; numerous farmers from my project complained about the rising costs of herbicides. However, in my discussions with P.Ag.s working with numerous agrochemical companies, they all expressed gratitude for employment opportunities in their hometowns. Companies like Monsanto have partially picked up the pieces of crumbling rural communities on the Prairies where federal and provincial governments and other employment opportunities have failed. Private agrochemical companies nurtured relationships with farm communities throughout the 1990s. They also solidified their place in the structure of public agricultural research by becoming regular financial contributors to major research funding organizations and AAFC research funding programs called the Agri-Science Clusters.

Private-Public Research, Producer Groups, and the Check-offs

Through my interviews with the scientists and technicians at the Station, I learned that in the l990s, the structure of their projects' financial support changed significantly. As Yvon Martel (2013), the chief scientist at the International Research Branch of AAFC in Ottawa explained, "In 1995, the Agri-Food Research and Development Matching Investment Initiative (MII) was created through which, the Department [AAFC], producers, and industry jointed funded hundreds of agricultural research projects" (p. 19). Prior to this time, they relied on A-base funding, which was money that came from AAFC to support the projects of scientists at the research stations. Although the process of receiving A-base funding changed throughout the years, in general the scientists, the Station Director, and supervisors in Regina or Ottawa deliberated the value of a project amongst themselves then allocated funds to support those projects deemed worthy. They reviewed projects each year with a council of farmers to gain their input as well. Overall, most funding decisions were made by the scientists and the Station Director and the majority of the money came directly from public funds channeled through AAFC. Although private research partnerships occurred before the 1990s, as we saw above with Chipman Chemicals, these partnerships were not part of the financial structure of public research funding. As Dr. Tom N., a genetics scientist in the cereal breeding division explained:

> Really the change to external funding was probably between the '80s and '90s. The '80s was still the old system, although some scientists were getting external funding at that time through contracts with private companies. But those few people were the ones paving the way to a different system. There wasn't so much external funding back then. As we moved into the '90s, funding agencies started to appear that hadn't been around before and we're gaining access to funds that traditionally weren't available to us. For example, there's ADF, which was a provincial funding agency(…)Producer groups also

> came onto the scene as grain check-offs became more common" (Tom N., January 27, 2015).

To understand the current funding situation, I want to unpack Tom's quote to define a few important changes to research funding. He mentions ADF above, which as Tom says, was a provincial funding agency that usually supported the universities rather than the federal research stations. That changed in 2007 with an initiative called Growing Forward, which involved the collaboration of the Ministers of Agriculture from the federal, provincial and territorial governments (Government of Canada, 2021, February 1). Growing Forward channeled federal funds into provincial programs, such as ADF, to support research, while allowing provincially-based organizations to make the final decisions on research projects (Samantha G. and Charlie A., October 7, 2014). Samantha G. called Growing Forward, "a cost-sharing program between AAFC and the provincial governments to fund crop insurance programs, business risk programs, disaster programs, research, and clusters that are all run provincially. This gives the provincial governments a lot of power." Samantha mentions the clusters, which I also heard several scientists refer to as well in the context of telling me who funded a specific project. I heard the Station scientists mention the Beef Cluster and the Pulse Cluster. Clusters form as the result of farmer check-off money. As Gray explains:

> producer check-offs are created through government policy that gives industry the ability to introduce a 'check-off,' 'a levy,' or 'a tax' on the sale of a product. Proceeds are typically put into a fund controlled by producers who decide how to invest it in agricultural research" (2014, p. 10).

Once a check-off has been created, farmers form producer groups such as Sask Mustard, which began in 2004 when the Saskatchewan Mustard Development Commission —comprised of mustard growers—voted to collect a 0.5 percent refundable levy on gross sales of mustard. An elected board of members for each producer group reviews research applications and contributes money for projects at the Station and other research institutes.

Some producer groups like Saskatchewan Pulse Growers and Sask Canola (a provincial producer group linked to the national industry association, the Canola Council of Canada) accept additional funding from AAFC and private industry partners to supplement their research funds (Samantha G. and Charlie A., October 7, 2014). This funding arrangement is called a “science cluster,” and it is through these clusters (i.e., Canola/Flax Science Cluster, Beef Science Cluster, and Pulse Science Cluster) that most Station scientists fund their projects. For the year ending August 31, 2015, Saskatchewan Pulse Growers recorded an “industry revenue” of $18,327,882 on the levy, $225,280 from industry partnerships, and $168,860 from AAFC (Saskatchewan Pulse Growers, 2015). The first four “core funders” listed on the Canola Council of Canada (2017) include ADM, Alberta Canola, BASF, and Bayer Crop Science. ADM, BASF, and Bayer Crop Science are all private agribusinesses. Thus, producer groups form powerful relationships with AAFC, the Saskatchewan Ministry of Agriculture, and agrochemical companies through their collection and distribution of research money.

As Tom N. explained in our interview, with these new funding agencies such as Sask Mustard and the Canola Cluster, the scientists shifted into a “proposal-driven” approach (January 7, 2015). Other scientists at the Station called it a “grant-based” approach to funding. This grant-based approach did not completely replace A-base funding as all of the scientists at the Station still receive A-base funds; however, it did change many aspects of the research process. First, according to Samantha G. and Charlie A. from the AAFC office in Regina, it made AAFC “a silent partner” (Samantha G. and Charlie A., October 7, 2014). Although Growing Forward consisted of 60% federal funds and 40% provincial funds, “Everything that the farmer sees in the way of extension pamphlets or website information has either the provincial letterhead on it or the producer groups' letterheads. Basically, our interface with the public is stripped away" (Samantha G. October 7, 2014). In this quote Samantha is describing how the Station and other AAFC institutes do not present research information to the public themselves. Extension information is transferred to the farming public via websites, pamphlets, and meetings organized by either the provincial government or producer groups such as Sask Pulse. Sask Pulse interacts with farmers through their Twitter account, website, webinars, conferences, and publications. They often include information based on the work of Station scientists but do not mention them specifically.

A second aspect of the research process that has been changed is the time allotted by the Station scientists to writing grants for funding. Almost all of the scientists and technicians I interviewed for this project complained about how much time they have to spend writing grants, writing reports, amending budgets for grants, and requesting grant money that has already been awarded by the funding agencies for equipment, personnel, travel expenses, etc. Scientists estimated that between 50 to 80% of their time each year is spent on these administrative tasks. This leaves very little time to work on the actual research projects. A third significant change that has occurred as they moved from primarily A-base funding to grant-based funding are the parameters of their projects. The scientists described for me how grants require very specific criteria including a three to four-year timeline on projects, a list of deliverable products as results of the research, and an experimental protocol for the field trials. On the subject of timelines, Jack M., a forage researcher at the Station, said:

> I do know that there is some research that doesn't get done because it's not viewed as an industry need. A lot of what comes into that category is long-term research because industry doesn't have the patience for long-term research where you need 30 years of information to show you, 'yes there is a positive or negative trend.' A lot of the funding is very short term, so you have to have a result in three, four years. 20 years doesn't meet their funding model. Let's put it that way. Unfortunately in arid environments you

> oftentimes need 20 years before you have a meaningful trend or result (Jack M., October 2, 2014).

Most of the research scientists I interviewed described three to four year timelines as negative constraints on their projects. In terms of project deliverables, all of the scientists are expected to write reports and papers for academic journals if they receive funding. However, other deliverables include practices, information, and crop varieties all with a wide environmental applicability. This detracts from research that is specifically geared towards the semi-arid desert of Palliser's Triangle. Dr. William O., a retired plant physiologist from the Station who worked in cereal breeding, described this issue of deliverables:

> We'd get a proposal rejected and the boss [Dr. Frank D., head of the cereals division] would say, 'we need a plastic wheat. That's what they [funding agencies] want. They want a wheat that no matter what the conditions are, it responds favorably.' We'd say, 'well okay, but what the hell's a plastic wheat anyway? Like where do we begin and if you're asking for a yield increase of 40% no matter what, well good luck boys' (William O., May 28, 2015).

William discussed the frustration of producing deliverables, in the form of new wheat varieties, to satisfy the "moving target" demands of funding agencies as well as the variety registration process of the Canadian Food Inspection Agency. He described the process of external funding as akin to "sales pitches to private industry" rather than peer-reviewed A-base funding. Dr. Carolyn M., a scientist at the Station who studies soil phosphorus, also described her frustration of deliverables, especially when they do not meet the expectations of funding agencies. To provide context, in the following quote, Carolyn is describing a project she worked on with two other Station scientists. In the project, they tracked the contents of moisture runoff in fields where cattle grazed on bales of hay over the winter. The runoff that is created when the snow melts, often includes significant amounts of nitrogen, phosphorus, and other nutrients that can become pollutants when they move into creeks and sloughs. Carolyn said:

> One of the first bale grazing projects that I did when I first came here was with Aidan G. and James A. and they had ADF funding and funding from the Sask Cattle [a producer group]. I don't think they [the funders] were 100% happy with it. In fact, when we tried to renew the project through ADF, they basically told us, 'we only want the good news.' They wanted us to talk about how these nutrients from bale grazing stay in the soil. They *did not* [emphasis original] want us to look at the runoff. So they were willing to fund us if we did a project that only looked at the soil" (Carolyn M., October 9, 2014).

Carolyn went on to explain that she and the other researchers were unwilling to change their original project, so they did not get ADF funding. At the time of our interview, all of Carolyn's projects were 100% A-base funded and she said:

> I think it makes me more objective because there's no outside funder potentially driving any of this. There's no producer group with an agenda. That is always the worry with depending on industry money. Industry may, for example, not want to know about the impact of glyphosate on soil microorganisms. So I would say that what I do makes me far more impartial (Carolyn M., October 9, 2014).

Carolyn's colleague, Dr. Aidan G., a forage specialist, said in his interview that while external funding encourages scientists to be more "attuned with what industry wants and that helps farmers in the short term," external funding will not cover long-term projects or those that are no longer "the flavor of the month" (November 5, 2014). Aidan used soil salinity research as an example and explained that while there are still many issues with salinity and alkaline patches within Palliser's Triangle, external funders no longer want to support those projects because they consider the issue "figured out and no longer necessary."

In terms of the research protocol that scientists must follow to get funding, several described feeling troubled by the extensive use of herbicides and fertilizers within the research plots. For many projects, the scientists must provide a description of the field practices in which their experiments take place in the grant proposal. The expectation of many funding agencies is that the research protocol will align with the dominant system of herbicides for weed control, fertilizers for nutrient management, and pesticides for insects and crop diseases. Using these inputs also makes the research process easier because scientists are able to eliminate some variables as impactful on their research results such as weed pressure and nutrient deficiencies. However, this also means that the results do not transfer as easily to organic farming contexts where inputs such as fertilizers, herbicides, and pesticides are not used. In the case of the organic research trials from the Station, Dr. Alessandra R. and Dr. James A. had to describe their trials as low-input rather than organic, otherwise they would not get funded. Dr. William O. discussed how the use of herbicides and fungicides impact wheat breeding research: “You select for an awful lot of things out there when you grow these plants. You don’t just select for what you think you’re selecting for. If you’re treating with a certain herbicide or fungicide, well then you’re selecting for a favorable result from those applications” (May 28, 2015). Overall, the trials at the Station, following the research parameters of funding agencies, create certain types of projects at the expense of others.

In a conversation at the Library with James A., we began discussing his work in conservation tillage. James said that when he arrived in the early 1980s, the work on conservation tillage was so new that many researchers considered a conservation system unpractical and uneconomical (Strand fieldnotes, 2014). He described the research at that time as the result of the Station scientists having “curiosities” about the potential of zero tillage systems. James believed that in the current financial structure, this research would never have been funded because the grant proposal could not support pursuing something considered uneconomical. He explained that in the 1980s, the scientists were encouraged to spend at least 15% of their time on “curiosity projects.” At this time, the financial structure was almost 100% A-base funding. Nowadays scientists at the Station still do “curiosity” research, but they have to find creative ways to add this type of work to their proposals or alternatively, they carry out "curiosity" research outside of their grant-funded projects. They no longer spend 15% of their time on this work. James said that he was lucky to get a few hours each year on his "curiosity" projects.

To conclude this section, I want to discuss one final observation of my own about producer groups and clusters. What I found while observing meetings co-sponsored by AAFC, Saskatchewan Agriculture, producer groups, and private agribusinesses such as Crop Sphere and Pulse Growers, both in the winter of 2015, is that the producer groups and clusters blur the boundary between farmers and private agribusinesses as well as between public and private funding and research results. Farmers and private agribusinesses are often presented as a singular group called the industry. This suggests that the interests of farmers and agribusinesses are aligned and equally represented through the work of producer groups. In terms of the funding and research results, by citing a cluster as the funding source, it becomes difficult to ascertain exactly how much money came from public and/or private sources. I was able to find some of this information in the yearly reports of the producer groups, available on their websites. However, I doubt that most farmers would take the time to seek out this information. As mentioned above, when the results of projects are reported, it is often done through the producer group websites, without acknowledging the public research institute or scientists affiliated with the project. Private agribusinesses, through the funding structures of producer groups and clusters, have found a way to become closely involved in the research process of public scientists at the Station. As we will see in the next section, scientists risk losing their funding if they publish results that challenge private agribusinesses and/or their products. Funding agencies cannot risk losing some of their major private contributors, so they will reject the proposals of scientists whose projects do not align with the interests of the industry.

ZERO TILLAGE RELIGION

Dr. James A., in his interview with me at the Station, said:

> If you took someone from 1986—that's when I started working here—if you took them and plunked them down in 2013, they wouldn't even know where they were. You know the landscape is that different in terms of the crops grown, the lack of fallow, the types of machines used, the scale of everything, and so on (James A., September 10, 2014).

Rick J., the Station engineer discussed earlier, estimated that in the Swift Current area, there is close to 100% adoption of zero or minimum tillage, which changed the landscape from "black to yellow" meaning that without tillage, the ground is often more yellow in color because crop stubble covers the surface. Leonard W., one of the chemical farmers I mentioned earlier, said, "It's like we've created a container of stubble, residue, or organic matter I guess you'd call it. We've got a container over our fields, so you don't see the soil like you used to" (August 19, 2015). I wanted to understand how farmers created this "container," so in the spring of 2015 I spent many days riding in tractors while seeding with zero disturbance equipment. I described one of those days spent with John A. in the previous chapter. I also spent several days riding alongside a young farmer in his sprayer. This next section describes one of these days recreated from my fieldnotes.

Spraying with Derek

Derek is a farmer in his early 20s who works with his dad Ronald H. on their farm near Wymark. Derek's main job in the spring is to run the sprayer across each field several times. On May 13th, 2015 I met Derek near the ruins of a countryside schoolhouse southwest of Wymark to take my first ride in the sprayer. Derek and I were introduced the previous fall during harvest after I spent nearly 10 hours riding in a combine with his mother, Hannah. I had interviewed both Hannah and her husband Ronald that fall and learned all about their farm's history. They bought their first air seeder in the early '90s and began eliminating summerfallow rotations at that same time. Within five years, Ronald was proud to say, they had fully transitioned to zero tillage and continuous cropping. Now they seed with a 66-foot Bourgault paralink hoe drill which, according to Ronald, “has minimum soil disturbance and the capability of seeding, while placing fertilizer simultaneously in between the seed rows” (Ronald and Hannah H., August 25, 2014). Because they seed about 11,000 acres, Ronald will keep two tractors hooked up to Bourgault paralinks running as many hours as possible each day during April and May, in order to finish up as early in the season as possible. This is the same seeding equipment owned by John A. and described in the previous chapter.

As I pulled up to the abandoned school, I immediately spotted Derek moving across the field in the sprayer in a north-south pattern. The mid-morning sun illuminated the continuous mist of water and chemical flowing out of the nozzles mounted on the bottom of long, red metal arms (known as booms) that extended out of either side of the CASE IH machine (See *Figure 57*). I drove my Malibu towards the machine to park it near the end of the field where I knew he would make a turn to head south. As he approached the northern boundary, he slowed the sprayer down and cut the flow of water across both booms simultaneously. As I approached the sprayer on foot, noticing the “Patriot” branding emblazoned across the side of the machine, Derek stopped and opened the door, and greeted me with a big smile.

Figure 57. The Patriot. The photo shows Derek's Case IH high clearance sprayer with booms fully extended. Photo by Katherine Strand.

I climbed up into the sprayer, which sits high off the ground so that it can straddle atop crops during spraying later in the season. Sprayers always remind me of the monster trucks my brothers and I played with as kids because of their wide-set, tall wheels that look as though they could crush a line of Chevy Malibus. The cab was very comfortable; it sat two with large windows that faced out in every direction. An impressive sound system blasted Metallica as I pushed my backpack under the "buddy seat." Derek immediately apologized for the music and turned it down, explaining that he often listens to metal while operating the sprayer. We turned towards the north and using a controller mounted on the right side of the steering wheel. After increasing his speed to about 16 MPH, Derek pushed a button to engage the auto-steering. He pushed another button on the controller to restart the nozzles. As I looked out on either side of the cab towards the booms, a cloud of moisture bubbled out of the nozzles and wrapped around the awkward metal arms. The booms bounced slightly off the ground as they adjusted to the uneven terrain but always landed safely on small tires mounted on the end of the booms on both sides. After spending many hours in combines last fall, moving at speeds of about 6 MPH, this felt as though we were hurtling out of control across the field. Derek explained that he could spray about 120 acres in 50 minutes, his record being 1200 acres in one day—which had happened that spring. A large GPS screen above his controller helped him keep track of the machine's functions, displaying the water pressure level in each boom, agitation pressure in the tank (keeping the water and chemicals mixed), tank levels, and individual nozzle performance (See *Figure 58)*. Using GPS, a miniature icon of a tractor tracked the automatic movement of the sprayer on a digital field, as it ran along north-south lines. Each section of the field where spraying had been completed was indicated by a swath of green to the right of the icon. Another part of the screen indicated when particular nozzles shut off automatically to avoid spraying during slight overlaps between passes. Derek found this feature incredibly important because it prevented waste.

Figure 58. Derek in the Patriot. The photo shows the sprayer cab with controls and the computer GPS interface. Photo by Katherine Strand.

As we moved across the field, following north-south lines, Derek offered some personal information about himself. He'd graduated from high school two years prior and attended a local bible college for one year before moving back to the farm. He was currently sharing a farmyard with his parents and living in the “old house,” originally built by his grandfather in the ’60s. Derek began driving grain trucks for his parents at 14, and first operated the sprayer at 18. He has two older sisters, one of whom is married to the mechanic working for his dad. Neither of his sisters drive the sprayer because his parents worry about their ability to drive the big machine without crashing the booms into power poles. Derek grinned and said that he’d only once hit an electric pole, and that it hadn't caused a lot of damage. When I asked if he plans to continue farming with his parents, Derek immediately said “yes.” However, he does not plan to take over completely for many years. As he explained, it had only been in the last 10 years that his parents had experienced financial success at farming and have been able to expand their land. He wants to let them enjoy their success for at least a few years before he steps in as the primary manager.

With about one third of the field left to spray, Derek notices his tank levels were getting low, so he made a call to his brother-in-law to ask for another employee of the farm to bring the truck out for a refill. Within ten minutes, two men arrive pulling a flatbed trailer loaded with three large plastic tanks. We stop at the north end of the field as they park the flatbed trailer next to a tank attached behind the cab of our CASE IH sprayer. I jump out of the cab to stretch my legs and watch as the three men dump two white jugs of the herbicide Heat into the middle tank on the flatbed trailer. Next, they connect one hose from a water tank and one hose from a tank with a Roundup label to that same middle container on the flatbed. Derek starts an engine, which pumps all the liquids together into the middle tank, agitates them for a few second, then pumps them into the tank attached to the sprayer. The whole process takes about 15 minutes. As we watch the pumps in action, I joke with the three men, asking them why they aren't wearing the proper protective gear recommended on the Roundup label. All three laugh and shrug their shoulders. "We haven't grown a third ear yet," one of them tells me with a big smile. A smell of water drifts into my nose as I notice a faint mist surround us as we stand next to the flatbed trailer. It leaves me feeling slightly disturbed as I lean against the trailer next to the empty jugs of herbicide.

After about three more hours in the sprayer with Derek, we finish that first field, along with another one on the other side of the old schoolhouse. Derek shuts off the pumps and pushes another button which prompts the booms to fold inward to rest alongside the cab for transport back to the farmyard. This is Derek's last field for this season's preburn. His father and brother-in-law will seed these fields in two days and he will return in two weeks to spray everything after the crop emerges, a process which takes up most of June. In early to mid-August, Derek will take the sprayer out again to "desiccate" their crops in preparation for harvest. Prior to moving to Wymark, I had never heard of this practice. In order to limit the number of field operations required each year, and to homogenize stubble height so that zero tillage seeders can easily penetrate the surface debris, many farmers no longer swath their crops (a process that involves cutting the crops and laying it out in long rows to dry) prior to combining them. Rather, many farmers now spray the crop with glyphosate or another herbicide called Reglone to kill the plants while leaving them standing to be "direct-cut" by the combine. The crops are combined anywhere between two days to two weeks after this final herbicide spray, making it more likely that herbicide residue will remain on the grain from the time it's taken off the field, through its entry to a mill for processing. Standing outside the cab door as I said my goodbyes, a wind picked up and blew off my hat. Derek jumped down and ran for it. He handed it to me and noted that it was a good thing the wind had held off until now. As he explained, spraying in the wind can make the neighbors grumpy, especially if the herbicide drifts onto their crops and causes damage. The herbicide may drift but the soil certainly does not. The fear of soil erosion, coupled with the success of continuous cropping zero tillage systems, have ensured that very few chemical farmers seriously contemplate a return to the older system of summerfallow and mechanical tillage.

This is No-till Country

Dr. Murray Fulton, from the University of Saskatchewan, summarized succinctly the overall feeling I took away from my time in Palliser's Triangle about the predominance of zero-tillage, herbicide-dependent farming: "Zero-tillage, like summerfallow before it, is now locked in, both technologically and cognitively; simply put, at some point in the future zero-tillage will be as hard to dislodge as summerfallow was to dislodge in the 1970s and 1980s" (2010, p. xiii). Most of the chemical farmers I interviewed or spent time around followed a "recipe" almost identical to those of Derek and John described above. They all used the same herbicide products, following the same seasonal schedule, and most used Bourgault Paralink technologies. The latter similarity is not altogether surprising, as Brandon W., the former owner of a 20,000 acre farm north of Swift Current, explained:

> We use Bourgault Paralink hoe drills, which are zero-tillage and maximized accuracy seeding. I'd guess that Bourgault owns about two-thirds of the seeding equipment market in this part of the world. They are the best and you know a farmer's serious if he's willing to invest in the best equipment (Brandon and Diane W. September 26, 2014).

Bourgault, based in St. Brieux, Saskatchewan—with a population of just 590, according to Wikipedia—was established in 1974 (Bourgault, 2020, November 20). Using the designs of Saskatchewan inventors and equipment manufacturers such as Terry Friggstad, they understood where the future of farming on the Prairies was headed, and developed their designs to become the gold standard of conservation tillage implements. As Martin D., an older farmer based in Wymark, explained, "I started out with open-air tractors and six to eight-foot seeding equipment. Now my son runs a 76-foot Bourgault air seeder, if that gives you an idea of how the scale of farming has changed. I don't operate the airseeder; I have no idea how to run that thing (Martin D., September 4, 2014).

Steve E., a farm financial planner at MNP in Swift Current, described equipment produced 10 years ago as "archaic" when compared to the Bourgault Paralink technology, explaining, "Nobody wants to go back to pulling steel around all summer for fallowing. There's a few dinosaurs around here still 50/50 cropping, but most of the farmers have left it behind and don't ever want to give up their Bourgaults and sprayers" (Steve E., December 4, 2014). The zero-tillage system is now so entrenched that Hillary S., a crops specialist for Saskatchewan Agriculture in Swift Current, explained that her immediate response to a farmer experiencing weed issues was, “I’ll go and take a look at something and say ‘Oh you should spray it.’ That’s my default” (Hillary S., August 28, 2014). Hillary acknowledge why this is problematic, particularly because as a provincial employee, she’s supposed to advise all types of farmers. Hillary is a collaborator on organic agriculture projects with the scientists at the Swift Current Research Station and is an enthusiastic supporter of that work. However, as she later went on to say, “Advising organic farmers is difficult. Like we don’t really learn about alternative systems at U. of Sask. And chemical farmers don’t ever want to hear a recommendation of tillage for their weed problems, even if it would help” (Hillary S., August 28, 2014). In regard to research at the Swift Current Station, a former agricultural engineer explained that getting approval and financing for projects that contradict the zero-tillage approach is extremely difficult. In the late 1990s, Paul L., a retired engineer from the Station, was involved in a project looking at using crop stubble and residue as a renewable resource. The project involved collecting stubble from the fields, while still maintaining soil sustainability by returning some plant material to the field each year. He presented his project idea at a conference in Regina with the 550 agricultural researchers, extension specialists, and industry representatives in attendance. The following quote describes the reaction of his fellow conference attendees:

> Paul L. I was yelled at. I was screamed at. I was threatened. When I left the meeting, it followed me for months afterwards. People were really upset. Keep in mind that in North America, especially Saskatchewan of all places, we had led the whole introduction of conservation tillage. And we were seen as the gods of zero-till and here was somebody saying that we can now take some straw off the land. One of the premises of conservation tillage was maintenance of all residues, but what they had neglected to understand was there are areas of the province where residues are a real nemesis and a lot of energy is expended trying to get rid of them. Whereas we could use them to

> the good of society(…)At that conference, this was heresy. It was "lets burn this guy at the stake." I'm not kidding.
>
> Katie S.: What do you think they were so afraid of?
>
> Paul L.: They were afraid that they were wrong and had been wrong for so long that they would be embarrassed. Maybe they did go overboard(…)The problem is that straw or crop stubble has a C-N [carbon-nitrogen] ration of like 46 to 1. It can't degrade unless nitrogen is taken up from the soil, which increases the need for nitrogen fertilizer. If you don't have a 16 or 18 to 1 C-N ration, nothing degrades because bacteria can't live on it.

Paul fully acknowledges the benefits of preventing soil erosion, but he explained why the system is faulty because of this carbon-nitrogen ration issue in the crop stubble. It's an issue I myself witnessed in my observations and discussions with several farmers around Wymark who used harrows on their fields in the spring of 2015 to help the residue breakdown, otherwise their air seeders would not be able to penetrate the thick surface matter. Farmers use harrow implements, with either metal discs or tines, to pulverize crop stubble on the surface prior to seeding with air seeders. The harrows do not penetrate the surface but instead move across the surface, dragging the discs or tines across the stubble. The main point I hope to draw from Paul's quote above is that even though certain cracks are becoming apparent in zero-tillage systems, the paradigm of conservation tillage is now firmly embedded in the farming culture of Saskatchewan, including farmers, research station employees, provincial extension specialists, and the University of Saskatchewan. This loyalty to conservation tillage limits potential research that could improve the system and leaves the research establishment ill-prepared to deal with the cracks that are beginning appear in zero-tillage's future.

Tombstone Kernels

One of those cracks takes the form of Fusarium head blight (FHB), something I first heard about while attending the annual Crop Sphere conference in Saskatoon, in 2014. Dr. Anita

Brulé-Babel, from the University of Manitoba, gave a presentation at Crop Sphere describing her research in wheat breeding and developing FHB resistance in new wheat varieties. She described FHB as an epidemic causing severe yield loss in wheat crops across the Prairies. FHB, also known as scab disease, happens when wheat gets infected with *Fusarium*—the genus for many species of fungi. FHB is detected in wheat when heads and/or kernels shrivel and develop white, pink, and/or orange blemishes, indicating a fungal infection. When kernels of wheat take on this appearance, they are called tombstone kernels—meaning the fungus has already partially or completely killed the plant tissue and is now feasting on the dead cells. During her presentation, Brulé-Babel mentioned previous work on FHB conducted at the Swift Current Research Station, so when I returned back to Wymark I called Stanley, my farmer friend and reliable source of information about the Station, and asked about the history of FHB research at Swift Current. Stanley did not hesitate: "Well she's talking about Alessandra R. Yeah that's a story you'll want to ask her about." I associated Dr. Alessandra R. with the low-input (organic) project at the Station, but later realized that she was trained as a plant pathologist and had been conducting research in that area for many years on FHB. At the first opportunity, I stopped by Alessandra's office to ask about her FHB work. She looked visibly uncomfortable and said that she was unsure if she could talk about it. Sensing her discomfort, I dropped the subject with her immediately, and it was only much later that she finally agreed to discuss the issue with me. In the meantime, I kept hearing about these tombstone kernels.

A couple months later, I asked Magnus and Sharon M., an older couple who farm and run a seed cleaning business north of Swift Current, about FHB over dinner at Boston Pizza. The conversation came up as Magnus was telling me that he can no longer grow peas because of root rot, a disease caused by the fungus *Aphanomyces*. Magnus explained that because the fungus is now in his soil, it will never go away and will continually cause trouble, especially in wetter years. I said that this disease sounded like FHB and asked if he ever encountered tombstone kernels in his wheat or while cleaning seed. He replied, "Oh yes. We have fusarium." Magnus explained that many farmers around Palliser's Triangle hired him after the 2014 harvest to clean the tombstone kernels out of their grain. While there are apparently buyers for FHB-infected wheat, Magnus did not know what use anyone could have for it. Sharon interrupted and asked him to tell me the story about their friend near Rosetown, Saskatchewan. Because 2014 had been such a wet year, this particular farmer found that all of his wheat fields were infected with FHB. The percentage of tombstone kernels was so high, that he was forced to bury the entire wheat harvest in a big hole. Magnus said that he had also heard of farmers burning their wheat crops because of a bad FHB infection.

With Magnus's story fresh in my mind, during an interview later that week, I asked a plant breeder from the Station, Dr. Tom N., about the potential of breeding wheat varieties with FHB resistance. Tom admitted that nobody ever anticipated crop disease becoming a major issue in Palliser's Triangle because fungal, bacterial, and viral infections tend to be more common in wetter environments. However, since about 2009 FHB has become an increasing problem because of more precipitation, so Tom recently submitted a proposal to study FHB resistance in durum wheat. As Tom explained, breeding for disease resistance is very difficult because for something like FHB, multiple genes contribute to a plant's ability to fight infection. In other words, they cannot pinpoint a single gene that could be isolated and selected for in-breeding trials. I asked Tom what other factors contributed to FHB in the region and he replied, "One of the advantages of summerfallow is that you get rid of plant debris. It's buried, so that's a way of controlling disease. FHB and many other pathogens live saprophytically on crop residue" (Tom

N., January 27, 2015). Unfamiliar with this term, I asked him to explain, and he responded: "Something like Fusarium feeds on dead plant tissue. So with conservation tillage, there's very little ground disturbance and the crop debris is left on the surface. This is great for erosion control, but it favors disease cycles of pathogens because they can overwinter on residue." Tom also explained that private industry has many products for treating FHB, but these products only suppress fungal infections. Overall, he described FHB as an "issue of great concern for scientists and farmers."

As I was preparing to leave Wymark in the Fall of 2015 to return to Montreal, Dr. Alessandra R. contacted me to let me know that she was finally ready for an interview. We discussed many things including her early adult life Uruguay in the 1970s, prior to and after the coup d'etat in 1973. She came to Canada through the United Nations and studied plant pathology at York University. In the late 1990s, Alessandra worked on a project where she was conducting surveys along the eastern border of Saskatchewan in order to map how FHB was moving in from Manitoba. During the late '80s and early '90s, the pathogen first began to appear in Saskatchewan, after moving into Manitoba from Minnesota and North Dakota. As she explained:

> I got money for four years from the funding agency ADF to do a survey of fields in that area and try to correlate [FHB with] agronomic practices. But the agronomic practices I was trying to correlate were crop rotations, tillage, but then we also included herbicides and pesticides. So we collected data. Over the winter we'd call producers. When we started analyzing the data, there was a correlation, but it was completely unexpected. It was not an objective [of our research] (Alessandra R., October 20, 2015).

Alessandra and her colleagues from the Station found a correlation between the use of glyphosate (the primary ingredient in Roundup) and the presence of FHB: in those fields where glyphosate had been sprayed at least once in the previous 18 months, they found a higher frequency of FHB-infected kernels and the presence of FHB pathogens in crop residue. They found multiple species of Fusarium including *Fusarium graminearum,* the type that produces the mycotoxin called deoxynivalenol (DON) in wheat kernels, which is harmful when ingested by humans and livestock. Alessandra explained that these fields had also adopted minimum or zero tillage systems, so it is possible that both tillage and the use of glyphosate contribute to this correlation. However because minimum tillage systems are highly dependent on glyphosate, it is almost impossible to examine these variable independently to determine if tillage or glyphosate is more responsible. Although it was not clear how Monsanto first became aware of her work, as she prepared for publication, she invited them to collaborate with her to explore the issue further. As Alessandra says, "I was so naïve when this all started. I told them this would be a great opportunity to help us with this research and oh I was so naïve. It was the other way around. They wanted to silence us" (Alessandra R., October 20, 2015). Alessandra explained that Monsanto began threatening her career and attacking her publicly through media interviews where they claimed that she suffered from a mental disorder:

> So the issue with Monsanto blew up, oh that was in about 2003, 2004 and it was a war. They told me they were going to destroy my career. I basically went into hiding. If it hadn't been for the support I got from Stanley and the NFU [National Farmers Union] and other people, oh who knows(…)A lot of people turned their backs on me. You know who were the people who really turned their backs were university colleagues(…)That was a turning point for me. As I said my university colleagues turned their backs on me because they didn't want to lose support from Monsanto. So they didn't want to be associated with anything related to me or going against them. So I was very disappointed. It changed my perspective on everything. So anyway it was more or less at the same time that we decided to have a project on organic. I guess it was a natural conclusion, a natural way of going. I started reading a lot of stuff on the effects of glyphosate coming from Europe. There were a lot of papers on that(…)So with the inability to continue the glyphosate work, I decided I'll be happy to do non-chemical research.

When Alessandra's original four-year grant from the Agriculture Development Fund[43] (ADF) expired, she did not attempt to apply for additional funding. In regard to ADF, she said, "They weren't happy with me. Even upset. They didn't want to upset Monsanto or any other multinationals." Along with the ADF, several university colleagues discouraged her from publishing the results. A colleague from Carleton asked her to send him the data, so that he could "help her get out of this mess." Alessandra also found it very difficult to continue the project because she could not find land that had not been sprayed with glyphosate with which she could compare her results. This proved particularly difficult when attempting to find land at the Station or other Research Stations in the Prairies. Despite all the discouragement from the ADF and her colleagues, Alessandra eventually published her research in several academic journals.

Alessandra's research was used by the National Farmers Union in 2005 to make a case to the Canadian Food Inspection Agency (CIFA) that the approval of more glyphosate-resistant cultivars, including Roundup Ready alfalfa should be halted (Ewins, 2005a). They urged CIFA to wait until more research could be conducted on the connection between glyphosate and FHB before allowing more Roundup Ready crops to enter the market, which might exacerbate the issue. Trish Jordan, the Director of Public and Industry Affairs for Monsanto, responded by claiming that the company conducted its own research and found "no causal link" between glyphosate and FHB (Jordan, as cited in Ewins 2005b, p. 1). "It appears the NFU needs to look at the entire body of research rather than using an isolated study to promote whatever their personal agenda is(…)They can throw out this study and we can probably throw 50 others back" (Jordan, Ewins 2005b, p.1).

43 ADF is a funding program administered by Saskatchewan Agriculture. The ADF funds agricultural research projects for AAFC scientists, as well as researchers from universities and other research institutes. Most of their projects are co-funded by producer groups such as the Saskatchewan Pulse Growers (Saskatchewan Agriculture, 2021, February 13).

Alessandra was happy to report that, throughout whole ordeal, that she felt fully supported by the Station director and many of her fellow scientists at the station. Additionally, the support she felt from the NFU helped her get through the worst of Monsanto's attacks. Her work with the organic trials at Swift Current was challenging at first because she's trained as a plant pathologist and knew very little about organic farming. She joked in the interview about how she labels the project proposals "Low-Input Agricultural Systems" rather than "Organic Agricultural Systems" because funding agencies are much less likely to support organic projects because they consider this a niche market and production system. "Low-input" as a concept is potentially relevant to chemical farmers as well as organic, so she and her collaborators make the case that their project is applicable to all Prairie farmers. It certainly seems as though Alessandra and her collaborators must walk a fine line to avoid any research or publications that could be viewed as offensive to those multinational agrochemical companies closely tied to universities and funding agencies such as the ADF. However, Alessandra continues to warn farmers about purchasing seed potentially contaminated with Fusarium contamination. She explained to me that although some companies sell seed treatments to prevent the disease, there is nothing currently on the market that can fully protect farmers against Fusarium. Additionally, once Fusarium has found its way onto a farmers' field, it can survive there for years and possibly for all eternity, feeding on the corpses of previous crops and waiting for its moment to infect the perfect host. In addition to its correlation with FHB, glyphosate is also becoming a major concern for consumers.

Glyphosate with Your Morning Breakfast

In August of 2018, the Superior Court of California in San Francisco ordered Monsanto to pay Dewayne Johnson, a former school groundskeeper, $289 million (later reduced to $78 million), after his legal team successfully linked Johnson's terminal cancer to repeated exposures to Roundup (Shochat and Fournier, 2019). It was revealed in the case that Monsanto had hired an intermediary company, Intertek, to coordinate the publication of articles with toxicology experts that would be reviewed by Monsanto prior to publication and would demonstrate glyphosate as non-carcinogenic. These studies intentionally skewed research findings to present Roundup as safe for human use in farming and in landscaping. These same studies, published in C*ritical Reviews in Toxicology*, were used by Health Canada to reapprove glyphosate as safe for use until the year 2032, even though in 2015 the World Health Organization's International Agency for Research on Cancer (IARC) categorized glyphosate as a probable human carcinogen (Health Canada, 2017).

I could not help but think about the IARC findings in the spring of 2015 as I followed my usual walking and jogging path that took me down a dirt road heading east out of Wymark and cutting through fields on either side for one mile before intersecting with a main north-south grid road. I walked or jogged on this road at least two or three times each week in the morning or late evening, weather permitting, and enjoyed observing the fields from early spring until harvest. As the crops grew thicker, the views from the narrow road were spectacular as the town faded into the distance and I felt completely surrounded by endless fields. Unfortunately, my jogging times often coincided with the preferences of chemical farmers to spray their fields early in the day before the wind picked up, or in the evening after it died down. On particularly calm days, I observed a foggy haze that hung close to grid roads, as dust kicked up from vehicles remained suspended in the air. On some of these days, I also caught the familiar whiff of water on the air, like the smell after a sprinkler systems has been run. I usually enjoy this smell, but since my time with Derek, I now knew that it meant I was surrounded by chemically-produced crops and airborne chemical. In all likelihood, given the type farming in this area, they were spraying glyphosate, so now different thoughts ran through my mind as the smell drifted in and out of my nose.

I also thought of various comments made by farmers from the Wymark area about Roundup. While riding in the combine with Jared W., a chemical farmer living between the hamlets of Rosenhof and Rheinfeld northeast of Wymark, he described a conversation between himself and a Monsanto chem-rep several years prior. Jared recounted that a chem rep had told him that Roundup is no worse for your body than drinking a cup of coffee each morning with breakfast. Jared agreed and then told a story about his dog eating Roundup granules from an open box in their shop. “He ate maybe half a box was fine” (Strand fieldnotes, 2014). For Jared this was proof enough that worrying about Roundup is just a fad, not unlike other health fads that come and go. A few months after my combine ride with Jared, I interviewed another farmer near Wymark who also mentioned the seeming trend of health-related Roundup worries. Brian F. spoke with a slight German accent that he carried with him from his childhood with newly immigrated Mennonite parents who had never learned to speak English fluently. Brian farms with his five sons, two who went to school until the age of 16, and three younger ones who planned to follow the same path. In addition to growing crops, they raise cattle, dairy cows, chickens, and pigs. The sons live at home with their parents and sell all the goods from the livestock to neighbors for extra money. In our interview, I asked Brian about his use of herbicides on the farm.

> To us they always say, Roundup is like vinegar. Like it’s not a deadly chemical kind of thing. Like if you get Banvil and stuff like these other chemicals, like not a good kind of thing. So that’s why I know talking that way about when we desiccate, we often desiccate with Roundup too and the first time we did, basically on just the pulses because the pulses is where we have trouble with weeds. Like it’s terrible hard to spray weeds out of pulses. Like you can put Edge down; you can put Pursuit on, and it still seems like weeds come

> through. So just before the plants are totally ripe, we'll just take and desiccate everything with Roundup. I know the first years we started doing Roundup on lentils, they told us like they won't buy them. They won't buy them because there's Roundup on them. But then all of a sudden, poof! That whole fad dies too. Like is it really a poison or is it a little bit of vinegar? That's why I said earlier, maybe if I were to study chemicals, I'd be able to answer that better. No, but I don't think it's terrible bad (Brian F., August 22, 2014).

However, grain buyers refusing to purchase lentils desiccated with Roundup is not an issue of the past. Maximum residue limits (MRL) on grains, a standard regulated by Health Canada, and established by the Canadian government and other governing bodies worldwide, has the potential to redefine agricultural production of all crops. MRLs, established by Health Canada (which might be slightly compromised as we learned above) through the work of consultants "determine whether the consumption of the maximum amount residues, that are expected to remain on foods when a pesticide is used according to label directions, will not be a concern to human health" (Government of Canada, 2015, February 17). Basically, MRLs are the amounts of pesticides, including herbicides, that the government has determined are safe for consumers to ingest. Some companies such as Kellogg's, apparently unhappy with Health Canada's MRLs, have taken matters into their own hands and refuse to buy grains that have been desiccated using glyphosate (Arnason, 2020) They plan to have completely phased out these grains from their supply chain by the end of 2025.

In organic production, MRLs thresholds are significantly lower and their rules far more stringent. Technically, there should be no presence of residue of organically banned substances on organic grains grown in Canada. However, if levels are more than 5% of the MLR for any pesticide, then the organic certifying body must investigate the circumstances surrounding this contamination (Government of Canada, 2021, February 18). In my time with organic farmers, none of them reported having been investigated for pesticide residues; however, five out the six discussed having had some issues selling grain where glyphosate residue was present. Most of these issues came as the farmers attempted to sell grain to countries within the European Union, which sets a lower MRL for all crops, including organic ones. These farmers are not themselves using any pesticides, but as my own jogging experiences made clear, residues can drift through the air and do not discriminate between organic and chemically farmed fields when deciding where to finally drop from the sky. But neither is this strictly an issue for organic farmers. Two chemical farmers also discussed issues with having foreign herbicides drift onto their fields and causing damage to their crops. In these cases, the farmers discussed the drift with their neighbors and were able settle the dispute without outside interference. However, in my interview with the provincial Agricultural Representative from Swift Current, Hillary S., she described calls from farmers asking for her assessment and assistance in settling matters. Usually, she referred these cases to private consultants because she did not want to get involved in cases that might result in litigation; however, on a few occasions she agreed to measure the breadth of damage and give a "unofficial opinion" on which product had caused the damage.

Later in the summer of 2015, I decided to ask a few of the Station scientists if they knew of any studies assessing the environmental impact of glyphosate on the Prairies. I was referred to an Environment Canada report published in 2011, *Presence and Levels of Priority Pesticides in Selected Canadian Aquatic Systems.* The report summarizes the findings of detection surveys from all across Canada. Surprisingly, I noticed that although it lists glyphosate, MCPA, and 2,4-D as the most commonly purchased pesticides in Alberta, Saskatchewan, and Manitoba (with glyphosate in the #1 spot), glyphosate was not included on the surveillance list. It did include MCPA and 2,4-D and reported that of the 60 wetlands sites sampled, all 60 contained MCPA and 2,4-D (Water Science and Technology Directorate, 2011, p. 42). Given that finding, it seems likely glyphosate would also have been found in all 60 samples, had it been included. Additionally, the report stated that “atmospheric transport” (p. 43) is the most likely mechanism for pesticide movement to wetlands through rainfall events. Out of curiosity, I decided to review the most recent *Health Canada Report on Glyphosate,* published in 2017, to see if any other detection surveys were included in the report, but I could not find any references other than to the 2011 Environment Canada study mentioned above. They did, however, refer to studies conducted in the U.S., and I found one comment particularly interesting. In the Midwestern U.S. in an air and rain herbicide detection study conducted in 2007, the researchers found a “detection frequency ranging from 60 to 100%” for glyphosate (Majewski et al., 2014, as cited in Health Canada, 2017, p. 45). Additionally, Majewski et al. found that:

> detectable concentrations of glyphosate were collected over the entire growing season, not just in spring as in previous years (before the introduction of GMO around 1995), which is reported to be consistent with how glyphosate is now used on genetically modified crops for post-emergent weed control during the growing season (p. 45).

Unfortunately, especially for my attempts at improving health with jogging, this last comment sounded very similar to the practices of many farmers in the Wymark area.

One May morning in 2019 I was listening to NPR's Morning Edition on National Public Radio (NPR), a habit from my life in the U.S. that I've carried with me to Saskatchewan. It included a report about Monsanto describing three cases of cancer patients who had successfully sued the company for glyphosate exposure—including Dewayne Johnson (Charles, 2019). Thousands of other cases have subsequently been filed. The report explained that researchers are divided on the toxicity levels and impacts of glyphosate. Farmers fear that public concern will lead to prohibitions on the use of glyphosate, which will severely affect current agricultural practices in the U.S. As I listened to the comments of farmers, I sympathized with their concerns, many of which had been echoed by people I had met with in Wymark. Maybe this recent spate of "fad health concerns" would fade away once again, as Brian and Jared had observed years prior. But for myself, I plan to invest in a treadmill for use during the winter and growing seasons.

Herbicide Resistant Weeds

While driving the miles and miles of empty narrow highways to visit farmers during my second July in Saskatchewan in 2015, I began noticing tall, bushy plants in some fields that reminded me of the Christmas tree farms I often saw in Colorado during childhood visits to see my Uncle Bob. At about three feet high, these plants had thick branches with dark leaves. Because of their haphazard locations on the fields, these were obviously not simply young spruces, a few years' away from Christmas displays. Sometimes I saw them growing in thick patches near the road, but other times I saw them growing along narrow pathways that extended across fields. Usually these "Christmas trees" were located in lentil fields, which is not surprising because this pulse crop is a weak weed competitor. I took the opportunity to point them out to Stanley while riding in his truck one day, and with a slight smirk, he identified the plants as kochia (See *Figure 59)*. I immediately felt silly for not identifying them myself, especially after hearing so much about kochia from farmers and scientists.

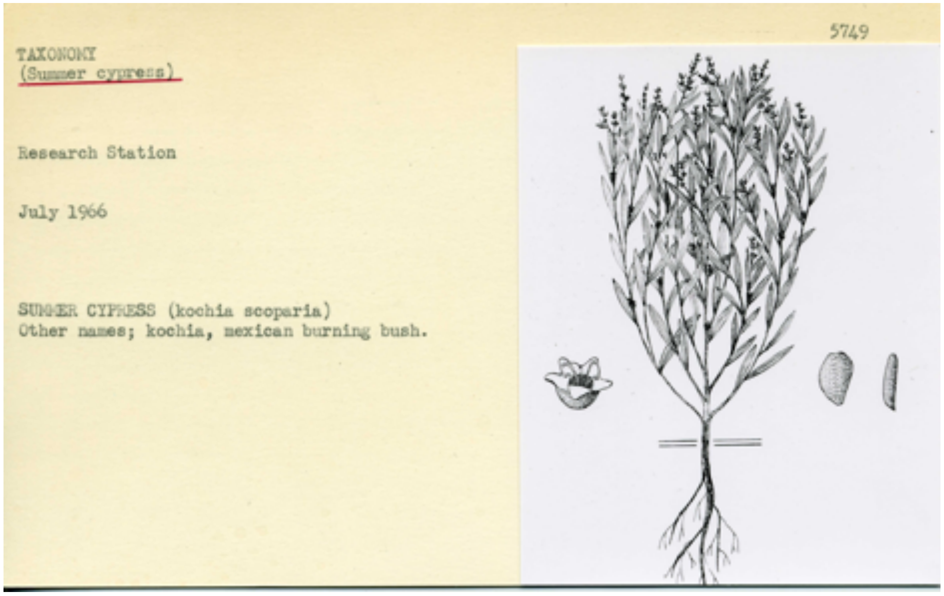

Figure 59. Kochia. Note original caption. The slide is from the Station Herbarium. Photo from SCRDC Archives.

On one of my first visits to the Swift Current Station, the director gave me a large folder filled with articles written by research scientists from stations across the Prairies and intended for use by farmers. One article, with no author listed, titled *Glyphosate Resistant Kochia,* caught my attention as I scanned through the folder. I found the following quotes particularly interesting:

> Kochia is a tumbleweed and as it tumbles across the landscape it drops seed to the ground along its path. One of the tell-tale signs that kochia is resistant to a particular herbicide group is that the resistant kochia will grow in relatively straight lines across fields treated with that herbicide…A tumbling kochia plant has the potential to travel great distances over the landscape if it does not encounter anything to block its progress (AAFC, 2014).

This explained the pattern I noticed across many fields in Palliser's Triangle and associated with miniature Christmas trees lookalikes. Without going into too much detail, it also points to the issue of the herbicide groups—key to any discussion of herbicide resistance. Herbicides commonly used on the Canadian Prairies fall into 18 different groups, which correspond to the mode of action a herbicide takes to kill a particular weed (Saskatchewan Agriculture, 2021). For example, 2,4-D falls into Group 4 herbicides, those that utilize a growth hormone and "affect cell wall plasticity and nucleic acid metabolism leading to uncontrolled cell division and growth, which causes vascular tissue destruction" (Bayer CropScience, 2013, p. 8). Whereas glyphosate, in Group 9, utilizes a very different mode of action as an enzyme inhibitor. A Group 9 herbicide is an "inhibitor of the chloroplast enzyme…which leads to depletion of key amino acids that are necessary for protein synthesis and plant growth" (Bayer CropScience, 2013, p. 11). The AAFC pamphlet explains:

> Many herbicides work by linking to a target enzyme site to disrupt whatever critical process it controls. Most herbicide resistant weeds in western Canada use a change in the 'shape' of that target enzyme to prevent the herbicide from linking to the site…the mechanism used by glyphosate resistant kochia is very different. Instead of a mutation that changes the 'shape' of the target site, the EPSPS enzyme (the target enzyme for glyphosate) in kochia remains susceptible and glyphosate applied to the plant can still link with the enzyme. Glyphosate resistant kochia simply produces much more than it needs by making many copies of the gene responsible for the production of EPSPS enzyme. As a result, all of the glyphosate entering the plant is tied up by the extra EPSPS enzyme and there is still enough EPSPS enzyme remaining to allow the resistant plant to function normally (AAFC, 2014, p. 1).

Kochia is a truly remarkable plant, not only because of its unique response to glyphosate, but because it reaches maturity and survives drought conditions by spreading root systems up to three meters in depth in its search for water and nutrients. When mature, it produces 25,000 seeds per plant (Raine, 2015). Kochia came to Canada with European immigrants as an ornamental plant. In the 1950s, the Swift Current Station studied its potential as livestock feed because it out-produced oats and contained more protein (Dominion Experimental Farm, 1950, p. 334). In the early '80s, scientists at the Swift Current Station urged farmers to used kochia as a forage crop, and to appreciate its ability to thrive in the worst possible conditions of drought and high salinity soils (Green, 1982). Farmers nowadays do not appreciate kochia for either. They fear the presence of herbicide-resistant kochia in their fields and what it means for the future of chemical use.

Of the farmers I interviewed or observed, three admitted to having herbicide resistant kochia on their fields. Two of these same farmers also discussed problems related to herbicide-resistant wild oats, while two others discussed herbicide resistant green foxtail and narrow-leaved hawk's beard. Wild oats present a unique challenge because some species in Canada have shown resistance to five different herbicide groups (Brenzil, 2018), but kochia is close behind. In a 2017 survey of 300 kochia samples from around Alberta, 40% were Group 9 (glyphosate) resistant, 8% were Group 4 resistant, and 10% showed a three-way resistance to Group 9, 4, and 2. This means that for those particular kochia plants and their seeds, three categories of herbicides will no longer be effective in controlling the weed. Clark Brenzil, the weed control specialist for Saskatchewan Agriculture, explained in a 2018 webinar that for the first few years they are present, herbicide-resistant weeds can be difficult to detect. To illustrate this point, he showed the progress of weeds resistant to Group two herbicides including kochia and narrow-leaved hawk's beard. After a herbicide-resistant plant enters the field, within one year or one herbicide application, .001% of the plant population (of a particular weed species) will become resistant. After two years, that number climbs to .02%. By year four, or after four applications of the herbicide, 4.2% of the plant population for a weed species is resistant. Some farmers will notice the resistance in their fields at this point, particularly in the case of kochia, because they will begin to see those distinct lines running across their fields that tend to follow the direction of prevailing winds. Finally, by year five or after the fifth application of the herbicide, 60.5% of the species population will be herbicide resistant. Most farmers recognize the problem at this point, but mitigation at year five tends to consist of drastic measures such as tillage before seeding, and strategic spot tillage during the growing season.

In addition to tillage, Brenzil recommends longer crop rotations, collecting chaff from combines to prevent increasing the seed bank, utilizing perennial crops such as alfalfa, and creating field boundaries (through tillage or perennial crops) to control the spread of new seeds entering the fields. Ultimately, he explained, "there's lots of things that organic producers have developed and utilized on an ongoing basis that we can introduce into our conventional systems to manage weeds better as well" (Brenzil, 2018, p. 1:09). In addition to some organic measures for weed control, Brenzil also mentioned herbicide layering and herbicide rotation, which basically means that farmers should avoid using only glyphosate on all their fields every year. A few farmers I interviewed mentioned their herbicide "cocktails," which generally consist of glyphosate plus one or two other chemicals they add for specific weed problems. None of the chemical farmers I interviewed expressed any interest in moving away from the use of glyphosate on their farms though. And as Brenzil discussed herbicide rotations and layering, he also mentioned that these "cocktails" can cost farmers up to $100 per acre, giving an example of blackgrass in Europe, which necessitates the use of six different chemicals for control. Although he did not state it explicitly, this example demonstrated that most herbicide solutions are only temporary precisely because of the herbicide resistance they engender. Additionally, he warned farmers to avoid pinning all their hopes on future chemical products not yet released. Brenzil explained that although chemical manufacturers have continued spending millions of dollars on new research, they have not released any new products since 2010 and many of the products they are currently working on are not suitable for use in western Canada.

Because of his long-term experience watching the landscapes transform with zero tillage technology, in my interview with Dr. James A., a soils researcher from the Station, I asked him for his perspective on the future of soil research in Saskatchewan. He replied:

> The biggest risk to soil health now is, well I would say it's herbicide resistant weeds. Things that will bring tillage back in a major way. Yeah [long pause] it's really quite something, this concept of landscapes transformed. It's more than just the visual landscape. Even the health of the landscape is so much different than it was. We've really, really changed the soil quality, so we don't have the same threats that we did. I mean it's still a very fragile thing, so it doesn't mean that you can let your guard down (James A., September 10, 2014).

When I asked the regional crop specialist for Saskatchewan Agriculture, Hillary S., for her thoughts about the future of farming in southwest Saskatchewan, she responded with a similar concern:

> The biggest thing I've noticed since I've been here is the increase in glyphosate resistant kochia. That's going to be something that's a big issue here because it's already Group 2 resistant and I don't know for some cases, some people are very proactive. In other cases it's like, "Oh no. It's fine. It's not me. It's not resistant." There's a lot of denial out there(…)Sometimes it takes a couple years to realize that your chemical is not working(…)And some guys know but if one product's cheap, then let's keep using it over and over and over again and it will eventually hit them. Eventually you can't use that product anymore (Hillary S., August 28, 2014).

Without the use of herbicides, farmers might have to return to tillage implements to mechanically destroy their weeds. As we have seen in the last two chapters, tillage no longer aligns with what farmers consider to be good field practices. To change back to tillage would require another ideological shift in Palliser's Triangle and this would have to take into consideration the creeping desert.

CONCLUSION

The use of herbicides became part of the Station's research agenda in the 1940s and a common part of farm practice within southwest Saskatchewan by the 1950s. In these early years of herbicide use, farmers and researchers alike believed that these substances held the potential to finally solve their surfacing problem. Herbicides such as 2,4-D in the 1950s and '60s, and glyphosate in the ’70s could reduce the need for mechanical tillage, which then preserved crop stubble on the surface and reduced the risks of soil erosion. By the 1980s, herbicides were promoted by the provincial and federal governments and private agrochemical businesses as critical tools for conserving soil organic matter. Farmers were “guilted” into eliminating their summerfallow rotations as the PFRA and Station scientists warned farmers that if they continued summerfallowing, they would be destroying the productivity of the land for future generations. Continuous cropping was presented as an alternative to summerfallow because it restored organic matter to the soil every year. During the 1980s, farmers were also strongly encouraged to adopt conservation tillage methods including herbicides to replace mechanical implements for weed control and low-disturbance seeders.

Second and related to the paragraph above, this chapter demonstrated the power of the desert as a conceptual tool. The campaign to rid the Prairies of summerfallow rested primarily on engendering fear in farmers. The PFRA and the Station scientists wanted farmers to become fearful of what would happen if they continued tilling their fields throughout a rotation of summerfallow. As we saw with Charlie from the PFRA, they started off their presentations with an image of an hourglass and statements like “It’s only a matter of time and your soils will erode away” (Samantha G. and Charlie A, October 7, 2014). During the 1980s, the fields of many farmers were eroding as drought conditions, combined with tillage practices, created unstable surfaces. This chapter included the accounts of several farmers who recalled the alarming feeling of watching their soils blow away. They were already fearful of what was happening to their farms and the government played on this fear to promote a series of practices that were endorsed as tools for soil conservation. Now farmers feel fearful of what might happen if these tools are no longer available to them. They feel frustration as they watch consumers reject products based on the presence of glyphosate without understanding why this herbicide is critical to dryland farming. Many farmers are fearful of integrating tillage back into their systems because they do not want to return to a time when the creeping sands of the desert threatened their livelihood.

Finally, throughout the period covered in this chapter, 1940-present, we see a close relationship forming between private agrochemical businesses, farmers, farmer organizations such as SSCA, and public research and extension services. Farmers, unlike many urban consumers, do not see Monsanto or any other agrochemical business as an enemy. These organizations hire the children of farmers for jobs that allow them to stay within the community. Monsanto and other agrochemical businesses sponsor farm organizations and events. As we also saw in this chapter, they contribute money to the organizations that fund projects at the Station. As we saw with two examples from Dr. Alessandra R. and Paul L., when they explored projects that challenged the zero tillage system, their work was met with powerful resistance. This resistance limits the range of possible projects within the Station, which makes it difficult to explore these cracks that are forming. Grant-based funding limits the scientists at the Station as they are encouraged to produce deliverables such as plastic wheat—a nonsoel[44] shaped in the highly controlled environment of fertilizers and herbicides (Tsing, 2012). Plastic wheat is designed to thrive across a wide geographic region if herbicides, pesticides, and fertilizers are applied. It is not encouraged to form relationships with other elements in the landscape, including the microbiology of the soil. Plastic wheat reinforces zero tillage systems on the

44 To remind readers, nonsoels are non-social landscape elements, as defined by Tsing (2012). She connects nonsoels such as sugarcane to her concept of scalability—systems that can expand without altering any of the basic elements that constitute those systems.

Prairies because farmers must recreate the conditions of its original breeding for it to thrive on their fields. As we saw above and in Chapter Two, these conditions are highly manipulated by inputs. In the Conclusion of this dissertation, I will provide a few examples of research at the Station that takes a different approach to deliverables. Unlike plastic wheat, these deliverables are the result of social interactions—between plants and soil microorganisms—within the desert landscape.

CHAPTER FIVE

THE SOIL TEST

Figure 60: Field Assessment. Photo by Katherine Strand.

INTRODUCTION

On November 18, 1960, the Experimental Farm (as it was known at that time) in Swift Current released an edition of *Weekly Letter* written by Willard Hinman for publication in local newspapers all over southwestern Saskatchewan. These Weekly Letters helped connect Station research staff with local communities by providing updates on their projects and recommendations for farmers in the southwest. That week, Hinman wrote a piece titled "Soil Tests," which, according to my archival research, was the first attempt by the Station to introduce the concept of soil testing to farmers in the district:

> For over a century scientists have been seeking chemical methods of determining soil fertility by soil tests. Soil tests, it was hoped could provide information that would serve as a guide for fertilization. The goal of the scientists was to not only be able to predict crop yields and to determine the nutrient-supplying power of the soil, but also to estimate the quantity of fertilizer which should be applied (1960, p. 1).

The purpose of this chapter is to examine the soil test as both a practice and conceptual tool, both historically and in contemporary farm practice, and to demonstrate how it serves as a primary tactic of geontopower within agriculture on the Prairies (Povinelli, 2016). Just as a clinic opens one's body to the gaze of the medical expert, the soil test invites the agricultural scientists' gaze for analysis and remediation of their soils (Foucault, 2003). The Dominion Government guaranteed homesteaders private property that would be protected federally as long as they adhered to certain guidelines. However, the government also sought to secure their interests by ensuring efficient production (Jones, 2002; Fitzgerald, 2003). As discussed earlier, Stefanik (2015) demonstrated how the Experimental Farms Service acted as a normalizing force on the Prairies. What I hope to add to the discussion is how this normalization actually works in practice through soil testing. Soil tests involve small samples of dirt taken from multiple locations in a farmer's field. The samples are chemically analyzed in a laboratory to determine the presence of elements[45] essential for plant growth, including nitrogen (N), phosphorus (P), and potassium (K) (Havlin et al., 2014). NPK are the primary elements involved with plant growth and the three key ingredients of most synthetic fertilizers. Soil tests occasionally assess the levels of other elements such as calcium (Ca), magnesium (Mg), sulphur (S), and zinc (Zn); however, most soils in Saskatchewan contain sufficient amounts of these other nutrients, so farmers rarely supplement them with fertilizers other than NPK. Soil testing services take into account soil type, nutrient levels, moisture level, soil pH,[46] electrical conductivity (to determine salinity levels), cation exchange capacity (CEC),[47] and desired yield (as determined by the farmer) in order to make recommendations about the types and amounts of fertilizer required for each field.

Fertilizer has become a huge industry in Canada. Nutrien, a major distributor and manufacturer of fertilizer in North America, South America, and Australia, estimated Canada's fertilizer consumption in 2019 at 2,651 thousand metric tonnes (TMT) of nitrogen per year, 1,180 TMT of phosphorus per year, and 446 TMT of potassium per year. During the same period, based on data from the International Fertilizer Institute, an estimated total of 4,277 thousand metric tonnes of NPK fertilizer (in all its many forms) was being consumed per year in Canada (Nutrien, 2020, p. 19). This makes Canada the 7th highest consumer of fertilizer in the

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45 Contemporary soil science lists 17 elements essential for plant growth, including carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), and potassium (K) (Havlin et al., 2014). Plant nutrients cycle through the atmosphere (the source for carbon and nitrogen), through water (the source for hydrogen and oxygen), and through rock (the source for every other element).

46 Soil pH measures the concentration of hydrogen ions in a soil solution; measurements range from 1 (most acidic) to 14 (most alkaline) (Stockdale, 2018, January 8). Highly acidic soils dissolve metal ions, which can become toxic to plants. Highly alkaline soils decrease the solubility of many minerals, often leading to nutrient deficiencies.

47 Cation exchange capacity measures a soil's ability to hold positively charged ions (e.g. potassium) through negatively charged ions on at the surface of soil particles (Stockdale, 2018 January 8). CEC is higher in clay soils and organic matter.

world, with China leading the pack with consumption rates around 44,825 TMT of NPK per year, India at number two with 28,572 TMT per year, and the US in third place at 20,504 TMT per year. Between 2006 and 2016, nitrogen fertilizer use in Canada increased by 65% (Statistics Canada, 2020, November 24), contributing significantly to greenhouse gas emissions when we consider that one tonne of nitrogen fertilizer requires about two tonnes of gasoline to produce, transport, and apply (Qualman, 2017).

Fertilizer is quickly becoming one of the highest input costs for producers in Saskatchewan, having risen in cost from 2004 to 2014 by 103% (AAFC, 2016, p. 8). Steve E., a farm financial planner based in Swift Current with whom I spoke, estimated that the average per acre costs of fertilizer and herbicide alone to grow canola in southwestern Saskatchewan came to $120 per acre, with nitrogen fertilizer accounting for approximately $81 of that amount. On large farms (>10,000 acres) producers can find themselves "4-6 million dollars in the hole before they even get the seed in the ground" (Interview). This number accounts for fertilizer as well as seed, herbicide, insecticide, fungicide, consulting, labour, and land costs. Few people in SW Saskatchewan grow crops on a large scale while also maintaining a herd of livestock. Thus, I only encountered three farmers (two organic and one chemical) who regularly spread manure or compost on their fields as fertilizer. Manure is hard to find in large enough quantities and can be time consuming to spread on large farms. And unlike NPK fertilizer, the benefits of composting can take years to manifest in crop yield. Compost ranges in price from between $40 to $90 per cubic yard, which translates into an initial cost (for the first application) of around $180 per acre. Without the benefit of an immediate increase in yield the year it's applied, these costs make compost unfeasible for most producers.

The soil test is the starting point of engagement for the fertilizer industry. Although soil testing in Saskatchewan was originally administered through the Dominion Experimental Stations and the University of Saskatchewan, private industry has taken over almost all of the testing done for farmers in the province. Private testing is done through professional agrologists or P.Ag.s, as they are called locally. Around Swift Current, P.Ag.s typically work for businesses such as the Pioneer Co-op and South West Terminal (SWT) that sell fertilizer to farmers after they've conducted soil tests and given soil fertility consultations. The P.Ag.s featured in this chapter all referred to the process as giving farmers "fertility prescriptions." The shift from public to private soil testing is symptomatic of a larger shift that began in the 1980s as the Research Branch of AAFC and Saskatchewan Agriculture slowly extricated themselves from agricultural extension services. P.Ag.s have gradually taken up the roles previously held by provincial Agricultural Representatives and the Station's Information Officer, and thus P.Ag.s have also become the primary administrators of Life within agriculture on the Prairies. P.Ag.s assess the soil for nutrient levels to determine what is needed to grow a high yielding crop. They set yield targets that create standards for the crop, thus standards for Life on the field. By focusing on only chemical attributes, and not biological microorganisms, they adhere to Liebig's definition of soil as merely a vessel for the transfer of nutrients from the soil and into the plant. Thus, soil is placed within the non-Life category. Through their consultations with farmers, they analyze soils, set yield targets, and make fertilizer recommendations to assist farmers in maintaining the health of their soils.

This chapter is divided into four main sections to help navigate the complicated terrain of the soil test. The first section is titled *Liebig's Calculable Soil*. This section provides historical background concerning how the chemical analysis of soils has dominated fertility research since

1840, when Justus von Liebig published *Chemistry and in its Applications to Agriculture and Physiology.* In 1875, A. W. Hoffman delivered the Faraday Lecture for the Royal Institution of Great Britain titled *The Life-Work of Liebig* (1876) and declared in the opening pages that Liebig's work on soil fertility:

> has supplied to agriculture the fundamental art of life, its main basis as a perdurable art, as an industry no longer liable to extinction by the exhaustion of the soil; and it has enabled us—let me repeat it—to secure not merely the continuous regeneration of plants, but also the ceaseless perpetuation of the animal race, including its chieftain man—a chain of incommensurable importance, whose first link hangs, if I may so speak, from Justus Liebig's hand (p. 20).

This section highlights key concepts from Liebig's work on soil fertility, concepts which continue to shape how P.Ag.s use the soil test, but also provides historical context for how the fertilizer industry began. The second section, titled *Potential Production,* traces the development of soil fertility research at the Station, as well as of Station researchers' recommendations on fertilizer, and the soil testing services offered in Saskatchewan by the Station, the provincial government, and the University of Saskatchewan. The third section, titled *The Farmer is No Longer Your Client,* continues the timeline to examine the period of the 1980s to early 2000s when the public sector of agricultural extension services at the Station and within Saskatchewan Agriculture discontinued many programs that offered farmers direct access to public agricultural research. Beginning with free soil testing offered by local input distributors during this period, we see farmers accessing the services of P.Ag.s for the first time. *The Fertile Grid* is the fourth and final section of this chapter. It consists primarily of ethnographic accounts of P.Ag.s who live and work in southwestern Saskatchewan. It includes a brief historical description of how agrologists became officially recognized in the province, thus providing P.Ag.s with professional credentials and unleashing their expert gaze upon the soils of Palliser's Triangle.

LIEBIG'S CALCULABLE SOIL

Clinical medicine, like soil fertility management, requires a rationalized and systematic approach to analyzing the body that can be duplicated across multiple contexts, so that clinicians can apply the same procedures to any human body. Foucault (2009, 1984) describes how this is accomplished through the establishment of norms by which a body—oftentimes through numerical measurement and/or visual assessment—will be assessed in relationship to said norms. A "calculable man" (Foucault, 1995, p. 193) emerges from the sloppy existence of life when key attributes of the body are singled out and brought into a meaningful, and usually numerically-based, comparison with the norm. Similarly, Justus von Liebig created a 'calculable soil' through his work in the 19th century in organic chemistry (Jacob, 1997; Rossiter, 1975). With his 1840 publication of *Organic Chemistry in its Application to Agriculture and Physiology,* Liebig created a paradigm from out of the "paradigmless" field of agricultural chemistry by bringing together three key concepts (Krohn & Schafer, 1976). First, he highlighted the importance of tracing elements—such as oxygen, carbon, and nitrogen—as they continuously cycle through the soil, the atmosphere, plants, and animals, thus creating the conditions that make agriculture possible. Liebig studied key elements such as carbon and nitrogen throughout their cycles and took account of their losses and gains at each stage. To frame his analysis of cycles, he drew inspiration from political economy principles. In order to redefine agriculture as a system of exploitation and resource exhaustion, he drew from the work of Adam Smith and John Stuart Mill. Second, using the analogy of circulating capital to think about mineral cycling, Liebig rested his paradigm on two assumptions, including the existence of a starting position (the "ought value" or norms for each type of soil and plant) and the possibility of achieving cyclical equilibrium through control mechanisms. Third, Liebig envisioned agricultural chemistry as a field working towards a specific societal goal; his work needed to increase food production for a booming world population. Thus, for Liebig, the science of agriculture was always “a theory about the most rational organizing of nature to satisfy human needs and at the same time a science about the rationality of human needs vis-à-vis nature” (Krohn & Schafer, 1976, p. 49).

Working in the early to mid-19th century, Liebig broke with vitalism[48] to create “ought values,” or norms, for plants, animals, and soils that could be generalized beyond local conditions (Krohn & Schafer, 1976). Using his new paradigm, Liebig simplified the concept of the mineral cycle into a system of losses and gains, one that could be easily understood and identified through soil testing, with the overarching societal goal of increasing yields. With “an ends” clearly defined, Liebig clarified that the means required the creation of better experimental protocols and the institutionalization of his paradigm in practice through extensive student training. Building on the work of such chemists as Humphry Davy, Theodore de Saussure, and Joseph Gay-Lussac, to name a few, Liebig turned the focus in agricultural science from humus, which contained inorganic minerals, to minerals like phosphorus (Rossiter, 1975). Although many of his ideas concerning how minerals moved through organic soil matter, humus, and the atmosphere, into plant material would later be refuted—largely because Liebig and his contemporaries were not yet aware of how microorganisms in the soil facilitate almost all

48

For a brief discussion of the relationship between vitalist and mechanist theories in 19th century science, see *The Liebig/Pasteur Controversy: Vitality without Vitalism* (1961) by George E. Hein. Hein uses the Liebig/Pasteur debate over fermentation to outline key differences between vitalist and mechanist approaches to this catalytic process and concludes that neither man can be considered purely mechanistic (as Liebig is often characterized) or vitalistic (as Pasteur is often described). Hein attempts to create clear definitions of what these terms mean. Hein states, “It is enough to recognize that any mechanistic theory says that the laws of chemistry and physics…are enough to explain the behavior of living things” (1961, p. 615). Whereas 19th century vitalism “holds that the basic laws governing the behavior of living organism are not reducible to the laws of chemistry and physics. Non-reducibility is a necessary condition for vitalism.” In its non-reducibility, vitalism invokes a divine creator, a non-material life force, or emergence (the whole is greater that the sum of its parts) to explain various phenomena associated with life. Hein uses this paper to explain that although Liebig and Pasteur argued over the true catalyst of fermentation, Liebig aligned himself with vitalists, while Pasteur relied on mechanistic theory in many of his writings.

cyclical transformations—he successfully put minerals at the forefront of all discussions concerning soil fertility and plant growth.

As a professor in Giessen, and later in his career, Munich, Liebig forged the path towards empirically-based soil fertilization by dismissing all other explanations for low crop yield and focusing on what he considered to be predatory acts of farming (Jacob, 1997). In describing Liebig's thoughts on the subject of fertilization, Shenstone (1902) states that, "to continue to draw on the store of mineral food in the soil of a farm without replacing it is like drawing out money from the bank for daily expenses and never troubling to earn any more to replace it" and may be "compared to a skillfully-contrived robbery, by which the fathers rob their own children" (p. 122). Indeed, Liebig considered this style of farming a "crime against human society" (Shenstone, 1902, p. 122), which could be remedied either through traditional applications of animal manures or through a more scientific method. Liebig explained the latter method:

> When we have exactly ascertained the quantity of ashes left after the combustion of cultivated plants which have grown upon varieties of soil, and have obtained correct analyses of these ashes, we …shall arrive at an exact knowledge of the sum of all the ingredients we withdraw from the soil in the different crops. With this knowledge the farmer will be able to keep an exact record of the produce of his fields in harvest, like the account-book of a well-regulated manufactory; and then by simple calculation he can determine precisely the substances he must supply each field, and the quantity of these, in order to restore their fertility (1843, p. 52).

Although the method used to arrive at such calculations no longer relies on the analysis of plant ash as they did in Liebig's time, the modern soil test administered by P.Ag.s rest on the same principle: the law of minimum. This principle simplifies the relationship between soil and plants by focusing on the nutritive element that is "present in the soil in minimum amount" (Liebig, 1863, p. 15). For Liebig, once the minimum element in each field had been identified, farmers could supplement with whatever form of fertilizer that contained that particular nutrient. He claimed that the process which was used to address the case of nitrogen deficiency, for example, was "quite indifferent for our purpose whether we supply the ammonia (the source of nitrogen) in the form of urine, or in that of a salt derived from coal-tar" (p. 507). Thus farmers could replace animal manure and grow crops on land previously reserved for animal feed and pasture. This set the stage for the mass production of fertilizers, which coincided with a general fear in the late 19th and early 20th centuries, particularly amongst European and American agricultural scholars, that unless farmers restored soil nutrients, food shortages and mass starvation would take hold throughout the world by the 1930s (Hager, 2008, p. 4). World trade of guano[49] from South America temporarily allayed these fears, but with guano mines quickly depleted by 1880, finding new inorganic sources of "artificial manures" (the phrase commonly used to describe fertilizers not derived from animal waste) became a top priority for researchers and Western governments (Hager, 2008; Rossiter, 1975).[50] These efforts culminated in early 20th century Germany, as the chemical company BASF brought Fritz Haber and Carl Bosch together to perfect Haber's method of converting atmospheric nitrogen (N_2, a form of nitrogen unavailable to all living things) into ammonia (NH_3-a compound of nitrogen and hydrogen that can be used in different forms as a fertilizer) (Hager, 2008; Smil, 2001).[51] In 1931, Bosch won the Nobel

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49

Guano is the accumulated droppings of sea birds and bats (Hager, 2008). It is high in nitrogen, phosphorus, and potassium and can accumulate to form small mountains that can be mined and sold as fertilizer.

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For a detailed history of pre-20th century fertilizer production and trade, see *The Emergence of Agricultural Science: Justus Liebig and the Americans 1840-1880* by Margaret W. Rossiter. Ashley et al. (2011), in *A Brief History of Phosphorus: From the Philosopher's Stone to Nutrient Recovery and Reuse,* offer a concise history of phosphate fertilizers from 40,000 years ago to the present. Ciceri et al. (2015) in *Historical and Technical Developments of Potassium Resources* give a short history of K-fertilizers (potash). This account covers the use of K-fertilizer from the 16th century until present day, and provides information about wood ash, kelp, and potash mineral deposits and mining, including Saskatchewan's role in the global extraction and trade of potash. For a history of nitrogen fertilizer derived from guano extraction, sodium nitrate in the Atacama Desert, the story of the Haber-Bosch process, and the industrial production of ammonia fertilizers see *The Alchemy of Air: A Jewish Genius, a Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler* by Thomas Hager. See also *The World's Greatest Fix: A History of Nitrogen and Agriculture* by G. J. Leigh.

51

Prize for developing this method of nitrogen production on an industrial scale; it has since become an essential component for worldwide food production. Estimates suggest that in 2008, 48% of the world's population (approximately 3.26 billion people) relied on food grown with Haber-Bosch nitrogen fertilizers (Erisman et al., 2008).

NPK Mentality

Krohn and Schafer (1976, p. 35) summarize the scientific and societal contributions of Justus von Liebig, claiming he created a paradigm to "elucidate agricultural processes, to construct these processes according to human needs and to integrate economic and technical knowledge." In Liebig's words, "I have simply tried to put a light into a dark room. All the furniture was there(...)Groping haphazardly one person found a chair, another one a table, the third one a bed(…)yet most were blind to the harmony of the furnishings and their interrelationships" (as quoted in Jacob, 1997, p. p.287). In 1857, however, Louis Pasteur published *Mémoire sur la Fermentation Appelée Lactique* which, in direct contradiction to Liebig's own writings on the subject of yeast fermentation,[52] outlined how the activity of living microorganisms caused lactic fermentation. In Latour's words, Pasteur created a "world where a ferment is as lively as a specific life form, so much so that it now feeds on the organic matter,

Haber and Bosch, while employed for BASF in early 20th century Germany, originally worked towards using the N_2 conversion process to provide food security for their country out of fear that a potential British blockade of Chilean nitrate would result in mass crop failures. During World War I, BASF, with government funding, expanded their ammonia plants to produce sodium nitrate—aka saltpeter, which could then be transformed into gunpowder and nitric acid to create TNT. This was the beginning of BASF's, called IG Farben after a merger with Bayer in 1925, transformation from a chemical firm to a "defense industry" (Hager, 2008, p. 140). It would eventually "arm and fuel the Nazi machine" (p. 262) during World War II. Following WWI, the allied countries desperately hoped to claim the Haber-Bosch process for their own use in fertilizer and ammunitions production. As part of the Treaty of Versailles, Bosch agreed to assist France in building their own plant, which eventually led to the French, British, and American production of ammonia from N_2 during the 1920s. See also *Enriching the Earth: Fritz Haber, Carl Bosch and the Transformation of World Food Production* By Vaclav Smil (2001).

52

Liebig wrote on the subject of yeast fermentation in 1939. His analysis concluded that fermentation was the result of decomposition (Latour 1993; Hein 1961). As Hein explains, "He assigned violent motion to the particles of the catalyst as it decomposed and assumed that the transmission of this motion to the reactants brought about their decomposition in turn" (1961, p. 614).

which has become food for it instead of being its cause" (1993, p. 133). Thus, without acknowledging the non-human actant involved in fermentation and countless other chemical transformations, Liebig was missing an essential piece of furniture—perhaps the rug that ties the room together—in the dark room of agricultural processes.

Pasteur's work on lactic fermentation was just the beginning of many challenges to Liebig's work. In regards to Liebig's proposed nitrogen cycle, wherein he explained that ammonia is released into the atmosphere through the decay of plant and animal residue then cycled back into the Earth's surface with precipitation, he failed to include important actors mediating this sequence of events (Leigh, 2004). In 1886, Hellriegel and Wilfarth successfully identified nodules, small globular-shaped plant organs, on the roots of legumes (i.e. clover, peas, and lentils) as the location for nitrogen fixation (the conversion of N_2 to NH_3) (Leigh, 2004). They explained that legumes, unlike wheat, are able to form a relationship with infectious, microscopic agents called bacteria to generate nodules that can provide the host plant with nitrogen. The work of Hellriegel and Wilfarth was only the beginning of extensive research in biological nitrogen fixation that is ongoing.

Around the same time that Haber and Bosch were perfecting their production of nitrogen fertilizer, Sir Albert Howard was focusing his attention on humus[53] (Howard, 1943; Montgomery & Biklé, 2016). In the late 19th and early 20th century, studying humus was considered out of

53 "Humus" and "soil organic matter" are often used interchangeably, although different meanings have been attached to the terms (See Encyclopedia of Soil Science eBook, 2017). Soil organic matter (SOM) is a broader term, which includes heterogeneous plant, animal, and microbial organic substances at all stages of decomposition in the soil (Lal, 2017). SOM includes soluble sugars, proteins, and other metabolites as the final stage of decomposition and organo-mineral complexes, which are soil mineral particles in aggregate relationships with organic particles. When soil scientists and other researchers use the term "humus," they are generally referring to a constituent of SOM that is further along in decomposition and therefore more amorphous in shape, having lost any recognizable plant or animal form. It is oftentimes darker in color, but still contains chemical and mineral components from earlier stages of decomposition. (Lal, 2017). However, "humus" can also be a term used to describe the soil horizon (or layers) that contain organic material.

vogue for any up-and-coming researcher, largely because Liebig dismissed humus as being secondary in importance to plant nourishment (Liebig, 1843). [54] Howard disagreed, arguing that humus was "a key material in the life cycle (Howard, 1943, p. 30)," essential to maintaining the "fungous bridge which connects soil and sap" (p. 41). Howard argued that chemical fertilizers could never replace humus because of its key role in providing the perfect environment for millions of microorganisms.[55] Howard promoted the Indore Process[56] as the only sustainable method of agriculture, which relied on the return of all organic waste such as crop stubble and manure to production systems through composting to sustain soil fertility. He charged farmers with the responsibility of manufacturing compost to sustain soil biota, which would, in turn, support plant health by improving soil structure, suppressing disease, warding off pests, and providing nutrients through decomposition and symbiotic alliances with plants. In his 1940 publication *An Agricultural Testament,* Howard directly challenged Liebig and what he referred to as the "NPK mentality." Therein, he (1943, p. 18) defines the concept:

54

In Liebig's comments regarding humus, he was responding to the vitalist theory that inorganic materials could not be the source of creation for organic ones, thus only organic materials in the soil (humus) could act as a source of nutrients for plants (DeGregori, 2003). Liebig refuted the vitalist-derived "humus theory" by demonstrating how humus is largely insoluble and therefore unavailable to plants through root systems (Rossiter, 1975; DeGregori, 2003). Again, he was unaware of the many microorganisms within humus that decompose and transform organic material into forms that are available to plants.

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When Howard discusses microorganisms, he rarely mentions specific species. He uses the broad categories of bacteria and fungi (Howard, 1943). The five main types of soil microorganisms are bacteria, fungi, algae, protozoa, and actinomycetes (Paul, 2015). Soil biota is a broader term that includes microorganisms, soil fauna (i.e. earthworms, nematodes, and mites), and plants, all of which coexist in a universe of complex interconnections between millions to hundreds of millions of species (Paul, 2015; Montgomery & Biklé, 2016).

56

Sir Albert Howard studied agriculture in a radically different context than did Justus von Liebig. Howard received a diploma in agriculture from Cambridge in 1897. After two brief postings in Barbados and Kent, Howard accepted a position at the Agricultural Research Institute in North Bihar, India where he studied under the tutelage of his "new professors—the peasants and the pests" (Howard, 2010 [1947], p. 4). After 19 years of work with his "professors," on a 75-acre experimental farm, Howard wrote reports and publications on what he called the "Indore Process." Directly contradicting the NPK mentality promoted, Howard explained why artificial manures cannot replace the natural processes of growth and decay that can, in fact, be stimulated by humans through the production and use of compost.

> The feature of the manuring of the West is the use of artificial manures. The factories engaged during the Great War in the fixation of atmospheric nitrogen for the manufacture of explosives had to find other markets, the use of nitrogenous fertilizers in agriculture increased, until today the majority of farmers and market gardeners base their manurial programme on the cheapest forms of nitrogen (N), phosphorus (P), and potassium (K) on the market. What may be conveniently described as the NPK mentality dominates farming alike in the experimental stations and the country-side. Vested interests, entrenched in time of natural emergency, have gained a stranglehold.

Howard, who published *Testament* 100 years after Liebig's monumental book, stressed the importance of humus as a reserve of nutrients essential to maintain the "living soil" (Howard, 1943, p. 31). During his lifetime, Liebig (1859) never recognized the soil as a living entity and instead focused only on isolating the "constituent elements" (p. 261) shared by plants, manures, and the soil. For Liebig, soils acted as temporary vessels for elements involved in the agriculturalist's pursuit of trading (p. 171). Liebig explains how agriculture is a game of trade as he boils soil science down to a simple economic scenario: the constituents of the soil are the farmer's capital; the elements of food supplied by the atmosphere, the interest of this capital: by means of the former, he produces the latter. In selling the produce of his farm, he alienates a portion of his capital and the interest; in returning to the land the constituents of the soil removed in the crops, he simply restores his capital to his field (p. 178). He goes on to explain:

> Every farmer who takes a sack of corn, or a cwt. of rape, turnips, potatoes, & corn, to the town, ought, like the Chinese coolie, to carry back with him from the town an equal (or, if possible, a larger) quantity of the mineral constituents of the produce soil, and restore them to the field from which they have been taken (p. 268)

According to Liebig (1859), a system which disobeys this simple economic formula "justly deserves to be branded as a system of spoliation" (p. 175). In his view, the job of the agricultural scientist was to follow the movement of these elements between soils, manure, artificial manures (fertilizers), and plants.

Howard criticized the “Liebig tradition” of using artificial manures, which, in his mind, “lead inevitably to artificial nutrition, artificial food, artificial animals, and finally to artificial men and women” (Howard 1940, 41). Howard connected poor human health to broken food systems and degraded soils. He feared that the NPK mentality of farmers and scientists would have deleterious consequences: “The slow poisoning of the life of the soil by artificial manures is one of the greatest calamities which has befallen agriculture and mankind. The responsibility for this disaster must be shared equally by the disciples of Liebig” (Howard, 1943, p. 197).

PRODUCTION POTENTIAL

The influence of Justus von Liebig on Canadian agriculture and the research stations can clearly be seen through a brief timeline of soil fertility work in Saskatchewan. Chemistry was considered an essential component of the original Experimental Farms Service:

> The Chemistry Division came into existence in 1887, even before the Science Service was formed and only a year after the Dominion Experimental Farm was established in 1886(…)From the very start, the Chemistry Division was the only chemical service available to thousands of farmers in Canada, who were given helpful information and practical advice. This service included many soil analyses and studies that were necessary to increase soil productivity and fertility (Siminovitch, 1986, p. 10).

Through research at the University of Saskatchewan’s Archives and Special Collections, I discovered that farmers were requesting soil testing to be conducted by a professor as early as 1922. In 1924, Dr. Hansen regretted to inform a farmer from Forget, Saskatchewan, that:

> The University cannot undertake to make complete chemical analysis of soils at the request of individual farmers. To analyze one sample completely requires several days’ work of a trained chemist at a cost of about $20 [about $300 Canadian today] per sample. We cannot even analyze samples where farmers offer to pay the cost as we haven’t the time and equipment to handle the work (Hansen, 1924, p. 1).

Researchers had, however, begun testing “commercial fertilizers” at the Swift Current Station in 1926, although these trials primarily involved comparing fertilized crops with test strips without fertilizer to assess the impact of inputs (Campbell, 1971) (See *Figure 61).* It was not until the establishment of the Soil Research Laboratory at the Station in 1935, as part of Prairie Farm Rehabilitation Act, that chemical analysis of soils began with Dr. J. L. Doughty at the helm. Liebig's influence was clear in a seminar Doughty gave for other researchers at the Station on December 6, 1937, titled *The Development of the Fertilizer Industry*. In the seminar, Doughty (1937) asserted, "The work of the famous German chemist, Liebig, earned for him the title of the Father of Agricultural Chemistry. In 1840 he published a book on Chemistry and its application to agriculture and physiology, which served as a basis for the preparation of mineral fertilizers. This work also effectively disposed of many ideas pertaining to plant growth that were not supported by scientific experiments. From Liebig's time onward, the use of mineral fertilizers steadily increased, and it is from this point that the fertilizer industry really started to expand" (p. 3). Doughty followed up this seminar with another in 1955, titled *Agriculture Depends on Chemistry.* wherein he explained that Liebig's 1843 book, "firmly established the relationship between agriculture and chemistry" (p. 1) and that "although agriculture was an industry for thousands of years before the basic principles of chemistry were discovered, it was only by the aid of chemistry that agriculture became a science" (p. 6).

Figure 61. 1938 Fertilizer Testing. The Val Marie Substation tested phosphorus fertilizers in large crocks. Photo from SCRDC Archives.

Despite Doughty's insistence that chemistry has transformed agriculture into a science, the testing of commercial fertilizers that began at the Station in 1926 and carried on for many decades, yielded such poor results that researchers still hesitated to recommend the use of fertilizers. In the Station's 1935 *Annual Report,* a summary of trials testing commercial fertilizers on wheat noted "an actual decrease in yield when fertilizers has [sic] applied…Until greater increases from fertilizer are obtained, it does not seem advisable to advocate their use in this area" (p. 61). Researchers and scientists throughout this early period in the Station's history agreed that without sufficient moisture, the use of fertilizer could not increase the yield enough to cover the cost of inputs. For Palliser's Triangle, the element "present in the soil in minimum amount" (Liebig, 1863, p. 15) according to the Station scientists was always water, thus negating any yield increase with the addition of fertilizer. In the minutes of a meeting held in 1937 at the Station titled *Discussions of Fertilizer Experiments*, a dispute broke out after Mr. Shorty Kemp (from the Field Husbandry Division of the Station) summarized the experiment results and concluded that "Fertilizers are not of much value in this area" (p. 3). Dr. Neidig, listed as a guest in the meeting minutes, was present and representing Consolidated Mining and Smelting, the only fertilizer manufacturer and distributor in Western Canada between the years 1930-1955 (Henry, 2016). Neidig objected to the findings and the research design by stating that in his own work: "We had striking results with farmers in dry years. Fertilizer sales are increasing and farmers are grateful for results obtained with fertilizers. In many cases fertilized crops were the only ones harvested. Australian results reported through Rothamsted showed increased yield of 20 to 30 percent with triple superphosphate(…)Similar results should be expected here(…)I can't believe these decreased yields over a period of ten years. They don't agree with our experience" (p. 4). The discussion continued as Neidig repeatedly questioned the work of Mr. Kemp and other researchers from the Station. Eventually Mr. Kemp agreed to review the entire research design, suggesting that Neidig, as a representative of a fertilizer manufacturer, influenced activities at the Station. Mr. Kemp and his associates within the Field Husbandry Division continued their experiments on commercial fertilizers into the late 1950s, but they could never fully realize the 20 to 30% increase in yield promised by Dr. Neidig.

Soil testing for farmers was offered by the Station throughout the 1940s. By 1941 this service became part of the "routine work" of scientists within the Soil Research Laboratory in Swift Current (Dominion Experimental Station Swift Current, 1941). In 1946, The University of Saskatchewan Department of Soils advertised soil testing services in their extension bulletin, *Fertilizers in Saskatchewan.* They advised farmers to collect the soil samples themselves, carefully label the boxes with the location of the land, and mail them to the University in Saskatoon. They provided this soil testing service free of charge, which was certainly an improvement from their service in 1924. Although fertilizer testing continued at the Division of

Field Husbandry and the Soil Research Laboratory, researchers from the Station continued to hesitate to recommend the use of fertilizer to farmers. Throughout the 1950s, *Weekly Letters* continued to advise against the use of commercial fertilizers for both grain and forage crops. For example, on March 28, 1953, the author[57] wrote:

> Commercial fertilizers have been tested at the experimental station, Swift Current for the past fifteen years and for a shorter time at the sub-stations in Southwestern Saskatchewan. Results have varied from year to year, from district to district(…)the average yields, over a period of years, have not shown sufficient increases from the use of fertilizer to justify recommending commercial fertilizers for general use in Southwestern Saskatchewan at the present time (Swift Current Research Station, 1953, p. 1) (See *Figure 62).*

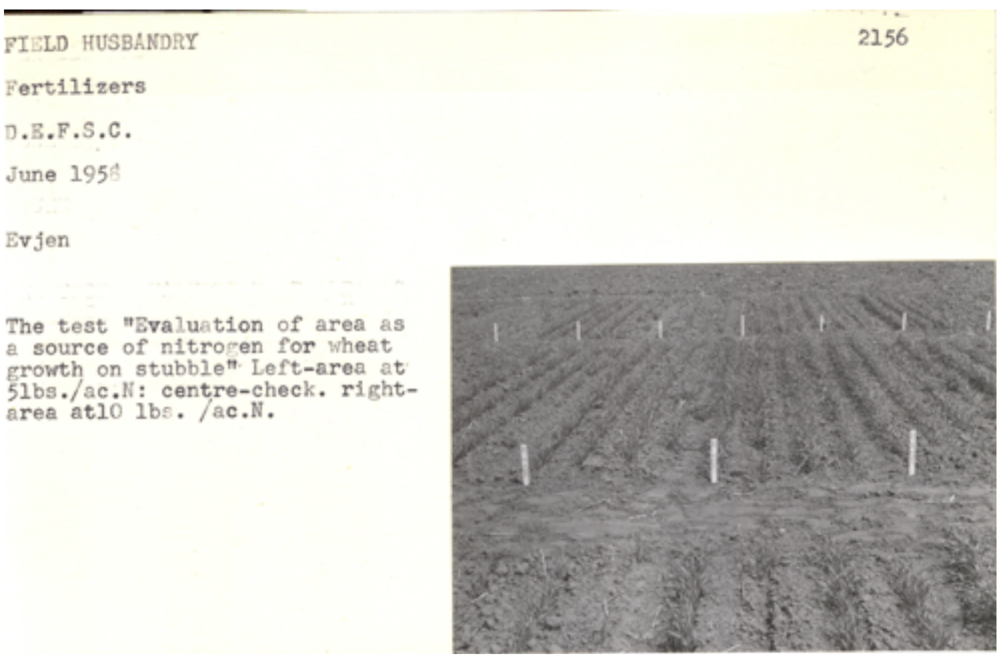

Figure 62. Fertilizer Plots. Note original caption. The photo above shows a typical fertilizer trial at the Station. In this photo, it's hard to discern any noticeable difference between the fertilized and unfertilized (center plot). Photo from SCRDC Archives.

Farmers throughout the 1950s and into the 1960s were receiving mixed messages. Despite the research findings at the Station, the *Guide to Farm Practice in Saskatchewan*—a

57 The *Weekly Letters* were available at the SCRDC archives from the years 1936 to 2010. The specific author(s) of these letters were not made available until 1957 with a few exceptions.

publication jointly prepared by representatives from The University of Saskatchewan, the Saskatchewan Department of Agriculture, and the Canadian Department of Agriculture—continually recommended the use of 11-48-0[58] fertilizer at rates of 30-50 pounds per acre for farmers in the brown soil zone (University of Saskatchewan et al., 1954, 1963, 1966). The Saskatchewan Advisory Fertilizer Council, with representatives from each of the three groups mentioned above, ultimately reviewed research from prairie experimental stations and universities to agree upon general recommendations for each of the main soil zones in the province. Thus, in direct communication with farmers such as through *Weekly Letters,* the scientists from the Station advocated caution when purchasing and applying fertilizer. However, as the Saskatchewan Advisory Fertilizer Council, which included representatives from the federal research stations, began its work in the 1950s they advocated for the use of fertilizer in the brown soil zone, including on poorer quality sandy loam (University of Saskatchewan et al., 1963, p. 18).

In 1966, The University of Saskatchewan hosted their annual "Farm and Home Week" event, with selected addresses on summerfallow, agricultural chemicals, and fertilizers. For the fertilizer segment of the event, Mr. Harry Ukrainetz spoke as a representative from the Scott Research Station in Saskatchewan. Ukrainetz explained that because fertilizer results may vary significantly depending on soil type, soil tests are essential for determining the best approach to fertility management. Dr. Rennie from the University of Saskatchewan followed up with an optimistic presentation about the future growth of the agricultural economy in Saskatchewan predicated on farmers adopting "optimum fertilizer consumption" (1966, p.19). According to Dr.

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All commercially sold fertilizers include a label on their packages such as11-48-0. This label corresponds to the percentage of nitrogen-phosphorus- potassium (or more specifically potash). The label 11-48-0 means that for each bag of fertilizer, there is 11% nitrogen, 48% phosphorus, and 0% potassium.

Rennie, in 1961 Saskatchewan farmers “consumed” 136,000 tons of fertilizer. However, based on his estimates, they should have been “consuming” around 519,000 tons to achieve 95,000,000 more bushels of wheat provincially (Rennie, 1966, p. 19). He agreed with Ukrainetz about soil testing:

> Today, we have learned that soils can be defined, classified and understood. They have a complex combination of characteristics no one of which has a meaning by itself. We have learned that soil management practices must be adjusted, depending on soil type. The so-called general recommendations in a soil management area must be replaced with specific ones that avoid the wasteful use of, and ensure maximum efficiency of, chemicals, fertilizers, etc. (Rennie, 1966, p. 20).

The final presentation from the fertilizers portion of the event came from Mr. William Silversides, the Manager of the Agricultural Department for the Federated Co-operatives. He reported that his experience in Alberta indicated “that many large farmers like a total and complete fertilizer service, which includes the services of an agronomist or soil specialist to take soil samples, recommend rates and types of plant food required from soil analysis reports, and the field application of the plant food required for the particular field and crop to be grown” (Silversides, 1966, p. 24). Silversides predicted that in 1966 Western Canada was in a “take-off” stage for fertilizer use, and use would rapidly increase in the following decade. Figure 63 demonstrates the accuracy of Silverside’s prediction, as nitrogen use alone increased from less than half a million tons in 1968, to 2.5 million tons in Canada in 2016 (Statistics Canada Table 32-10-0037-01 (001-0067), (as cited in Qualman and the National Farmers Union, 2019, p. 26). Saskatchewan's “take-off was perhaps in part the result of the new Saskatchewan Soil Testing Laboratory that opened its doors at the University of Saskatchewan in 1966. Beginning in that year, the lab offered nutrient recommendations based on soil samples provided by farmers (Saskatchewan Soil Testing Laboratory, 1971). In 1971, they began offering a new service to farmers, which expanded their previous nutrient recommendations to also include “expected yield increase information" to enable "the farmer to calculate the optimum amounts of nutrient for his particular cost-price situation" (p. 3). The cost for testing in 1971 was $9.00 per field and although the lab was located at the university in Saskatoon, the bulletin reassured farmers that "fertilizer dealers and agronomists are often willing to assist farmers in taking soil samples" (p. 10). Between 1955 and 1970, five fertilizer manufacturers joined Consolidated Mining and Smelting as new operations, thus making numerous nutrient inputs widely available throughout the Prairies by 1970.

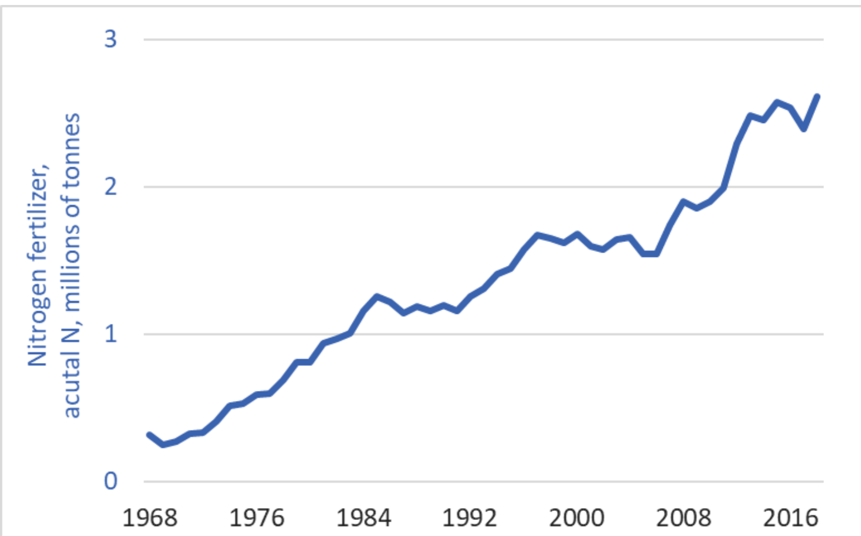

Figure 63: The Take-off Stage. "Canadian nitrogen fertilizer application tonnage, 1968-2016" (Qualman and the National Farmers Union, 2019, p. 26).

Throughout this period, *Weekly Letters* remained reluctant to recommend fertilizer, generally. However, nearly all contained directives for farmers to undertake soil testing to help inform their decisions about fertility inputs (Weekly Letters 1960-1979). For example, on July 9, 1976, Station researcher Don Read, who was heavily involved in testing fertilizer on farmers' fields throughout the 1960s and early '70s wrote an article titled "Yield Response of Different Wheat Varieties to Fertilizer" in a *Weekly Letter,* stating that, "the optimum level of fertilizer can only be determined by a soil test" (Read, 1976, p. 1). Read's colleague, Frank Warder wrote a similar article on October 14, 1977 titled "Why Soil Test*,"* in which he said:

> When making a decision to seed a crop on stubble next spring, the soil moisture situation and the fertility level, particularly the available nitrogen in the soil, are factors which should be considered(…)Soil samples taken in October should be sent to the Soil Testing Laboratory, University of Saskatchewan, Saskatoon, for analysis and fertilizer recommendations (p. 1).

Thus, throughout this period, we see the researchers from the Station deferring to soil tests provided by the Soil Testing Laboratory in Saskatoon to guide farmers in their fertility management decisions. Rather than providing general recommendations on soil fertility, the Station scientists advised farmers to use the information on their soil test results to guide their decisions on fertilizer requirements to attain their desired crop yield.

In January, 1978, at the Dryland Wheat Production in Southwest Saskatchewan Seminar in Swift Current, a summary of soil fertility research conducted at the Station between 1967-1976 was provided by Don Read. In it, Read explained that during this period, across his 6-15 trial location sites, "a variety of results were obtained from these tests, at some there was little response to fertilizer, while at others there were large yield increases" (1978, p. 85). However, as farmers reduced summerfallow rotations and began continuous cropping strategies of the 1970s, they began to experience greater responses from fertilizer, particularly because the increased number of rotations was depleting their soils of nitrogen. On November 21, 1980 Frank Warder, Read's close colleague in fertility research, wrote a *Weekly Letter* article titled "Soil Fertility Research in Southwestern Saskatchewan 1938-1980*."* Warder (1980) reiterated Read's summary that stubble crops or continuous cropping were depleting the soils of nitrogen, but extended his comments to fallow soils: "In more recent years it has been found that stubble land is generally low in available nitrogen and also that fallow soils frequently require additional nitrogen to produce maximum yields" (p. 1). He concluded the letter by stating, "Total fertilizer use has increased dramatically during these years. In 1940 only 34 tons of fertilizer were used in Southwest Saskatchewan. Conservative estimates now show that over 50,000 tons are used annually in the same area" (Warder, 1980, p. 2). Overall, by the late 1970s, fertilizer research at the Station continued to generate varying results in terms of the impact of fertilizer on yield.

Beginning in the 1970s and continuing into contemporary research at the Station today, scientists began expanding their experiments to include assessing the risk of fertilizers as environmental pollutants. The first mention of this interest in *Weekly Letters* appeared on February 26, 1971, when Dr. Con Campbell wrote an article titled "Are Fertilizers Pollutants?" He assured readers that when fertilizers are used properly, the risk of them becoming pollutants on the Canadian Prairies is "very unlikely" (Campbell, 1971, p. 1). However, he does concede that nitrogen, as the nutrient most deficient in prairie soils and thus the one applied in the greatest quantities throughout the province, is also very water soluble. For this reason, nitrogen is mobile in the soil and with erosion, can move into waterways. As Campbell also explained, "When an ammonium form of nitrogen is applied to the soil, as much as 10 to 30 percent might be lost to the air. However, the latter process does not contribute to pollution because nitrogen is a very important constituent of air." The ammonium form of nitrogen is still a commonly utilized form in agricultural fertilizers, and we now know that "after carbon dioxide and methane, nitrous oxide N_20 is the most potent greenhouse gas, trapping and contributing to global warming" (Sanders, 2012). Dr. Campbell clearly did not understand the impact of N_20 at that time; however, as early as 1967 he fully appreciated the importance of organic matter to soils. On February 3, 1967, he wrote a *Weekly Letter* article imploring farmers to understand, "that soil organic matter is a tremendous asset to soil fertility; it therefore should neither be taken for granted nor unnecessarily abused!” (Campbell, 1967, p. 1). Until he retired in 1998, Campbell's interest in how agricultural practices affect soil organic matter remained a central focus of his work; his research included work on how soil organic matter can create carbon sinks to mitigate $C0_2$ levels in the atmosphere (Campbell et al., 2005).

To summarize this section, researchers at the Station shifted their focus beginning in the 1970s to consider potential environmental issues associated with fertilizer use including leaching, the impact on microorganisms, and acidification of the soil (Campbell et al., 1994). By the early 1990s, fertilizer use in southwestern Saskatchewan became standard practice for most farmers, despite the variable results being produced in fertilizer testing from the Station. This corresponded to an overall shift beginning in the late 1970s in farming practices away from summerfallowing in favour of continuous cropping. As farmers adopted minimum tillage, continuous cropping systems, they increased their organic matter on the surface (McConkey et al., 2012; Campbell et al., 1994; Rennie et al., 1993). While this improved overall soil structure and decreased soil erosion, it also slowed down the microbial process of organic matter decomposition, which had been assisted by tillage in the years when summerfallowing was still common. As the process of organic matter decomposition slowed down with minimum tillage, less inorganic nitrogen became available for plants, thus necessitating nitrogen fertilizer inputs. Thus, while farmers in the late ’70s and early ’80s began seeing a greater return on their fertilizer investment as they shifted to continuous cropping, it may also have been due to improvements in fertilizer quality and improvements in the accuracy of equipment in placing fertilizer in ideal locations in proximity to the seed.[59]

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59 Fertilizer placement has evolved from a broadcast method to placement between seeded rows called mid-row banding or alongside seeded rows called side-row banding. Newer models of air seeders can do either mid or side-row banding. Mid-row models include separate knife openers as well as separate shoots for the fertilizer. Side-

By the early 1990s, the use of soil testing and fertilizer inputs became part of Agriculture Canada's *Best Management Practices for Field Crop Production* (1990, p. 4). According to the agency, "Best management practices are tools for meeting today's agricultural goals. To be a best management practice, an action must maintain or increase crop returns while minimizing the impact on the environment" (Agriculture Canada, 1990, p. 4). As a best management practice, soil testing was viewed as the only way to maximize a field's economic potential and without a soil test, "anything else is just a blind guess" (p. 27). In 1994, Dr. Campbell and Dr. Rennie, long-time contributors to the development of soil fertility research and soil testing in Saskatchewan, published an edited guide to soil fertility titled *Nitrogen, Phosphorus, Potassium, Sulphur: Answers to Your Questions, A Producers Version* (Campbell et al., 1994). In the guide, the authors—who included several representatives from fertilizer companies as well as from the University of Saskatchewan and Agriculture Canada Research Station scientists—answered questions submitted by professional agrologists which were representative of the most common inquiries from farmers. The questions were broken down into categories: soil testing, economics, and environment. Regarding environmental concerns, the following question was asked: "Some people believe that farmers use more commercial fertilizer than they need. What do the long-term trends in fertilizer show?" (Campbell et al., 1994, p. 47). The following is the complete response:

> Long term trends in fertilizer consumption in western Canada show crops remove more nutrients than we replace with fertilizers. For example, the average ratio of nutrient removal compared to replacement for the prairies during 1984-1989 were 1.6 for N, 1.2 for P and 9.9 for K. In other words, prairie crops remove 1.6 times more nitrogen than is replaced by fertilizer N, 1.2 times more P, and almost 10 times more K. This suggests that the use of commercial fertilizers may need to be increased just to replace the nutrients exported in crops. This helps us explain the

row models do not have separate openers but include off center separate shoots to place the fertilizer alongside the seed.

> gradual decrease in soil organic matter that has been observed in prairie soils over the last 50 years.

On a related question about the use of "natural means (e.g., using green manures, crop rotations, forages)" to replace nutrients, the author responded,

> All plants withdraw N, P, K, and S from the soil. If these nutrients are not replaced in some way the system will eventually become impoverished with regards to these nutrients. Most producers, in recognition of this fact, apply fertilizers to replace the nutrients removed in grain or feed (p. 47).

The author never addresses the possibility of "natural means" to fertilize soils other than to mention that pulse crops such as lentils can replace some nitrogen, though not enough to reduce the impoverishment of western Canadian soils.

As demonstrated by the above, Liebig's influence continued in the Prairies well into the late 20th century. "Exported" nutrients and "impoverished" soils bring to mind Liebig's 1859 discussion of farmers keeping account books to track those minerals gained and lost on their fields, in order to avoid being "branded as a system of spoliation" (p. 175). As we saw throughout this section, the researchers from the Station, remained hesitant to recommend the use of fertilizers to their farmers because of variable yield results in their trials. However, either through their research or through direct consultation with the Saskatchewan Advisory Fertilizer Council, they contributed to the semi-annual *Guide to Farm Practice in Saskatchewan*, which recommended fertilizer for the brown soil zone. The *Guide* served as a primary source of information for farmers in the pre-digital age and was widely distributed throughout provincial extension offices and experimental stations in the province. While I do not know exactly what can account for this discrepancy between the *Guide* and the research results from the Station, I can say that soil testing resolved the matter. Rather than attempting to give wholesale fertility advice to all farmers within the brown soil zone, the researchers at the Station could give general information then instruct farmers to obtain a soil test for more specific guidance. As we saw in this section, soil testing was a service offered by the Saskatchewan Soil Testing Laboratory at the University in Saskatoon. Farmers oftentimes collected their own samples and the results were mailed directly to them, including potential yield outcomes for varying amounts of fertilizer.

Through my ethnographic research, I have learned that the soil testing process has changed significantly for contemporary farmers. Since the University no longer offers farmers testing services, most tests must be processed through accredited private laboratories. Farmers no longer collect their own samples or receive results from labs; rather, they use consulting services, which we will explore later in this chapter. Another major change that occurred as researchers from the Station moved away from fertility trials and recommendations during the 1980s and '90s, is that they reduced their role in terms of the extension services offered to farmers. By recommending a soil test, the Station researchers inevitably gave private agribusinesses an authoritative role in advising farmers. At the time, the Station researchers probably did not foresee that outcome because soil testing was primarily managed by the farmers themselves in the 1970s and '80s. However, this phase did not last long and as we will see later in this chapter, farmers began accessing the services of P.Ag.s as early as the 1980s.

The next section delves further into the shift at the Station in terms of agricultural extension. It compares accounts given by scientists and other employees—both retired and currently employed at the Station—about their role in extension work both prior to 2000, and after, demonstrating how their relationships with farmers changed after the government changed their mandate. As the provincial government dramatically decreased extension services for farmers in 2004, an informational gap between public research and farmers was created, which private consulting services and professional agrologists have since filled.

THE FARMER IS NO LONGER YOUR CLIENT

On Thursday mornings at the Station, retired employees gather to drink coffee and visit in the conference room of the main building of the research grounds. I attended these coffee rows throughout my time living in Wymark and eventually began referring to them in my notes as "coffee with the old dudes." The attendees I joined were always men, but included a variety of former scientists, technicians, and support staff. The diversity of personalities and backgrounds meant that these mornings were good for a few laughs as Duncan E., the photographer for the Station for 35 years before retiring in the 1990s, and Dr. Gerald H., the lead scientist on soil salinity before the program was cut, would inevitably get into arguments. Friendly banter included such topics as politics, forgotten details about the Station, and on one occasion the correct term for the sound geese make. On that particular morning, Gerald described a recent walk where he saw a goose perched in a tree and heard it "quacking" at him. Duncan quickly interrupted, asking Gerald if he had finally lost his mind. Duncan told Gerald that if he ever witnessed a goose quacking in a tree again, he needed to film this oddity because it would certainly be a first. The debate was on. Duncan insisted that the proper term for the noise a goose makes is "honking." Gerald held firm and said that he has heard the term "quacking" used as well. Duncan suggested that because Gerald was originally from the U.S., maybe American geese "quack" rather than "honk." All eyes turned to me. I did not want to choose sides but sheepishly admitted that I always heard "honk" rather than "quack." Most of these debates concluded with Duncan asking someone to "bring out the device." We'd wait as someone around the table offered the services of their smart phone to settle the debate with a quick Google search. On the “quack” versus “honk” debate, the balance of search hits sided with Duncan.

After a few coffee rows with the retired guys, I began asking them questions about the Station and whether they could speak to any significant changes that occurred while they were employees. Everyone agreed that the Station was almost unrecognizable from what they remembered from the 1950s through to the 1970s. In addition to the massive physical changes made to the research grounds— including many buildings having been torn down and a few new facilities added—they often discussed how the relationship between the farm community and the Station had deteriorated. Duncan explained that for most of his time at the Station, there had been a constant flow of farmers in and out of the main building. They frequently visited or called to ask scientists questions about weeds, soil fertility, and economic considerations for certain practices. Dr. Will O., another regular and former physiologist in the cereals division, explained that at one time the Station employed an Information Officer to assist in extension activities for the community. The Information Officer wrote publications, organized field days, spoke on local radio stations, gave presentations, and assisted the scientists as they carried out cooperative experiments on privately-owned farmers' lands. I was interested to learn that the first Information Officer, Peder Myhr also hosted a television program in the 1950s called *Farming Today*. Joined by his co-host Mark Kilcher, a forage agronomist at the Station, Myhr gave weekly 15-minute reports with updates about the Station and important topics in dryland agriculture. Stanley, the farmer I worked most closely with, remembered watching *Farming Today* with Myhr and Kilcher on the local station, CJFB-TV. He recalled that on each episode, Myhr would start the discussion by rolling a cigarette on camera. As the show concluded he would sign off and light the cigarette. By 1970, 700 episodes of Farming Today had aired on local television (Campbell, 1970, p. 75). Unfortunately, I was never able to find a recording of the program, which was disappointing, not least because I wanted to see the famous cigarette roll. I was able to recover some VHS recordings of the 1980s version of the show hosted by Peter M., Myhr's successor as Information Officer. Through these conversations I learned that Peter now lived in Medicine Hat, AB and they provided me with his contact information. I called him that same day and he agreed to an interview at his home in a retirement facility in Alberta.

When I asked Peter M. about *Farming Today,* telling him that I had recovered copies of the show from the Station, he laughed and looked slightly embarrassed: "You know there's nothing magical about them. They're not highly professional, but we did get a fair bit of feedback from the farmers. The other thing that happened out of that show is that it kept the research station, you know, in there" (June 12, 2015). Peter went on to explain that through the television show, radio appearances, field days, local conferences, the *Weekly Letters*, and formal or impromptu meetings with farmers, during his tenure there the Station kept in constant communication with farmers in southwestern Saskatchewan. Throughout the 1980s, Peter's extension work took him all over the region as part of the federal and provincial governments encouragement of minimum tillage and continuous cropping methods, following the Sparrow Report*.* As Peter explained in our interview, when he took the position on in 1981, he acted as a mediator between the scientists and farmers:

> I'm guessing on average we had 15 to 20 contacts per day with maybe 25% of them more casual visits. It was very obvious that some people found it [the Station] just a comfortable place just to come and have a chat sort of thing(…)The extension person's job was sort of to protect the research scientists from the prolific visits, so they could get some work done (June 12, 2015).

I found his comments about the number of farmer visitors each day surprising, although the retired guys at coffee row had mentioned a break in the relationship between farmers and the

Station. Throughout all my time at the Station, I never saw farmers around the offices of scientists or in the lobby unless they were there to attend some formal meeting, usually organized by the provincial agricultural representatives.

Throughout Peter's time as Information Officer, he worked closely with Grant P. and other provincial agricultural representatives to lengthen the reach of the Station's extension work. According to Grant, who worked as an agricultural representative for the provincial government between 1970 and 2004, his primary role was to give farmers general agronomic advice about practices that were already widely adopted in the agricultural systems of southwestern Saskatchewan. He utilized the *Guide to Farm Practice in Saskatchewan* to relay information to farmers. Grant referred to this publication as the "bible" for Agricultural Representatives. Grant gave farmers advice about weed issues, machinery options, fertilizer blends, and crop rotations, but he did not introduce them to new practices. That was primarily the job of either the PFRA or Station scientists. However, Grant advised the scientists at the Station about their projects, particularly those related to soils, weeds, and machinery.

As an agricultural representative, Grant communicated with farmers on a daily basis and knew exactly what issues they were experiencing on any given year. He conveyed this information to the Station scientists, oftentimes with Peter present, to help them assess the urgency or applicability of their projects to issues of the day. Peter and Grant organized meetings between farmers and scientists so that on occasion, they could discuss these issues directly. As Paul L., a former engineer at the Station, explained:

> When I first came here, scientists had an expectation of roughly two external meetings a year for producers in the area(…)What this did was not just make sure the information went to the producer directly, unfiltered and unedited, but also the extension personnel were there to learn just like the producers. So everyone heard the information from the horse's mouth and it kept everyone honest, making sure everyone got the same information (August 18, 2015).

Paul then spoke specifically to Grant's role as an Agricultural Representative:

> Grant used to come out every couple of weeks and have coffee with the guys or do whatever, so he'd hear about the projects these guys were doing or interested in doing. The scientists would have an idea of what was important to chase and sort of try to make the connection to the real world. Well Grant would sometimes go "no, no, no, no. You're missing the important thing." It would make them work backwards to address whatever important thing they'd missed (Peter M., June 12, 2015).

Thus, through the work of the Information Officer and the agricultural representatives, as well as *Weekly Letters* and television program, the Station maintained an "open channel of communication with the farming public" (Peter M., June 12, 2015). Echoing the sentiments of members of the coffee row, according to Peter, as well as all of the Station scientists I interviewed, things began to change in 1987. In 1985 Peter was asked to join a technology transfer project in Pakistan, but had been guaranteed that his position at the Station would be there when he returned. After two years in Pakistan with his family, in 1987 he arrived back in Swift Current to find that his job title was no longer "Information Officer." He was now an "Agent to Market Research." Along with this change in job title, Peter was told to "move out of the day-to-day extension programs;" the main responsibility of his new job was to "promote and sell or market the research. So if a plant breeder had new crops coming on, it was a matter of getting that into the industry" (Peter M., June 12, 2015). Peter did continue many of his exciting extension projects until he left the station in 1995, but he was informed they were no longer the priority. His first priority was to build relationships with industry partners such as seed distributors and the Saskatchewan Wheat Pool—a grain handling and processing company that was cooperatively owned until the mid-1990s. As we saw in Chapter Three, this shift came at a time when the Station began relying more on private/public funding partnerships to support their research. The change in that job title was only the beginning of the Station's gradual move away from agricultural extension.

> Dr. Frank D.: Here [at the Station] we had a very strong connection, a very strong sense that the scientists, technicians, support staff, everybody that was working here were on a mission and the mission was the people of the area. And that has changed over the course of time that our primary client now is the Minister of Agriculture and the political party that he represents. So you have a completely different focus, focus and structure to deliver on that. There's things done now to make it more difficult to meet the needs of agriculture in the local area. Yes, it's very, very different (Wheat Breeder at the Station from 1978-2015).

Frank, a retired cereal breeder from the Station, highlights the shift from the time the Station opened in 1920 when the scientists were on a mission to help contain the soil and contain the people to the current focus of the Station's research. In Paul's interview, he explained that although extension cuts began in the late 1980s, many people continued working closely with farmers into the 1990s. However, by 2000, their supervisors told them explicitly to stop their extension activities.

> Paul L.: The change in extension was done covertly in 1996. It was overtly done probably by 2000. We were told that we were not responsible for extension, period. That was part of the strategy of reduction in service. You do science. You rely on the provinces to disseminate information (Engineer at the Station from 1983-2014, August 18, 2015).

Dr. Carolyn M., a soils phosphorus researcher, also said that she was explicitly told not to do extension.

> Dr. Carolyn M.: When I arrived I was told specifically that my job is not extension. I'm not quite sure who our extension branch is, but my job is to provide the information to the extension people rather than spend a lot of my time. You could spend a lot of time doing that sort of thing (Research Scientist on soil nutrient cycling from 2008-present, October 9, 2014).

Scientists at the station were now being told directly that they should not spend time on extension activities. According to Paul L., by 2004, "Extension became a bad word for the provinces" (August 18, 2015). I also heard this from Charles A. and Samantha G., two employees in the Agriculture and Agri-Food Canada communications and technology transfer division in Regina. Although Carolyn M. seemed confused on this point in the quote above, Charles and Samantha are the “extension branch” for the Station; however, they do not write material for farmers. Instead, they write articles and post on the AAFC Twitter account, giving the general public information about agriculture and food. Charles and Samantha both agreed that although AAFC calls them the extension branch, they do not consider their work extension because they are not working directly with farmers. The reason Charles and Samantha described extension as a “bad word” for the provinces is because in 2004, the Saskatchewan Ministry of Agriculture closed 22 Rural Service Centres, laid off 120 staff members, and consolidated extension services into nine Regional Offices with a call centre in Moose Jaw (Briere, 2004, April 8). Grant P. was given “early retirement” at this time. He described this consolidation which took place:

> The best description of my job, of extension would be a conduit between research stations and the university and the farm(…)In 2004, the province sort of shut down that informational conduit and industry picked it up. I still have the bias that we were unbiased more or less and that these fellows that are out there now are carrying a bias. Not always but ah yeah, some of them very markedly I would say(…)Now there’s a dilution factor. I shouldn’t say that they [Agricultural Representatives] aren’t there because they are. There are seven or eight of them in these offices where we had 40 at one time. Our ratio of extension worker to farmer was like 1 to 2500 and now they’re probably 1 to 25,000 or 20,000—something like that. So the chances of an individual farmer bending one of their ears on a regular basis is small, very small (Grant P., February 13, 2015).

By 2000, the Station scientists were told to stop spending time on extension work altogether. In 2004, the Saskatchewan Ministry of Agriculture reduced their agricultural extension services to leave only nine offices open throughout the entire province. As Grant stated above, private industry has since filled the void left by extension work, and taken on the role as the primary informational conduit between agricultural research and farmers. Charles A. from AAFC’s communications department explained that "private agrologists are now the primary filter and translator of research" (October 7, 2014). Station scientists continue to participate in local conferences as guest speakers, and they occasionally write articles for newspapers or agree to make comments within articles. However, before they are allowed to publish anything for public consumption, the scientists must obtain written permission, oftentimes from the head office in Ottawa, before they can do so (this same level of permission is not required, however, should they wish to submit articles for publication in academic journals). Dr. Carolyn M. told me that on a few occasions when she's been contacted by local newspapers to submit an article or comment on a topic, by the time she's received written approval from Ottawa, the journalists have found someone else to provide content. This approval process has left many of the Station scientists feeling disconnected from local farmers. This stands in stark contrast to the *Weekly Letters* that scientists from the Station were required to write prior to the 1980s. Clearly, the Station scientists and Saskatchewan Agriculture have both relinquished their roles as the primary advisors to farmers in Palliser's Triangle. The next section describes the work of professional agrologists or P.Ag.s., the individuals who have accepted the roles previously held in the public sector. As explained above, P.Ag.s have taken on many of the roles previously held by provincial Agricultural Representatives and the Information Officer from the Station. To start this section, I describe my first experience collecting samples for soil testing with the guidance of a local P.Ag., Christy S.

THE FERTILE GRID

On a fall day in September during my first year in Swift Current, I managed to arrange a breakfast at Humpty's—a greasy spoon much beloved by the farming crowd—with a very elusive crop consultant who worked for several farmers in my network. Having already unsuccessfully attempted to meet with him several times unsuccessfully, or even to talk briefly over the phone, I felt anxious about making the best use of our time and had rehearsed key questions the night before. Kalvin R., a short man with a direct personality, was accompanied by his assistant Christy S. who was about half his age but towered over him as they entered the restaurant. Although both friendly, Kalvin seemed more reticent than Christy to reveal details about their work and clients around Swift Current. I reassured him that I did not want to know specific names or details concerning any of his farming clientele, but simply wanted to know exactly what it means to be an independent crop consultant with professional agrologist credentials. During our meeting, Kalvin offered only vague details about his business, explaining that he had left private chemical sales 10 years ago to start his company with his wife, who could not attend our breakfast. Christy, a recent graduate of McGill in her mid-20s, almost immediately offered to take me soil sampling that afternoon on a Hutterite colony north of town. Kalvin, who was constantly checking his phone and noticeably anxious to get going, delighted in that plan and stayed just long enough to get his eggs and coffee down and pay for the meal on his way out.

After he left, Christy offered a few words of apology for Kalvin and explained that having recently acquired a few farm clients at the 10,000-plus acre mark, he had to remain at their beck and call during most waking hours of the day. Drowning in the success of their own business, largely due Kalvin's outstanding reputation as a consultant, he could not afford to give us his undivided attention that day; as my research continued I would hear many such stories from independent crop consultants. Christy and I left the restaurant a short time later to head north towards the Hutterite colony in her white, relatively new, though noticeably dusty, four-wheel drive pickup truck, their company name stencilled in large lettering along both sides. I told her that I had noticed signs for their company along many two-lane highways during my travels in the southwest. She explained that Kalvin's local company is affiliated with a business called Western Ag, based in Saskatoon. Kalvin is considered independent because he does not work for a retail company and does not usually give recommendations for specific brands of fertilizer, herbicides, or other inputs. His affiliation with Western Ag means that Kalvin sends soil samples to their lab for testing and makes use of their computer software to write input prescriptions (more on this later) for his clients.

After a 15-minute drive, Christy veered off the road and onto a freshly harvested field owned by a nearby Hutterite colony. Her wheels kicked up a cloud of dust and crunched over the field like footsteps on a bag of potato chips as we rolled over the four-inch thick blanket of greyish, tan wheat stubble which extended as far as the eye could see. She came to a quick stop and pulled out her handheld GPS device to record the location, which was roughly in the vicinity of where she had taken a sample the year before. She wrote a few quick notes on a clear plastic bag marked with the Western Ag logo, including the farm name, GPS location, and date. Christy explained the general concept of soil testing to me as we left the vehicle to collect a bucket and a shovel with a long, narrow scoop (see *Figure 64)*:

> Basically we take a few samples in the row or between the rows for fields with mid-row fertilizer banding(….),Scoop away the first 4 inches then cut a profile down four to six inches(….) Make sure you have a clean sample with no bird shit or other droppings because that will throw the test way off (Strand fieldnotes 2014).

Christy collected a sample, then I collected one, and we mixed our dirt together in the bucket. We removed about two cups worth from the bucket and placed it inside the clear plastic bag to be posted to the lab in Saskatoon. For each quarter section field, we took samples from five locations, giving Christy and Kalvin an approximate average content level for NPK, sulphur, and other micronutrients, electrical conductivity, and desired yield (as determined by the farmer).

The output leads to "thousands [of dollars] worth of fertilizer treatments for each field," Christy explained. That comment helped me understand the true gravity of the seemingly simple task of placing scoops of dirt—while minding the bird shit—into a plastic bag to be sent to a distant lab for analysis. Her seemingly mundane work that day would help this Hutterite colony make fertilizer decisions on hundreds of acres. The impact of their work extends to thousands of acres around Swift Current when we take into account Christy's full list of clientele.

Figure 64. Scoop the Dirt. In this photo, Christy demonstrates the best technique for taking soil samples. Photo by Katherine Strand.

Some weeks to months after the initial soil testing, Christy and Kalvin review the results with their clients to discuss plans for the upcoming growing season. Using the Cropcaster program and its series of algorithms, they can adjust NPK levels to demonstrate to each farmer what their net profit per acre will be, with fertilizer expenses taken into account (See *Figure 65*). Once the NPK rate is agreed upon, farmers purchase fertilizer and, at the time of seeding, set the prescription rate for fertilizer appropriately, using their in-tractor computers (See *Figure 66).* And this is how, as previously mentioned, farmers can find themselves millions of dollars in debt even before the seed even goes into the ground. If they get sufficient moisture over the winter and if, in the spring, there are no significant problems with disease, weeds, or hail (such good fortune is rare, at least across all of a farmer's land), then these costs will pay off in the form of an abundant crop, with sales covering the accrued debt and allowing for a bit extra to cover the costs of international vacations, new equipment, and farmstead beautification projects. I have heard organic farmers call this type of production "purchasing your crop." For them, it means that if a farmer has the money to spend—or in many cases, to borrow, with their capacity to do so being determined by how much collateral they have available in the form of land and equipment—they need not bother with good management practices, because they can grow a crop on any type of land through just inputting the appropriate fertilizer. This approach to fertility treats soil as merely a vessel to contain nutrients, as they make the exchange from fertilizer placed at seeding to the growing plant. As we shall see later in the chapter, however, many non-organic farmers who use fertilizer consider these inputs to be essential to maintaining good soil health. They, in turn, would categorize organic farmers as "miners" or "robbers" of the soil because they do not replace the nutrients lost each year with synthetic NPK. Because organic farmers do not replace these nutrients with fertilizer, they tend to see soil not as a vessel, but as a living entity that requires special care to assist in building and maintaining organic matter, but more on this later.

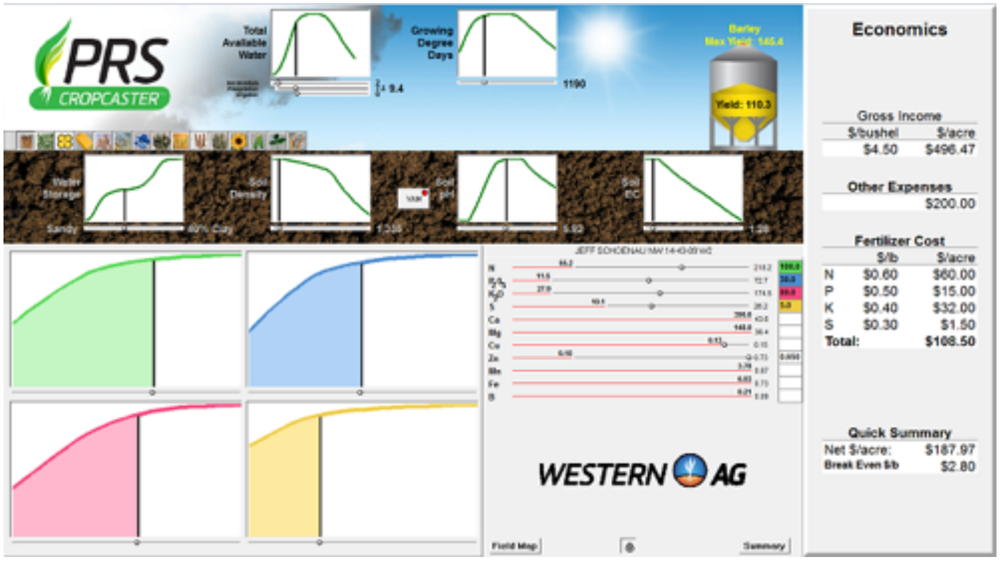

Figure 65. Cropcaster. This shows the interactive computer program used by Western AG to write fertility prescriptions. Photo from wsternag.ca (accessed January 12, 2021).

Figure 66. Seed and Fertilizer. This photo shows the in-cab computer interface that farmers use to set their rates of seed and fertilizer as pounds/acre. Photo by Katherine Strand

For Christy and Kalvin, soil testing has grown from simply sampling soil, into offering full-scale consulting packages that include: crop monitoring for weeds, disease, and pests; treatment recommendations including herbicides, insecticides, fungicides, and mechanical interventions like tillage; and staging recommendations—assessing the best timing for seeding, for herbicide applications, for pre-harvest desiccation or swathing, and for the commencement of crop harvest. In addition to meeting with farmers to consult with them about their soil fertility, Christy and Kalvin survey their fields for the presence and concentration of various weed species to give pre-seeding "burn-off" recommendations—herbicides applied before seeding—as well as fertilizer/seed rate field plans. I joined Christy as she conducted early spring weed surveys on the land of a farmer named Martin D., whom I had interviewed the previous fall. Christy explained that Martin had purchased their complete package of consulting services. As such, Christy would monitor Martin's fields for disease and weed issues throughout the growing season. They would do so in addition to their fertility testing and prescription drafting, herbicide cocktail recommendations, seeding plans, and harvest staging—the latter of which is a process of monitoring crop to determine when plants are ready to desiccate or ready for harvest. When I asked Martin about the cost of Christy and Kalvin's services he replied: "I think it's around six to eight dollars an acre for advice on chemical and fertilizer requirements for the year, and, ah, I think it's well worth the money because things have become so complicated in the chemical world and all the different options" (Interview September 4, 2014). In 2014, Martin grew crops on about 3,000 acres of rented and owned land, tallying up to between $18,000 to $24,000 for consulting services, which was a relatively small expense compared to others he incurred in that year.

Professional Agrologists, AKA Land Scientists

Martin's heavy reliance on consulting services was not unique among the farmers I worked with throughout the course of this project. After my first couple of interviews in which farmers mentioned agrology services, I made sure to ask all of my participating farmers about P.Ag.s.; among chemical farmers nearly all used soil testing services, with many also contracting full-scale consulting packages for their farming operations. Older farmers recalled the 1980s as being the time when soil testing first began, and that by the late 1990s/early 2000s they were hearing about, and even using, consulting services for fertility prescriptions, herbicide and pesticide recommendations, field monitoring, and staging for crop input treatments such as fungicides and staging for harvest—meaning the best time to apply a desiccant or swath then combine. Leonard W., a Swift Current farmer around 80 years old, and formerly on the board of directors for the Canadian Wheat Board, explained to me that he first had his soil tested in the late 1980s when the Pioneer Co-op offered free testing for anyone purchasing fertilizer from the store. In my interviews with other farmers around the southwest, I only encountered two who remembered using the services offered by the University of Saskatchewan. Most remembered their first soil test as being administered by P.Ag.s working for the Co-op, Viterra, or other agricultural input dealers in Swift Current. Like Leonard, they became aware of these services in the late 1980s or early '90s.

While most chemical farmers use the services of P.Ag.s., the extent of the services they access varies. Leonard hires a P.Ag. to test his soils for fertility every few years to establish "benchmarks." When I asked Ronald H., a farmer who seeds about 10,000 acres each year south of Swift Current, if he used P.Ag. services, he explained:

> We have a full, well not full-time, we have an agrologist that works for us year round on a per acre fee. So he does our soil tests. He does all our, yeah, fertility recommendations and also in-crop [herbicide] or pre-burn, in-crop desiccating, so he scouts my fields. We never have to. We just don't have time, but he, and he's

> got a hired gal that she or Kalvin they scout our fields and then they send recommendations and I print them out and we just look at them and make a note of what kind of chemicals to buy so that's what we go off. All our recommendations, per field.

Ronald also began using P.Ag. services when the Co-op in Swift Current offered free soil testing to customers in the 1980s. Large farmers such as Ronald and Brandon W. (see Chapter Six) use full consulting packages each year and/or keep a P. Ag. on "retainer" for guaranteed 24/7 service. As John A., a farmer in his 70s based east of Swift Current, explained to me, "These big farmers like Wheeler are the ones who use Kalvin and those girls. They don't have time to wipe their own asses, let alone look at their fields" (Strand fieldnotes, 2015). John's colourful remarks highlight the role that farm size plays in determining the extent of P.Ag. services that farmers will use. Just as Ronald discussed above, many farmers, even those with multiple full-time employees, do not have time to scout their fields, take soil samples, or gather new agronomic information to guide management decisions. Ronald considers Kalvin an "asset" to his farm and explained that agrologists are "huge in our lives."

P.Ag.s work in a variety of contexts beyond just private consulting, like Christy and Kalvin. They work in agrology departments at agrochemical companies and farm input distributors like the Pioneer Co-op, as provincial extension agents, in farm insurance, and even in farm financing—to name just a few. This professional designation is required in Canada to work as an agrologist for any public or private entity. The Saskatchewan Institute of Agrologists (SIA) defines a P.Ag. as a "science-based professional in agriculture, bioresources, food, or the environment, who responsibly teaches, transfers, knowledge, or conducts research" (Saskatchewan Institute of Agrologists, 2018). To become a P.Ag. one must first obtain a bachelor's degree in agriculture or a related field and then seek official designation through a certifying board. In Saskatchewan, most choose to certify through SIA, although it is possible to be granted status through other provincial boards and national certifying bodies such as the Certified Crop Advisor (CCA) program. For SIA certification, those with a bachelor's degree in agriculture or related fields obtain the P.Ag. status by "articling," which means expanding their professional education by attending informational meetings held across the province that have been accredited by SIA. Public and private entities host the meetings and may include such events as the Pulse Growers meeting I attended in 2015. Once they have fulfilled the minimum hours required, they must pass an ethics exam proctored by SIA, to receive a certificate on fine cardstock displaying their credentials. P.Ag.s retain this certification as long as they continue to practice for a minimum number of hours each year, and pay the annual fee.

The origins of this profession can be traced back to 1919 when, at MacDonald College in Montreal, recent agriculture degree graduates and those working for the Experimental Farms Service began discussing the need to create a provincially and/or nationally recognized organization(s) to regulate those individuals advising farmers (McKenzie 1970).[60] In Saskatchewan, these conversations resulted in the creation of provincial acts such as the Agrologist Act, approved by the Saskatchewan legislature in 1946, which set out the legal standards of the agrologist profession for the future of SIA. Indeed, as part of the Act, the term "agrologist" was used first to provide a clear distinction from "agronomists" or "technical agriculturalists," and prevent these "unqualified persons from practicing" (McKenzie, 1970, p. 11):

> In Quebec professional people in agriculture were called "agronomes." This title was well known and understood by farmers and there was considerable regret that there was no comparable word in English. Probably the closest translation is

60 R.E. McKenzie (1970) is the author of *1946 to 1970: An Account of the First 25 Years.* The booklet was published by the Saskatchewan Institute of Agrologists and in the introduction, J. A. Peck, the President of SIA in 1970, explains that the organization chose McKenzie to write the history because he was an original member when the Agrologist Act passed in 1946.

> "agronomist" but this title in English refers to specialists in soils and crops and hence was not inclusive enough(…) It seemed that the only solution was to coin a new word(…) At the meeting on January 10 he [Dr. Harrington[61]] presented the newly coined word "agrologist" as a possible alternative, explaining that "agros" referred to land or farm and "logist" meant scientist. The initial reaction was stunned silence, but before the meeting was over the council [Professional Status Committee of Northern Saskatchewan Local] had become convinced that this was the long-sought word they had been searched for (McKenzie, 1970, p. 13).

It seems also that these professionals wanted to be clearly distinguished from farmers, for, as McKenzie explains, "we still hear references today to agriculturalist, when agrologist is meant. An agriculturalist is a farmer and may be an agrologist as well, but the two words are not synonymous" (1970, pp. 13-14). He later goes on to say, "So in 1970, with a few possible exceptions, it is generally recognized that if there is agrological work to be done you hire an agrologist and not a vanquished politician or a practical farmer who went broke" (p. 53). Agrologists, unlike farmers, could "speak authoritatively to better serve Canadian agriculture" (p. 2) because they received formal university training and continued their education through the articling processes described above. In 1946, Harrington and other members of the Status Committee sent a letter to all members of the legislature explaining how the farming community would benefit if agrologists attained a professional status and the statutory rights incumbent therewith.

> Recognition of the need, in this present scientific age, for really well qualified people to carry on agrological work is becoming apparent on all sides(…)Moreover in the future with the inevitably greater mechanization of farming and greater reliance on scientific procedures it is probable that the losses from inefficiency and lack of knowledge will be of even greater concern(…)An agrologist act would meet the need which is arising as agriculture faces a much more scientific future (February 4, 1946 letter from Professional Status

61 James Bishop Harrington was a professor in the Field Husbandry Department at the University of Saskatchewan in Saskatoon, and consultant for the Ministry of Agriculture (University Archives & Special Collections, 2018). He served as the chairman of the Professional Status Committee of the Northern Saskatchewan Local and his work proved pivotal in getting the Agrologist Act passed (McKenzie, 1970).

> Committee of the Northern Saskatchewan Local to the Saskatchewan Legislation, as quoted in McKenzie, 1970, pp. 16-17).

As Harrington and other members of the committee distanced themselves from unqualified advisors and ill-equipped farmers, they simultaneously established themselves, institutionally and with state support, as authorities on all matters agricultural.

The approach differs little from that which Foucault (2003) described when examining the history of western medicine in Europe (primarily France) during the late 18th and early 19th centuries. Briefly, Foucault described how institutions like the Société royale de médecine at Versailles gradually "became a point for the centralization of knowledge, an authority for the registration and judgement of all medical activity" (2003, p. 28). This institution endowed doctors with authority by controlling admission in order to distance successful applicants from those "charlatans, quacks, and unqualified and incapable persons practicing medicine" (p. 44). Consequently, while this enabled the practice of some types of medicine, doctoring, and training, it simultaneously restricted others. Thus, "good medicine would be given status and legal protection by the state" (p. 20). Likewise, good agrology was given protection by the provincial government of Saskatchewan through the Agrologist Act of 1946.

As if to pick up on that very similarity, there is a video called "What Agrologists Do!" featured on the SIA website (Saskatchewan Institute of Agrologists, 2018). In it, SIA explains that agrologists are "health professionals." It cuts to an image of a doctor before explaining that it is "not that kind of health," but rather, the health of plants, lakes, and forests. P.Ag.s have the authority to write fertilizer prescriptions for farmers who give them access to their fields through the soil test. The soil test invites the P.Ag. to assess the quality of their soils and potential for production. If the soils are found lacking in nitrogen, phosphorus, potassium, or other nutritive elements, P.Ag.s can offer to solutions improve the health of the soils and their productive potential. Overall, SIA has become a centralized location of agricultural knowledge, as they work closely with the University of Saskatchewan to train P.Ag.s to become practitioners of agricultural science.

Private agricultural consulting has become a large industry in Saskatchewan. Grant P., the Agricultural Representative mentioned previously, recalled in an interview that when he began working for the ministry in 1970, there were between 5 to 10 agrologists working for private industry across the entire province (Grant P., February 13, 2015). By the time he was encouraged to retire in 2004, agrology/agronomy departments within agro-chemical sales companies "mushroomed, like they probably increased tenfold" (Grant P., February 13, 2015). SIA (2017) reports that as of November 2017, the institute had 1,853 registered members with 662 of those individuals employed within the province as agrologists either full or part-time. 426 of those employed P.Ag.s worked for the private sector with a mean income of $84,529.33 per year, not including benefits and bonuses (2017, p. 6). As we shall see in the next section, *Three Wise Women*, P.Ag.s have taken on the role as the primary conduit of knowledge transfer between public scientists and farmers.

Three Wise Women

Although Christy and Kalvin were my first introduction to the world of P.Ag.s through interviews and participant observation with P.Ag.s as well as farmers who use their services, I became well-acquainted with the nature of their work. In addition to helping farmers save time, P.Ag.s often act as mediators between family members—usually fathers and sons—who disagree about management decisions. They may also serve as a sounding board for farmers who already have plans, but need continual reassurance. And for some P.Ag.s, the relationships they develop with their clients become very close. P.Ag.s take variable approaches to assisting their farmer clients, and in the following three profiles, we see three examples of some of these approaches.

Jenna

I first met Jenna T. at a fall seminar hosted at her place of employment, the Pioneer Co-op in Swift Current which was featuring a speaker from the Saskatchewan Ministry of Agriculture on the increasing prevalence of the wheat disease fusarium head blight (FHB). I attended with John A., and as we walked into a large conference room, Jenna greeted him and asked that he stay afterwards so she could discuss zinc deficiency in his soils. We ate a large lunch of roast beef, potatoes, and salad with our choice of four desserts, all provided by the Co-op. Compared to other government-hosted events I've attended, I thought the food was amazing, but then John reminded me that for all the money farmers spend at the Co-op each year, they should be serving "booze" as well. Jenna introduced the speaker, who updated farmers on FHB in the area but offered no management solutions. And she then followed up by discussing a few products that farmers could use to "suppress disease symptoms." Afterwards, Jenna, John, and I stayed behind to discuss the soil zinc deficiency issues affecting his crops. She gave him a couple pamphlets on potential soil amendments to his "nutrient management plan." John suggested Jenna talk with me about my project, so she and I agreed on an interview time for the following day. As we said our goodbyes, John hugged Jenna and said he would be "lost" next year when she started her maternity leave.

I met Jenna in her office at the Co-op, where she was going through the results of soil testing from John's field that had been taken earlier that fall. She showed me the printout with John's name, the field name, and the sample results, including information about soil type, nutrient levels, moisture levels, soil pH, electric conductivity, and CEC. The printout also included John's seeding plan and desired yield outcome, which Jenna explained she planned to use to create a fertilizer blend that John could apply when he seeded this spring. Jenna described herself to me as a "farm girl" who grew up in Saskatchewan and attended the University of Saskatchewan, obtaining her bachelor's degree in agriculture. She did two summers of research for Monsanto while at university, and was at various points employed by DOW Chemical, BrettYoung (a private seed company), and Syngenta. Jenna described her current work at Pioneer as "basic agronomy consulting," meaning that she primarily worked with farmers on soil testing and fertilizer blends. She rarely visits farms except to collect soil samples once a year, but explained that for customers who purchase products from Pioneer, she might also do some field scouting for disease and weeds. However, she says the company's strategy is "more reactive than proactive," particularly when it comes to disease issues (November 13, 2014), because they do not have enough people to carry out more involved examinations. According to Jenna, she and the other P.Ag. from Pioneer offer more services to their clients with larger farms. Jenna called farms of 8000 acres or more her "key guys," whom she visited more often and admired for their "well-manicured yards with decent equipment" (November, 13, 2014). In her opinion, these key guys "take pride in what their land looks like," and spend money "putting in what they need to." She compared them to those farmers with "sloppy" fields and farmyards. These "disasters" result from farmers who are "mining the land" by "not putting much back into the land."

Melody

Several farmers I interviewed mentioned Melody D. as their go-to P.Ag. for both full consulting services and occasional soil testing and/or scouting. When I contacted her, she expressed excitement at the opportunity to discuss her work with me, explaining to me that she had built her own business as an independent P.Ag. after working intermittently for Viterra[62] and raising four children. Melody's clients' farms range in size from 2,500 acres to 23,000 acres, the largest of which belongs to a Hutterite colony. Our interview was one of my favourites because she spent nearly three hours speaking very candidly about the P.Ag. business specifically, and the agrochemical industry more broadly. Like Jenna T., Melody earned a bachelor's degree from the University of Saskatchewan in soil science. In addition to working at Viterra, she spent years working in a job blending and delivering fertilizer for an Esso station in the northern part of the province. She lives with her husband on an acreage west of Swift Current, which is a short drive from her childhood farm, now managed by a younger brother. She dreamed of farming that land but some traditions never change in rural communities, including a preference for sons to inherit the family farm. Melody is married to a Syngenta sales representative which, according to several P.Ag.s I know and/or interviewed, is a highly coveted position for someone with professional agrologist credentials. Those with this type of job are more commonly known as "chem. reps." Her husband, and other chem. reps. for companies like Monsanto and BASF, differ from P.Ag.s like Jenna because they do not work in sales out of a local input distributor such as Pioneer. Chem. reps. must have P.Ag. credentials to work for companies like Syngenta, which means they can provide agronomic advice directly to farmers or through P.Ag.s working at businesses such as Pioneer that sell Syngenta products. Chem. reps. work in designated regions to keep supplies and information flowing to input distributors such as Pioneer, as well as attending to the needs of important clients including large Hutterite colonies and high acreage farmers such as Brandon W. from north of Swift Current. For these A-list customers, her

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62 When Melody began working for Viterra, it was known as Westco. Agricore purchased the company and renamed it Viterra.

husband arranges for product to move directly from Syngenta warehouses to their farmyards. As an added bonus to A-list customers, chem. reps. occasionally make home visits giving farmers perks in the form of Saskatchewan Roughrider tickets and Las Vegas vacations. Melody explained that their goal is to get invited to the family weddings of "A-list" customers, which they view as the sign of a mutually trusting relationship.

Melody described to me the many facets of her work and how it evolved from selling the same three fertilizer blends that everybody used on every field out of an Esso in the 1980s, to the thousands of fertilizer blends, herbicides, and pesticides now on the market. She left Viterra in 2013 because she felt there'd been a shift in the business to prioritize sales over sound agronomic advice. Her business, much like that of her husband's, is all about building close relationships with her clients. In our interview she related stories about farmers even going so far as to rely on her to run a combine during their busy season, to settle disputes between father-son duos disagreeing about management decisions, and, in the case of one farmer, helping him through a drug addiction that risked him losing the family land. As she explained, some farmers need "someone else to give them head nods(…)They have a pretty good idea of what they're going to do. They just want to check" (July 9, 2015). Others become more dependent and have an expectation of "'You tell me how to grow a good crop." Melody described one story of field scouting while one of her large clients was on an extended summer vacation that highlighted how P.Ag.s sometimes step into a management role unheard of among extension agents a decade ago and still uncommon for even the wives of many male farmers.

> Just the other day I scouted some lentils for grasshoppers for a neighbour, and he had left on holidays already. So I phoned him and I said, "I hate to ruin your holiday, but you need to spray for hoppers." And he's like, "oh crap"(…),He's like, "I'm not home. I can't get it done. How many days do I have?" I'm like, "you really need to get it down tomorrow." And I said, "but I know a local custom guy" and I said, "maybe Ron will do it for you?" Right away he's like, "okay well

> good. Go check my other fields now and make sure I didn't miss anything and then let me know." And so I did and he was good to go, so then about the next morning the custom guy texted me and says, "how many acres do I need to do and where am I going (Melody D., July, 9, 2015)?"

Sometimes she worries about clients, like that one, becoming too dependent on her to make all their farming decisions. Melody has seen a huge influx of agronomy/soil science/agriculture graduates from the University of Saskatchewan who all become P.Ag.s looking to find jobs like hers or her husband's. She questions their training and experience and wonders if they know how much responsibility comes with the job. Melody recognizes the "huge money" flows that result from her agronomic advice in the form of input purchases and potential crop yields; however, she feels a deep sense of responsibility when she knows that clients' family farms are at stake. However, she also criticizes other P.Ag.s who are so fearful of legal repercussions that they "don't want to stick their necks out(…)They don't have the confidence." She made these remarks in regard to a 25-year-old male P.Ag. who had recently begun working near Swift Current. He frequently called Melody for help and reassurance when identifying disease issues in crops and deciding if a treatment was necessary for his clients. She resented his lack of confidence. In Melody's opinion, his worry over the potential legal and financial repercussions from farmers if he gave them the wrong advice paralyzed him in making any decisions. Towards the end of the interview Melody explained that although the responsibility sometimes weighs on her, she wants her client relationships to last a lifetime:

> It will be a tough day when I have to part ways with a client because I want to be a part of that farm. Like I want to be at the board table. I have farms that are willing to take me to the account with them. And that's where I want to be with all of them. To me that is that ultimate role (Melody D., July, 9, 2015).

Melody nurtures close relationships with farmers because she wants to serve as their P.Ag. for as long as she's able and as long as the farm is still in business. She described several examples of farms where she has advised two generations of farmers on the same farm—usually fathers and sons. She wants to be a permanent part of their farm operations, perhaps even into a third generation.

Kathy

As a consultant for FarmersEdge (see https://www.farmersedge.ca), Kathy E. represents a new wave of P.Ag. consulting characterized by utilizing the collection of extensive real-time data, from grid-based soil testing to on-field weather stations, in-season soil moisture probes, satellite imagery, and equipment monitors. The data is then combined with field analysis using ArcGIS software and algorithms designed to generate fertility prescriptions, data updates and reports that are all accessible remotely via smartphones and computers, and advanced equipment using variable rate technology. Variable rate technology in seeding equipment automatically adjusts fertilizer and seed levels to address specific zones within a field—such as a zone with lower nitrogen than other zones (See *Figure 67).* As part of Kathy's services, she collects data—soil samples, field scouting, and satellite imagery—to create zone profiles. For newer equipment the zones are uploaded into the tractor computer at seeding time and the fertilizer/seed levels are automatically adjusted. Variable rate technology is also available for applications of pesticides and herbicides—zones are established and the level of spray adjusted to address the variable conditions. With this type of consulting service, farmers get a new perspective on their square-shaped fields using an ArcGIS software platform that generates layers of maps with data on soil fertility, field harvest records, moisture levels, crop health, product application, field profitability, etc. (See *Figure 68).* Combines and tractors equipped with computer systems become centres of data collection that stream information directly to Kathy's office and can be programmed to alter product application automatically in real time as the farmer rides along.

Satellite imagery with the capacity to assess crop health can be updated every couple of days to give farmers with large acreages (and not enough time) the best chance to intervene on issues affecting health. They translate this data into colour-coded layers of grid-shaped maps that use key variables (e.g. nitrogen levels, yield, and/or moisture content) to pluck out zones as small as an acre for specific fertility treatments. The mapping program highlights these zones in bright colours to shift the farmer's perspective from their real-time experience of the field as a repetitive flow of gently rolling, slightly mottled brown surface to a dynamic patchwork of irregularly shaped zones. This enables farmers to make management decisions specific to each zone rather than applying products uniformly across entire fields and/or farms.

Figure 67. Variable Rate Field Zones. The above shows typical field zone (polygon) map, superimposed on a photo of a farmer seeding. Photo from Center Field Solutions Ltd (2020).

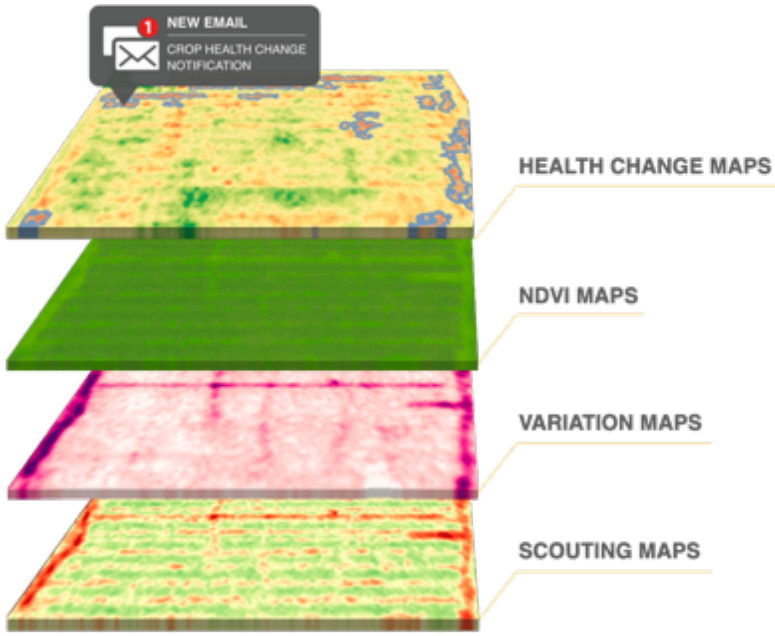

Figure 68. A Layered Grid. This image shows some of the layered data available to farmers through Farmers Edge. Photo from FarmersEdge (2021).

Like Melody and Jenna, Kathy grew up on a farm, received a degree from the University of Saskatchewan, and obtained her P.Ag. status in the province shortly thereafter. When I met Kathy, she was newly engaged to a farmer from a large operation in the Swift Current area. Kathy's first job after completing her agribusiness/agronomy degree was with an industry giant, Bayer CropScience. She started her job at Farmers Edge Inc. in 2013 as the company, then only in its eighth year, began offering a "whole farm package" in "precision solutions." As Kathy explained in our interview, this package, which includes all the features listed above, is designed to make,

> everything automatic for them [farmers]. It will be a lot more passive for farmers. Like they won't have to actually do anything other than make sure that it's the right product or input that they're spraying in the monitor(…)It's going to take the work that they don't have time to do and take it out of their hands and help them with that" (Kathy E., November 2014).

Kathy works with 20 clients in the Swift Current area and describes them as "progressive customers(…)each over 6000 acres," who use the most advanced Bourgault tractors and combines. The bulk of their work is based on soil sampling and fertilizer consultations, which result in "prescriptions" that she delivers to clients in binders, as well as online with their FarmCommand mobile app.[63] The prescriptions recommend certain fertilizer blends and amounts but do not endorse any particular suppliers. The whole package costs $6.00 per acre, but they offer individual services (e.g. soil moisture monitoring) for as little as $1.00 per acre. For her whole package customers, Kathy offers "another set of eyes for the grower because a lot of farmers don't have a whole lot of time to look at their fields to make decisions" (Interview November 17, 2014). Through the FarmCommand mobile app, they can assess their fields while "out at the lake in the summer."

These P.Ag. profiles give us insight into a blossoming industry of consulting that provides employment to a traditionally disenfranchised segment of rural populations. Through these three women's experiences we can gain insight into how they are utilizing different tools to develop relationships with farmers. Melody's approach blurs the line between consultant and friend. She communicates regularly with her farmer clients and even assists in some of their farm labour. Melody hopes to work with the same farmers for her entire career. Kathy's work is guided by the data-centric approach of Farmers Edge. While she may not develop close relationships with her farmer clients, she believes that the information she can provide for them, in terms of detailed maps that divide fields into management zones, will change the way they farm. As I watched the conversation between Jenna and John A. after the seminar, I knew that

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63 FarmCommand is a mobile app software platform that FarmersEdge offers to all of its customers. The home screen on the app offers menu options including a dashboard, maps, weather and moisture, analytics and reports, equipment, and predictive modelling. The analytics and reports option provides information about total fuel consumption and equipment efficiency. It also analyzes the profitability of specific fields and zones to help farmers decide where their time and money is best spent. The predictive modelling option lets farmers know what zones are at highest risk for pest, disease, and weed infestation, as well as giving them predictions on the timing of harvest and yield.

she felt a genuine affection for him. She felt comfortable joking with him and discussing her personal life. However, because Jenna works for Pioneer, she has to make sales to keep her job. For this reason, she did not treat all farmers equally and only gave special attention to her best customers.

Although their approaches differ, for all three women the work they do affects the management decisions for tens of thousands of acres. For those of us familiar with *Prairie Patrimony (*Salamon 1992)*,* a primary text for anyone studying rural North America, for women, especially in their early 20s such as Kathy and Christy S., to influence land management decisions on this scale flies in the face of the traditional division of labour on US and Canadian farms. As we saw in Melody's profile, she always hoped to assume responsibility for her parent's farm. However, preference was given to her younger brother, so she had to settle for crop consulting as an alternative to farming. All of these women share similar backgrounds as daughters of farmers and graduates from the University of Saskatchewan. In fact, most job advertisements for consultants state that employers prefer individuals who grew up on farms and have education or job experience in Saskatchewan communities. Multinational agrochemical companies understand that hiring locally helps build trust and forge links with long-standing farm families, lending a sense of security to their business. However, it also creates new opportunities for young women. As Kathy explained, 60% of her graduating class from the College of Agriculture and Bioresources at the University of Saskatchewan were women. According to her, most of the consultants working around the Swift Current area are women, something I also observed to be true. This opens up another job market for the wives and daughters of farmers beyond nursing and teaching, the two areas of employment Kathy considers "typical" for Saskatchewan women. These observations provide an interesting paradox in which we have just 28.7% of farmers in Canada identified as female (Statistics Canada, 2020), but at least in Swift Current, we see a major agribusiness industry dominated by women. Having grown up on a ranch in a predominantly agricultural region of Wyoming, I can attest to how women are made to be silent partners on farms and ranches. While contributing significantly to the labour and oftentimes decision making, women rarely become the public face of an operation. Thus, I cannot help but see this new development as positive in this regard, for it gives women a level of status which is often unobtainable through their roles as the wives and daughters of farmers. However, the field of consulting is not without its critics.

Gunslingers on the Grid

At the beginning of this chapter, I compared consulting in agriculture to the practice of clinical medicine as viewed through a Foucauldian lens. When I first heard consultants using the term "prescription," I immediately made the connection to the medical profession. However, I only really began thinking in these terms after a conversation with a retired engineer from SCRDC who grew up on a farm and worked among scientists and farmers at the research station for his entire career. In our interview, Paul L. and his wife Denise described consulting and P.Ag.s:

> Paul L.: I'm not sure how widespread this is but I know it's happening. It's no different than medical doctors when the pharmacy reps come to call. So if I've got a pharmacy rep from whatever company, wants to push that specific pain drug on me, and they're willing to give me just a little bit of incentive to do it, I'm going to push that pain drug right? And to the detriment of the other companies' offers. What do you think happens with P.Ag.s when they're approached by seed companies or fertilizer companies or companies that offer agronomy services that these guys would call upon? Who do you think they're going to go with?
>
> Katie S.: Well some are in relationships with the chemical reps. They're married.
>
> Paul L.: So instead of Monsanto, I'll go with Bayer.

> Denise L.: But in some professions that would be a conflict of interest that would have to be declared.
>
> Paul L.: But here it's just a gunslinger mentality. It's whatever I can make money from right? But most of these guys are pretty ethical but at the same time it's happening (Denise and Paul L., August, 18 2015).

Although I never attempted to confirm Paul's statements, I did come across multiple instances where it became clear that the agrochemical input industry is ultimately a small community, with individuals working in it oftentimes coming from families in those communities they serve. Melody, for example, is married to a chem. rep. from Syngenta, while Kathy is engaged to the owner of a large farm in the area. Most people in the agrochemical input business attended university together and have formed long-term relationships that extend into their work. Paul describes it as an "incestuous business" and clearly expressed his concern about a lack of oversight throughout the interview. In a conversation with John A.—the almost 80-year old large-scale farmer east of Swift Current—and his daughter Elizabeth, who is in her early 40s and farms with John in addition to running her own seed testing business, they both described the interconnectedness of farmers and those working for agribusinesses. Elizabeth is close friends with Melody D., so John said that if he needs advice, he'll just invite Melody over for a beer to "pick her brain" (Strand fieldnotes 2015). Elizabeth said that most farmers in the Swift Current area know at least one P.Ag. personally and many are related to those P.Ag.s John summarized the conversation, calling the relationship between P.Ag.s and farmers a "family network" (Strand fieldnotes, 2015).

Paul was not the only employee at SCRDC to raise ethical questions about the advice coming from consulting services. While she never directly criticized P.Ag.s and their role, Dr. Carolyn M., a Station scientist specializing in phosphorus cycling, did report results from a long-term study of soil phosphorus on a field site in southern Saskatchewan that called into question their recommendations for using the phosphorus fertilizer (Strand fieldnotes, 2015). In the study, her team used a field established in 1967 where phosphorus had been applied every year until 1995. The field belonged to a farmer in southeastern Saskatchewan who primarily grew wheat. In 1995, they split the farmer's field into two areas-one that continued to receive phosphorous and another that no longer received phosphorus. Besides the difference in phosphorus application, the farmer treated the two areas of his field with the exact same practices. Her team observed very little difference in yield during the 15-year study between the two areas, leading them to question how phosphorous is measured in soil testing. Carolyn suggests that because some phosphorous is insoluble and tightly bound to other soil particles, it remains temporarily unavailable to plants and may not register on soil tests. She calls this "legacy phosphorus" or "residual phosphorus" and explains that in her 15-year study, plants eventually became able to utilize this stored P as those soil compounds broke down. In our interview, she explained that some soil scientists question nutrient recommendations, leading them to practically beg farmers not to continue applying fertilizer at established rates because of its environmental impact and cost to the producers. Of course, this recommendation is not popular among Saskatchewan farmers, with their deeply saturated agrochemical, familial networks. At least three farmers I spoke to about their fertilizer programs apply phosphorous every year as more of an insurance policy. They understand that residual phosphorous might become available to their plants at some point later on, but they cannot afford to risk a year's crop if that turns out not to be the case.

Organic farmers also question the process of using soil testing to create prescriptions based on the current standard of established plant nutrient requirement. Robert S., an organic farmer and accountant, calls this style of fertilization "paint-by-number farming," explaining in an interview that this system simply plugs data into equations and does not allow for the flexibility that he considers key to successful organic production. Although Kathy's variable rate approach attempts to correct this issue for chemical farmers—it divides fields into smaller zones with specific fertilizer prescriptions for each of those zones—in reality most of my project participants did not vary their rates of fertilizer, herbicide, or pesticides to adjust for differences across or between fields. They simply applied inputs as efficiently as possible, which meant that everything got its dose at whatever time the farmer was able to bring their equipment to that area of the farm. Steve E., a farm financial consultant working for Meyers Norris Penny (MNP), referred to this approach as reactive rather than proactive, explaining that P.Ag.s are simply trained to plug numbers into a template for fertilization and risk reduction, which does very little to actually save farmers on input costs. This template collects only a minimal amount of data to assess large masses of land, which is the best anybody can do when only a handful of people (between P.Ag.s and farmers) are managing land that used to support hundreds of farm families. The scalability of industrial grain farms in Palliser's Triangle makes this type of land management possible. Farmers, with large equipment, can seed 1,000 acres using the same procedure as seeding 10,000 acres. Bourgault air seeders, with implements 76-feet wide, allow farmers to seed up to 700 acres in one day. If we think about the original homesteads, this was about the size of two family farms one hundred years ago. P.Ag.s assist in these large acreages by appropriating the field scouting and decision making that farmers used to manage themselves. Finally, farmers bring in an unskilled, and mostly foreign labor force, to run their large machinery—more on this in the next chapter.

CONCLUSION

In 2014, *The Western Producer* published the article, "New Soil Test Methods Can Pay Dividends" (Arnason, 2014). I regularly read *The Western Producer* because it was often mentioned by my farmer collaborators when I asked them about the sources they use for farming news and information. The article references the work of Dr. Bianca Moebius-Clune, formerly of Cornell University and now with the U. S. Department of Agriculture, and Rick Haney who also works for the U. S. Department of Agriculture. In it, both Haney and Moebius-Clune advocate for a discipline-wide transition in soil science to a new type of soil test. They begin:

> Standard soil testing has been foundational to our success in agriculture. It has allowed us to identify a very specific (and) fixable constraint: a nutrient deficiency(…)More and more we're understanding that beyond nutrient deficiencies there are really biological and physical constraints that we've never identified before. Those are largely what are limiting production today and what are limiting our ability to make progress on air and water quality (Moebius-Clune, 2014, as quoted in Arnason, 2014).

Rick Haney follows up her comments with the following observations: "The problem is that conventional (testing) tools are not measuring the right soil characteristics(…)The Haney test isn't designed to replace things. It's designed to tell a better story, more insight into what's happening in our soils" (Haney, 2014, as quoted in Arnason, 2014). Both soil scientists have been involved for many years in the development of new soil tests to assess the biological activity of microorganisms in the soil. Dr. Moebius-Clune has worked with Cornell to develop the Cornell Soil Health Test, which assesses chemical, as well as physical and biological, components in the soil. Rick Haney, along with his colleague Daren Harmel, developed the Haney Soil Test, which assesses the biological activity of soils by measuring microbial respiration by assessing the level of $C0_2$ released from soils (Haney et al., 2018). Haney claims that through the use of his soil test, farmers tend to reduce their fertilizer use by 30 to 50%, which subsequently increased their net profits by 7 to 18%.

Thus, it would seem that 21st century soil testing and analysis might finally throw off the shackles of Justus von Liebig's law of minimum to adopt an approach more similar to Sir Albert Howard's. Howard did not accept Liebig's approach to soil health because he considered the soil a "living" biological system (Howard, 1943, p. 31). As Haney et al. (2018) explain: "producers have the potential to significantly reduce the negative environmental effects of modern farming practices by managing the soil as a living ecosystem" (p.162). Liebig's concept of soil health was based solely on its productive potential for crops. In the Conclusion of this dissertation, we will discuss how this concept of soil health no longer guides the work of scientists at the Station. By removing Liebig's conceptual constraint, scientists can see endless potential in how microorganisms may help us to create and support more resilient agricultural systems.

This chapter traced how the work of Justus von Liebig in the 1800s influenced fertilizer testing research at the Station and the development of soil testing services within Saskatchewan. We can see Liebig's influence throughout the section *Production Potential* as the Station scientists attempted to improve production through the use of fertilizers and assessed its impact on soil health by focusing on the resulting yield. Many of the early fertilizer recommendations were based on an accounting system similar to what Liebig proposed, discussed in the first section of this chapter. Scientists at the Station estimated the amount of NPK taken out of soils after harvesting wheat, then estimated that the same amount would be necessary for the next rotation of wheat. However, as fertilizer testing commenced at the Station, the scientists could not recommend fertilizers to local farmers because, at least in their minds, water was the most limiting factor in Palliser's Triangle. By the late 1960s and early '70s, scientists at the Station used the *Weekly Letters* to persuade farmers to use a soil test to guide their decisions on fertilizer. This coincided with a "take-off" period for fertilizer use on the Canadian Prairies. The soil test became a powerful tool for administering Life on the Prairies. The soil test became the primary means of assessing soil health and therefore evaluating the quality of the farmer. If a farmer failed to replace NPK, thus impoverishing the soil, he/she was failing to optimize the productive potential of the soil. In this scenario, the farmer was failing to optimize Life on their fields. As public extension activities decreased in the late 1980s through the early 2000s, professional agrologists began using this tool as part of their consulting services and strategy for selling fertilizer. In present-day farm communities around Palliser's Triangle, P.Ag.s administer all of the soil testing and inevitably influence production decisions on thousands of acres. These P.Ag.s are oftentimes women, which is in part remaking gender roles within agricultural communities that traditionally placed women in the role of silent partner. This chapter described the work of a few P.Ag.s around Swift Current to demonstrate the various roles these individuals assume in the lives of farmers. However, they all rely on similar forms of the soil test to make recommendations on fertilizer. P.Ag.s have become a disciplinary force and through their soil test, they re-establish the Life and non-Life divide by focusing only on the chemical attributes of soil. To create a more resilient form of agriculture within Palliser's Triangle, we need to rethink the primary tool that is utilized to assess soils. This may inevitably alter the role of P.Ag.s in agricultural communities. It may also necessitate a revitalization in public agricultural extension work as farmers and agricultural scientists all over the Prairies learn about the biological health of soil microbial communities and the best ways to protect and harness these microbial communities for agriculture and for all Life within Palliser's Triangle.

CHAPTER SIX

THE GAME OF RISK AND SCALE

Figure 69: Prairie Tombstones. Photo by Katherine Strand.

INTRODUCTION

"CONCENTRATION OF OWNERSHIP matters—a lot" (Qualman et al., 2020). These words open the 2020 National Farmers Union report, written by Darin Qualman (NFU), Dr. Annette Aurélie Desmarais (the University of Manitoba), Dr. André Magnan (the University of Regina), and Dr. Mengistu Wendimu (the University of Manitoba). In the report, the authors provide startling statistics on the concentration of ownership of agricultural land in the Prairie provinces:

> We find that 38 percent of the farmland is operated and controlled by just 8 percent of Saskatchewan farms, just 2,433 operations(…)20 years from now, the area of land operated by small farms will be negligible, and farms larger than 5,000 acres may operate 50 to 60 percent of Prairie farmland (up from about 37 percent today) (Qualman et al., 2020, pp. 8,11).

In addition to larger farms owning and/or leasing the majority of farmland, they are also capturing the "lion's share of farm revenue and net income" (p. 12):

> Farms larger than 10,000 acres make up less than 2 percent of total Prairie farms, yet those very large operations captured approximately 15 percent of gross revenues and net income(…)At the other end of the size distribution, farms smaller than 1,000 acres, though they make up 53 percent of total farms, captured just 21 percent of revenues and 18 percent of net income.

Some of the impacts of this social inequality on the Prairies are already manifesting, including a loss since 1991 of 70% of young farmers (Qualman et al., 2020). Younger farmers cannot compete with farms between 5,000 and 10,000 acres in terms of purchasing land. Large operations enjoy higher borrowing capacities, and because more of their land is paid off, they generate higher net returns on their crops. The authors go on to warn that if federal and provincial polices are not enacted to address these inequalities, there will be permanent damage to "Canadians' abilities to democratically shape our food systems" (p. 24). They list many potential areas that could be addressed through policy including, "reshaping farm-support programs to counter market forces pushing farms towards giant proportions(.…)imposing limits on the area any one entity can own(…)[and] developing land access programs for young and new farmers" (p. 25).

This chapter is an ethnographic account of land concentration within Palliser's Triangle. The main story that we follow occurred while I was living in Wymark between the years of 2014 and 2015. A large farm near Stewart Valley, owned by Brandon and Diane W., sold the bulk of their land to the Monette's from south of Swift Current. Throughout the chapter, I refer to the Monette's as the "Whopper farm," a term that I heard in conversations about this land sale. Following this monumental land sale, Brandon and Diane and the Whopper became the talk of the town. Every coffee row I attended included discussions amongst farmers, Station scientists, and community members from Stewart Valley about the growth of the Whopper farm and rumours about why Brandon and Diane had sold out.

The chapter is divided into six main sections wherein I explore the issue of land concentration. The first, *Rivalries on the Grid,* is a general introduction to how farmers discuss farm size and potential expansion using the cultural artifact of rural municipality maps—RM maps. The second, *Auction Day,* describes the family farm of Diane and Brandon, and an auction held in their yard outside of Stewart Valley. It also includes information from an interview I conducted with Brandon and Diane months before the land sale that precipitated this auction. The third section, *Farming is a Business,* discusses federal and provincial government discourse from the 1960s and the 1980s that encouraged farmers to think of their farms as businesses rather than lifestyles. I suggest that farmers adopted the discourse, in part, because it helped distance themselves from their farms in order to soften the blow of the many farm losses that occurred in the 1980s. This section also highlights important changes in contemporary farm lifestyles that further support the discourse of “farming is a business.” I then describe the changes that are occurring on the grid as farmyards disappear through land consolidation. The next section, *Farming is a Business—a Big Data Business,* includes an interview with the Data Solutions Manger at the John Deere dealership in Swift Current. In this section I delve into how farming has been transformed into a massive data collection enterprise, and I use information gleaned from the interview to describe how land concentration may eventually result overwhelmingly in the use of robotic machinery on the Prairies. The next section, *A Messy Organic Grid,* provides an alternative scenario to the seemingly inevitable land concentration and robotization in agriculture, as farmers converting to organic agriculture present an alternative which allows them to remain small while receiving a higher net return on their grain and livestock sales. The final section, *Ungracious Living,* includes the experiences of farmers losing their neighbours to land consolidation and how that has changed life on the grid. I include personal reflections about how it feels to take walks in an agricultural landscape that has been altered by land consolidation.

RIVALRIES ON THE GRID

One evening in late November John and Brenda A., a farming couple in their 70s living east of Swift Current, invited me over for supper and some homemade wine. I had met them earlier that fall at a potluck dinner I attended at Stanley W. and Karen’s house. John’s and Stanley’s families were closely tied through multiple generations, as both men’s ancestors had homesteaded in the Horsham southwest of Swift Current, both had attended the Horsham School before it closed in 1953, and both men’s families had socialized through the years. After Stanley and Karen decided to convert their farm to organic in 1995, a friendly rivalry developed between the men. Farming approximately 10,000 acres with their daughter and son-in-law, John and Brenda firmly believed that chemical farming with fertilizer and herbicides constituted the best field management practice, while Stanley and Karen worried about the environmental implications of these inputs. Stanley often joked with John about refusing to give chemical companies a single penny of his money for the last 20 years, while John enjoyed talking about his new equipment and his impressive line of large, shiny grain bins which sat alongside the main road that both families used on a daily basis. It was clear to me after spending time with both families at the potlucks that these men felt a genuine affection for one another but would often get into heated discussions about the best way to farm, particularly as the evenings progressed and the alcohol took effect.

On this night, after supper and a few stories about neighbouring farms, John spread out the Enterprise Rural Municipality No. 142 map on the kitchen table; it included all the farms in the Horsham area divided into quarter sections along the township's range lines. RM maps paint a picture of the grid using intersecting lines to create numbered sections, with additional coloured lines indicating the different types of grid roads (See *Figures 70 and 71).* The township and range lines form the foundation of the map, with their corresponding numbers scattered along horizontal and vertical axes. Small black dots scattered inside the numbered squares represent the location of farmyards. Each section on the map is further divided into quarter sections and within these squares, appearing in capitalized, black print, are the first and last names of landowners. The landowner names correspond to an alphabetical index of residents which appears along the right-hand side of the map, along with the name and legal notation for the land's location (e.g. SW 02 18 27). Other symbols scattered on the map indicate vacant yards, colonies, cemeteries, garbage dumps, gas compressor stations, and community water wells. Most of the cream-coloured squares blend into the overall beige shading of the map; however, there are some spots of green squares to indicate pastures, and others blue to indicate water. There is no geographic or topographic information on these maps to indicate changes in elevation, drainage systems, or vegetation. This was my first of many encounters with RM maps, and it left an impression that shaped my understanding of these symbolic artifacts and how farmers interact with them. On that November evening, I wrote, “John brought out an RM map after supper. It reminds me of a board game” (Strand fieldnotes, 2014).

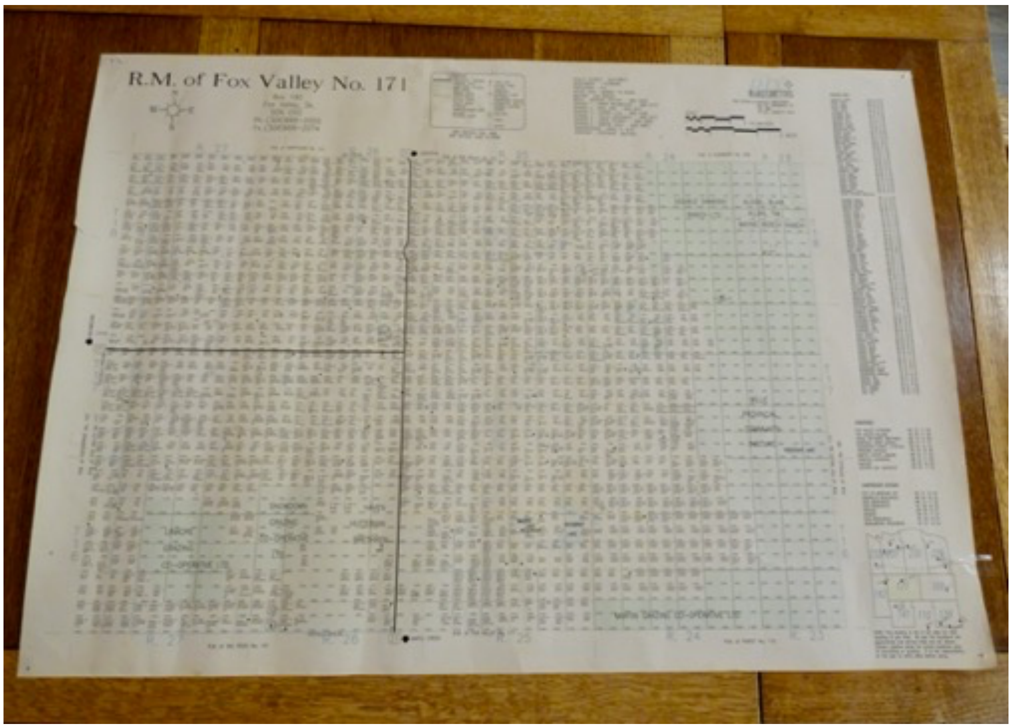

Figure 70. The RM Map. This image shows an example of an RM map, in this case the one from Fox Valley No. 171. Photo by Katherine Strand.

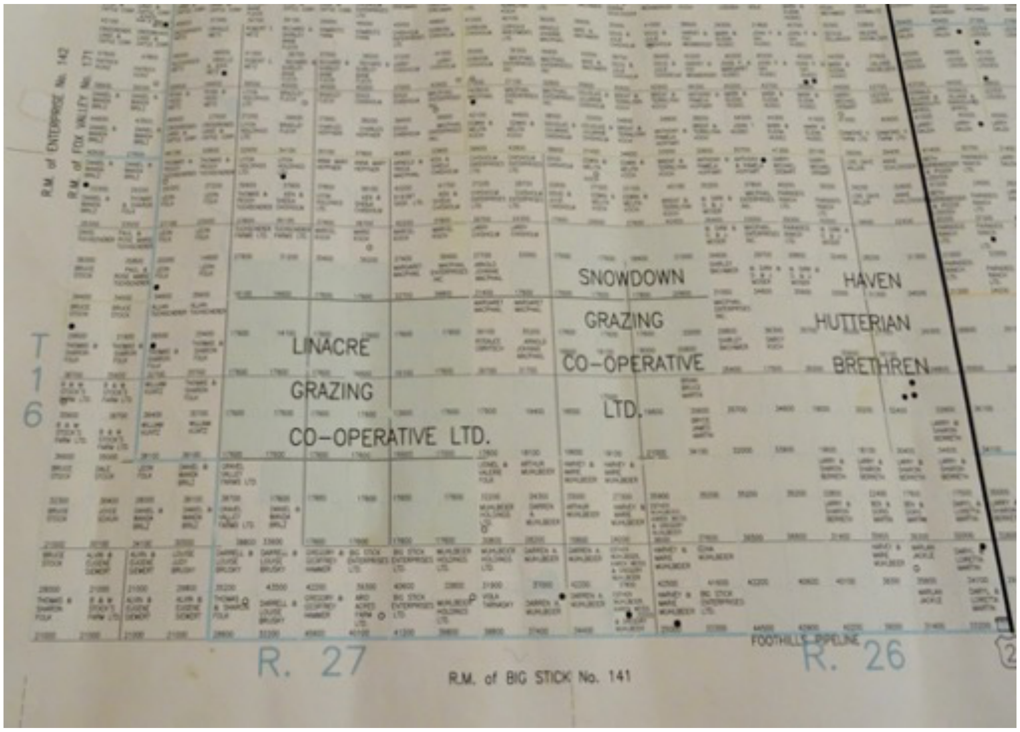

Figure 71. Squares on the Map. This zoomed image is taken from the map in the previous figure. Note the names in the squares, Township line 16 on the left side, and Range lines 27 and 26 along the bottom. Photo by Katherine Strand.

With the RM map spread across the table, John began by pointing out the squares marked with his name and Brenda's. Although at this point I was already under the general impression that John and Brenda were "big farmers" in the area, the map provided confirmation, with a multitude of squares bearing the well-known family name. Next, John pointed out a few squares with Stanley and Karen's names and although nothing was said, it was obvious to me that the families farmed on radically different scales. I began noticing the names of other familiar farmers, including Rob and Beth T. who also attended the potlucks, who feature later in this chapter. After a few minutes of familiarizing ourselves with the squares, John poured another glass of wine and began explaining the "lay of the land." He pointed out three squares in the northwest area of his farm. In 2001, John and Brenda bought these three quarter-sections from a family who, in previous years, had suffered a series of traumas including severe illnesses, money troubles, which ultimately resulted in a permanent move to Edmonton. The family had rented the land to John and Brenda, for many years, but in 2001 decided to sell because the "kids in their 30s didn't care about the land and wanted the money." Fortunately for John and Brenda, the sale corresponded with their daughter and son-in-law's decision to move back to Swift Current and become more involved with the farm. Their daughter eventually moved a house onto the site of the previous owners' farmyard, which at that point was a collection of rundown buildings and a few old grain bins, although the whole family still refers to the land as "Barr's place." The fact that these squares on the map cling to the identities of their previous owners and original homesteaders was a phenomenon I observed frequently.

After a few more stories of past acquisitions, John offered a glimpse into his strategy for future land takeovers. He pointed out two squares near the southwest boundary of his farm with an unfamiliar name. John explained that the owner was a woman in her mid-50s who had inherited two quarter-sections from her parents 20 years ago. This woman lives in Swift Current and rents the land to another "big farmer" in the area. None of her immediate family still farms in this region, so "everyone," including John, believes that she will eventually sell the land. Owners with rental agreements typically give their tenants the "first right of refusal" before entertaining other purchase offers, meaning that typically the "other big farmer" would have the option of buying the land first. However, John explained that in the last couple years, this owner had expressed dissatisfaction about how the land has been treated by the current renter. "Many," including John, believe this rental relationship has turned sour, which opens the possibility that someone else could rent and eventually buy the land. He also explains that the "other big farmer" is known for questionable takeover tactics, including calling potential sellers "a day after the funeral" of their spouse and cornering potential sellers at weddings to make purchase or rental offers. The discussion highlighted that there is generally an agreed upon proper way to go about these takeovers, which includes waiting at least a few days after someone has died to make an offer. John hopes he can acquire this land because it would adjoin his squares and is "pretty good land(…)with very few sloughs(....)and heavier soil." John, unlike many smaller farmers, including Stanley, is in a position to buy these squares at around "$500,000 a quarter" because again, unlike small farmers, he can use his existing land as collateral to get a loan. If he fails to make a payment, the bank could take possession of the new squares as well as any existing plots he has leveraged as collateral. John explains that the last eight years have been profitable for his family because of an extended period of above average precipitation, so he is willing to play a game of risk on this RM Coulee board in order to extend his territory.

Months later, I rode across what had formerly been Barr's land in John's green tractor as it pulled his brand-new L7800 Bourgault Air Seeder with his new 3320 Bourgault Paralink Hoe Drill, while it extended 60 feet wide and slowly dispersing peas along with a phosphorous mixed fertilizer. Throughout our eight hours in the cab together, the discussion led back to the squares on the RM game board of squares and the game of risk played around Swift Current. Over the winter, an even bigger farmer than John, Brandon W., whose farm was located near Stewart Valley (north of Swift Current), sold his 20,000 acres to a whopper of a farmer near Neville (south of Swift Current) with 40,000 acres. I will return to a discussion of Brandon, in later sections of this chapter, but in that moment, in John's mind this big buyout, which I heard discussed in numerous coffee rows for many months, represented the "dismal" future of farming. In the cab that day, John said, "it's all greed and ego(…)why else would one man want to farm the same amount where 10 farmers could make a good living" (Strand notes, 2015). Many questions arise for lifelong farmers such as John when they hear stories of land consolidation on such a large scale. How can one person afford to purchase so much land? What does this mean for land prices in the area? How can a single farmer logistically manage so much land? What happened to the families who used to farm that land? The loss of family farms is a key area of interest for farm advocacy groups such as the National Farmers Union (NFU) of Canada. The NFU report on the state of farms in Canada created by Darrin Qualman in 2019, speaks to the issue of farm consolidation, explaining that, "there are fewer than 193,000 farms in Canada today, down from 280,000 28 years ago(…)Saskatchewan has lost nearly half since 1981" (Qualman 2019, p. 13).

Later that same week, I joined Sharon and Magnus M., an older couple I met through my participation in the Swift Current community choir, for supper in Swift Current. They shared information with me that helped explain how exactly that "even bigger farm" (Brandon's) was swallowed up whole by "the Whopper farm." They farm near Stewart Valley and Magnus operates his own seed cleaning plant in the winter to supplement their income. I spent a couple days seed cleaning with Magnus in January and February and affectionately began referring to him as "the mad scientist" in my fieldnotes. At around 80 years old and with a shocking head of dishevelled white hair, Magnus built his first seed cleaning plant over 40 years ago. When he first rolled up the tarps to reveal a complicated system of pulsating screens, barrels, and chutes, his current plant reminded me of a carnival exhibit as it moved grain from the back end to front, removing weed seeds, insects, small rocks, and other "garbage" to extract "clean seed" (See *Figure 72).* I observed Magnus on unbearably cold days as he stood outside his machine and continuously listened as the grain moved through the apparatus. At the detection of the slightest change in sounds (mostly imperceptible to me), he swiftly climbed a series of steps or a ladder to access the different areas of the machine that might be in need of slight adjustments to ensure proper cleaning. Magnus pulls this mobile plant around to over 50 farms each winter to clean their grain in preparation for spring seeding. Sharon and Magnus know Brandon and his family well because they both farm near the town of Stewart Valley north of Swift Current. They both attend coffee row in their small town and Sharon attends a Golden Girls club weekly with other older women in the community, including Brandon's mother.

Figure 72. The Seed Cleaner. Magnus is pictured above tinkering with his seed cleaning plant. Only his legs are visible. Photo by Katherine Strand.

Sharon and Magnus shared information with me at dinner that night that I would hear repeated at the coffee rows, as well as by the old dudes at the station; news like this travels fast. Brandon, although never having mentioned his plans to me when I had interviewed him a few months earlier, decided to sell to the Whopper from the south because, according to Sharon and Magnus, he could no longer mentally or physically deal with the stress of managing 20,000 acres of cropland. Brandon required several vacations each year to unwind from his daily tasks and delegating employees to ensure every acre was sprayed, seeded, and harvested each year within the small windows of time available each busy season. Additional stresses came as he stretched his debt load—beyond that associated with equipment purchases and land payments—to

$6,000,000 each growing season just to purchase inputs and seed in anticipation for the spring. Sharon explained that according to Brandon's mother, he longed for past years when he had still been able to spend the majority of his time in the tractor or combine cab doing his own fieldwork. During the busy season, to farm 20,000 acres, Brandon required close to 20 employees to assist in field management, grain bin management, marketing, input supply, mechanical assistance, computer assistance, and operation logistics. He spent all his time in a home office on the phone and radio, directing the activities of his employees. According to his mom, "it didn't feel like farming anymore." Brandon apparently took a deal for $25 million dollars (a figure I heard from multiple sources), kept about 2000 acres including his farmyard, and happily accepted his new rank as a "smaller farmer" in the area.

The Whopper, according to Sharon, Magnus, and others at coffee row, had purchased Brandon's farm, grain bins, and some equipment with the help of investors based in Calgary. These same investors helped the Whopper grow from a modest 3,000 acres in the year 2000 to 50,000 acres by 2015. Magnus continually shook his head throughout dinner, echoing John's sentiments on the subject from earlier that week:

> It's just against my philosophy to see these big land buyouts. People need to stay on the land, otherwise investors are in a position to eliminate farmers altogether and supply distributors directly. They [the investors] don't give a lick for the land and won't take care of it (Strand fieldnotes, 2015).

He later went on to discuss how every farmer in the region had to get used to Hutterite colonies moving into their area and changing the game board indefinitely because they have to farm on such a large scale (minimum 10,000 acres) to support communities of at least 100 people. Through their practice of pooling resources within and between colonies, they can purchase land and equipment at higher prices than individual farm families. "We had to get used to colonies changing the competition, but eventually we've mostly accepted them as good neighbours"

(Strand fieldnotes, 2015). That night at dinner, though, Magnus and Sharon could not foresee the Whopper becoming a good neighbour. We concluded the evening by making plans to attend the upcoming auction at the Wheeler farmyard the following month. When they first mentioned it, I couldn't help but think about Dr. Eric Ramírez-Ferrero's (2005) incredible ethnography of farming in Oklahoma and the high rate of suicide amongst male farmers during the farm crisis of the 1980s. In it, he describes farm auctions not only as humiliating to the families whose private life and financial status is now on display, but also potentially cathartic because the tightly held family secret of financial distress can be revealed to neighbours and friends. Farmers whom he interviewed, expressed dread about the auction beforehand, but felt better afterwards because their neighbours came to offer support and kindness. I asked Sharon and Magnus if they thought it would be appropriate for me to attend, given my impression of auctions from Ramírez-Ferrero's work. They seemed almost confused by my hesitation and both agreed that I should attend, because auctions are community events and this particular one could not be missed.

AUCTION DAY

On auction day I drove about 30 minutes north of Swift Current to the small community of Stewart Valley. Stewart Valley is very similar to Wymark. At one time this small village had grain elevators, businesses, and restaurants. The only buildings that remain, however, aside from a handful of well-kept homes, are the Pioneer Co-op and a small school which children in the area can attend through to grade eight, before being shipped down the highway to Swift Current for high school. I had visited Stewart Valley on a few occasions earlier in the year and stopped on my way to the homes of Brandon W. and Sharon and Magnus, both of whom farm nearby. Prior to that Christmas I had also visited a friend of Sharon's who lives in town and the three of us spent the day making Norwegian potato pancakes called lefsa. Most of the families who originally homesteaded in the Stewart Valley area were Norwegian and although many have since sold their farms and moved away, signs of that Scandinavian heritage linger, particularly with the country church east of town that is utilized during the summer months.

As I approached Brandon and Diane's farmyard, I noticed at least 100 vehicles parked alongside the road and in a stubble field that runs parallel to their buildings. The auction had started an hour earlier and a large crowd had already assembled to get a closer look at the hundreds of items for sale. After parking, I walked towards the buildings and heard the rhythmic repetitions typical of an auctioneer over a loudspeaker. Richie Brothers were hosting the auction, and trucks and trailers with their logo were parked throughout the farmyard. Various pieces of equipment, such as combines, tractors, grain augers, trailers, air seeders, and countless other items, were arranged in perfect rows as people meandered around, looking at items and checking for their information in the auction pamphlet. There was a crowd of people gathered around a truck with a camper shell that had been converted into a tiny office with two men sitting inside and two others perched outside at opposite ends, their job to spot bidders to inform the auctioneer. I jotted down some interesting auctioneer quotes from the day including, "You're gonna get a lot of work out of her for not a lot of money," "You know where her home has been," "She's clean and tight gentlemen." I noted throughout the day that the auctioneer often used the feminine pronoun to describe the equipment to an almost entirely male crowd. I also noted that I was one of only four other women there that day, including Sharon and Diane W. — Brandon's wife and farm partner. My notes from the day read as follows:

> The overall feeling is one of a giant pissing contest between men. They all stand in a semi-circle around the auctioneer truck, arms folded and legs slightly more than shoulder-width apart. When making a bid, I noticed that most men gesture with a slight lifting of their hand and pointed finger. The actual hand never leaves its perch folded on the opposite arm. The spotters watch the crowd from above like hawks, waiting for any slight movement

> that could indicate a bid. During the live-bidding, most men maintain a poker face and exhibit no emotions when losing or winning a bid (Strand fieldnotes, 2015) (See *Figure 73).*

The auctioneer sat inside the makeshift office while another sat inside in front of a laptop, connected to hundreds more bidders worldwide. Many items were sold to buyers who were not physically present, including an air seeder to a bidder in Spain and a tractor to a bidder in Saudi Arabia. I recognized many people walking around, including Magnus and Sharon, Brandon, and two other large farmers in the area whom I had already interviewed. There were also several small groupings of Hutterite men, reminding me of the Blues Brothers in their sunglasses, hats, and homemade suits (See *Figure 75*). Each time an item sold, people would disperse briefly before coming together again for the next lot (See *Figure 73 and 74*)*).*

Figure 73. The Bidders. A group of auction bidders at the farm auction. Photo by Katherine Strand

Figure 74. Auction Day. The on-farm auction near Stewart Valley. Photo by Katherine Strand.

Figure 75. Colony Bidders. Members of a Hutterite colony attended the auction and are pictured here. Photo by Katherine Strand.

People who were not actively bidding on an item walked freely around the yard and gathered in small groups to socialize. A food truck with tables and a porta potty trailer created a centralized area in the yard for socializing, so I sat with Sharon and Magnus for lunch to discuss the auction. Sharon immediately expressed her disappointment with how it had been hosted. She explained that farm auctions are usually more personal, with local women providing the food and a more relaxed environment to allow neighbours to catch up. She and Magnus felt like they did not recognize anyone there and planned to leave as soon as we finished lunch. Magnus called out to Dan F., a farmer located west of Stewart Valley whom I had already interviewed, as he walked by and he sat down to join us. After a brief greeting, the conversation turned once more to Brandon and the Whopper. Magnus had heard the farm sold for $33 million, but Dan disagreed and said it had gone for $25 million. Both spotted the infamous man, the Whopper as he stood near the auction truck, who had made the land purchase, and pointed him out to me. I was shocked to see that the man looked to be about my age, mid-30s. Yet according to Dan and Magnus he had already amassed a farming empire of at least 50,000 acres in Saskatchewan and was expanding into the United States. Both agreed that he was only able to do this because his farm had attracted financial backers from Calgary and/or China, and so he had the capital to purchase land, employee homes located in Stewart Valley, and possibly more equipment from the auction today. Dan described the location of these headquarters, which was south of Wymark. It included several large shops, more employee housing, several long lines of grain bins, and an employee cafeteria. The farm had started out average-sized, but after the young man married into wealth, according to Dan and Magnus, they were able to expand beyond their original operation near Neville, SK.

At several points in the conversation, both men shook their heads in disgust at the size of the young man's farm, especially now that he owned Brandon's land as well. They explained that for farms the size of Brandon's (roughly 20,000 acres), there's less and less benefit to the community. Farms this size bring in seasonal labour from outside of Canada, thus contributing very little to local employment. They typically do not purchase inputs locally because they can get better deals purchasing directly from chemical plants and warehouses. Finally, both Dan and Magnus agreed that farms this size are not managed properly. With so many acres to seed and harvest each year, it is logistically impossible to customize practices to suit the needs of particular conditions and soil types. Magnus also argued that in order to keep investors satisfied, Brandon had to shorten his rotation cycle to seed canola and lentils more often. In order to limit diseases and balance soil nutrient requirements, these high-dollar crops should be cycled with wheat or other cereal crops. Farmers will sometimes seed lentils or canola on the same land for multiple years to increase their rate of return because these crops fetch a higher price than most cereal rotations. Their comments reminded me of my interview with Steve E., the farm financial planner at MNP. As he said, "The capital requirement to farm increases all the time. I think the expression is 'there's only three ways to get into farming these days, alimony, patrimony, and matrimony' (laughing)" (Steve E., December, 4, 2014). On the basis of our lunch conversation, it sounded like the Whopper's farming empire benefited from at least two of these strategies.

Sharon and Magnus eventually said their goodbyes and I followed Dan to a line of trailers scheduled for bidding after lunch. He had his eye on a trailer specifically designed for transporting chemical tanks, but doubted that he would purchase it that day. With so many people in attendance, including representatives from several Hutterite colonies, Dan thought that there would be many bids for most equipment, thus driving up the winning price. I asked if he recognized many people in the crowd, and he acknowledged a few neighbours dispersed throughout, but felt that many of them must have travelled to the auction from outside the Swift Current area. We then both said a brief hello to Diane, Brandon's wife and farm partner, who thanked us for coming before quickly walking away towards their large house at the west end of the yard. Our conversation then turned back to Brandon as Dan explained that many farmers will choose not to hold public auctions, opting instead to sell their equipment to dealerships or through online services such as Kjiji. Although that might take longer, according to Dan, farmers feel less exposed to the prying eyes of neighbours who are not only able to examine farmyards and equipment, but can also find out the sale price of all the auction lots on the Richie Brothers Website. He freely admitted that part of his own motivation for attending that day was curiosity, particularly about the shop Brandon had built only a year prior. Dan had walked through the shop first thing that morning, as the large doors had been open to showcase many of the smaller items for sale, including a lot with three porcelain toilets.

As the day wore on, I watched as hundreds of items found new owners and the biggest ticket items, including five almost-new combines, sold for over $300,000 each. The auction still in full swing, I felt like I had observed enough to understand how the game worked, and walked towards my car before spotting Brandon. He was surrounded by a few other men, but he recognized me and said hello. He asked if I had bought anything and as the group of men waited for my answer, I called back, "I'll be taking a combine home to Wyoming." They all laughed. The brief conversation left me feeling slightly uplifted, although I kept thinking about Sharon telling me earlier in the day that Brandon's mother could not attend the auction because she found it so painful. According to Sharon, Brandon had been able to keep about 2000 acres of the family land, including the original homestead. Nobody knew for sure why Brandon decided to sell. Some continued to suspected issues with debt, but others I spoke to vehemently disagreed, claiming that Brandon was one of the best farmers and businessmen in the region. There were those who tended to cite the stress issues previously mentioned as key reasons for Brandon dismantling his empire. As I drove home, I thought about my interview with Brandon the previous fall.

The Interview with Brandon and Diane

Although Brandon and Diane never explicitly told me about their plans to downsize the farm from 20,000 acres to potentially 2,000, there may have been hints as we discussed the farm in the interview which took place only a few months before I heard the big news that had spread around Swift Current. When they first started farming as a married couple, Diane and Brandon worked with his parents on their farm, seeding about 600 acres each year. As he explained, after his dad died they quickly expanded, and at the time of our interview, they were managing about 22,000 acres, owning 25% of it and renting the other 75%. Some of the land was over 120 km away from the Stewart Valley area. Both Brandon and Diane answered my questions with short, direct answers and although they were very gracious hosts, our interview was interrupted five times during the 70-minute conversation. It reflected daily life with Brandon, which he described as consisting of sitting behind the desk on the phone, radio, or computer. With a productions manager, logistics and systems manager, and operations manager working directly under him and an unspecified number of employees working under each of those managers, Brandon spent most days organizing people, marketing, and arranging for millions of dollars' worth of grain and inputs to move on and off the farm each year. He estimated that in the previous year, he had spent at most six hours operating machinery, which acted as a "fun break" from the desk work. Brandon and Diane used to operate all their own machinery, but according to Diane, "Years ago I used to drive the combine and grain carts, but I haven't for a long time. I just (pause), it was just more important for the books and stuff to get done. There was lots of paperwork once we expanded" (Diane and Brandon W., September 26, 2014). Michael H., a technician at the Swift

Current Station who primarily works in the salinity lab, told me shortly after Brandon sold the land that he needed at least two vacations per year to handle the stress of managing that much land. The two men knew each other for years through school events that their kids both attended in Swift Current, so they talked often about Brandon's farm. Michael also told me that Brandon spent more time in the "boardroom" discussing financial matters with his investors than doing the day-to-day farm work.

Although we did not discuss how his farm was financed, after I described how many ranches in the area where I grew-up in Wyoming were owned by absentee landlords living in other states or other countries Brandon made the following comment:

> That's becoming more and more common, isn't it? Around here, yes, and everywhere. Some people start with a large agricultural asset or some have an extreme amount of money, and they'll purchase agricultural assets as an investment. Some just need a place to park their money (September 26, 2014).

I wondered at the time if such an arrangement characterized their farm's ownership, but for whatever reason, it did not feel appropriate to ask. I did ask Brandon and Diane a question about the future of their farm:

> Katie S.: What would you say is the biggest concern for maintaining your farm going forward?
>
> Brandon and Diane W.: Labour (in unison).
>
> Katie S.: Labour? Okay so why do you both say that?
>
> Brandon W.: Everything else is controllable. Right now 60% of our labour force is from outside the country.
>
> Katie S.: Why is that and how does it work?
>
> Diane W.: We just don't have the people here.
>
> Brandon W.: And that 60% is all brought in on government programs. It can be changed on a whim.

> Diane W.: They're already talking about cutting it back.
>
> Brandon W.: The Temporary Foreign Worker Program is the only reason why our business has functioned(…)Very few farms have enough people and if they do, the quality is not what you would like. The labour market is tight enough around here that you can quit your job in the morning and have a job by the afternoon.

Brandon explained that although they provide housing for the employees and keep them employed year-round, they struggle constantly to get enough help during the busy periods of seeding and harvesting. This was not the first time I heard about foreign workers coming to Canada for agricultural labor. While living in Wymark, I met or heard about workers from Mexico (usually Mennonite families), Bolivia, Peru, and Bulgaria. Brandon and Diane's workers came from Australia, New Zealand, Europe, and South Africa.

To conclude our interview, I asked Brandon and Diane about whether they thought their farm would continue under the management of their three children in the future:

> Brandon W.: I don't know if the kids will take over. We look at it as a business. There's very few emotional ties to it, which I think there's a lot of people who we associate with that look at it the same. It's a business. Generations on the family farm, that's different. Those are two different things and not right or wrong. That's just our philosophy. I doubt whether our kids will. Our eldest son just graduated and he's not showing any interest at the moment.
>
> Diane W.: Our son who's in grade ten, he's a good equipment operator. He has a natural ability but no desire to work out there. He'd love to work out there if it was just him and his dad, but with five combines, three carts, four trucks plus all the yard guys, he has no desire to go out there.
>
> Brandon W.: He's different. It's different. Like I grew up working alongside dad. If he wants to work alongside me, it's either on the phone or in the office. It's just different. I used to go and ride on tractors with dad for a long time when I was growing up. I don't know if I have six hours in machinery this year. So it's a business. It's not a family farm.

I read the interview differently now, after the sale. These excerpts about viewing farm assets as investments, purely a business, and feeling at the mercy of labour now all seem like clues as to what they were undoubtedly considering, perhaps even as we spoke over coffee that day. Brandon and Diane were the only farmers I interviewed with children who did not express hope that their kids would one day take over the farm. I began to question their concluding statements about their kids, however, after hearing that they had decided to keep those 2,000 acres of the family farm, and to continue living and working near Stewart Valley. Perhaps it's sentimental on my part, but I would like to think it is because they have not totally resigned themselves to this being the end of their family's farming legacy.

FARMING IS A BUSINESS

In one of my first conversations with Rob T. and his partner Gertrude as I sat in their fully restored 1920s farm house east of Swift Current, he dropped one of his perfectly timed phrases about farming in his voice worthy of audio books or documentary narration: "This is next year country. Sure didn't work out this year. Sure to work out next year" (Strand fieldnotes, 2014). I find it hard to describe why I found Rob's voice so engaging, but there is a quality about it that ingrained his words into my mind long after our conversations. We laughed at his impeccable delivery of these words in a conversation about how farmers are both gamblers and hopeless romantics when it comes to the future. Rob and Gertrude spent most of their years divided between the farm and jobs at Olds College in Alberta. Like most of the farmers I encountered, they too had what I began to refer to as an "almost lost the farm" story. Some farmers like Rob told the story with a lightheartedness that minimized the trauma of their ordeal. Others like Joe W., my neighbour from Wymark, told the story in bits and pieces while shaking his head each time. The story often came up as he connected current financial or management issues on their farm back to the ’80s when the interest rates nearly devoured them.

Although the productivist discourse that encouraged farmers to think of themselves as businessmen and the farm as a business began as early as the 1920s (Fitzgerald, 2003), it's a conversation that has never fully been resolved, as farmers across Canada and the U.S. failed to live up to the vision of the industrial, factory-style of production promoted by federal, provincial, and state governments of all political stripes. At a conference hosted by the University of Saskatchewan in 1968, researchers from prairie universities, provincial governments, and the federal government gathered to discuss “farmers in the backwash of progress” (Thair, 1968, p. 1). Based on estimates provided by the Agricultural and Rural Development Act (ARDA), in the late 1960s, 60% of Canadian farmers lived below the poverty level, which was defined as below $3,000 net income at that time (p. 1). John Bennett published his ethnographic study of farmers, ranchers, and “Indians” in Maple Creek (approximately 137 kilometers west of Swift Current and within Palliser’s Triangle) a year after this conference in 1969. In that ethnography, he divided farmers into two subcultures: prairie homestead and prairie farm. The prairie homestead subculture characterized most farmers near Maple Creek. Bennett (1969) describes the prairie homestead subculture in the following quote:

> Relative poverty and less interest in “modern conveniences” meant a very simple mode of life, one resembling the original pioneer homestead period. Their houses were simple, two or three-room wood shacks, a few with dirt floors. Clothing was scarce and old; furniture even scarcer and older; decoration primitive or nonexistent. All had electricity and usually a refrigerator, but many had wood stoves and no plumbing(…)their style was due largely to relative poverty (p. 68)

According to the researchers from the 1968 conference, most farmers in Canada were failing to adapt themselves to the demands of modern life and this reflected poorly on the country as a whole (Abell, 1968). They asserted that part of the solution rested with farmers stepping up to meet the challenges of modern farming, which required constant technological adaptations and increasing capital investments to outrun the "price-cost squeeze, the relationship between costs of production and prices received for farm products, a relationship which has seen costs increase each year with only modest or no change in the prices received for farm products" (McRorie, 1968, p. 31). McRorie cited the technological treadmill as the key factor driving this price-cost squeeze, which favours early adopters of technology (Dudley, 2002). These early adopters are often larger farmers with more access to capital; by purchasing a piece of equipment that increases their farm yields, they drive down commodity prices. Farmers who fail to adopt that technology continue to produce at lower yields, and also earn less income precisely because those who have adopted the more efficient technology have driven commodity prices down. As McRorie (1968, p. 31) explained, "Technology has made possible the rapid expansion in farm output per man, while at the same time making constant production adjustments a necessary part of economic farm survival." McRorie summarized the thoughts of many conference participants, noting:

> Farming has now reached a stage of development where it has become a business and must in fact be treated as a business. A strong back and willing hands are no longer enough. Lady Luck will still be important, but more than ever, a farmer's success will be measured by his ability as a manager (1968, p. 34)

At the same conference, Drew followed up stating that, "planning is essential in the operation of a farm business. Farming is, after all, a business(…)To stay in business the 'by guess and by golly' system must be replaced by analytical analysis" (1968, p. 35). These sentiments were echoed in the 1984 edition of the annual *Guide to Farm Practice in Saskatchewan* prepared by Saskatchewan Agricultural Services, the University of Saskatchewan, and Agriculture Canada. It included a 30-page chapter on Farm Business Management. The section opens on a familiar note: “The purpose of planning is to assist the farm manager to make better farm management decisions(…)A farm manager can use various ‘tools’ or techniques to assist him in planning and managing his farm business” (Saskatchewan Agricultural Co-ordinating Committee., 1984, p. 10). And just in case the farmer had forgotten, the *Guide* reminded “him” that “Farming is a business. It should be evaluated each year for progress” (p. 32). As Müller explains, “The figure of the farmer-entrepreneur dominates in Canadian government publications(…)The farmer-entrepreneur is a rational individualist willing to take risks”(2008, p. 391). She points to these publications, in addition to pioneer origin stories emphasizing self-reliance and autonomous battles with nature, as having created a neo-liberal ideology amongst prairie farmers that redefined the formerly collectively conceptualized structures for market protection (e.g. The Canadian Wheat Board) as “obstacles to the freedom of enterprise” (p. 396). Müller found that farmers reflected the government discourse in their descriptions of how farming has evolved from a lifestyle to a business. Drawing on Dudley (1994) and Foucault (2004), Müller explains that farmers have internalized this logic of the market, which creates a *homo oeconomicus* figure, an entrepreneur solely responsible for their own successes and failures. She goes on to explain:

> Because they have internalized the identity of the farmer-entrepreneur they are set to confront these obscure forces of the market alone. From being inseparably interwoven with the traditional conditions of life, family and neighbourhood, craftsmanship and religion, village and church, the farmers and their land becomes inseparably connected to market and capital, technology and innovation, corporations and banks (p. 50).

Brandon W. perfectly exemplifies this type of internalized market logic of the shift towards the entrepreneur-farmer, approaching farming as a business.

I heard other farmers express similar sentiments both in Saskatchewan and during my previous research from the United States. I have often thought and read about this concept since my Masters work in Wyoming, Colorado, and Nebraska and throughout my stay in Wymark, but it was not until my interview with Dr. James A., a soils researcher at the Station, that my thinking shifted slightly to consider how this entrepreneurial spirit also acts as a coping mechanism for the stresses associated with losing the family farm:

> James A.: I remember this farm review thing in the ’80s. So if a farmer was going to lose their land or lose the farm, I guess there was a review process. I can’t remember who, but there was a group with some farmers on the committee and creditors and certainly the government. But anyways they’d meet here at the Station. I remember they’d be sitting off in the lobby and you’d see them, and it was quite devastating because you knew that they were obviously on their last leg. They were here because they were going to foreclose and lose the whole thing. That was pretty tough times. It was also a different era too in the sense that at that time, there was really more of a sense of the farm as a lifestyle as opposed to the farm as business. So farmers would really hang on, hang on, hang on until they were done, until they were bankrupt totally and lost all their assets. Whereas now if a farmer is going under, they’ll usually exit with some capital, rather than walking away with the shirt on their back type of thing. The creditors get the farm, the car, everything. So in that regard it’s different now. The attitude of the farmers is much different now. It’s much more business oriented.
>
> Katie S.: Do you have any idea of what could account for that change?
>
> James A.: Well I think in some ways it was that reality check of the ’80s where the sense of hanging on at all costs kind of thing, as a lifestyle, as maintaining the tradition or whatever, I think a lot of people could just see that that didn’t work. Essentially you’re walking away with nothing. You might be 50 years old and spend your whole life on the place and walk away with nothing. There’s some farmers at that time who were, as I said, would keep hanging on to the farm until they had exhausted everything. You know, it really wasn’t good. It made sense for them at that time because it was the social expectation, but from a personal preservation point of view, it really didn’t. I guess it’s always next year country, so you’re always hoping to turn it around next year, but in the 80s with prices so low, there was limited opportunities to turn it around.
>
> Katie S.: Do you think they’re better situated now to protect themselves against bankruptcy and losing the farm?
>
> James A. Well yeah, I mean they’re more diversified, so that’s a help. There was one farmer who came in and was talking about the ’80s. He said “Well I was just about to go bankrupt, but I decided to put the whole farm into lentils.” He’d never grown lentils before. He put the whole farm into lentils. Lentils were at a huge price that year and he essentially did turn the whole

> farm around by going out of wheat and into lentils. Now that was kind of a hail Mary kind of action, but now the amount of diversification certainly does prevent some of the market risk. Farmers at that time were almost entirely wheat, so that certainly has helped some resilience. I would say agronomy has improved. Most of the survivors that are farming now and doing well are much bigger, much better managers, and much better agronomists. There used to be a saying that in farming, it's the dumb kid who takes over the farm. I remember that was back in the '80s that I heard that a lot. But now it has switched and it's only the smart one who has a chance(…)Now the attitude would be different. It wouldn't be the same social problem. I'm not saying it would be easy, but it's not the same social stigma and the same family pressures to hang on to the farm that there was in the '80s. I remember talking to one farmer and he was a bit bitter. He said, "The only thing I recommend is never take over the family farm because then you have all this pressure from the family to just hang on until there's nothing left of you." He said, "If you didn't have that pressure. If it were just a business then it would be a lot easier" (James A., September 10, 2014).

This excerpt underscores several of the points previously made. However, I think the last line in particular helps us to understand that farmers also adopt this way of thinking in order to distance themselves emotionally from the farm and the fear that they might lose it at any point in the future. As James suggests, it also helps remove some of the stigma associated with selling land, because other farmers and family members can more easily accept it as being a rational business choice, rather than some kind of a moral failure on the part of the farmer. Of course, I still met many farmers who could never imagine selling their land. While riding in the tractor and seeding with John A., he jokingly said that he would prefer to drop dead while working on the land, but that, on a serious note, he could never sell. The farm had been built by his grandfather, grandmother, uncles, aunts, father, mother, wife, and kids. For this reason, he felt that he had no right to ever sell the farm because it belonged to everyone.

John and Brenda A. still live on their farmyard and drive to Swift Current each week to attend church and buy groceries and supplies. The Dominion Lands Act of 1872 required at least six months' residence on the land in order to fulfill the contractual obligations which allowed homesteaders to retain ownership (Kitto, 1919). For this reason, farmyards both abandoned and occupied are scattered throughout the prairie agricultural landscape like small islands in a sea of monotone fields. As I travelled through southwestern Saskatchewan to various events and interviews, I learned to recognize the signs of an occupied farmyard, versus one that is either totally abandoned or is being used only for grain or equipment storage, or as shop space. Farmyards that are occupied year-round and serve as both a living and work space have manicured landscaping with mowed grass, pruned trees, and occasionally more involved elements such as ponds, perennial gardens, vegetable gardens, etc. (See *Figure 76).* These farmyards have multiple buildings, including one or more houses that also show signs of care, such as intact windows, newer siding, furniture on the porches/decks, and occasionally toys scattered outside the house. These farmyards typically house multiple vehicles, including at least one decaying "farm truck" and one "town vehicle" for grocery runs, appointments, etc. The other sign that a farmyard is being used as both living and work space is the presence of dogs and/or horses, though many people keep cats around their farmyards even when they do not live there year-round in an effort to keep the mice from destroying the interiors of their equipment and buildings.

Figure 76. Occupied. An example of a farmyard that is used as both work and living space. Note the flower bed on the right. Photo by Katherine Strand.

There are a few key signs to help differentiate a farmyard that is utilized for both living space and workspace versus one that is only used for seasonal farm labour and storage. The first is that workspace-only farmyards tend to lack involved landscaping projects and also show signs of deteriorating past landscaping work. Trees begin to die off as people are no longer dedicated to watering them regularly, flower beds and gardens remain empty or fill with weeds, and grassy areas, especially between rows of trees and near buildings, become overgrown. Some grassy areas are still mowed but the owners no longer make the extra effort to mow in-between obstacles or trim around buildings. There is oftentimes still a house on the property but occasionally the windows are boarded, the front deck is falling down, the paint is beginning to decay, and there are rarely toys or furniture around the outside of the house. You might still see one or two "farm trucks" around the yard and equipment such as combines, tractors, and sprayers, but "town vehicles" are less frequently seen, especially in winter months.

In my interview with Brandon and Diane W., they described the typical procedures involved with purchasing new land that includes a farmyard. Because they already lived on a large farmyard with multiple shops and grain bins, they would not need to keep all the buildings. So some would be torn down, especially if they showed signs of decay. If the newly purchased farmyard was close to their own, they usually removed everything, including trees, carefully picked the land over to prevent equipment damage, and then converted the yard into more space for growing crops. As Brandon explained, "for these yards, you could drive by and not ever know that there used to be a house, or shop. You'd never know that someone used to live there" (Diane and Brandon W., September 26, 2014). If the farmyard was further from his own home base and if the shop and grain bins were in good condition, he would usually keep them for storage purposes, which they did in one case where they sold the house and it was moved off the property, but kept in place a building for storage and the grain bins. I saw a few of these kinds of property in my travels, including many that had only a row of grain bins framed by a bit of remaining mowed grass or gravel (See *Figure 77).*There might occasionally be a tree or patch of shrubs, such as caragana, near the road leading to the bins, but oftentimes, these lonely rows of bins were the only signs left to indicate that a homestead and farmyard ever existed.

Figure 77. Workspace. The only things left from this farmyard near Wymark are a line of trees and a line of grain bins. Photo by Katherine Strand.

The other type of farmyard I observed in my travels was fully decayed, no longer used either for work or living (See *Figures 78 and 79).* These buildings were partially collapsed, with no paint remaining on the exteriors. The grass was overgrown and trees at least partially dead with branches and debris lying all around. The grain bins were also of an older style—small square or round sheds made of wood with flat bottoms and short "cubby-hole" doors (See *Figure 80)*. These bins came from an earlier era before metal storage was available and before hopper bottoms and grain augers, a time when grain was moved by hand with a shovel. Even though I always enjoyed seeing them and inevitably featured them in photos taken at dusk on my way home from an interview, I often wondered why these yards existed at all. I eventually learned that there were often very practical reasons for keeping them around. First and foremost, dismantling these yards requires time, labour, and resources. Every bit of junk, including thousands of metal nails, must be removed or buried very deep before it is safe to run equipment across the land to seed crops (See *Figure 81)*. Farmers without the resources of someone like the Wheelers cannot afford to spend the money or take time off to clear the yards, only to gain a few extra acres of cropland. The Wheelers had cleared their lands because it made farming with their large equipment easier. With over 70 feet of width to negotiate with their Bourgault Paralink seeders, any obstacles that could be removed would be, in order to prevent damage to this equipment worth millions. I also eventually learned that yards are cleared because neat and tidy land is a valued trait of "choice farmers" all over Palliser's Triangle.

Figure 78. What's Left. The remnants of an old farmyard near Mankota. Photo by Katherine Strand.

Figure 79. Lean into the Wind. This building was surrounded by old machinery. Photo taken near Wymark by Katherine Strand.

Figure 80. Flat Bottom Bin. The old style grain bin with a flat bottom. Modern grain bins usually have hopper bottoms. Photo by Katherine Strand.

Figure 81. The Dump. A farmyard dump near Fox Valley. Photo by Katherine Strand.

An interview with Randy B., a farmer in his early 60s, living near Hazlet, Saskatchewan shed more light on some of these seemingly abandoned farmyards. He described the original homestead sites from both his mother's and father's sides of the family, which were near his own farmyard and still included houses from the 1920s. Both sides of the family immigrated from Ireland in the early 20th century and both started out in tar paper shacks. They also both built nicer homes around 1916 because, as Randy explained, "Times were fairly prosperous at that time and a lot of houses and barns and facilities were built during that era. Crops were good and prices were good, which is an unusual combination. That only happens two or three times in a career" (Randy B., November 28, 2014). Randy went on to describe his father's family homestead. They expanded the house in 1928, and it still remains on the property today. Randy, his wife, and two sons lived in the house for many years before they bought his current farmyard and built a new house in the late ’80s. Over the years Randy considered tearing down the old houses on both homesteads but always felt he “couldn’t quite get rid of them, maybe for sentimental reasons.” Randy and his wife were also going through another transition, as they'd begun slowly selling land to their youngest son and had bought a condo in Swift Current. Randy’s wife stays at the condo most of the time, although “she occasionally comes out, cooks up a fridge full of food for us guys, does the laundry, and hollers about how poorly things are kept then goes back to town.” Randy’s son and his family live in Hazlet, so oftentimes he is alone with the dogs in the farm house, which “just feels different from when we all lived out here together.”

Randy’s story of a slow transition to residing in town is common amongst SW Saskatchewan farmers. It is becoming increasingly common for farmers to move into nearby towns, while still actively farming, and to commute daily to the farmyard. Two of my project participants, Dan B. and Martin D., lived in Swift Current but farmed 10-20 miles outside of town. These farmers are grain-only operations, so they do not have the burden of feeding livestock daily, which means that during the winter, they can easily visit the farm just once a week. I interviewed both of these farmers at their homes in Swift Current. In my fieldnotes for both interviews, I commented on how these interviews felt different from those we had conducted in their farmyards. “It feels strange to discuss the farms, while sitting in the middle of Swift Current. Dan referred to buildings on the farmyard and would follow-up with something like, ‘if we were on the yard, you’d see...'” (Dan B., March 22, 2015). After this interview with Dan, I reflected on my own childhood in Wyoming. When I was around 16 years old, my mom took a job in town because my family needed health insurance. My brothers and I still discuss how that dramatically shifted our feelings about the ranch. We inevitably began spending more time in town, which created a feeling of distance from the ranch that was never fully reversed. Although they did not explicitly state anything to that effect, I sensed this distancing from Dan and Martin.

My own childhood story is very similar to those of Saskatchewan farmers. As National Farmers Union researcher Darrin Qualman explains: "In the 33-year period from 1985 to 2018, input costs consumed more than 95% of farm revenue and left farmers with just 5%(...)To make ends meet, farmers have been forced deeply into debt and most farm families must also rely on off-farm sources of income" (2019, pp. 10, 12). Between 2001 and 2014, "off-farm employment contributed 41%, investment income contributed 15%, pension income contributed 10%, and farm-supported-program payments contributed 15%" to operator income (p. 12). Although I never asked farmers about their pensions or any government program payments, they often discussed off-farm employment. A typical situation for many of them involved the wife working at least part-time in Swift Current, or the husband working part-time at such occupations as school bus driving, manure hauling, and cleaning grain—jobs that don't interfere with the busy growing season. While riding in the combine with Hannah H. for seven hours, she described also working full-time in Swift Current as a registered nurse, then using all her vacation time to help her husband Ronald with seeding and harvest. Ronald has never taken on full-time, off-farm employment, but does drive a school bus route as a substitute to make extra cash in the winter. Off-farm employment can be a burden, usually taken on by women, because if the family still lives on the farm it involves daily commutes. For Hannah, her commute into Swift Current was about 20 minutes. For two farm families near Fox Valley whom I know personally, the commute for the wives who are public health nurses is about 45 minutes to either Leader or Maple Creek, SK. It is easy to see why some farmers might choose to relocate into town if these commutes become too burdensome, especially during the long Saskatchewan winters. The daily commute between town and the farmyard is a relatively new development for communities in southwestern Saskatchewan. In discussions with Mary J. and Mary P., two elderly friends in their 90s who both grew up on farms near Swift Current, trips to town as children occurred only every few months at best and twice per year during more difficult times. I met Mary and Mary after they cornered me outside of Safeway grocery story asking for donations to a local charity. I eventually found myself in a four-hour-long conversation over coffee with them as they shared their complete life stories. It was fascinating, and I particularly enjoyed watching the two tease one another and occasionally quibble over historical details that were understandably becoming fuzzy. Mary P. recalled the feeling how different it was to walk on the paved roads and sidewalks when they visited town; life on the farm was dusty and mucky, with no pavement or even gravel to provide a surface buffer. Clothing was impossible to keep clean, but they did their best to look nice on those trips to town every few months. During Mary and Mary's childhoods, they attended country schools, which could be found at regular intervals on the grid—usually about two or three miles apart. In our conversation, Mary P. recalled a story about walking to school one winter day. She recalled there being at least a foot of snow on the ground that morning. As the day progressed, a blizzard intensified, creating conditions for a treacherous walk home for her and her siblings. They decided to stop at a neighbour's house and make the trip home in the morning. As she recounted the story, Mary P. kept saying that she could not imagine her parents' worry as they sat in their house, unable to travel in the storm and wondering about their children. Most country schools and churches have since closed; children now bus to school and families commute to Swift Current for church. As Stanley W. explained to me, in the 1960s and '70s some parents pushed to close schools in favour of busing to Swift Current, believing this would provide a better education for their children. What they did not consider, however, is that the country schools and churches provided a centre of community life for farm families. Stanley, with his old-time fiddle, actually started a band whose primary purpose was to play the unrecorded and unwritten tunes that livened up monthly dances at the country school of his childhood. Along with his bandmates, he appreciated the significance of this music, which everybody knew, and played at country schools all across Saskatchewan. As I travelled around the Prairies I photographed a few of the country schools that are still standing, although decaying quickly. Oftentimes the only thing that remains of these former cornerstones of the community is a metal sign, placed along the road in the corner of a field, with the school's name. Sometimes there is no trace left of the schools at all, as the buildings have been torn down and the land reabsorbed into the surrounding field.

FARMING IS A BUSINESS, A BIG DATA BUSINESS

To begin this section, I return to a comment recorded above by Dr. James A., "There used to be a saying that in farming, it's the dumb kid who takes over the farm. I remember that was back in the '80s that I heard that a lot. But now it has switched and it's only the smart one who has a chance" (James A., September 10, 2014). James and I followed up on this interview a few times. I often spent my afternoons in the Station Library, which has since been dismantled after they eliminated the librarian position during the course of my fieldwork; all of the Library's contents were given away or stored—more on this in the next chapter. I was grateful for the opportunity to work there and read through the extensive archives before it closed, because it also allowed me to engage in daily conversations with the research scientists, technicians, and other employees as they came in to make copies or borrow books. James always paused to check in on my research progress and these conversations often had me revisiting our interview. In one such conversation, he re-emphasized the importance of knowledge and intellect to “manage” a 21st century farm. Although I was already aware of the complex data collection systems installed in every new tractor, combine, and sprayer manufactured these days, James helped me realize how much data is directing the future of farming. In one of our library conversations, he started out by saying that farming is no longer a physically demanding job. The main demand on farmers like Brandon W.—with 20,000 acres, 30 or more pieces of equipment (including at least 5 combines), inputs worth millions of dollars, thousands of bushels of grain, at least one hundred grain bins, and around 20 employees— is staying informed about all these elements of modern farming in order to keep farms going with increasingly stringent if not impossible profit margins (see Qualman above). Part of how they stay informed today is, of course, through the use of P.Ag.s. Prior to selling his land, Brandon kept an agrologist employed full-time, with two others on retainer to assist with more challenging questions. He also used the services of a farm coach who advised on agrology questions but also helped with marketing, input supply chains, and equipment purchases or leases. At the heart of all these services are massive data collection systems. I heard about the role of data collection throughout my time working with and interviewing professional agrologists , but wanted to delve further into it. So I approached Brian C., the Integrated Data Solutions Manager from the primary John Deere equipment dealership, JayDee Agtech, in Swift Current.

The John Deere dealership is an obtrusive building west of Swift Current, easily visible from Highway One, and flanked by long lines of tractors, combines, sprayers, and seeders bearing the legendary green and yellow paint of the John Deere brand that have come to signify different things to different farmers. For some the colours represent the only equipment worth buying. For others these colours are overpriced and usually disappointing equipment. For all farmers, these colours have been a permanent fixture on the Prairies for over a hundred years, and most will have at least one piece of equipment from John Deere on their farmyards, even if it is lying in the junk pile or has been transformed into an antique lawn ornament. The interior of the dealership is impressive, complete with vaulted ceilings, a full wall of windows facing south, and a display of John Deere-themed toy tractors and implements, with price tags averaging $200 dollars. My brief perusal of the toys was a humbling reminder of my own financial status; if the toy tractors feel expensive, the life-sized tractors must only be for the gods.

I had met Brian a few months prior at a workshop hosted in Swift Current that included various speakers discussing the agronomy and marketing of pulses. Brian is also a professional agrologist and in fact used to work for Brandon W. as his personal P.Ag. before taking the job at JayDee. After he was hired, Brian took online classes at "John Deere University" to learn about their Operations Center data platform, mobile weather stations, drone field monitoring, and Normalized Difference Vegetation Index (NDVI)[64] mapping. Brian assists farmers with the Operations Center platform and weather stations, but at the time of our interview, this particular office was not offering any drone services. However, they did help farmers find services to collect drone data that could be used with John Deere's Operations Center. Brian summed up his job to me with the following quote:

> My job and the whole Operations Center platform are all about turning tons and tons and tons of data into usable information. Every machine a farmer is running these days comes equipped with a full telematics system that collects data on the tractor or combine cab processor and automatically sends it to the platform, which a farmer can look at miles away on his iPhone or tablet (Brian C., May 3, 2015).

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64 In the agricultural context, NDVI maps are used to detect differences in the chlorophyll levels of plants in a growing crop. The level of chlorophyll is a strong indicator of plant health, so when spots of low chlorophyll emerge, this can mean an issue with disease, pests, or weeds. For more information on NDVI and its use in other contexts see https://eos.com/ndvi/.

He went on to explain that some of the data collected include: crop yield seeding rate, fertilizer tank levels, chemical tank levels, tractor performance, tractor alerts, and fuel usage, to name a few. As he explained, through this system, a person can "tune into" the tractor cab monitor from their living room couch. The Operations Center can also process the data to create maps, which analyze the yield per acre. The data also collects field histories, so that a farmer can click on a given field and view information on what was seeded and which inputs were used (similar to the ArcGIS system for variable rate farming previously discussed). At this point in my research I was familiar with the in-cab monitors that Brian referred to in our interview after spending many hours in tractors and combines—including some John Deere machines. The monitors are small touch-screen computers that give the tractor, sprayer, or combine commands such as automatically adjusting the fertilizer rate. These screens also allow the farmer to monitor tractor performance, seed and input levels, yield rate, and many other types of data. Additionally, the monitors are equipped with either GPS directed autosteer or for more accuracy, real-time kinematic (RTK) guidance systems that utilize a calibrated base station (https://www.deere.ca/). Autosteer generates perfect lines following the grid across fields, with zero overlap, and creates a more enjoyable experience for the operator because they are relieved of the intense level of concentration needed to steer a tractor, combine, or sprayer manually dead straight and without overlap. Three of my project farmers thought GPS autosteer systems were the best technological improvement in farming during their careers. For Brian, autosteer, data collection/analysis, and remote data monitoring all turn "ok equipment operators into good operators" (May, 3, 2015). As Brian explained:

> The future of all John Deere equipment and technology is based on a model of one manager and multiple workers. John Deere is giving farmers what they're asking for, which is equipment that can be run by unskilled labour. This is a problem here and everywhere, this shortage of labour. The longer

> view is equipment that operates robotically and is monitored remotely by one manager, so eventually swapping the unskilled labour for robotics. With the data collection and remote monitoring capabilities, we're working towards being able to farm from an iPhone anywhere in the world (Brian C., May 3, 2015).

As Brian explained this futuristic vision to me, he must have observed a look of apprehension on my face. He laughed, reassuring me that John Deere is at least a few years away from turning the Canadian Prairies into a world of autonomous robotic machines creeping back and forth across massive fields in perfect north-south and east-west trajectories. He did, however, admit that the technology for such a world is already "there for John Deere and already in many machines utilized by farmers around Swift Current" (Brian C., May 3, 2015). However, there are questions of legality and safety that John Deere has not yet resolved, so it will "take a few years yet." He followed up with a now familiar refrain:

> But you have to remember that farming is a business these days and not a lifestyle. We can't get romantic about what farming is. That romantic notion that people refer to from the past kept an impoverished class in place. If you want a family farm, then you need to be okay keeping an impoverished class amongst Canadian society" (Brian C., May 3, 2015).

Following our interview, I took a brief tour of the building and its large shop where multiple mechanics worked on three combines. I thanked Brian and left with an apprehensive feeling about the future of farming. Brian had presented just two options to me: farmlands devoid of any human presence with massive machines following the grid to seed, spray, and harvest, or a messy collection of small farms and poor farmers in the "backwash of progress" (Thair, 1968, p. 1). The overarching feeling amongst farmers and other community members I spoke with in southwestern Saskatchewan is that farm consolidation is inevitable, and will continue until there are only a few farms left. This sentiment is reinforced with each year that brings new school and business closures to prairie small towns. I often thought about how older farmers I spoke with felt as they watched familiar farmyards disappear, thus erasing landmarks that had been part of the landscape since their childhoods. These farmyard landmarks breakup this sea of subtlety and seasonal textures that extends for miles in every direction. In the absence of major geologic monuments that characterize other regions, such as mountains or rivers, farmyards help make sense of these spaces that Wallace Stegner (2000, p. 7) described as "quiescent, close to static; looked at for any length of time, they begin to impose their awful perfection to the observer's mind. Eternity is a peneplain." The grid and farmyards were the tools foreign settlers used to make sense of a seemingly endless horizon. Now it is the grid that ushers in a new stage of farming dominated by data collection, GPS-navigated equipment, and perhaps in the near future, robotic farming. However, it is notable that some small farms persist mostly because they did step off the technology treadmill onto one defined by regenerative agriculture, using fewer inputs and older equipment. And while these farms create new challenges, they also present an alternate vision for a future on the Prairies.

A MESSY ORGANIC GRID

According to Statistics Canada, in 2016 2.5% of Saskatchewan farms produced organic products (Statistics Canada, 2020). Although above the national average at 2.2%, organic farms are still a very small minority in the province, with only 583,856 acres seeded to organic field crops in 2019[65] (Zeidan, 2019, p. 37). I interviewed five organic farmers in southwest Saskatchewan, among whom my close confidants, Stanley and Karen W., were included. The

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According to Statistics Canada, in 2019, 12,901,000 acres were seeded to wheat in Saskatchewan alone. 11,550,000 acres were seeded to canola and 3,387,700 acres were seeded to lentils. Organic wheat only accounted for 246,190 acres of the total listed above-about 1.9%. Organic lentils only accounted for 50,686 acres of the total listed above-about 1.5%.

average size of these farms was about 2,000 acres with the largest at about 6,000 acres. This stood in stark contrast to chemical farmers I interviewed, who farmed about 6,000 acres on average, with the largest farm—that of Brandon and Diane W.— coming in at 20,000 acres. Beyond the obvious size difference between chemical and organic farms from my project, I noticed that all of the organic farmers from my project grew more varieties of crops than the chemical farmers. Most of the chemical farmers adhered to a three-year rotation of lentils (large green), wheat (durum and soft white wheat), and canola with an occasional year of barley, mustard, or flax thrown in. Organic farmers also grew lentils and wheat, but also included many types within each of those categories—for example, within the wheat category, they might grow durum, soft white wheat, Kamut, spelt, einkorn, and emmer. Many organic farmers extended their regular rotations to include wheat, lentils, flax, alfalfa, barley, fall rye, and a green manure crop. The green manure rotation usually included at least three different species of plants, which were seeded in the spring and plowed under in July. These multi-species green manure rotations included plants that fixed nitrogen in the soil, brought phosphorus to the surface, added organic matter, and provided a surface cover to protect from wind and water erosion. Additionally, three of the five organic farms included livestock in their operations, which could be used to graze crop stubble to improve soil composition and structure. The manure could also be utilized as a field input, either applied directly or after conversion into compost.

What I began to realize months into my research is that every organic farmer I met offered a unique approach to growing crops in Palliser’s Triangle. Although there was some overlap, each system included the use of different rotations, implements, timelines, livestock cycling, and soil inputs. This struck me as important, because after about ten interviews with chemical farmers, I could almost predict their approach to farming, and their timeline—although the exact amounts of fertilizer and types of chemical varied slightly between them. For the most part, they all grew the same varieties of crops, used the same methods of weed control, seeded and fertilized using the same kinds of machinery, approached harvesting with same method of desiccating and straight cutting,[66] and followed almost identical seasonal timelines for spraying, seeding, and harvesting. The timelines of organic farmers varied significantly because unlike chemical farmers, they could not use chemical herbicides to kill weeds prior to seeding. Chemical farmers typically apply a "burnoff" product early in the spring, and seed shortly thereafter. This burnoff kills the weeds and allows the crop to gain a head start. While the crop is growing, they are also able to spray their crops a couple more times to kill the weeds. In contrast, organic farmers typically have one chance throughout the entire growing season to kill their weeds. Each spring they wait until the weeds have emerged then pre-work their fields about twice before seeding. There is a long list of implements organic farmers use to pre-work their fields including many varieties of discers, rod weeders, cultivators, chisels, and harrows. This mechanical method of killing weeds can only be done prior to seeding, so the timing of these practices is crucial. If they wait too long, then the weeds will have used up too much moisture, thus leaving very little in the soil for the crop. If they use mechanical weed control too early, they may not succeed in killing the majority of the weeds, as tiny weeds are often able to survive mechanical tillage or a second batch of weeds emerge just before the farmer is able to seed. As

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Desiccating involves the use of either glyphosate or a produce called Reglone. These products are sprayed on the growing crop to kill the plants, dry the grains, and prepare the field for harvest. The field is typically harvested within a few days after the product is applied, thus making it an increasingly controversial practice, because the product is still present on the grain when harvested. Because the crop is still "standing" when harvested, this is called straight cutting. This method is in contrast to those of organic farmers who cannot utilize these products. They either wait until the plant has matured and dried on its own before straight cutting to harvest, or they swath the plants and allow them to dry in windrows. The windrows sit for one to two weeks on the field before the farmer can combine the crop. Prior to the use of desiccants, all farmers used the methods of organic producers. However, most chemical farmers from my project no longer own swathers. For organic farmers, this remains an essential piece of equipment on their farms.

described above, their timelines at harvest also vary, because they cannot apply desiccants to force the crop to dry in preparation for harvest.

I want to emphasize that most chemical farmers are locked into a system that allows them to farm thousands of acres in short periods of time with very few people contributing to the labour. Organic farmers cannot cover as much ground as quickly because they must make multiple trips across each field during seeding and harvest. As per above, they also must wait until each field is ready for certain types of work to be undertaken. Chemical farmers use herbicides and desiccants to overcome timing and labour constraints, allowing them to set their own timelines rather than waiting for ideal weather, plant growth, and weed growth conditions. While it may seem like chemical farmers enjoy more freedom in terms of playing a larger role in influencing seasonal cycles, creating ideal crop conditions, or adjusting timelines to suit their scheduling needs, it is the organic farmers who are truly able to adjust their systems to address seasonal fluctuations and incorporate new technology. This flexibility in organic farming systems is essential as we enter a new era of production that is increasingly dominated by climate change, herbicide resistant and tolerant weeds, environmental contamination, and rural depopulation. In terms of our discussion within this chapter, the flexibility and variability of organic farms is also essential to keeping small farms from disappearing, while giving families a sustainable income. As Darrin Qualman of the NFU explains:

> Organic farmers usually earn higher net incomes per hectare, partly as a result of premium prices, but also because of lower production costs resulting from reduced input purchases. Higher per-hectare net returns can allow organic farmers to farm fewer hectares and still make a living, and this can enable a region to support more farm families (2019, p. 45).

In October 2020, according to Organicbiz (2020), in western Canada the average price of organic milling wheat was $13.50/bushel, representing a 213% premium above chemically grown wheat.

This premium is why organic farmers are able to stay in business while staying relatively small compared to their non-organic neighbours; their yields tend to be 8 to 25% below those of those same neighbours (Qualman, 2019, p. 46). Based on the organic farmers I interviewed, this also affords them the advantage of marketing flexibility. Because they grow more types of crops, and may also sell animal products, they have market diversity built into their systems. Additionally, they typically sell to a greater number of buyers in many different types of markets all over the world. Most chemical farmers sell only to local grain elevators and do not market their grain outside of the prairie provinces.

This is not to suggest that organic farmers have it all figured out in terms of sustainable farming and marketing. As Grant P., an organic inspector and former Agricultural Extension Representative for the provincial government with over 40 years of experience advising farmers as a professional agrologist, explained:

> I should clarify that as an agrologist with my background training, I don't personally think that organic agriculture is sustainable in its present form, nor is conventional agriculture with chemicals. I think we're running into a road block in both cases just the way they are currently operating just because there isn't enough sustainability built into the rules for organic, and these conventional people over here well they're just running hog wild with thinking that they can cure anything with chemicals. At some point these things won't be curable with chemicals like resistant weeds and resistant diseases, lots of things(…)So I don't think the ideal system is out for either group of people. I'll pop either of their balloons for them if I get into conversations. But there's some in the organic group that are getting quite close(…)I still learn tons about organic with every farm because there's no formula, like with conventional agriculture. The progressive organic farmers understand the health of their soil(…)They have a healthy annual or perennial forage component with lots of legumes in their rotation. They have diverse rotations and minimal tillage with lots of green manure plow-downs and usually livestock incorporated into their operations. That's the future (Grant P., February 13, 2015).

Grant went on to explain that weed control can create many challenges for organic farmers in this region, because without the use of chemical herbicides, they must find different techniques. Some organic farmers still rely heavily on aggressive tillage and summerfallow rotations, which destroys soil structure, disrupts communities of soil microorganisms, and creates conditions conducive to wind and water erosion. All of the organic farmers I interviewed used some form of tillage for weed control, but they all understood why these practices must be reduced in order to promote soil health. They all aspired to create a system of regenerative agriculture on their farms, incorporating many elements Pat listed above, with the goal of building soil organic matter through diverse crop rotations, conservation tillage, and rotational livestock grazing.[67] Regenerative agriculture also includes elements of animal welfare and social sustainability as guiding concepts for farm communities and workers, with the long-term goals of providing stability for small-scale farmers, and also of creating soil conditions to capture carbon dioxide from the atmosphere and store it underground within organic matter through microorganism and mineral associations (Rodale Institute, 2020). We will return to this potential climate mitigation through soil carbon capture in the concluding chapter of this dissertation, but for now suffice to say that organic farmers in southwestern Saskatchewan envision a very different future for the Prairies than their chemical farming neighbours. They are stepping away from games of risk and scale, and experimenting with playing a different game altogether.

UNGRACIOUS LIVING

In 1919, F.H. Kitto wrote the following passage in an informational and promotional book about Saskatchewan, published by the Department of the Interior.

> Annual visitors to the province have witnessed a series of scenes unfolding to their astonished gaze that constitute the drama of national growth crowding

67 For more on regenerative agriculture, see rodaleinstitute.org, regenorganic.org, and brownranch.us.

> into the space of a few years the events that took our forefathers generations to accomplish. First on the lonely prairie is seen the humble "shack" of the bachelor homesteader, who drives with dogged perseverance his slowly moving yoke of oxen as the virgin soil is broken in long furrows. The next visit the golden grain is seen, the furrow has widened, cattle are grazing beyond and other "shacks" have made their appearance in the landscape. Succeeding scenes show rapid advancement. Horses replace the oxen, gas tractors assist the horses, the "shack" fades from the scene and modern buildings spring up as if by magic, the patches of grain take definite shape in expansive fields. Trees, flowers, a woman's face and romping children appear and the annual tourist wakes up with a start to find that in a few short years the pioneer scenes that interested him have passed away and he is merely travelling in a land as conventional as his own (Kitto, 1919, p. 83).

A tourist to the Saskatchewan Prairies would witness a very different "conventional" space than that which Kitto had envisioned for the province. In the process of smoothing the grid, large-scale, consolidating farmers are clearing homesteads, removing shelterbelts, and creating single fields across whole sections with a single crop, rather than dividing sections into individual crops. Their 130-foot wide sprayers, 76-foot wide Bourgault seeders, and 45-foot wide combine harvesters follow the north-south and east-west lines of the grid with perfect accuracy, thanks to new auto-steering technologies. Rather than new "shacks" popping up over the hill, old shacks are removed to accommodate the giant equipment operated by an inexperienced labour force. Every year, small farmers decide to sell because of financial difficulties and stress as they fall to the advantage of those large-scale farmers. They have less access to capital, and are running older equipment that is not only less reliable, but more difficult to repair as it becomes impossible to find parts for machines that large manufacturers no longer have any incentive to support. Many of my project collaborators feel that this consolidation and smoothing of the grid is inevitable. Even those with larger-sized farms, these families must continually work to take over new squares on the grid to remain competitive and cover their massive overhead. However, as we saw in the last section, some farmers are stepping away from the game in order to adopt a new style of farming. This future includes efforts to incorporate regenerative farming with close attention paid to building soil organic matter, improving conditions for livestock, and creating a secure livelihood for farmers. In this scenario, there might be new "shacks" appearing over the hill.

I met Stanley and Karen W. within my first week of living in Wymark. Stanley immediately invited me to a monthly potluck that they hosted on their farm for a group of about 20 people, including their close neighbours John and Brenda. I gladly accepted and planned to attend the potluck that month. I promised to bring my mom's version of jambalaya. During this first visit, I met many farmers from the region including some who still lived on their farms and others who retired and moved to Swift Current. These evenings were filled with lots of food, lots of drink, and many interesting stories about the region and the state of farming. I attended almost every potluck for the year I lived in Wymark. One of the potluck topics that frequently inspired passionate conversation was how the community was changing over time as more and more farmers disappeared from the grid. Stanley described his childhood and early adulthood as one filled with activities around the Horsham region including curling, baseball, schoolhouse dances, multi-day winter visits at neighbours' homes, and harvest suppers. He once described how much more everyone walked in those days. They walked to school, to neighbours' homes, to dances, and home again from dances in the early hours of the morning. He found it interesting that although these walks often happened in the middle of winter and without battery-operated flashlights, he never felt unsafe or alone because in every direction, you could see the lights of a neighbour's home and knew you would be welcome if the journey became too arduous. Stanley concluded these remarks by stating how lonely these walks would feel today if they had to stumble home in the moonlight three grid sections over. It was at this same potluck that Stanley and Karen explained the origin of their monthly potlucks. The tradition had begun close to ten years prior when several of their close neighbours sold their farms and moved away. Karen described the loneliness that they both felt because their social life had almost entirely disappeared as those neighbours left the region. They decided to start the monthly potluck to invite their friends and some fellow farmers from further away to socialize regularly. One of the monthly attendees drove three hours each way to join the crowd at Stanley and Karen's. As he explained to me one Saturday, "I farm up around Leader, Saskatchewan and my closest neighbour is 90 years old. There's nobody left in that country" (Strand fieldnotes, 2014). The following is a passage from my fieldnotes following a potluck dinner that discussed this issue:

> As Stanley and Karen described the origin of the potluck and almost everyone else shared their stories of the emptying grid. The overall feeling was melancholy. The older farmers found it difficult to understand today's scale of farming. They found it difficult to put into words what has been lost. The best way they could describe it to me was by recounting stories and events that happened right here on Stanley's family land. Stanley's family utilized one corner of the field near their house for a baseball diamond. This baseball field was a hub of activity with people practising and playing most nights and large community games happening on weekends. In the winter, the activity shifted to the ice rink which was located on a neighbour's farm not far from Stanley and Karen's house" (Strand fieldnotes, 2014).

Shortly after moving to Wymark, I began walking or jogging on a road heading east out of town. I ventured down that road at least once or twice each week for my entire stay in the small hamlet—aside from a few bitter cold weeks in the winter (See *Figure 82*). What I began to notice, after many walks along the grid roads outside of Wymark, is that the whole agricultural space feels industrial. You rarely see people walking in the industrial zones of cities. People stick to the residential zones, which offer parks and coffee shops and pleasant places to sit and watch life go by. Walking in an industrial zone feels awkward and even unsafe; there are so few people outside and only the occasional large utility vehicle roars by to rattle your senses. In many industrial zones, you're met with a series of large buildings and doors but uncertainty over where to enter. The roads are wide and rarely offer sidewalks to help guide walkers as they navigate these spaces. This is the feeling I always experienced while walking the grid roads. What I realized after a few potlucks with Stanley and Karen, and after hearing about their own frequent walks between houses and events at the country school, is that my feeling while on walks was completely different from what they experienced years ago. For them, the whole area used to feel residential. They walked the main roads, but they also walked along small trails that cut across pastures. They ran into people as they walked and felt comfortable stopping unannounced at houses for quick visits. I never ran into other walkers outside of Wymark, and I only occasionally saw people walking when I drove to various farmyards across Southwest Saskatchewan. Overall, although I generally enjoyed my walks east of Wymark, I also felt slightly uneasy on this grid road.

Figure 82. My Grid Road. The grid road east of Wymark. A natural gas well is in the distance. Photo by Katherine Strand.

Maureen Hunter, from the Canadian Wheat Board, gave a presentation at the 1980 Prairie Production Symposium at the University of Saskatchewan titled *Expanded Production and Quality of Farm Life.* I found a copy in the Station library and was immediately drawn to her opening paragraphs, in which she described to the audience a dream she'd had:

> The road that runs from my father's farm to my grandfather's farm is just an ordinary country road. I have travelled it more times than I can count. Only one trip stands out clearly in my mind. This is a trip I made down the road in a dream.
>
> It was harvest-time, in that dream; the air was fragrant, the sunlight mellow. I began the drive in high spirits. But in the slow way that comprehension comes to us when we dream, I began to realize that something was very wrong. Every spare inch of land, for as far as the eye could see in every direction, had been seeded to grain. Where once had been trees and green farm lawns, there was nothing but grain. The ditches along the road were seeded to grain, the neighbor's yard right to the doorsteps were seeded to grain. Even the beautiful rows of trees that sheltered my grandfather's farmyard were gone—ploughed under and seeded to grain.
>
> My grandmother had planted those trees when she moved onto that farm and into her first real "house." It was not just for shelter that she planted them. Those trees represented something to her—something she had craved for many years. They were a promise of gracious living, even in an ungracious land.
>
> It was at this point that the horror of the dream came home to me. For what purpose had so much that was gracious been destroyed? The answer to this question was clear: the destruction was in the name of growth.

Perhaps my discomfort at walking the grid roads was as a result of what Maureen Hunter describes above. Perhaps I felt awkward because every "gracious aspect" had been removed from the grid.

CONCLUSION

This chapter followed the stories of a few of my farmer collaborators as they helped me understand the game of risk and scale. Although this game is far from over, the current trend is towards fewer farmers managing large expanses of land that used to support entire communities of people. Most of the farmers I interviewed or spent time around felt like this trend is inevitable given the current land prices, input costs, and machinery costs coupled with low returns on their grain sales. With organic farmers, we see an alternative path developing, which allows farmers to remain smaller in terms of the land they manage because they have lower overhead costs and receive a premium for their grain.

This chapter traced some of the changes that have happened within the farm communities of southwestern Saskatchewan including a shift in how they understand their farms as businesses rather than lifeways. This shift is accompanied by many changes in the farm lifestyle that oftentimes includes off-farm jobs and leaving the farm entirely to live in nearby towns. These changes create distance between farmers and their farms, as many no longer live on the Prairie grid. I met at least two farmers who commuted between Swift Current and their work on the fields and in farmyards. Based on my interview with the Data Systems manager at the John Deere dealership in Swift Current, we can see how the agribusiness industry envisions the future of farming on the Prairies. They anticipate a full conversion to robotic machinery that can complete all field operations with the guidance of one farmer at the end of an iPhone. This future will result in a further smoothing of the grid as less people are needed to manage Canada's breadbasket. This potential future is one that many of my project farmers mentioned, sometimes jokingly, as we discussed the technology inside the cabs of their tractors that self-guides the machinery across fields without human interference. After learning about the massive data collection enterprise that farming has become, I began to understand how this future has, at least in part, already arrived.

CHAPTER 7

CONCLUSION

THE EXPERIMENT CONTINUES

Figure 83.Stages of the Prairies Photo by Katherine Strand.

THE LIBRARY AND THE HERBARIUM

When I reflect on my time at the Station in Swift Current, one event stands out as particularly significant. After six months of field research, I decided to drive to Wyoming to spend Christmas with my family. I returned to Wymark a couple weeks later and went to the Station in early January to continue my archival work in the Library. As I walked into the small room with teal green shiny floors and windows lining the north and south walls, I immediately noticed boxes stacked up near the librarian's office and in a work space with desks and a copy machine. Sherri M., the librarian, sat in the work space with a tall pile of books beside her as she checked off items on a list. I sat with Sherri while she did her work and explained what had transpired over the holidays. She received an email in late December from her supervisors in Ottawa and the Station Director letting her know that the Library was officially closed. Sherri knew this day would come because in conversations with the Station Director, she learned that her supervisors were not planning to fill her position when she retired. Sherri planned to retire that spring and did not know what would happen to the Library when she left. She was surprised by the email because the closure seemed sudden; however, it became clear to her that the decision was made so that she could assist in dismantling the Library before her planned retirement in the spring. Her work that day involved gathering books and documents in boxes for shipments to Ottawa.

The Station established the Library in the late 1930s, although the official date is unknown. As Kilcher (1986:70) explains, "The establishment of the Library is not recorded in any of the early reports of the Station, but probably Mr. Taggart [the first Director], Grant Denike, Mr. Mack, and Miss Bain gathered and classified bulletins, books, journals, and reports to start this important research adjunct." The first librarian was Mabel Barnes, who was married to Sidney Barnes—the early soils researcher who constructed the tank experiments (see Chapter Three). The majority of the time I spent working at the Station was in the Library, so I felt sentimental when hearing Sherri's news of its planned dismemberment. In my first six months of research, I visited the Library several days of each week while I sifted through the SCRDC Archives. The Director allowed me to work in the Library unaccompanied by Station personnel. My time there helped me get to know the scientists, technicians, and staff. As I sat working at one of the desks, people would come through every day to retrieve books, talk to the librarian, or make copies on the machine. Most people would linger for a few minutes, and sometimes for an hour, to ask about my work in the archives, around the Station, and with farmers. Eventually, I felt included in the "water-cooler" conversations of the Station employees.

In these "water-cooler" chats, I learned that most technicians and scientists were shocked and saddened to hear the news about the Library closure. They viewed the Library as an asset for their work and believed that the archives were important both historically and scientifically. They worried about the fate of the archival collection. I shared their worry and asked the Director about any plans for the archive's storage and preservation. He said that the government provided no plans, and then he asked if I knew of any facilities that might be interested in taking the collection. I offered him some suggestions and he assured me that no matter what, the archives would remain safe—even if that meant safely stored in the Station basement.

By late February 2015, the scientists and technicians received an email from the Director letting them know that any remaining books and documents in the Library were up for grabs. By this time Sherri had completed her list of books slated for shipments, which left many full shelves of materials available to anyone at the Station. The week after the Station-wide email felt like a madhouse. People came in with large carts and loaded up books for their workspaces, offices, and laboratories. I watched as two people fought over the last copy of *Budd's Flora of the Canadian Provinces*—written by the Station's retired soils and botany researcher Archie Budd. After about two weeks of book purges, the Library looked as though a plough wind[68] had come through. Around this time, Jack M. came into the Library to rummage through the remnants of the Library collection. As a forage specialist, he was hoping to get a copy of *Budd's Flora*, so I regretfully informed him that others had taken every copy in the first week of the purge. While Jack looked around, he asked if I had taken any books yet. I said no and asked him if that was even a possibility. He responded, "Well you can take them now or dig them out of the dumpster in a few months' time" (Strand fieldnotes, 2015). Sensing my surprise at his comment, he explained that shredding and disposing of old books and documents regularly occurred at AAFC research stations. According to Jack, the protocol at the Station following the retirement of an employee was to shred all of her/his documents. He also described the closure of the library at the Lacombe branch station in Alberta. In the months leading up to the closure and in its immediate aftermath, the employees at Lacombe were asked to dispose of books, documents, and pamphlets in large dumpsters. Through Jack's conversations with close colleagues at the Lacombe station, he learned that the government authorized these disposals because they worried about liability issues arising if the public acquired some of these documents. According to Mike, the official reason for Library closures was that scientists rarely used them and rather than allotting resources for libraries, the Ministry of Agriculture hoped to modernize information systems by expanding digital services. Unofficially, Mike's colleagues in Lacombe believed that the government was attempting to "rewrite history" by eliminating these libraries. When I asked

68 The name given to "strong, sudden downdrafts [which] bring cool, dense air from aloft, rapidly spreading it outward ahead of the thunderstorm or squall line. Plough winds often strike a larger area than tornadoes but can be just as strong" (Environment and Climate Change Canada, 2017).

Mike to explain further, he regretted that he could not say any more on the subject but encouraged me to take whatever books I wanted before they met their untimely end at the Swift Current dump. Months later I learned through an article on Canada's National Observer that Harper's government had closed 16 research libraries, including the one in Swift Current and another at the Lethbridge branch station (Mandel, 2015, September 29). As Mike and I looked around the Library, he shook his head and said he could not believe how quickly the Library was dismantled when it took over 70 years to create. He also said that before the Library closed, the Ministry of Agriculture promised the scientists that the materials in all of the branch station libraries would be digitized for their use. We both laughed as we looked around at the scattered remnants of the Station's carefully curated collection of books, papers, periodicals, pamphlets, and abundant reference materials. My thoughts then turned to an interview I conducted before Christmas with the director of a large funding agency that awards grants to AAFC scientists including those at the Station. In the interview Kent P. said, "You know I sometimes wonder if we look back in 20 years, if we won't look back and say that we witnessed the slow death of public research at AG Canada" (Kent P., October 29, 2014).

After I helped Jack take a load of books to his office, he asked me about the archives in the Library. I shared all the information I had learned from the librarian and the Station Director. He thought for a moment then asked if I had been down to visit the Herbarium in the basement. At this point in my research I had heard about the Herbarium from Jack and others in forage research, but I had not visited the collection. Jack grabbed his keys and we headed down to the lowest level of the main building. Months later, I spent a week in this part of the building sorting through Station photos in what used to be the photography lab. The Herbarium consisted of cabinets in a windowless room that stored hundreds of large cards. Each card included a beautifully placed preserved plant, the Latin name of the species, and common name(s) for the species (see *Figures 84 and 85*). The cards provided information on the location where the specimen was collected including a small map, the name of the area, the habitat, and the elevation. The name of the collector and date was also included on the cards. Jack carefully brought out many examples to show me before gently replacing them and closing the cabinet doors. In the 1980s when Jack began working at the Station, the Herbarium was an active component in the research of many scientists and technicians. The Herbarium was first created in 1936 when a forage specialist from the Manyberries Experimental Station transferred to Swift Current and brought his collection of native grasses with him to the Station (Best, 1967, September 8). Dr. Clark's collection included specimens he had procured in Alberta, Montana, and Saskatchewan since 1926. He created the Herbarium to store these specimens and serve as a resource for scientists to learn plant taxonomy, record the distribution of native plants, compare similar species, and learn about the semi-arid habitat through the plants (Looman, 1982, September 24). The collection continued to grow over the years as many scientists and technicians contributed plants to the Herbarium. It grew substantially when Archie Budd became curator in 1943, and he added specimens in the 1940s and 1950s. Described as a "self-taught botanist" (Kilcher, 1986, p. 27), Budd began working at the Station in 1926 as a technician for soils research projects (Campbell, 1971). He added hundreds of specimens to the collection from the Prairies but also the Rocky Mountains, eastern Canada, the western coast of Canada and the U.S., and northern Saskatchewan, Alberta, and Manitoba. While Budd was curator between 1943 to 1957, he grew the collection from less than 2000 species to over 6000 species. Budd used the Herbarium when he wrote *Budd's Flora of the Canadian Prairie Provinces: A Guide to the Plants of Alberta, Manitoba, and Saskatchewan* in 1979. The Herbarium continued to grow throughout the 1960s and 1970s and by 1977 included 50,000 specimens of native and non-native plants. By the late 1970s, the collection was used to track the movement and distribution of native and non-native weeds.

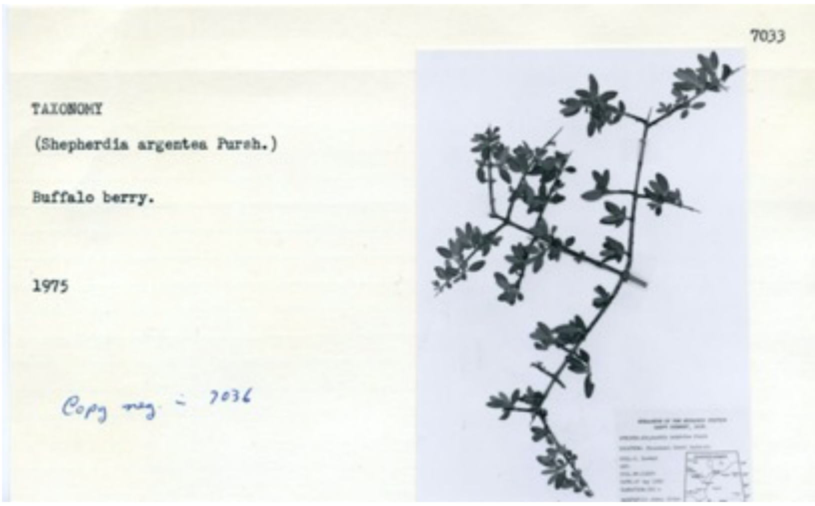

Figure 84. Buffalo Berry. Above is an example of one of the cards stored in the Herbarium—note the small map in the right corner. Photo from the SCRDC Archives.

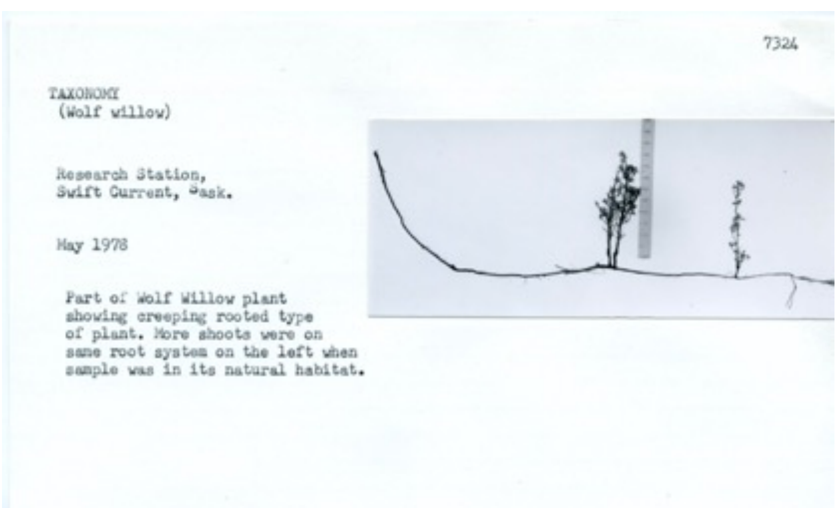

Figure 85. Wolf Willow. Above is another example of a samples stored in the Herbarium. Photo from SCRDC archives.

When Jack arrived in the 1980s, scientists and technicians were still adding species to the Herbarium. However, interest in the collection waned throughout the late 1990s and early 2000s.

Jack attributed the lack of interest to a general move away from plant taxonomy and identification using phenotypes and less interest in studying the native Prairies. Genetic research on plants became more common and the government no longer wanted to support projects like the Herbarium. The collection still includes thousands of species; however, some cards have been transferred to other collections, including an herbarium in Saskatoon. As Jack explained to me that day, he continually fights to keep the Herbarium stored in the basement. He wondered if the archives from the Library would also end up stored in the basement. He fights to keep the Herbarium because he hopes that at some point it will be useful again to researchers at the Station. We both agreed that day that the archives should also be preserved in the basement for that same reason. A few months later, during a meeting for the organic research group, James A., a soils researcher from the Station, mentioned that he had been searching in the archives for information on tillage for weed control prior to the use of herbicides. This research took him all the way back to the *Annual Reports* from the 1930s and 40s. I made sure to mention this to the Station Director and to Jack.

I share this story of the Library closure and Herbarium tour because I think it relates closely to my primary research question. How did the original desert categorization of Palliser's Triangle influence the development of farming and agricultural science? To start, I return to Eckbo's (2002) definition of surfacing one more time. As part of his methods for landscape design, surfacing is the "conscious rearrangement of the elements of the landscape" (5) to facilitate "the continuous establishment of relations between man the land" (6). Surfacing is the "control of all the ground areas which have been in any way disturbed. This is the problem of *surfacing* [emphasis added], and it is essential to eliminate summer dust and winter mud. The forces of nature are intolerant of bare ground" (Eckbo 2002:64). I would like to amend this definition to suggest that surfacing not only facilitates the establishment of relations between man and land, it also creates social entanglements of humans, non-humans, institutions, Life, and non-Life. In Palliser's Triangle, questions of surfacing began as soon as the Station was established. The researchers needed to find a way to contain the bare soils that nature found "intolerant." They needed to stop the exodus of people and their solution of covering the surface of the soil with crop stubble and distancing farmers from engaging with these bare soils formed the foundation of a research project that lasted more than 70 years. This surfacing project also brought about significant changes in the structure of public agricultural science in the Prairies. It changed the relationship between farmers, public agricultural research and extension, and private industry. As I mentioned in Chapter Four, the progression of surfacing research led to the elimination of summerfallow rotations and the adoption of zero or minimum tillage seeding. To make this system successful, Rennie and Ellis (1978, 59) argued that "inputs such as fertilizers and herbicides are a must." Private agrochemical companies watched the development of this research at the Station and other public facilities and grabbed the opportunity to profit from this new system of surfacing. They nurtured close relationships with agricultural communities through the work of private agrologists. As these agrologists took on a larger role in the lives of farmers, the federal and provincial governments scaled back extension services.

Private industry also nurtured close relationships with the Station and other public research facilities through cooperative projects on herbicides and their potential for reduced tillage farming. Funding partnerships between private and public entities led to a change in the whole financial structure of the Station from A-base funding—100% AAFC—to grant-based funding, which oftentimes involves matching investment initiatives to support research projects with public, private, and check-off money from farmers. As explained in Chapter Four, this clusters approach seems intentionally obscure as it blurs the line between farmers and multinational agrochemical corporations. When I asked the Station scientists about the impact of the changes in extension services and funding arrangements, most responded with comments about how this has distanced them from close relationships with farmers. The Station is no longer the prominent voice, the expert gaze, within the agricultural communities of Palliser's Triangle. Even if they are responsible for new research, this information oftentimes gets translated through producer group websites and the names of the Scientists, if mentioned at all, are minor additions on elaborate websites. As we saw in Chapter Five, scientists from the Station must obtain multi-level permission to publish information intended for a general audience. To relate this back to my story about the Library closure, as the Station has become a less prominent figure within the agricultural communities of Palliser's Triangle, governments such as the one led by Harper feel emboldened to make severe cuts to public agricultural research because they know that it will not incite outrage within farming communities. They know it will mostly go unnoticed. In all of my interviews with farmers, I asked them about their thoughts on the importance of the Station. The chemical farmers gave variable responses. Some knew that the Station was responsible for many new durum and spring wheat varieties and acknowledged the significance of the cereal breeding research. Some mentioned presentations that they heard from specific scientists over the years. Some chemical farmers did not even know that the Station existed or thought it closed down years ago. When I asked Brandon W., the large-scale farmer featured in the previous chapter, about the Station he said:

> My dad moved into to chemical fallow in this area and he was the leader. He was fully chem. fallow for ten years before the Swift Current Research Station finally came out with a report saying, 'yeah chem. fallow is economical in this part of the world.' And at the time when the report came out, we were into zero tillage and very quickly moving into continuous cropping. They hadn't even tried it yet, so from my perspective, government agencies like the research station move along after the majority of the curve

> and certainly after the leaders have established what and where the technology is and where the curve is going" (Brandon W., September 26, 2014).

I found this response the most troubling because farmers like Brandon W. hold political and social influence, and he did not understand the contributions of the Station to all of the practices he mentioned in this quote.

The responses of the organic farmers were very different. They knew more about the Station, including the names and research areas of multiple scientists. They attended field day events regularly, and they understood the importance of public agricultural research. I would suggest that this is because the organic, low-input, research group includes a farmer advisory board to help guide their work. They meet regularly with the farmers and after attending several of these meetings, I noticed that the scientists included the advice of the farmers in their research designs. This type of meeting used to occur for all of the research groups at the Station and as we saw in Chapter Three, meetings between farmers and scientists used to take place on illustration stations owned and operated by farmers. Another reason why organic farmers know more about the Station is that they do not have close relationships with private industry representatives or professional agrologists. They seek out information from the public sector because private industry has not filled that gap for organic farmers. Private industry does not see any profit incentive in nurturing relationships with organic farmers and this relates back to surfacing. Organic farmers rely on mechanical weed control. They cannot preserve all of their crop stubble because they must disturb the surface to eliminate weeds. Although their implements and strategies have improved since the early 20th century, this mechanical disruption is still risky in terms of soil erosion. They also create new types of surfaces that have never appeared on chemical fields. Organic farmers seed multi-species green manure crops in the spring, only to plough them back into the ground in late summer. This green manure provides organic matter and soil nutrients, which improves the quality of their soils. They include more perennial crops in their rotations, which also improves their soil quality and helps control weeds. Perennial crops create permanent or semi-permanent cover on field surfaces and is often integrated with grazing rotations for livestock. Within my research project, organic farmers undoubtedly knew more about the Station; however, they represent a fraction of the farming population in Canada and on the Prairies. Chemical farmers know less about the Station, and when thinking about the comments from those whom I interviewed, I would comfortably speculate that most would not care about the Library closure.

The second reason I included this story in the opening section of the chapter is that the Herbarium represents possibilities for the future of agricultural research at the Station. The Herbarium represents a wiggly, yet persistent line of research at the Station that began in 1936. This line of research ebbed and flowed as it weathered all of the political ideologies, policy changes, structural reorganizations, and employee changeovers that have impacted the Station. This line of research is all about the native Prairie and the native species of grasses, forbs, and shrubs that collectively constitute the vegetation of this grasslands ecology. The wiggly line began when Dr. Clark transferred from Manyberries, AB to the Station in 1936 (Best, 1967). Although forage research was part of the Station's original agenda when it was established in 1920, the work mostly involved testing the best varieties and methods for producing non-native hay for livestock (Campbell, 1971). Dr. Clark became the head of the forage division in 1936 and he brought with him years of experience studying native Prairie species. While at the Manyberries Station, Dr. Clark (1938) began a project to study the chemical composition of native pastureland species in 1928. Through this project, Dr. Clark and his colleagues gathered hundreds of samples of plant species and charted their location and distribution within the High Plains of North America. By the time he arrived at the Station, Dr. Clark had developed a clear appreciation for native species and believed that if these species were studied as a community, they could help the scientists understand the unfathomable complexities of the short-grass, semi-arid desert of Palliser's Triangle. In a seminar paper delivered at the Station and titled *The Relationship Between Vegetation Types and Soil Types,* Clark (19371, p. 9-10) states, "Every plant is a measure of the conditions under which it grows. It is an index of soil, of climate and of all other factor of its environment influencing plant life, it is an indicator of the behavior of other plants in the same habitat(…)Plant communities are more reliable than single species as indicators of edaphic or other conditions of the habitat(….) All the species making up the plant cover must be taken into consideration as well as the percentage of different species, their density and general growth conditions." Dr. Clark's colleague Archie Budd, followed-up with a discussion after the seminar. Budd (as mentioned in Clark, 1937, p. 1) seemed to agree with Clark and wrote, "The entire plant cover is a better species [for study], since in it we have a record which is as stable as the most stable species and as sensitive as the most exacting plant." Budd wrote this in the context of explaining why native plant communities provide the best window for viewing and possibly understanding the collective conditions that create Palliser's Triangle. At the end of his discussion, Budd (as mentioned in Clark 1937, p. 4) states, "Nature has experimented for ages with our soil and climatic conditions and our task now is to correctly interpret her findings." Budd and Clark both indicate an interest in understanding the desert of Palliser's Triangle through the lens of perhaps its most accessible component—the native plant communities. They wanted to study these communities to help them access the longer-term history of the region, particularly because the desert conditions include wide climatic fluctuations.

Through the years, Clark and Budd and others who succeeded them, fought a battle to keep native plants relevant to agricultural research. Another wiggly line of research began with the establishment of the Station and at times, seemed incompatible with native species work. This alternative line was forage testing and breeding with non-native species. Although it began in the 1920s, non-native species became extremely important during the reclamation period of the 1930s (Janzen, 1936). As we saw in Chapter Three, non-native species such as crested wheat grass were seeded on thousands of abandoned homesteads to stabilize the "small deserts" (p. 1). Scientists within the Forage Division continually tested varieties of non-native grass and legume species to compare with their native counterparts. This work evolved into forage breeding and in 1955, Dr. Dave Heinrichs licensed a salt-tolerant variety of alfalfa called Rambler (Campbell, 1971; Kilcher, 1986). Rambler's most impressive characteristic is the extensive creeping root system that it creates (See *Figure 86*). Rambler grows a deep vertical taproot to access moisture at lower levels, then horizontal roots span out to access more nutrients and moisture. The root system improves overall soil structure and plant resilience in variable climatic conditions. In 1963, Dr. Tom Lawrence from the Station registered a new variety of Russian wild ryegrass called Sawki for the commercial development of seed (Kilcher, 1986, p. 38). In 1979, he wrote a damaging report for native plant enthusiasts in the *Research Hi-lites* pamphlet from the Station.

> Carefully documented research has shown that most native grasses, like Twiggy, just don't stack up(...)The introduced species are generally better adapted than native species in reseeding programs. Their seed flows more easily through a drill, they tend to be more easily established, produce more, and can be grazed at heavier rates. Introduced species also respond better to fertilizers and are better seed producers…Long term grazing studies have shown that we can realize about 20 kg/ha [20 kilograms per hectare] of liveweight gain from a well-managed native grass pasture, whereas studies with cultivated forage crops indicate that we can realize about 100 to 150 kg/ha of liveweight

> gain(…)The native grasses are not as good as some people claim them to be. Their supposed virtues do not stand up to close scrutiny. Their usefulness is very limited and questionable at best (Lawrence, 1979, pp. 39, 40, 41).

I would argue that Lawrence is missing the point of Clark and Budd's suggestions from above. Rather than studying native plants as a community to learn about the desert, Lawrence tests them in highly-controlled cultivated field conditions. His explanation does not tell us much about the native plants or the environment in which they grow. It does tell us a lot about the environment where he tested the plants and his assessment criteria for categorizing plants as useful or not useful.

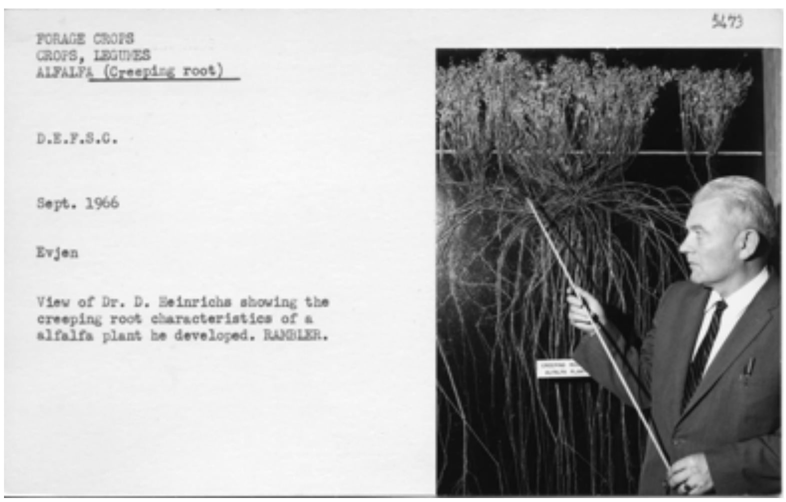

Figure 86. The Rambler. Note the original caption. Heinrichs with an exhibit of Rambler alfalfa. Photo from SCRDC archives.

In my interview with Jack, he mentioned that the debate over the value of native v. non-native species continues today. For Jack and the other forage scientist at the Station, they have settled into a research program that incorporates both native and non-native plants in foraged fields to see how they work together. That being said, I can confidently speculate where Jack's heart lies in this debate. Jack is one of two remaining native Prairie specialists within the AAFC research network. He works on restoring and preserving what remains of the native Prairie including the Suffield National Wildlife Area and Grasslands National Park. He also works on projects to develop native plants such as purple prairie clover for livestock use—I return to this topic in later sections of this chapter. Over the years, Jack has provided advice to farmers and managers of community pastures who plan to reseed their grazing areas. He usually advises a mix of native species but explained, "You can't recreate the complexity of that system. You can't reseed the 300 species that might be on that site if it were native Prairie. So one of my research questions, that we're always trying to address is which of the 300 are key components in the mix" (Jack M., October 2, 2014). Jack explained that this research question is ongoing because the complexity of the grasslands ecosystem does not lend itself readily to obvious reductions. He added that in a semi-arid environment, years of research data are required before any results become clear. As he described his work in the Grasslands National Park, Jack said something that is significant to my question of categorizing Palliser's Triangle as a desert.

> There are a number of shall we say parties involved in the Grasslands. There are those that recognize it as having value and then there are those that still view it as, not necessarily wasteland, but under-utilized or unused. You know like provincial and federal governments when they do their statistics, range or native prairie is not an actual component. It falls under 'unimproved land.' And the question is well why is it 'unimproved?' If you look at soil carbon and things of that nature, what you're trying to do with a lot of your annual cropping is get it back to the condition it was, under native Prairie. So you've already got the best and now you're trying to get back to there. So why is this land unimproved? It's unimproved because it's that focus on annual crop production. You need to sell the wheat. You need to sell the canola or whatever it is and there's a lack of recognition of what perennial crop production provides (Jack M., October 2, 2014).

The federal and provincial governments categorize grasslands as "unimproved." Whereas the improved land includes all the fields that scientists at the Station have worked on for years to restore the surface stability, soil structure, nutrient content, organic matter, and moisture retention—all the attributes that characterize the native Prairie. By placing Palliser's Triangle within the category of desert, Captain Palliser branded the region "unimproved" in the eyes of land developers, politicians, homesteaders, "blowhard" dryland experts (Jones, 2002), and researchers at the Station. Unimproved lands needed to be brought into the grid to make them productive. Dr. Palmer drew inspiration from the native Prairie to guide his work on preserving a trash cover on the surface. Based on my research, he did not look carefully at the species of Prairie plants that constitute communities and he did not consider how these plants collectively stabilized the surface. Dr. Palmer undoubtedly helped stabilize the unruly soils of the 1920s and 30s, which eventually supported agricultural communities across the Prairies. Unknowingly, Dr. Palmer and many scientists from the Station set a path in motion that created our zero tillage, high input surfaces. The stability of the whole system is now in question because of herbicide resistant weeds. Perhaps if Dr. Palmer and others had looked more carefully at the native species on unimproved lands, they may have created a different path forward. For example, in 1937, Dr. Clarke gave a seminar presentation titled "The Relationship Between Vegetative Types and Soil Types" in which he said the following about the native prairie:

The living plant materials form a wonderfully efficient anchorage system for the soil, especially the surfaces layer. This living network which holds the soil in place constitutes about 1/10 by weight of the total organic matter in the surface six inches of soil(…)The binding action and other favorable soil conditions were shown very clearly during the recent drought. In little bluestem, the soil was firmly held in place(…)The channels made by roots and rhizomes enabled the soil to absorb water more readily and this decreases run-off and increases the amount of available moisture in the soil (pp. 7-8).

This passage clearly shows that native plant species not only stabilize the surface with their remarkable "anchorage system," but that perhaps they could have been used to inspire a different path forward in terms of containing the desert.

CHAPTER REVIEWS

To answer my primary research questions, I divided this dissertation into seven chapters including the introduction and conclusion. In Chapter One, *An Ethnographic Journey Into*

Palliser's Triangle, I introduced my research project by describing a day combining with a farmer collaborator. Chapter One described how I became interested in dryland farming and what led to my decision to choose the Station and surrounding farm communities for my project. I gave general information about the farmers who participated in my project, including an overview of dryland agriculture in Palliser's Triangle. I also provided a brief introduction to the Station, its founding in 1920, and the research of its scientists as well as a brief history of the region. Chapter Two, *Gridiron Industry in the Desert,* primarily serves as an overview of literature and theory for my dissertation. I provide a definition for what I mean by industrial farming. I argue that the primary characteristic of industrial farming is the production of a handful of capitalist species—plant and/or animal species that have been genetically manipulated by humans in ways that streamline their production for national and international markets. These capitalist species define social arrangements within the landscapes of their production. I highlight other attributes of industrial agriculture including scalability and appropriationism. Chapter Two also delves into a review of work from Stefanik (2015), Henke (2008), and Müller (2008) to describe how agricultural science and extension services are disciplinary institutions within rural communities that shape how farmers engage with their fields and how they define good versus bad farmers. I provide a brief discussion of biopower as it relates to Stefanik's work in Palliser's Triangle. The final sections from Chapter Two outline three primary concepts that guide my entire dissertation. These include the desert, the grid, and surfacing. I connect these concepts to Deleuze and Guattari's (1987) work on capitalist spaces envisioned as entanglements of smooth and striated space. I offer Eckbo's (2002) landscaping tool/concept of surfacing as a means to discuss how farmers engage with their fields to recreate striated space.

Chapter Three *Surfacing the Desert,* reviews the primary homesteading period within Palliser's Triangle from 1908 through the late 1930s. During this period, as homesteaders claimed their place on the grid, they adopted summerfallowing as their primary means for moisture conservation and the dust mulching technique to maintain their summerfallow rotations (Campbell, 1971; Kilcher, 1985). Through these practices, they created perfectly smooth, weed free surfaces within their fields. The combination of dust mulching during summerfallow rotations is called black fallow and with surfaces in this condition, fields become highly vulnerable to wind erosion. This chapter described how soil erosion threatened to erase the cadastral grid in the 1920s and 1930s as dust storms smoothed over fence lines, fields, and roads within Palliser's Triangle. In desperation, many settlers fled the Prairies to escape lives of starvation and impoverishment (Jones, 2002; McManus, 2011). The Dominion Government responded to the national crisis by establishing the Station in 1920, the Prairie Farm Rehabilitation Administration in 1935, and the Soil Research Laboratory in 1936. These institutions worked to stabilize badly eroded areas to contain the mass movement of people out of the Prairies. They also initiated research projects that studied soil erosion and concluded that the preservation of crop stubble on the surface was the only way to permanently stabilize annual crop fields. The suite of farm practices that preserve crop stubble are called trash farming (Palmer et al., 1946). In this chapter, we saw how the discourse on what constituted good farming shifted from creating surfaces of black fallow to preserving trash on the surface. To attain the status of good farmer, settlers had to remake the surfaces of their fields to keep up with the evolving expert advice.

Chapter Four, *Cracks on the Surface*, picks up where Chapter Three left off as the Station initiates its herbicide testing in the 1940s. Station researchers tested herbicides for many years to assess if chemical weed control could completely replace mechanical control methods, which would help prevent soil erosion by preserving more crop stubble on the surface. In the 1970s and 1980s, federal and provincial governments and the University of Saskatchewan began encouraging the replacement of summerfallow rotations with continuous cropping. This chapter delves into the Sparrow Report of 1984 to show how farmers were guilted into adopting conservation tillage and continuous cropping through a public campaign that capitalized on their fears of the creeping desert. These campaigns, led by the Station, the PFRA, and private agrochemical businesses, eventually led to an almost 100% adoption rate of conservation tillage systems. During this period, private agrochemical companies began forming close relationships with the Station and with farmers as they promoted their products as tools for conservation. This chapter briefly describes a shift in the funding structure at the Station that took place in the late 1990s and early 2000s. During this period, the Station moved from all A-base funding to grant-based funding, which ultimately made scientists more dependent on the clusters to support their projects. I listed many ways grant-based funding has influenced the work of the Station scientists, including: the elimination of long-term research, inputs required in the experimental protocol, and a focus on deliverables such as plastic wheat. I also included a couple of examples of how grant-based funding is withdrawn if the projects Station scientists to not align with the interests of industry. To conclude the chapter, I outlined three key issues that jeopardize the future of herbicide-dependent, zero-tillage systems. These include health risks associated with glyphosate and consumer fears of herbicide residues, crop diseases correlated with glyphosate use including fusarium head blight, and herbicide resistant weeds.

Chapter Five, *The Soil Test,* explored fertilizer use as another major component of farming practices within Palliser's Triangle. To provide historical context, the chapter began with the work of Justus von Liebig, the father of agricultural chemistry, who established the law of minimum for soil nutrient analysis (Doughty, 1937). Liebig generated a calculable soil through his work, which established a foundation for soil nutrient testing to grow. I explored the ways he influenced the work of the Station scientists as they tested fertilizers beginning in 1926. Although they recorded inconsistent monetary returns from fertilizer in their trials for several decades, by the 1960s, *Weekly Letters* from the Station recommended soil testing to farmers. Soil testing services began in the public sector, primarily after the University of Saskatchewan opened the Soil Testing Laboratory in 1966 (Saskatchewan Soil Testing Laboratory, 1971). However, by the 1980s, private industry testing became common throughout Palliser's Triangle. In the second half of the chapter, I discussed the role of private agrologists in farming communities. As the Station and provincial government cut back extension services in the 1990s and early 2000s, P.Ag.s took on the role as the primary advisors for farmers. The work of P.Ag.s began with soil testing services but has since evolved into full consulting services. These services appropriate the work of decision making from farmers, as P.Ag.s increasingly assume management roles on farms. For this chapter, I provided ethnographic descriptions of the work of three P.Ag.s from the Swift Current area to demonstrate the variety of approaches they take in their roles as farm advisors. I concluded the chapter with a couple of examples of new types of soil testing that challenge Liebig's approach to soil nutrients. These forms of testing include biological as well as chemical screenings because the scientists who developed the tests classify soil as a living ecosystem (Haney et al., 2018; Arnason, 2014). This vision of soil clearly challenges the stark division between Life and non-Life and thus, it challenges the foundation of geontopower in Palliser's Triangle that is maintained through the soil test.

In Chapter Six, *The Game of Risk and Scale,* I follow the story of Brandon and Diane W. who sold their large farm near Stewart Valley to the Whopper farmer south of Swift Current. I use this ethnographic account to highlight key issues in land consolidation on the Prairies. The scalability of dryland grain farming has led to large farms taking control of significant portions of agricultural land in Saskatchewan. Within this type of production, a farm manager oversees an unskilled, and mostly non-Canadian, workforce as they seed entire sections of land as a single crop. In this chapter, I discussed the possibility of robotic machinery eventually replacing the unskilled labour force that currently keeps large farms operational. As whopper farms around Saskatchewan buy more land, they erase all signs of the families who used to live on the grid. Thus, we are starting to see a smoothing of the grid. In contrast to the model of land consolidation, I provided a brief description of organic farmers from my project and how they manage to survive in the game of risk and scale while staying relatively small. To conclude this chapter, I explained the origin of Karen and Stanley's potluck dinners, which began after their neighbors mostly sold their farms and moved away. They started hosting the dinners as a way to socialize within the continually emptying grid.

SMOOTH DESERT, STRIATED GRID, AND THE DETERRITORIALIZED PRAIRIES

In Chapter Two, I looked at Deleuze and Guattari's (1987) concepts of smooth and striated spaces to help frame my research about agriculture in the Prairies. As mentioned in that earlier discussion, capitalist spaces are entanglements of both smooth and striated space. Tynan says "Capitalist power, especially in its contemporary imperialist forms, *exceeds* [emphasis original] the striated spaces of the state, even if it ultimately depends upon these…It is not a question, then, of a simple opposition between smooth and striated but of a worldwide production of smooth space that state power must find ways to manage (2020, pp. 74, 75)."

Through its operation in local, striated spaces, capitalism is ultimately a smoothing force on Earth as it deterritorializes natural resources, people, commodities, capital, etc. through globalized networks. In the context of Palliser's Triangle, we can see this entanglement of smooth and striated space. The grid of the Dominion Survey striated the Prairies to create a comprehensive inventory of its newly acquired assets as well as establish addresses—land locations—that exist independently of those who occupy them (Seigert and Winthrop-Young, 2015; Bantjes 2005). Settlers, and their relatives that succeeded them, created physical manifestations of the invisible grid lines with their fields, farmyards, roads, and fences. The smoothing forces of the desert threatened to erase these physical manifestations, so public agricultural science initiated a new phase in farming to contain drifting soils to ensure farmers would remain in the Prairies (See *Figure 87).* They wanted to make sure families would continue living and caring for their physical manifestations of the grid. Here, we see an obvious example of how smooth and striated spaces co-exist. A less obvious example comes as we think about how the grid enabled scalability in grain production that has resulted in land concentration. Although the foundation of land concentration is still the grid—conquering more and more squares on the RM map—a smoothing of the grid inevitably results with concentration. Large-scale farmers such as Brandon W., remove many of the physical manifestations of the grid that settlers and their ancestors worked so hard to maintain. In the previous chapter, we heard about Brandon's removal of houses, fences, trees, and farmyard buildings to the point where one can no longer see any trace of the former occupants. Ronald H., another large-scale farmer south of Wymark, discussed in our interview how he seeds entire sections of land to the same crop. Before purchasing his 76-foot airseeder implement, his sprayer with 120-foot boom span, and his 45-foot combine header, he divided full sections of land into quarters to seed each quarter to a different crop. This old system no longer works logistically, both in terms of his equipment size and timing constraints, so he seeds entire sections with the same crop and fertilizer to increase the efficiency of his farm. What used to be a patchwork of small fields and crops, is now a massive field with one crop. Thus, we have a smoothing of the localized grid in the process of manifesting a larger-scale grid. I want to explore this idea further through a more detailed discussion of the factors that contribute to this process of smoothing the striated grid.

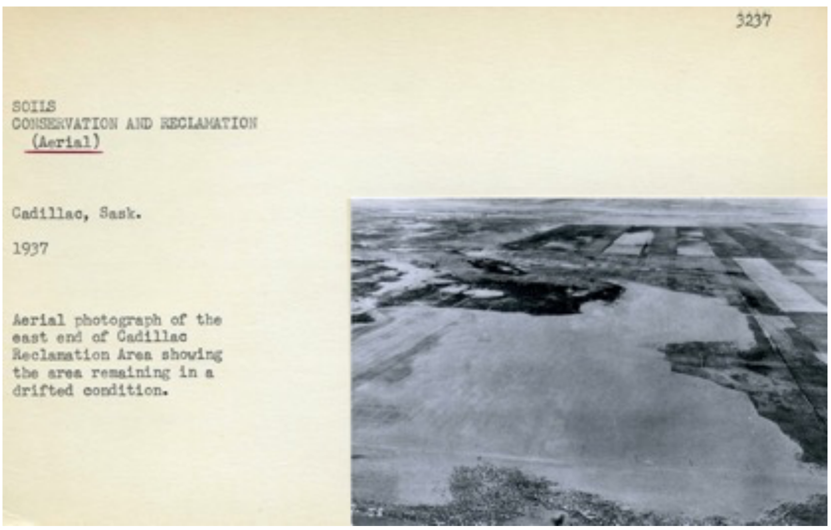

Figure 87. A Smooth Grid. Pictured above is an aerial photo that clearly shows how the desert smooths the grid—note the original caption. Photo from SCRDC archives.

The grid in Palliser's Triangle enabled scalability as Tsing (2012) defines it. "The ability to expand—expand, and expand—without rethinking basic elements(…)scalability projects banish meaningful diversity, which is to say diversity that might change things" (pp. 505-507). The grid, enables farmers to continually expand their operations without changing the basic elements involved in their farming. Machinery such as air seeders, combines, and sprayers gets bigger and wider—creating thicker passes on the field— but the mechanics of the machines have not significantly changed in the past ten to twenty years, aside from their sophisticated computers (Rick J., September 17, 2015). The computerized operating systems of these mammoth pieces of machinery follow a grid pattern, capable of complete self-guidance. The grid organizes a vast system of data collection: yield rate, soil nutrient levels, crop rotation, topography, soil type, soil moisture levels, weed and pest thresholds,[69] satellite imagery, localized climatic conditions, soil salinity, and so on. This data can be cataloged for a field through time. This catalog of data can be analyzed to create a course of action on the field—such as placing pounds of seed and fertilizer per acre—that can be uploaded to the computer systems in machinery to automatically carry out this course of action with a few button clicks from the farmer. All of these advancements in computer technology, data collection, and data analysis have lessened the need for skilled agricultural labour. Unskilled labour, including individuals such as myself, can be trained to operate combines and tractors within a period of days. In my own experience, both during ethnographic fieldwork and since moving onto a farm with my partner, I was able to operate a combine after a couple of short training sessions. In my first year of living on the land that my partner and I own, I combined two quarter-section fields on my own. Of course I still needed assistance when I experienced a mechanical failure with our combine header, so computerized systems cannot solve every problem.

Capitalist species also enable scalability in grain production in Palliser's Triangle. For farmers like John A. the process of seeding 1,000 acres of wheat does not change when he moves up to 5,000 acres of wheat. It might require bigger machinery, higher input costs, more human labour, and more grain bins and trucks, but the actual process does not change. His technique for seeding 1,000 acres does not change for 5,000 acres. Capitalist species, as nonsoels, enable this expansion because in the case of wheat, it is designed to flourish in the highly manipulated

69 Economic thresholds are often used in weed and pest management. The following quote is about weeds but can also be applied to insects, fungal infestations, and other pest/disease issues in crops. "An economic threshold for weed control, or the 'break-even point' is the level of weed infestation at which the cost of controlling weeds is equal to the increase in crop value obtained as a result of controlling the weeds. When weed pressure is above the economic threshold, controlling weeds will result in higher net returns. When weed pressure is below the economic threshold, controlling weeds will result in lower net returns" (Agriculture and Agri-Food Canada, n.d.).

environment of fertilizers, herbicides, and pesticides— all elements that can be controlled by humans. It is not designed to socialize with localized landscape elements such as soil microorganisms, which works to the advantage of large-scale farmers because they can depend on predictable results if they recreate specific conditions for wheat. Of course, rainfall and hail always make the outcome of any growing season somewhat unpredictable, which is why companies like John Deere are offering full consulting packages, in which they set up weather stations to collect data on a specific field to help mitigate the unpredictability of rainfall. Data catalogues for specific fields also mitigate unpredictability by analyzing soil moisture levels and recorded rainfall to assess the productive potential of any given field and therefore, assess the risk of adding fertilizer that may not increase yield if moisture levels are low for multiple years.

Private consulting companies collect and manage data for farmers. As we saw in Chapter Two, they offer farmers incentives in exchange for more access to data. When chemical farmer John A. purchased his new combine, John Deere—the combine manufacturer—offered him an extended warranty if he allowed them to automatically access the data collection system within his combine's computer system. If John had agreed, the company would have remotely collected real time information on his combine's performance as well as crop yield data. In all of my discussions and interviews with P.Ag.s I never asked important questions about the data they collected on farmers and fields. Who has access to this data? Who owns this data? What happens to it when a farmer is no longer your client or no longer farming? I didn't think to ask these questions until after my fieldwork as I began to analyze my own data. These questions are important for multiple reasons, especially when we think about how the grid creates addresses—land locations—that exist independently of the farmers. If a section of land is sold to another farmer, can the new owner and/or their P.Ag. access the data collected during the previous owners' tenure? As we saw in Chapter Five, P.Ag.s already appropriate on-farm decision making through their consulting services, which rely on the collection of field data. Large-scale farmers offload many decisions onto P.Ag.s because they do not have enough time, or perhaps the expertise, to scout their own fields and research treatments for specific issues. When we think about the role of P.Ag.s, the computerized machinery, the data collection systems, and the use of unskilled labour, it becomes increasingly difficult to figure out what role the farmer plays in this system. Brandon W. became a manager when he farmed 20,000 acres. He managed the work of deputy managers who oversaw specific aspects of the farm such as logistics, marketing, and agrology. With this example, it becomes easier to envision a future for farming that is deterritorialized to the point that local people and their expertise are no longer necessary to the production of food on the Prairies.

As we learned in the previous chapter from Brian C., the data solutions manager for the John Deere dealership in Swift Current, the technology required for unmanned—robotized—agricultural equipment has already been developed by John Deere and is already incorporated within many machines owned by local farmers. Brian said that the liability issues of robotic machinery is the main reason that it has not been deployed within Palliser's Triangle, and I assume worldwide. Brian defined the liability issues as those arising when robotic machinery damages personal property or endangers human lives. Obviously, this is a complex legal issue; however, the likelihood of damage or injuries becomes far less as the grid is smoothed over. As fewer people live on farmyards and many yards are wiped clean by large-scale operators like Brandon W., the issue of liability becomes less pressing for companies like John Deere and for the individuals who own the robotic machinery. As more Prairie farmyards and fences are smoothed over, one can imagine a future in which the grid roads are also smoothed over. With less need for maintained roads to provide access to farmyards and smaller, segmented fields, the land reserved for roads and parallel ditches on both sides might become incorporated into massive monocrop fields. This might all seem far-fetched, but I personally witnessed the destruction of established shelterbelts—created with trees and shrubs—to make way for large machinery (See *Figure 88).* Since the early 20th century, shelterbelts in Palliser's Triangle were considered a necessity for life on the Prairies (Kulshreshtna and Kort, 2008; Gray, 1967). A tree nursery was established in Indian Head, Saskatchewan in 1901 and by the 1930s, the PFRA included the establishment of shelterbelts as part of the emergency relief efforts. Between 1901 and 2002, 576 million tree seedings from the Indian Head nursery were distributed to farmers throughout the province. Tree seedlings were used to establish shelterbelts alongside fields and roads to protect these elements from the wind and drifting soil. Trees were also planted around farmyards to provide protection and improve the quality of life by providing a barrier between farm homes and the "bald prairie" (Jacobson, 1939). On several occasions while living in Wymark and traveling around Palliser's Triangle, I observed the remnants of shelterbelts—torn up by their roots and pushed into large piles, awaiting the time when their owner deemed it safe to burn them. Shelterbelts manifested the grid as most of those remaining that I observed, extended alongside roads and fields. Knowing firsthand how difficult it can be to establish trees in semi-arid conditions, I was always shocked to see these piles of trees. It helped me visualize the Prairies as a non-gridded space or a space where the individual squares of the grid are so massive that they no longer feel like an integral part of day-to-day life. In this scenario, robotic machinery has taken over from human guided machinery. As I mentioned in Chapter One with my story of the black blizzard, the desert continues to deterritorialize the grid as a smoothing force, although surfacing has contained this process to local events. The smoothing force that feels more significant at this moment is land concentration bundled with data-centric farming and robotic machinery. Perhaps it feels more significant because many farmers accept land concentration and rural abandonment as inevitable. The desert, especially in the 1930s and again in the 1980s, was conceptualized as something to be conquered through management strategies carried out by farmers with the assistance of public extension and agricultural science. This new form of deterritorialization is conceptualized by private agribusinesses as technological progress. There are those within Palliser's Triangle who envision a different future for the Prairies. I have alluded to their work throughout the dissertation and I want to conclude with a brief description of this research, perhaps because as a small-scale farmer with much larger neighbors in all directions from my home in Palliser's Triangle, I want to hope for a different future. In this future, we can envision a reterritorializing of the grid, but perhaps in ways that are based on the appreciation of the desert and all the organisms who flourish in semi-arid conditions.

Figure 88. Removing the Shelterbelt. Pictured above is an example of tree and shelterbelt removal in Palliser's Triangle. Photo by Katherine Strand

RETHINKING THE GRID AND THE DESERT

As mentioned above, by placing southwest Saskatchewan in the desert category, Captain Palliser defined it as a region of marginal value to the Dominion Government's dream of transforming all of its newly acquired Prairie regions into the nation's breadbasket (Jones, 2002). Prior to 1908, the region was excluded from any major homesteading events because cattle barons controlled grazing leases on vast acreages. This all changed with Frank Oliver and dryland farming experts such as Campbell, MacKay, and Motherwell (McManus, 2011). They still categorized the region as a desert but claimed to have enough expertise to conquer this desert. In the 1920s and 30s, the desert became a threatening force for the lives of settlers and scientists from the Station and the PFRA shifted the discourse to one of containment in the desert. As mentioned in Chapter One, this goal of containment and permanence was the Station's line-leader. This discourse of the desert as a creeping threat, in need of containment, guided the research agenda at the Station from its establishment in 1920 until the late 1990s and early 2000s. By this time, most farmers in the region had adopted zero tillage farming. The desert was finally contained under a thick mat of crop stubble. I would argue that the desert is still the line-leader for some scientists at the Station, and it is through their work that we might get closer to understanding the semi-arid ecosystem of Palliser's Triangle.

Seeking Microbial Friends for the Future

Early research in soil microbiology began in the 1950s at the Station and by the 1960s, two microbiologists joined the research staff. Prior to the 1950s,[70] the scientists were likely aware of the importance of microorganisms in the soil but without a microbiologist on their team, this area of research did not develop until the 1960s. Dr. Purna Chandra was hired in 1961.

70 In the October 23, 1937 edition of *Weekly Letters,* an unnamed author wrote "Soil Micro-organisms." On February 11, 1952, F.D. Cook gave a seminar paper at the Station titled "Salient Points of Soil Bacteriology," in which he cited the work of Louis Pasteur and called soil an "intact enzyme system" (p. 3).

In 1963 he wrote an edition of *Weekly Letters* titled "Life in the Soil," in which he wrote:

> The soil we see in the fields is not just a mass of dirt but is the abode of teeming millions of microorganisms. The majority of them are not visible to the naked eye. Soil would be dead and inert mass if it was not for these myriads of tiny creatures. They have a great impact on our agricultural economy. Most of this microscopic life in the soil consists of bacteria, fungi (mold), actinomycetes, protozoa, and algae. In spite of their minute size, they weight three to five thousand pounds per acre in the top six inches of soil…The bacteria known as Azotobacter and Clostridium sp. help to make atmospheric nitrogen available to the plants. Our atmosphere is very rich in nitrogen but this nitrogen is not of use to plants without the help of these bacteria. Another kind of nitrogen fixing bacteria lives in association with the root nodules of legumes [e.g. peas and lentils] and may fix as much as 60 to 250 pounds of nitrogen per acre annually. It would cost millions of dollars to buy the nitrogen fixed by these bacteria annually in the cultivated soils of Canada…These microbes play an important role in controlling the soil fertility that makes possible our food, clothing, shelter and the ultimate *destiny of mankind* [emphasis added] (p.1).

The Station hired Dr. Bix Biederbeck in 1968 and in 1969, he released an edition of *Weekly Letters* titled "Soil Microorganisms and Soil Fertility," in which he wrote:

> Soil shelters more life than can be found in any other environment on Earth, but the majority of the soil organisms are too small to be seen by the naked eye and special techniques are required to reveal their abundance and variety. There are usually more microorganisms in a handful of Prairie soil than there are people living in this world (p. 1).

Biederbeck's work through the 1980s and '90s turned to assessing the impact of tillage practices and inputs such as 2,4-D on the soil microbiome (1983). Through this work, he reported that herbicides and fertilizers undoubtedly impact microorganism but always within acceptable limits or "normal rates" (Biederbeck et al., 1984; Campbell et al., 1991). Dr. Camille B. was hired in 2003 to replace Biederbeck when he retired. Her work expanded the microbiology research at the Station and, in my opinion, holds interesting possibilities for the future of farming within the Prairies. I turn now to my interview with her.

In preparation for my interview with Camille., I read through the fragmented articles of her blog abandoned in 2012, *Reflexions on Life, Humans, and Microorganisms,* and attempted to comb through her many scientific publications listed on the Station website. I found the blog particularly interesting because it very much left with me an impression of someone who believed microorganisms will change the world. I felt slightly nervous for our interview because I knew I was meeting a research powerhouse; however, my nervousness quickly subsided as Camille graciously welcomed me at her office door with a wobbly, soft-spoken Quebecois accent and wide smile.

Arbuscular mycorrhizal fungi (AMF) led Dr. Camille B. down a path that began in Quebec but moved to the open Prairies and dryland farms of Saskatchewan. Camille focused both her research and PhD on AMF because, as she explains, "we know almost nothing" about soil microbiology and these microorganisms in particular. This is despite the fact that the entire evolution of plants from being strictly oceanic species into terrestrial organisms occurred only because plants formed relationships with mycorrhizal fungi. This 400 million-year long symbiosis allowed early rootless plants to access nutrients from the rocky substrate that formed Earth's crust before soil had developed in the way we understand it today (Hamel and Plenchette, 2007). What we know about this process today is that plants offer energy in the form of carbon from photosynthesis in exchange for "services provided by many organisms, including AMF" (Camille B., October 16, 2014). AMF and other microorganisms cannot survive without the carbon provided by plants. In exchange, AMF form large hyphal networks which are thread-like structures within the rhizosphere, that increase soil accessibility. Through these networks, AMF "channel plant available nutrients, especially, phosphorus, into the roots, which then download it into the vascular system of the plant."

Throughout the interview, Camille remained perched on the edge of her office chair, as if unable to fully contain her energy when discussing AMF, plant symbiosis, and the future of agriculture. When I asked her who she considers her primary audience for her research projects, Camille answered with the following response:

> Me, I think I'm working for the planet actually (laughs). I'm not modest. I want to save the world. So to me the microorganisms in the soil are very important and the AMF in particular because of the association with the plant. Because you know if you think about it, these plants, these crops that we have, if you don't take care of them so, so painfully then they are nothing. While other plants beside in the roadside ditches and pasture, they do just fine on their own. Okay so what's the problem with these agricultural crops? We have played with them a little bit so they will produce more seeds, larger seeds, but there is a big, big part of the story missing in that they aren't adapted to the biological environment. So if we could have crops that work well with the soil biology then maybe we could use less fertilizer and as a result produce less greenhouse gases (October 16, 2014).

As she mentions, part of Camille's research compares soil samples taken from roadside ditches, pasture land, cropped fields that are both organic and chemical/cultivated, as well as reduced tillage, and native prairie, primarily within Grasslands National Park, to assess the biodiversity of microorganisms. She has been finding significant differences between those soil samples, even when they are taken just a few meters apart. There is no doubt that everything taking place on the surface affects communities at the root zone and perhaps even deeper. Camille gave a few examples including how applications of glyphosate, the active ingredient in Roundup, increases the prevalence of Glomus mosseae, a type of AMF that is now found in almost all agricultural soil. Tillage dramatically alters biodiversity because it disrupts the hyphal networks these fungi worked hard to construct, which in turn disrupts the relationship with plants and soil structure. Finally, she discussed crop fertilization, explaining, "so to increase your yield you add more phosphorus(…)but very little of what you add is going to the plant. It's going to be fixed in the soil because as you add more phosphorus, more phosphorus, the microorganisms that accumulate phosphorus and hold it, well now there are more of them (laugh)" (October 16, 2014). In general, the addition of fertilizers results in less symbiosis between plants and microorganisms because when plants have access to abundant nutrients, they have less need to "seek microbial partners to help them retrieve resources." Camille explained that these changes happen very quickly, with scientists observing differences in microbial communities even after a rain. What they are less certain about, however, is the importance of these changes to long-term biodiversity.

For Camille, there are endless possibilities in terms of how AMF research could be used to improve agriculture worldwide. She is involved with colleagues from the Station's wheat breeding program to investigate how new cultivars could be developed which possess strong biological adaptation to their microbial environment. To encourage this biological adaptation, early stages of cultivar selection must be taken out of the greenhouse, with plants grown in a synthetic medium with ample nutrients, and moved into the local community of microorganisms within actual fields. This would shift the focus from producing new wheat breeds with positive response to high synthetic fertilizer to producing breeds that succeed within the "complex soil communities of symbiotic partners and pathogens" (October 16, 2014). Camille is also investigating the possibility of developing AMF inoculants,[71] which are soil inputs that artificially introduce, or increase the prevalence of, certain types of fungi into agricultural fields to create symbiosis with the crop. Inoculants are developed to unite a particular crop (e.g. soft white wheat or chickpeas) with a specific type of AMF to assist the plant, such as with

71 Soil inoculants are not new to agriculture. Products such as Nodulator or Tag Team were commonly used amongst the farmers who participated in this research. These products are typically mixed with the seed prior to placement in the tank for seeding. They contain the bacterial strain *Rhizobium leguminosarum,* which forms a symbiotic relationship with pulse crops (i.e. lentils) to produce nodules on the roots, which then transform atmospheric nitrogen (N_2) into ammonia nitrogen (a form of N that plants can use). Farmers do not typically use nitrogen fertilizer on their lentil or pea crops because this symbiosis between plant and bacteria provides plenty of N for the growing crop and usually leaves some behind for the next rotation.

phosphorus availability, without the addition of other inputs like fertilizers or pesticides. As she explains, plants are always “actively seeking microbial friends,” so she hopes to focus on researching agricultural practices that promote those friendships, as well as create new friendships through the development of inoculants.

As Camille pursues these new areas of research, which could potentially reduce our reliance on things like fertilizers and pesticides, her greatest challenge comes as these fungi resist traditional methods of scientific study. To begin with, they do not fall under species level category under Linnaean Taxonomy. As Camille explains, “These fungi are complicated (laughs). Fungi are not like humans. They are just pipes that grow. Pipes that grow and they fuse too, and they don’t have real cells these ones. They just have pipes and the cell nuclei are floating, so you can have nuclei here and here (makes hand gestures). And then they may fuse and you get some new assortment of nuclei” (October 16, 2014). Also, unlike other types of microorganisms (e.g. many types of bacteria), AMF cannot be grown in a pure laboratory culture. This means that they cannot be separated from their companion plants or roots for research purposes, which results in challenges when trying to understand growth variability and taxonomy. For most AMF, Camille uses Operational Taxonomic Units (OTUs) to group fungi with similar spores and DNA sequences. Since Camille arrived at Station in 2003, DNA sequencing technology has both improved in quality, and decreased in cost from $12,000 per plate of sequencing in 2007, to $1,600 per plate. By extracting and sequencing the nucleic acid from rhizosphere soil samples, Camille is able to use new software to compare her samples with databases such as Genbank and IMG. The combination of being able to utilize this new software for comparison with access to huge genetic databases allows her to sort through the overwhelming amounts of data generated by a single soil sample, and ultimately classify AMF with more precision. Future work in the area of AMF gene sequencing may allow scientists to link specific genes with particular symbiotic functions. For Camille, this "last frontier" of soil microbiology could affect the way scientists breed new crop varieties and produce AMF inoculants. It also paves the way for genetic engineering, in both AMF and plants, to "open additional pathways for symbiosis."

I was surprised at the conclusion of our interview to hear that Camille would be leaving the Station in the next month and returning to Quebec to be near her family. She explained that her work would be transferred to a sister AAFC research station in Quebec City, and had no fears that the move would affect her projects on Prairie AMF. The final ten minutes of our interview turned to climate change, with Camille expressing her fear for the future and confidence that her expertise is needed now more than ever. As she explained in an interview for the Saskatchewan Institute of Agrologists, "We must innovate. The nitrogen in synthetic fertilizers is derived from expensive processes. Reserves of phosphorus are measured in decades; the mines will be empty someday(…)the nitrogen derived from microorganisms does not cost anything(…)It remains to convince industry to invest in this type of research" (SIA Interview, n.d.). The issue of industry support is also a problem for Dr. Jack M. and Dr. Aidan G., two forage scientists at the Station, in their work on native plants and their potential in forage pastures. I want to turn now to a brief discussion of their research on Dalea purpurea, commonly known as purple prairie clover.

Purple Prairie Clover

In 2000, Aidan G. and Jack M. began a project investigating the potential of native plant species for reintroduction into annually cropped fields. As Aidan explained, in the late 1990s and early 2000s, farmers in Palliser's Triangle were struggling, yet again, with drought conditions that made it difficult to sustain annual crops (November 6, 2015). AAFC began investing in projects that focused on native plant species that could be reintroduced to the Prairies in an effort to take fields on "marginal land" out of annual crop production permanently. Aidan and Jack began research on purple prairie clover (See *Figure 89)* and that work has continued through the support of A-base funding and grants awarded by the Beef Cluster because this native forb "is an incredible plant" (Aidan G., November 6, 2015).

Figure 89. Purple Prairie Clover. Photo from prairiepollinator.ca (accessed February 10, 2021).

Purple prairie clover (PPC) is incredible for many reasons. To begin, it evolved to survive in the short grass prairie of Palliser's Triangle, so PPC can flourish on lands considered marginal for annual crop production (Aidan G., November 6, 2015). PPC is a perennial legume, which means that it forms relationship with nitrogen-fixing bacteria that colonize its roots to create nodules. Thus, in addition to surviving in short grass prairies, it also restores the soils of these ecosystems by continually adding nitrogen. PPC attracts pollinators including bees and butterflies and is grazed by many types of animals and birds, thus making it an important community member for Prairie ecosystems. Jack and Aidan's work is supported by the Beef Cluster because PPC is also a species with a lot of potential for livestock grazing. In separate interviews, Jack and Aidan both discussed the "condensed tannins" of PPC and their role in reducing methane emissions in cattle. Aidan described condensed tannins as "polyphenols, like a micronutrient with many antioxidant properties. In purple prairie clover, tannins levels are highest in the bright purple flowers and cattle will graze them" (November 6, 2015). When cattle graze PPC, usually mixed with other forages, these condensed tannins reduce bloating. Bloated cattle are a big issue in beef production. As producers rely more on grain feeding, usually in feedlots, to bring cattle up to an ideal butcher weight, they also increase the amount of methane released into the atmosphere as the cattle release the gases causing bloat. Grass-fed cattle release less methane, but there is still room for improvement, which is where PPC comes into the picture. Aidan described PPC as "very high in condensed tannins, making it the complete package" in terms of its potential as a forage crop. However, unlike alfalfa, Aidan argued that PPC, "is not going to be the McDonalds of forages where you can have it all over because it's not going to grow all over. So we're going to have to deal with understanding its best locations to understand its potential in forages" (November 6, 2015). Although the research is ongoing for Aidan and Jack, they both described feeling constrained by their grant-based funding. Communities of native species in experimental paddocks, in mixes with other natives and non-natives, usually persist longer than non-natives even after being grazed heavily. Natives have longevity because they are able to survive the wide climatic fluctuations that characterize Palliser's Triangle.

The longevity of native plant species such as purple prairie clover is also the reason why Aidan and Jack can only get relatively small grants—especially when compared to the cereal breeders— for their work in this area of research. Seed producers, such as BrettYoung Seed & Crop Inputs, do not want to invest in public research that offers only limited profit incentives. Seed producers and distributors propagate seed for annual and perennial crops to sell to farmers.

As Aidan explained, crops like canola and wheat have a high potential for agribusinesses to profit because they need to be reseeded frequently—every year in the case of canola— and require a lot of fertilizer to help them flourish. A species like PPC is just too successful in the semi-arid desert for private agribusinesses to invest large sums, through the clusters, on native plant species. "The industry doesn't want something that will live forever. They want something that will die out, so they can sell the producer more seed. So in some regards we run into a bit of a disconnect there in getting industry money but thinking about the interests of farmers" (Aidan G., November 6, 2015). Aidan and Jack both know the potential that PPC holds, especially in terms of the future of agriculture in Palliser's Triangle, but at this point seed companies will not propagate the seed. Without the private agribusiness network of seed production and distribution, farmers do not have access to purple prairie clover. Although this situation causes tremendous frustration, both Aidan and Jack planned to continue researching native plants. In our interview, Jack said the following:

> With native species there's big opportunities for creativity because you can come up with an ideal that will bring conservation groups, and the livestock groups, and society together and they all say 'oh yeah, this *is* [emphasis original] a good ideal.' And also with native plants, one of the reasons I got into native plants is because there is so little done with them. It allows for that creativity. You can do different things. Whereas with some of these species, where they've got 100 to 200 years' worth of research, well you're limited to much more narrow aspects (October 2, 2014).

Jack and Adian's research takes on more significance when we consider worldwide climate change and the role of grasslands in carbon sequestration. Recent estimates suggest that grasslands can store as much as 180 tonnes of carbon per hectare (Wood, 2020, July 31). As Gord Vaadeland (2019), the Executive Director of the Saskatchewan Chapter of Canadian Parks and Wilderness Society, explains, "It is estimated that soils under native grasslands in western Canada may contain up to 200 tonnes of carbon per hectare within the first metre under fescue prairie, with estimates of perhaps two to three billion tonnes of carbon within the uncultivated grasslands of western Canada." According to Samantha G. and Charlie A., two AAFC employees based in the Regina office mentioned in previous chapters, zero tillage was promoted throughout the 1990s and early 2000s as a carbon mitigation strategy because without tillage it was suggested that soil carbon increases, thus creating carbon sinks. More recently, the possibly of carbon sinks in zero tillage fields is being questioned in part because although plant material increases on the surface, this does not directly translate to more carbon storage in the subsurface particularly in lower levels of the soil profile (Ogle et al., 2019). Additionally, as mentioned in previous chapters, the GHG emissions associated with zero tillage farmers using more herbicides and fertilizers may outweigh any benefit gained with on-field carbon storage (Qualman and the National Farmers Union, 2019). Conserving Canada's existing grasslands, as well as converting annual crop land back to mixtures of native and tame grasslands, holds the most potential in terms of the Prairies helping Canada achieve its long-term climate goals. A study based in California found that although forests store more carbon than grasslands in a stable climate, in an unstable climate—characterized by drought and frequent fires—grasslands prove more resilient (Dass et al., 2018). This is because grasslands sequester most of their carbon underground in their roots and the surrounding soil and for the most part, this is unaffected when fires pass through.

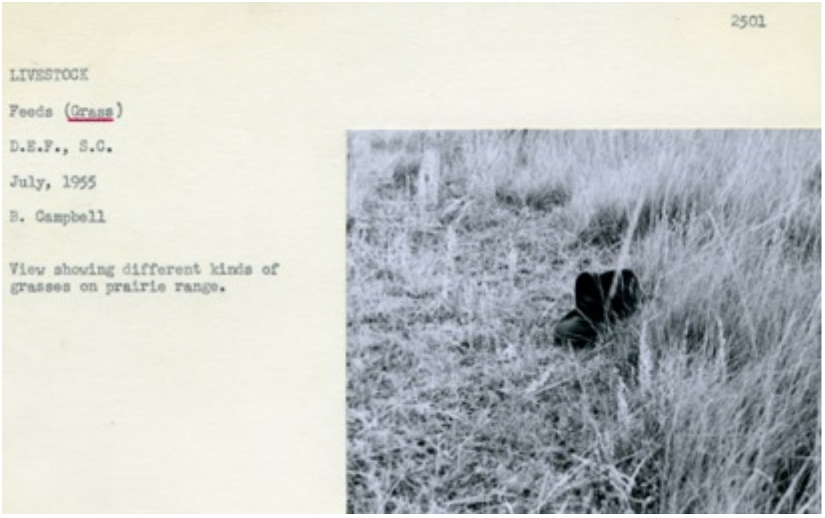

Figure 90. Prairie Grasses. Photo from SCRDC Archives—note original caption.

Figure 91. Grasslands Dweller. This photo was taken in Grasslands National Park in the summer of 2014. Photo by Katherine Strand.

CONCLUSION

In concluding this dissertation, I want to pose a question. What type of agricultural surface would serve the interests of conservation groups, livestock groups, and society? And, what types of entanglements would that surface create? In this dissertation, I have shown how the dominant system of zero tillage high input surfacing has created a social arrangement that gives private agribusinesses a key role in food production. It has also led to a weakened relationship between farmers and the Station scientists in Palliser's Triangle. Through the entanglement of weeds and long-term herbicide use, we now have herbicide resistant weeds. Many of the tools farmers use to maintain zero tillage surfaces may not be available to them for much longer, especially in terms of herbicide weed control. Issues such as this cannot be addressed within the current financial structure of the Station because grant-based funding limits the possibility of many projects, particularly those that conflict with the dominant zero tillage high input model. It also limits the timeframe for research projects to three to four years. This is an issue for the semi-arid climate of southwestern Saskatchewan. Garth K., the microbiology lab technician at the Station, said the following about doing research in the desert:

> We live in the semi-arid prairie, some things take a long time and we have so much variation from year to year. Sometimes it's wet. Sometimes it's dry as well, so when we're talking about things like soil organic matter, which is the kind of thing that's looked upon as good for soil health. It improves water retention, soil tilth, nutrient storage ability, and it provides for a better environment for microorganisms. Well we looked at organic matter levels on different crop rotations and different treatments, it [the trial] went 30 years before some differences were found but the differences were significant(…)Because of our environment, we need a longer-term scale to determine the outcome of any given practice (November 20, 2014).

The 30-year research trial that Garth referred to above is part of the long-term cropping studies that have been carried out within the fields of many branch stations across Canada (Lafond and Harker, 2012). The Station has contributed data to these long-term studies through three projects at the Station that many of the scientists, technicians, and general laborers mentioned during my fieldwork. These three projects include: The Old Rotations—established in 1966, the OMC Rotations—established in 1981, and the New Rotations—established in 1987. For each project, land has been set aside to test specific treatments and rotations and their long-term effect on attributes such as soil organic matter. Each year these plots are seeded, harvested, and data is collected. Hundreds of publications have been based on the data collected through the long-term studies from the branch stations (Campbell et al., 2012). Several scientists mentioned that the long-term rotations may not exist for much longer. Plot space at the Station is valuable and some of their Ottawa supervisors no longer understand why these studies are useful. In order to keep paying for the long-term projects, scientists often have to find creative ways to include them in their grant applications to ensure that funding will be available for the labor and maintenance of the long-term plots. Garth, in the quote above, highlights why this type of long-term research is essential in the desert. Charlie A., from the AAFC office in Regina and former PFRA employee, said something similar in our interview: “True public good research is about governments looking out for future generations. Public good oftentimes can’t be quantified and it requires a long-term approach. When it takes 60 years to recover one inch of the topsoil that was lost in the 1930s, well it’s only the government who has that kind of timeframe” (Charlie A., October 7, 2014). When I asked Dr. Carolyn M., the soil phosphorus scientist at the Station, a question about the role of public research in society, she responded with the following: “Our role is public good research. We are defined by that and defined by long-term public good research because we’re the only people in a position where we can do long-term” (October 9, 2014). Many of the scientists are in agreement about the value of long-term research because, at least in the case of Garth. K, they understand that humans operate at a much different timescale than the ecosystem of Palliser’s Triangle. Meaningful results within experimental trials are not measurable within a three to four year grant cycle and perhaps not measurable within the timeframe that any single researcher spends working at the Station. Native plants and their symbiotic relationships with microorganisms may help us tap into this deeper timescale. It is also important to preserve the archives, the Herbarium, and the long-term rotations. In my opinion, the long-term rotations might be the most at risk because unlike the Herbarium and the archives, these projects cannot be squirrelled away in the Station basement. Dr. Janzen, a current soil scientist at the Lethbridge branch station, says the following about the long-term rotations of AAFC's research network:

> Perhaps the best justification for the establishment and maintenance of long-term sites is that they provide a resource for future scientists posing questions we have not yet anticipated. There was no way of knowing in 1910, for example, that rotation ABC would one day provide information pertinent to the issue of global warming. Indeed, most of the key findings from this site could not have been envisioned at the turn of the century. Future generations of scientists, in addressing the questions that will inevitably arise regarding agricultural sustainability, will cherish the long-term ecological sites they inherit, provided they have been adequately established, documented, and maintained (as cited in Lafond and Harker, 2012, p. 4).

As a researcher and now resident of Palliser's Triangle, I know that we have only begun to understand this desert and our place within it as farmers. The grid has structured our knowledge of and experiences within the desert since the early 20th century. Part of me knows that we need to get beyond the grid to expand our knowledge of Palliser's Triangle. Right now it feels as though we are struggling to see the Prairie for the pastures and fields. This dissertation discussed two smoothing forces that may eventually erase the grid; however, neither one feels like a hopeful future—at least from my perspective as a small-scale farmer. The potential of native plant species in terms of their adaptability and longevity does feel hopeful. Perhaps these plants will help us see a future beyond the grid that is not characterized by containing the desert.

FUTURE RESEARCH

I am interested in exploring three main areas of research that are related to my dissertation project. To begin, although I visited two Hutterite colonies while living in Swift Current and spent time amongst the families in those colonies, I did not feel like that time was enough to include as much ethnographic information about the colonies in this dissertation. In my experience, it takes a long time to develop meaningful relationships with members of a colony. I have realized that fact since moving to the farm with my partner. We live within a few miles of the Fox Valley Colony and only after a couple years of living here have I finally developed friendships with some members of the colony. Hutterites present an interesting paradox in terms of my work. They contribute significantly to land concentration issues, but when you consider that 70 to 150 people live on each colony, this makes the question of consolidation more complicated. For the Hutterite colonies that I've spent time around, their farm management style is very progressive. They use the best technology available for growing grain and raising dairy cattle. Their model also relieves the labour issue that most other large farmers find very challenging. I would be interested in pursuing a project that is only about Hutterite colonies within Palliser's Triangle to expand my existing project.

Secondly, I am interested in exploring the potential for native prairie restoration within Palliser's Triangle. I am somewhat familiar with the work of conservationists in the Grasslands National Park, but I did not get the opportunity to research how these projects are translating onto privately owned farmer land. In coordination with grasslands restoration, I am also interested in bison reintroduction programs and the expanding area of bison production on industrial farms.

Finally, I am interested in returning to the desert of my childhood, the Red Desert, to write a book that I might eventually call Desert Dwellers. For this project, I would conduct an ethnographic study about individuals who either live or work in the desert and fall into one or more of the following categories:: ranchers, oil riggers, uranium miners, conservationists, government workers with the Bureau of Land Management, and Native Americans—including the local Shoshone and Northern Arapaho tribes. The study would focus on how each of the groups use the desert and categorize it in terms of delineating it as a particular place. I would also include a study of other key inhabitants such as: the wild horses, the desert elk herd, the prairie sage chickens, coyotes, the endangered black-footed ferret, and many types of raptors including eagles and hawks. I have an artist and photographer interested in joining me on this project to provide visual representation of the Red Desert and its many inhabitants.

REFERENCES CITED

Primary Sources

Best, K. F. (1967, September 8). *Swift Current Research Station Herbarium* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Beveridge, C. E. (1938, January 10). *Land utilization as it affects relief in Saskatchewan* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Biederbeck, B. (1969, May 16). *Soil microorganisms and soil fertility* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Bolton, J. L. (1937, December 13). *Perennial and biennial forage crop development in the drought area* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Budd, A. C. (1937, March 22). *Our changing weed flora and its effect on agricultural practices* [Seminar paper delivered at Swift Current Experimental Farm. Swift Current Research and Development Centre Archives, Swift Current.

Campbell, C. (1967, February 3). *Soil Organic matter* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Campbell, C. (1971, February 26). *Are fertilizers pollutants?* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Chandra, P. (1963, January 11). *Life in the soil* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Clarke, S. E. (1936, February 10). *Reseeding abandoned farm areas* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Clarke, S. E. (1937, January 18). *The relationship between vegetative types and soil types* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Clarke, S. E. (1938, January 24). *The chemical composition of native forage plants* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Clarke, S. E. (1939, January 11). *Future policy concerning the distribution of grass seed and the type of projects- their application to a planned agriculture* [Seminar paper delivered at

Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Commercial fertilizers for Southwestern Saskatchewan (1953, March 28). [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Cook, F. D. (1952, February 11). *Salient points on soil bacteriology* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1935). *Annual Report for 1935*. Swift Current Research and Development Centre Archives, Swift Current

Dominion Experimental Station Swift Current, Sask. (1937). *Annual Report for 1937*. Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1937). *Discussions of Fertilizer Experiments.* Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1938). *Annual report for 1938*. Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1947). *Annual report for 1938*. Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1947). *Annual report for 1938*. Swift Current Research and Development Centre Archives, Swift Current.

Dominion Experimental Station Swift Current, Sask. (1950). *Annual report for 1938*. Swift Current Research and Development Centre Archives, Swift Current.

Dominion of Canada (1920). *Official report of the debates of the House of Commons of the Dominion of Canada Fourth Session-Thirteenth Parliament.* Swift Current Research and Development Centre Archives, Swift Current.

Doughty, J. L. (1937, December 6). *The development of the fertilizer industry* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Doughty, J. L. (1955, March 15). *Agriculture depends on chemistry* [Seminar paper delivered at Swift Current Experimental Farm]. Archive 100. Swift Current Research and Development Centre Archives, Swift Current.

Ficht, J. P. (1950, January 30). *Public relations* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Ficht, J. P. (1950, February 23). *Third Western Canadian Weed Control Conference, Edmonton, AB 1949* [Seminar paper delivered at Swift Current Experimental Station]. Swift Current Research and Development Centre Archives, Swift Current.

Hansen, R. (1924, February 25). [Correspondence to H. H. Phillips, farmer in Forget, SK]. H. C. Moss Fonds (MG 321). University of Saskatchewan, University Archives and Special Collections.

Harding, W. M. (1937, December 20). *Cultural practices in relation to soil drifting control* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Harding, W. M. (1938, December 12). *Cultural experiments, past results and future experiments to meet a changing agriculture* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Hinman, W. C. (1960, November 18). *Soil tests* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Janzen, P. J. (1936, February 10). *Experiments on badly drifted areas* [Seminar paper delivered at Swift Current Experimental farm]. Swift Current Research and Development Centre Archives, Swift Current.

Looman, J., (1982, September 24. *Why an herbarium* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

McKenzie, R. E. (1949, November 14). *Research programme of the forage plants division* [Seminar paper delivered at Swift Current Experimental farm]. Swift Current Research and Development Centre Archives, Swift Current.

Milne, R. A. (1937, December 20). *Fundamental studies in soil drifting* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Motherwell, W. R. (1910). *Correspondence between W. R. Motherwell and S. Fisher*. Swift Current Research and Development Centre Archives, Swift Current.

Murray, J. A. (1940, January 8). *The Objects and Achievements of the A.I.As* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Read, D. W. L. (1976, July 9). *Yield response of different wheat varieties to fertilizer* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Shirriff, C. (1936, February 3). *Soil drifting control in south western Saskatchewan* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Soil micro-organisms (1937, October 23). [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Soil Research Laboratory Swift Current, Sask. (1937). *Annual report for 1937*. Swift Current Research and Development Centre Archives, Swift Current.

Soil Research Laboratory, Swift Current, Sask. (1939). *Annual report of the Soil Research Laboratory for the year 1939*. Swift Current Research and Development Centre Archives, Swift Current.

Soil Research Laboratory, Swift Current, Sask. (1940). *Annual report of the Soil Research Laboratory for the year 1940*. Swift Current Research and Development Centre Archives, Swift Current.

Soil Research Laboratory, Swift Current, Sask. (1944). *Annual report of the Soil Research Laboratory for the year 1944*. Swift Current Research and Development Centre Archives, Swift Current.

Stalwick, A. E. (1938, January 6). *A comparative study of solonetz and non-solonetz soils of Saskatchewan* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Thomson, L. B. (1936, June 13). *Plowless fallow* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Thomson, L. B. (1938, January 10). *Economics and land utilization* [Seminar paper delivered at Swift Current Experimental Farm]. Swift Current Research and Development Centre Archives, Swift Current.

Warder, F. (1977, October 14). *Why soil test* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Warder, F. (1980, November 21). *Soil fertility research in southwestern Saskatchewan 1938-1980* [Weekly Letters]. Swift Current Research and Development Centre Archives, Swift Current.

Secondary Sources

Abell, H. (1968). Farm families in a changing world. *Farm Families in Transition: Summaries of Papers and Symposia Presented at the 36th Annual Farm and Home Week*, 17–20. Extension Division, The University of Saskatchewan.

Agriculture and Agri-Food Canada. (2016). *An overview of the Canadian Agriculture and Agri-food system 2016*. Government of Canada. https://www.agr.gc.ca/eng/about-our-department/publications/economic-publications/an-overview-of-the-canadian-agriculture-and-agri-food-system-2016/?id=1462288050282

Agriculture and Agri-Food Canada. (2014). *Glyphosate Resistant Kochia*. Agriculture and Agri-Food Canada.

Agriculture and Agri-Food Canada. (n.d.). *Using herbicides for weed control: Economic thresholds*. Weed Management Options Which Reduce Pesticide Risk. https://www.umanitoba.ca/outreach/naturalagriculture/weed/files/herbicide/thresholds_e.htm

Agriculture Canada. (1990). *Best management practices field crop production*. Ministry of Agriculture and Food.

Ahara, M. (2013). The development of agricultural research in Agriculture and Agri-Food Canada. In Y. Martel, J.-M. Deschênes, & N. Corbeil (Eds.), *The Innovators rooted in science: The History of Research Branch 1986-2011* (pp. 15–18). Agriculture and Agri-Food Canada.

Anderson, C. H. (1969). Minimum tillage and chemical fallow. *Work Planning Meeting Soil Drifting*, 34–37.

Anderson, C. H. (1969). Report of "bipyridyl development program." *Work Planning Meeting Soil Drifting*, 37–39.

Anderson, K., & Kuhn, K. (2014). *Cowspiracy: The sustainability secret*. Appian Way, A.U.M. Films, and First Spark Media.

Anzieu, D. (1989). *The skin ego*. Yale University Press.

Archer, S., & Stokes, C. (2000). Stress, disturbance, and change in rangeland ecosystems. In O. Arnalds & S. Archer (Eds.), *Rangeland Desertification* (pp. 17–38). Kluwer Academic.

Arnason, R. (2020, January 29). Kellogg's says pre-harvest glyphosate is not "grrreat." *The Western Producer*. https://www.producer.com/news/kelloggs-says-pre-harvest-glyphosate-is-not-grrreat/

Arnason, R. (2014, August 14). New soil test methods can pay dividends. *The Western Producer*. https://www.producer.com/news/new-soil-test-methods-can-pay-dividends/

Asch, M. (2014). From terra nullius to affirmation: Reconciling Aboriginal rights with the Canadian Constitution. *Canadian Journal of Law and Society*, *17*(2), 23–39.

Ashley, K., Cordell, D., & Mavinic, D. (2011). A brief history of phosphorus: From the philosopher's stone to nutrient recovery and reuse. *Chemosphere*, *84*(6), 737–746.

Awada, L., Gray, R., & Nagy, C. (2016). The benefits and costs of zero tillage RD&E on the Canadian Prairies. *Canadian Journal of Agricultural Economics*, *64*, 417–438.

Awada, L., Lindwall, C. W., & Sonntag, B. (2014). The Development and Adoption of Conservation Tillage Systems on the Canadian Prairies. *International Soil and Water Conservation Research*, *2*(1), 47–65.

Ayres, K. W., Acton, D. F., & Ellis, J. G. (1985). *The soils of the Swift Current map area 72J Saskatchewan*, Extension publication 481. Saskatchewan Institute of Pedology, University of Saskatchewan.

Bakhtin, M. (1984). *Rabelais and his world* (H. Iswolsky, Trans.). Indiana University Press.

Bantjes, R. (2005). Improved earth: Prairie space as modern artefact, 1869-1944. In *Improved Earth: Prairie Space as Modern Artefact, 1869-1944*. University of Toronto Press Incorporated.

Bantjes, R. (2014). "Vertical perspective does not exist": The scandal of converging verticals and the final crisis of perspectiva artificialis. *Journal of the History of Ideas*, *75*(2), 307–338

Barker, B. (2020). *Lentil seed guide 2020*. Saskatchewan Pulse Growers. https://saskpulse.com/files/newsletters/200221_Lentil_Varieties_2020.pdf

Barker, J. (2017). *In our hands: Seeding change*. Black Bark Films.

Barney, D. (2011). To hear the whistle blow: Technology and politics on the Battle River Branch Line. *TOPIA*, *25*(Spring), 5–27.

Barth, B. (2016). *Permaculture: You've heard of it, but what the heck is it?* Modern Farmer. https://modernfarmer.com/2016/04/permaculture/

BASF. (2020, December 15). *Clearfield production system for lentils*. https://agro.basf.ca/basf_solutions/seedsandsystems/clearfield_lentils.html

Bayer CropScience. (2013). *Herbicide resistance management guide: An educational guide to help manage or delay the onset of herbicide resistance*. Bayer CropScience.

Bayer CropScience. (2020, December 15). *A history of Roundup*. https://www.roundup.ca/en/rounduphistory

Beck, J. (2001). Without form and void: the American desert as trope and terrain. *Nepantla: Views from South*, *2*(1), 63–83.

Bennett, J. W. (1969). *Northern plainsmen; adaptive strategy and agrarian life*. Aldine Pub. Co.

Betz, J., & Siegel, T. (2016). *Seed: The untold story*. Collective Eye Films and Seneca Falls Picture Company.

Bick, E. (1987). The experience of the skin in early object relations. In M. Harris (Ed.), *The collected papers of Martha Harris and Esther Bick* (pp. 114–118). Clunie Press.

Biederbeck, V. O., Campbell, C. A., & P., Z. R. (1984). Effect of crop rotation and fertilization on some biological properties of a loam in southwestern Saskatchewan. *Canadian Journal of Soil Science*, *64*, 355–367.

Biodynamic Association. (2021, January 31. *What is biodynamics?* https://www.biodynamics.com/what-is-biodynamics

Blanchette, A. (2020). *Porkopolis: American animality, standardized life, & the factory farm*. Duke University Press.

Blomley, N. (2003). Law, property, and the geography of violence-the frontier, the survey, and the grid. *Sage Urban Studies Abstracts*, *31*(4).

Bourdieu, P. (1998). Practical reason: On the theory of action. Polity Press.

Bourdieu, P. (1977). Outline of a theory of practice. In J. Goody (Ed.), *Cambridge studies in social anthropology* (Vol. 16, Issue 16). Cambridge University Press.

Bourgault. (2020, November 20). *The history of Bourgault Industries Ltd.* Bourgault Industries Ltd. https://www.bourgault.com/AboutUs/History/tabid/145/language/en-US/Default.aspx

Bracken, J. (1921). *Dry farming in western Canada*. The Grain Growers Guide Limited.

Brenzil, C. (2018, December 18). Herbicide resistance in Saskatchewan Fields. *Webinars for Agribusiness, Farmers, and Ranchers*. Saskatchewan Agriculture.

Briere, K. (2004, April 8). Rural ag centres see layoffs. *The Western Producer*. https://www.producer.com/news/rural-ag-centres-see-layoffs/

Brown, K. (2001). Gridded lives: Why Kazakhstan and Montana are nearly the same place. *The American Historical Review*, *106*(1), 17.

Burrows, A. (1880). *North-western Canada: A practical guide to the habitable regions of Manitoba and the North West Territories*.

Burton, R. (2004). Seeing through the good farmer's eyes: Towards developing an understanding of the social symbolic value of productivist' behavior. *Sociologia Ruralis*, *44*(2), 195–215.

Burton, R. (2012). Understanding farmers' aesthetic preference for tidy agricultural landscapes: A Bourdieusian perspective. *Landscape Research*, *37*(1), 51–71.

Campbell, C. A. (1983). Zero-till versus conventional tillage: Effect on soil organic matter and N fertility. *Alberta Zero-till Workshop at Lethbridge, AB*, 1–29.

Campbell, C. A., Juma, N. G., Zentner, R. P., Smith, E., Izaurralde, R. C., Robertzon, J. A., Dyck, M., & Janzen, H. H. (2012). A bibliography of scientific publications based on long-term rotation studies in the Canadian Prairies. *Prairie Soils and Crops Journal*, *5*, 7–29.

Campbell, C. A., McGill, W. B., & Paul, E. A. (1983). Cropping practices on the Canadian Prairies and their effect on soil organic matter and nitrogen fertility: Past, present, and future trends. *Proceedings of* the *Agricultural Nitrogen Residues with Particular Reference to Their Conservation as Fertilizers and Behaviour as Potential Pollutants*. Joint FAO/IAEA.

Campbell, C. A., Rennie, D. A., & Bailey, L. D [eds]. (1993). *Nitrogen, Phosphorus, Potassium Sulphur: Answers to your questions a producer's version*. Agriculture and Agri-food Canada.

Campbell, C. A., Janzen, H. H., Paustian, K., Gregorich, E. G., Sherrod, L., Liang, B. C., & Zentner, R. P. (2005). Carbon storage in soils of the North American Great Plains: Effect of cropping frequency. *Agron. J.*, *97*, 349–363.

Campbell, H. W. (1909). *Campbell's 1907 soil culture manual: A complete guide to scientific agriculture as adapted to the semi-arid regions*. The Campbell Soil Culture Co. (Inc.). https://archive.org/details/campbellssoilcul00camprich/page/n5/mode/2up

Campbell, J. B. (1971). *The Swift Current Research Station 1920-1970*. The Canada Department of Agriculture.

Canada Department of Agriculture. (1961). *PFRA Prairie Farm Rehabilitation Act: What it means to the Prairie Provinces,* Publication No. 1138. Canada Department of Agriculture.

Canada Department of Agriculture. (1969). *Prairie resources and PFRA*. Canada Department of Agriculture.

Canadian Experimental Farm Service. (1939). *Fifty years of progress on Dominion Experimental Farms 1886-1936*. Ottawa: Director of Public Information.

Canadian Society of Technical Agriculturalists. (1939). *Prairie Farm Rehabilitation*. Canadian Society of Technical Agriculturalists.

Cannavo, P. F. (2001). American Contradictions and Pastoral Visions: An Appraisal of Leo Marx, The Machine in the Garden. *Organization and Environment*, *14*(1), 74–92.

Carter, S. (2019). Lost harvests: Prairie Indian reserve farmers and government policy (Second, Ser. McGill-queen's native and northern series, 3). McGill-Queen's University Press.

Carter, S. (1999). *Aboriginal people and colonizers of western Canada to 1900* (Ser. Themes in Canadian social history, 5). University of Toronto Press.

Center Field Solutions Ltd. (2020). *Variable Rate Fertilizer*. Center Field Solutions Ltd. https://www.centerfieldsolutions.ca/variable-rate-fertilizer/

Charles, D. (2019). *Safe or scary? The shifting reputation of glyphosate aka Roundup*. NPR Morning Edition. https://www.npr.org/sections/thesalt/2019/05/30/727914874/safe-or-scary-the-shifting-reputation-of-glyphosate-aka-roundup

Ciceri, D., Manning, D., & Allanore, A. (2015). Historical and technical developments of potassium resources. *Science of the Total Environment*, *502*, 590–601.

Cochrane, W. W. (1979). *The development of American agriculture: A historical analysis*. University of Minnesota Press.

Cohen, W. A. (2004). Introduction: Locating filth. In W. A. Cohen & R. Johnson (Eds.), *Filth: Dirt, disgust, and modern life* (pp. vii–xxxvii). University of Minnesota Press.

Corteva agriscience. (2020, December 3). *Corteva Technology User Agreement*. Clearfield Production System for Canola. https://www.clearfieldcanola.ca/technology-use-agreement.html

Cronon, W. (1996). The trouble with wilderness; or, Getting back to the wrong nature. In *Uncommon ground: Rethinking the human place in nature* (pp. 69–90). W.W. Norton & Co.

Cronon, W. (1991). *Nature's metropolis: Chicago and the great west* (1st ed.). W.W. Norton.

Cunfer, G. (2005). *On the Great Plains: Agriculture and environment*. Texas A & M University Press.

Daschuk, J. W. (2014). *Clearing the plains: Disease, politics of starvation, and the loss of aboriginal life*. University of Regina Press

Dass, P., Houlton, B. Z., Wang, Y., & Warlind, D. (2018). Grasslands may be more reliable carbon sinks than forests in California. *Environmental Research Letters*, *13*(7).

DeGregori, T. R. (2003). Muck and magic or change and progress: Vitalism versus Hamiltonian matter-of-fact knowledge. *Journal of Economic Issues*, *XXXVII* (1), 17–33.

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia*. Continuum.

Douglas, M. (2013). *Purity and danger: An analysis of concepts of pollution and taboo*. Taylor & Francis.

Dudley, M. K. (1994). *Debt and dispossession*. University of Chicago Press.

Dudley, K. (2002). The Entrepreneurial Self: Identity and Morality in a Midwestern Farming Community. In J. Adams (Ed.), *Fighting for the Farm: Rural America Transformed*. University of Pennsylvania Press.

Drew, J. L. (1968). Farm business planning. *Farm Families in Transition: Summaries of Papers and Symposia Presented at the 36th Annual Farm and Home Week*, 34–38.

Earl, P. D. (2019). *The rise and fall of united grain growers: Cooperatives, market regulation, and free enterprise*. University of Manitoba Press.

Eaton, E. (2013). *Growing resistance: Canadian farmers and the politics of genetically modified wheat*. University of Manitoba Press.

Eckbo, G. (2002). *Landscape for living*. Hennessey + Ingalls.

Egoz, S., Bowring, J., & Perkins, H. C. (2001). Tastes in tension: Form, function, and meaning in New Zealand's farmed landscapes. *Landscape and Urban Planning*, *57*, 177–196.

Eisenhauer, E. E. (1939). Land utilization in Saskatchewan. In *Prairie Farm Rehabilitation*. Canadian Society of Technical Agriculturalists.

Ellert, B. (2015, May 15). *Asael E. Palmer and the unfinished story of soil conservation on the Canadian Prairies*. [Address]. BYU Kennedy Center, Provo, Utah. https://www.youtube.com/watch?v=Y7751yp9P9E

Environment and Climate Change Canada (2017). *Top ten weather stories for 2009: Story nine*. Government of Canada. https://ec.gc.ca/meteo-weather/default.asp?lang=En&n=C7C3F964-1

Erisman, J. W., Sutton, M. A., Galloway, J., Kilmont, Z., & Winiwarter, W. (2008). How a century of ammonia synthesis changed the world. *Nature Geoscience*, *1*, 636–639.

Evans, C. L. (2002). *The war on weeds in the prairie west: An environmental history*. University of Calgary Press.

Evans, C. L. (1996). *The culture of weeds in western Canada 1800-1950: An environmental history.* [Unpublished doctoral dissertation]. The University of British Columbia.

Ewins, A. (2005a, September 29). Action urged on possible fusarium link. *The Western Producer*. https://www.producer.com/news/action-urged-on-possible-fusarium-link/

Ewins, A. (2005b, October 27). Monsanto defends glyphosate studies. *The Western Producer*. https://www.producer.com/news/monsanto-defends-glyphosate-studies/

Experimental Farms Service. (1942). *Soil Research Laboratory Swift Current, Sask. report of investigations*. Dominion of Canada, Department of Agriculture.

Fairbairn, G. L. (1984). *From prairie roots: The remarkable story of Saskatchewan wheat pool*. Western Producer Prairie Books.

Fairbairn, G. L. (1984). *Will the Bounty End?* Western Producer Prairie Books.

FarmersEdge. (2021). *FarmCommand*. FarmersEdge. https://www.farmersedge.ca/farmcommand/

Fifty years along the Cutbank (1955). Burnham Homemakers Club (ed.). Burnham Homemakers Club.

Fitzgerald, D. K. (2003). *Every farm a factory: the industrial ideal in American agriculture*. Yale University Press.

Foucault, M. (2009). *Security, territory, population: Lectures at the collège de france, 1977-78*. (G. Burchell, Trans., M. Senellart, Ewald François, & A. Fontana, Eds.) (Ser. Michel Foucault). Palgrave Macmillan.

Foucault, M. (2004). *Sécurité, territoire, population: cours au Collège de France, 1977-1978* (Gallimard/).

Foucault, M. (2003). *The birth of the clinic*. Routledge.

Foucault, M. (1995). *Discipline and punish: the birth of the prison*. Vintage Books.

Foucault, M. (1984). *The Foucault Reader* (P. Rabinow (ed.)). Pantheon Books.

Foucault, M., & Hurley, R. (1990). *The history of sexuality* (Vintage books). Vintage Books.

Francis, D., & Kitzan, C. (2007). Introduction. In D. Francis and C. Kitzan (Eds.) *The Prairie West as Promised Land*. University of Calgary Press.

Friesen, G. (1987). *The Canadian prairies: a history*. University of Toronto Press.

Fulton, M. (2010). Forward. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. ix–xiv). Knowledge Impact in Society.

Furniss, E. (1999). *The burden of history: Colonialism and the frontier myth in a rural Canadian community*. UPC Press.

Gaylord, D. R. (1982). Geologic history of the Ferris Dune Field, south-central Wyoming. In R. Marrs & K. E. Kolm (Eds.), *Interpretation of windflow characteristics from Eolian landforms* (pp. 65–82). The Geological Society of America.

Genoways, T. (2015). *The chain: Farm, factory, and the fate of our food*. Harper Paperbacks.

Germination Magazine. (2007). *AC Barrie wheat variety crowned seed of the year 2007*. https://germination.ca/ac-barrie-wheat-variety-crowned-seed-of-the-year-2007/

Geyh, P. (2009). *Cities, citizens, and technologies: urban life and postmodernity*. Routledge.

Gibson, J. W. (2019). Automating agriculture: Precision technologies, agbots, and the fourth industrial revolution. In J. W. Gibson & S. E. Alexander (Eds.), *In defense of farmers: The future of agriculture in the shadow of corporate power* (pp. 135–174). The University of Nebraska Press.

Glass, R. (2004). Frank & Mary (Dorsch) Glass. In Fox Valley/Liebenthal History Book Committee (Ed.), *Fox Valley Liebenthal remember when...* (pp. 547-552). Friesens Corporation History Book Division.

Glass, S. (2004). Ludwig & Karoline (Jackle) Glass. In Fox Valley/Liebenthal History Book Committee (Ed.), *Fox Valley Liebenthal remember when...* (pp. 556-562). Friesens Corporation History Book Division.

Grinnell, G. B. (1892). *Blackfoot lodge tales: The story of a Prairie People*. Charles Scribner's Sons.

Goodman, D., Bernardo, S., & Wilkinson, J. (1987). *From farming to biotechnology: A theory of agro-industrial development*. Basil Blackwell.

Government of Canada. (2021, February 18). *Chemical residues and organic production*. https://inspection.canada.ca/organic-products/chemical-residues-and-organic-production/eng/1389651477171/1389651725636

Government of Canada. (2021, February 1). *Growing Forward 2-AgriInvest program guidelines*. https://www.agr.gc.ca/eng/agricultural-programs-and-services/agriinvest/resources/growing-forward-2-agriinvest-program-guidelines/?id=1366308493939#def

Government of Canada. (2015, February 17). *Maximum residue limits for pesticides*. https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management/public/protecting-your-health-environment/pesticides-food/maximum-residue-limits-pesticides.html

Government of Saskatchewan. (2021, February 12). *Crop production dashboard.* https://dashboard.saskatchewan.ca/business-economy/business-industry-trade/crop-production#by-seeded-area-tab

Grant, J. (2001). The dark side of the grid: power and urban design. *Planning Perspectives*, *16*(3), 219–241

Gray, J. H. (1967). *Men against the desert*. Modern Press.

Gray, R. (2010). It all makes cents: The economics of conservation tillage. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 149–161). Knowledge Impact in Society.

Gray, R. (2014). Solutions to the agricultural research funding conundrum: agricultural research funding. *Canadian Journal of Agricultural Economics/Revue Canadienne D'agroeconomie*, *62*(1), 7–22.

Hager, T. (2008). *The alchemy of air: A Jewish genius, a doomed tycoon, and the scientific discovery that fed the world but fueled the rise of Hitler*. Three Rivers Press.

Halford, J. (1984). Machinery for minimum tillage: A farmer's perspective. In G. Hass (Ed.), *"The Optimum Tillage Challenge," Proceedings of the Saskatchewan Institute of Agrologist Update Series*. University of Saskatchewan Printing Services.

Hamel, C., & Plenchette, C. (2007). Preface. In C. Hamel & C. Plenchette (Eds.), *Mycorrhizae in crop production*. CBC Press.

Haney, R. L., Haney, E. B., Smith, D. R., Hamel, R. D., & White, M. J. (2018). The soil health tool—Theory and initial broad-scale application. *Applied Soil Ecology*, *125*(April 2018), 162–168.

Havlin, J. L., Tisdale, S. L., Nelson, W. L., & Beaton, J. D. (2014). *Soil fertility and fertilizers: An introduction to nutrient management eighth edition*. Pearson.

Haynes, R. D. (2013). *Desert: Nature and culture* (Ser. Earth series). Reaktion Books.

Health Canada. (2017). *Re-evaluation decision RVD2017-01 Glyphosate*. Health Canada Pest Management Regulatory Agency. http://publications.gc.ca/collections/collection_2017/sc-hc/H113-28/H113-28-2017-1-eng.pdf

Heidel, B., Cox, S. E., & Blomquist, F. C. (2018). Dune habitat of an endangered species, *Penstemon haydenii Wats.* (blowout penstemon), in Carbon County, Wyoming. *Western North American Naturalist*, *78*(2), 119–125.

Hein, G. E. (1961). The Liebig-Pasteur controversy: Vitality without vitalism. *Journal of Chemical Education*, *38*(12), 614–619.

Henke, C. (2008). *Cultivating science, harvesting power science and industrial agriculture in California*. MIT Press.

Henry, L. (2016, October 28). Potashium: fertilizer mergers. *Grainnews*. https://www.grainews.ca/columns/les-henry-a-quick-look-at-the-history-of-prairie-fertilizer/

Henry, L., Harron, B., & Flaten, D. (1987). *The nature and management of salt-affected land in Saskatchewan*. Saskatchewan Agriculture Soils and Crops Branch.

Hill, K. W. (1956). *Soil drifting: Its causes and control, Publication No. 896*. Experimental Farms Service, Department of Agriculture.

Hoechst. (1984). *Conservation for profit*. Hoechest Canada Inc.

Hofmann, A. W. (1876). The Faraday Lecture. In *the Faraday Lecture for 1875: The life-work of*

Liebig (Hofmann, A). MacMillian and Co. https://archive.org/details/lifeworkliebigin00hofmuoft/page/n5/mode/2up

Holm, F. A., & Johnson, E. N. (2009). The history of herbicide use for weed management on the prairies. *Prairie Soils and Crops Journal*, *2*, 1–11.

Hopkins, E. S., Palmer, A. E., & Chepil, W. S. (1946). *Soil drifting control in the prairie provinces: Publication 568*. Dominion of Canada Department of Agriculture, Field Husbandry Division, Experimental Farms Service.

Hostetler, J. A., & Huntington, G. E. (1980). *The Hutterites in North America* (G. Spindler & L. Spindler (eds.)). Holt, Rinehart and Winston, Inc.

Howard, A. (2010). *The soil and health: A study of organic agriculture*. University Press of Kentucky.

Howard, A. (1943). *An agricultural testament*. Oxford University Press.

Hudec, J., & Hudec, M. (2004). John & Mary Hudec. In Fox Valley/Liebenthal History Book Committee (Ed.), *Fox Valley Liebenthal remember when...* (pp. 655–660). Friesens Corporation History Book Division.

Hunter, M. (1980). Expanded production and quality of farm life. *Prairie Production Symposium: Program, Resource People. Summary Papers, and Proceedings*, 1–21. Canadian Wheat Board.

Isern, T. D. (1988). The discer: Tillage for the Canadian Plains. *Agricultural History*, *62*(2), 79–97.

Jackle, H. (2004). Harold & Irene (Wenzel) Jackle. In Fox Valley/Liebenthal History Book Committee (Ed.), *Fox Valley Liebenthal remember when...* (pp. 692–696). Friesens Corporation History Book Division.

Jacob, H. E. (1997). *Six thousand years of bread: It's holy and unholy history*. The Lyons Press.

Jacobson, W. L. (1939). Progress of small water development projects. In C. G. O'Brien (Ed.), *Prairie Farm Rehabilitation* (pp. 58–63). Canadian Society of Technical Agriculturalists.

Jones, D. C. (2002). *Empire of dust: settling and abandoning the Prairie dry belt*. University of Calgary Press.

Kenner, R. (2008). *Food, Inc.* Magnolia Pictures, Participant, and River Road Entertainment.

Kerber, J. (2010). *Writing in dust: Reading the prairie environmentally* (Ser. Environmental humanities series). Wilfrid Laurier University Press

Kilcher, M. R. (1986). *Swift Current Research Station 1920-1985: Historical series No. 25*. Research Branch Agriculture Canada.

Kimbrell, A. (2002). *Fatal harvest: The tragedy of industrial agriculture* (A. Kimbrell (ed.)). Island Press.

Kirk, L. E. (1938). Doctor Angus Mackay. In *Morton MSS Manuscript Collection*. University of Saskatchewan Library, University of Saskatchewan.

Kitto, F. H. (1919). *The Province of Saskatchewan Canada: Its development and opportunities*. Natural Resources Intelligence Branch, Department of the Interior Canada.

Krasowski, S. (2019). *No surrender: The land remains Indigenous*. University of Regina Press.

Krohn, W., & Schäfer, W. (1976). The origins and structure of agricultural chemistry. In G. Lemaine, R. Macleod, M. Mulkay, & P. Weingart (Eds.), *Perspectives on the emergence of scientific disciplines* (pp. 27–52). Mouton & Co.

Kulshreshtha, S., & Kort, J. (2008). External economic benefits and social goods from prairie shelterbelts. *Agroforestry Systems*, *75*, 39–47.

Lafond, G. P., & Harker, K. N. (2012). Long-term cropping studies on the Canadian Prairies: An introduction. *Prairie Soils and Crops Journal*, *5*, 1–6.

Laforge, J. M. L., & McLachlan, S. M. (2018). Environmentality on the Canadian Prairies: Settler-farmer subjectivities and agri-environmental objects. *Antipode*, *50*(2), 359–383.

LaFrance, M. (2009). Skin and the self: Cultural theory and Anglo-American psychoanalysis. *Body and Society*, *15*(3), 3–24.

Lal, R. (Ed.). (2017). *Encyclopedia of soil science* (Third). CRC Press, Taylor & Francis Group.

Larney, F., & Janzen, H. (2012). Long-term erosion-productivity relationships: The Lethbridge soil scalping studies. *Prairie Soils Crops J*, *5*, 139–146. http://www.prairiesoilsandcrops.ca/articles/volume-5-14-screen.pdf

Latour, B. (1993). *We have never been modern*. Harvard University Press.

Lawrence, T. (1979). Food production and utilization. In *1979 Research Hi-lites* (pp. 38–41). Research Station, Swift Current Saskatchewan.

Leigh, G. J. (2004). *The world's greatest fix: A history of nitrogen and agriculture*. Oxford University Press.

Liebig, J. Von (1843). *Familiar letters on chemistry and its relation to commerce, physiology, and agriculture* (J. Gardner (Ed.)). James M. Campbell & Co. https://archive.org/details/101144945.nlm.nih.gov/mode/2up

Liebig, J. Von. (1859). *Letters on modern agriculture* (J. Blyth (ed.)). John Wiley. https://archive.org/details/agl9999.0001.001.umich.edu/page/n3/mode/2up

Liebig, J. Von. (1863). *The natural laws of husbandry* (J. Blyth (Ed.)). D. Appleton and Company. https://archive.org/details/naturallawshusb02blytgoog/page/n5/mode/2up

Liebig, J. Von. (1876). *The Faraday Lecture for 1975: The life-work of Liebig* (A. W. Hofmann (Ed.)). MacMillian and Co. https://archive.org/details/lifeworkliebigin00hofmuoft/page/n5/mode/2up

Limerick, P. N. (1985). *Desert passages: Encounters with the American deserts* (1st ed.). University of New Mexico.

Lindwall, W. (2010). Breakthroughs in engineering and equipment development. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 37–44). Knowledge Impact in Society.

Lobao, L., & Meyer, K. (2001). The great agricultural transition: Crisis, change, and social consequences of twentieth century US farming. *Annual Review of Sociology*, *27*, 103–124.

MacKay, A. (1909). *Preparing land for grain-crops in Saskatchewan*. Dominion of Canada Department of Agriculture, Experimental Farms Service. https://archive.org/details/cihm_83997/page/n5/mode/2up?view=theater

Majewski, M. S., Coupe, R. H., Foreman, W. T., & Capel, P. D. (2014). Pesticides in Mississippi air and rain: A comparison between 1995 and 2007. *Environmental Toxicology and Chemistry*, *33*(6), 1283–1293.

Mandel, C. (2015, September 29). Inside the Harper government's trashing of a research library. *Canada's National Observer*. https://www.nationalobserver.com/2015/09/29/news/exclusive-inside-harper-governments-trashing-research-library

Manning, E. (2009). What if it didn't all begin and end with containment? Toward a leaky sense of self. *Body and Society*, *15*(3), 33–45.

Martel, Y. (2013). The management of the Research Branch from 1986 to 2011. In Y. Martel, J.-M. Deschênes, & N. Corbeil (Eds.), *The Innovators rooted in science: The history of Research Branch 1986-2011* (pp. 19–42). Agriculture and Agri-Food Canada.

Marx, K. (1992). *Capital: A critique of political economy, vol. I (B. Fowkes, trans.)*. Penguin.

McCaig, T., Schellenberg, M., & Zentner, R. (2013). Semi-arid Prairie Agricultural Research Centre Swift Current, Saskatchewan. In *The innovators rooted in science: the history of the Research Branch 1986-2011* (pp. 298–304). Agriculture and Agri-Food Canada.

McClinton, B., & Polegi, J. (n.d.). *Saskatchewan Soil Conservation Association (SSCA)-History*. Saskatchewan Soil Conservation Association Inc. http://prairiesoilsandcrops.com/about/history

McConkey, B. (2010). Foundations for growth-The role of researchers and AAFC research stations. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 25–36). Knowledge Impact in Society.

McConkey, B., Campbell, C. A., Zentner, R. P., Peru, M., & VandenBygaart, A. J. (2012). Effect of tillage and cropping frequency on sustainable agriculture in the brown soil zone. *Prairie Soils and Crops Journal*, *5*, 51–58.

McCutcheon, J. (1994). Conservation tillage: Another dimension. *Saskatchewan Direct Seeding Workshop: Strategies, Techniques, & Farmer Experience to Increase Your Profits and Conserve Your Soil*, 196–202. Saskatchewan Soil Conservation Association.

McEachern, C. (1992). Farmers and conservation: Conflict and accommodation in farming politics. *Journal of Rural Studies*, *8*(2), 159–171.

McGowan, D. C. (1975). *Grassland settlers: The Swift Current region during the era of the ranching frontier*. Canadian Plains Research Center, University of Regina.

McInnis, A. (2004). *The development of better farm practices in Saskatchewan*. Panel NB3.1.2G3 Prepared for the Winning the Prairie Gamble exhibit. Western Development Museum.

McKeague, J. A., & Stobbe, P. C. (1978). *History of soil survey in Canada 1914-1975*. Canada Department of Agriculture.

McKenzie, R. E. (1970). *1946-1970: An account of the first 25 years*. Saskatchewan Institute of Agrologists.

McLaughlin, D. (2007). Introduction-The global context of the Canadian Wheat Board. In T. Pugh & D. McLaughlin (Eds.), *Our board our business: Why farmers support the Canadian Wheat Board*. Fernwood Publishing Company Limited.

McManus, C. R. (2011). *Happyland: A history of the "dirty thirties" in Saskatchewan, 1914-1937*. University of Calgary Press.

McRorie, H. D. (1968). Economic aspects of farming. *Farm Families in Transition: Summaries of Papers and Symposia Presented at the 36th Annual Farm and Home Week*, 30–34. Extension Division, The University of Saskatchewan.

Miheguli, R., Schoenau, J. J., & Jefferson, P. (2018). Yield and uptake of phosphorus by wheat and canola grown after two years of forage legume and annual crops. *American Journal of Plant Sciences*, *09*(09), 1807–1825.

Mintz, S. W. (1985). *Sweetness and power: The place of sugar in modern history*. Viking.

Mitchell, A. (1984). Tillage alternatives brown and dark brown soil zones. In G. Hass (Ed.), *"The Optimum Tillage Challenge"* (pp. 128–141). University of Saskatchewan Printing Services.

Mitchell, T. (1991). *Colonizing Egypt*. University of California Press.

Monsanto. (1994). *Roundup herbicide: A farmer's guide for controlling annual and perennial weeds in reduced tillage*. Saskatchewan Soil Conservation Association Inc.

Montgomery, D. R., & Biklé, A. (2016). *The hidden half of nature: The microbial roots of life and health*. W.W. Norton & Co.

Morgan, R. G. (2020). *Beaver, bison, horse: The traditional knowledge and ecology of the Northern Great Plains*. University of Regina Press.

Moss, H. C. (1983). *History of the Saskatchewan Soil Survey 1921-1959*. Saskatchewan Institute of Pedology, University of Saskatchewan.

Motherwell, W. R. (1910). *Methods of soil cultivation underlying successful grain growing in the province of Saskatchewan: Being the revised reports of two addresses delivered by the Honourable W.R. Motherwell, Minister of Agriculture, before the Dry Farming Congress*. Saskatchewan Department of Agriculture. https://archive.org/details/cihm_83792/page/n5/mode/2up?view=theater

Moynan, J. C., & Tinline, M. J. (1939). Sub-stations and Their Relation to Rehabilitation. In G. C. O'Brien (Ed.), *Prairie Farm Rehabilitation* (pp. 78–84). Canadian Society of Technical Agriculturalists.

Müller, B. (2008). Still Feeding the World? The Political Ecology of Canadian Prairie Farmers. *Anthropologica*, *50*(2), 389–407.

Mumford, L. (1961). *The city in history: It's origins, its transformations, and its prospects*. Secker and Warberg.

Nutrien. (2020). *Nutrien feeding the future: Fact book 2020*. Nutrien Ltd. https://www.nutrien.com/sites/default/files/uploads/2020-10/Nutrien%20Fact%20Book%202020.pdf

Oetelaar, G. (2014). Worldviews and human-animal relations: Critical perspectives on bison-human relations among the Euro-Canadians and Blackfoot. *Critique of Anthropology*, *34*(1), 94–112.

Ogden, T. (1989). *The primitive edge of experience*. Jason Aronson, Rowman and Littlefield Publishers, INC.

Ogle, S., Alsaker, C., Baldock, J., Bernoux, M., Breidt, F. J., McConkey, B., Regina, K., & Vazquez-Amabile, G. G. (2019). Climate and soil characteristics determine where no-till management can store carbon in soils and mitigate greenhouse gas emissions. *Scientific Reports*, *139*, 224–231.

Olmstead, A. L., & Rhode, P. W. (2002). The red queen and the hard reds: Productivity growth in American wheat, 1800-1949. *The Journal of Economic History*, *62*(4), 929–966.

OrganicBiz. (2020). *Organic price quotes: Late October*. OrganicBiz. https://organicbiz.ca/organic-price-quotes-late-october-5/

Owram, D. (2007). The promise of the West as settlement frontier. In R. D. Francis and C. Kitzan (Eds.), *The Prairie West as promised land*. University of Calgary Press.

Palmer, A. E. (1939). Organized Methods of Soil Drifting Control. In G. C. O'Brien (Ed.), *Prairie Farm Rehabilitation* (pp. 35–37). Canadian Society of Technical Agriculturalists.

Paul, E. A. (Ed.). (2015). Soil microbiology, ecology, and biochemistry (Fourth). Academic Press.

Pennock, D., & Anderson, D. (n.d.). *Soils of Saskatchewan*. Retrieved January 29, 2021, from http://www.soilsofsask.ca/.

Plant life: Anything related to plant life (2021, February 3.). *Strip Farming*. https://lifeofplant.blogspot.com/search?q=strip+farming

Pollan, M. (2006). *The omnivore's dilemma: A natural history of four meals*. The Penguin Press.

Potyondi, B. (1995). *In Palliser's Triangle: Living in the grasslands 1850-1930*. Purich Publishing.

Povinelli, E. (2016). *Geontologies: A requiem to late liberalism*. Duke University Press.

Press, M., Arnould, E. J., Murray, J. B., & Strand, K. (2014). Ideological challenges to changing strategic orientation in commodity agriculture. *Journal of Marketing*, *78*(6), 103–119.

Proulx, A. (2008). Introduction. In A. Proulx & M. Stupich (Eds.), *Red Desert: History of place*. University of Texas Press.

Qualman, D., Desmarais, A. A., & Magnan, A. (2020). *Concentration matters: Farmland inequality on the Prairies*. Canadian Centre for Policy Alternatives Manitoba Office. https://www.nfu.ca/wp-content/uploads/2020/11/Farmland-Concentration.pdf

Qualman, D., & The National Farmers Union. (2019). *Tackling the farm crisis and the climate crisis: A transformative strategy for Canadian farms and food systems*. The National Farmers Union.

Raine, M. (2015, June 11). Weed of the week: Kochia. *The Western Producer*. *https://www.producer.com/crops/weed-of-the-week-kochia/*

Ramírez-Ferrero, E. (2005). *Troubled fields: Men, emotions, and the crisis in American farming*. Columbia University Press.

Read, D. W. L. (1978). Rotations and fertilizer tests. *Dryland Wheat Production in Southwestern Saskatchewan: Seminar Series*, 81–93. Research Branch, Agriculture Canada.

RealAgriculture. (2021, January 21). *About RealAgriculture*. https://www.realagriculture.com/about/

Rennie, D. A. (1966). Future production goals with optimum fertilization and a change in land use. *Selected Addresses on Summerfallow, Agricultural Chemicals, & Fertilizers from the 34th Annual University Farm & Home Week*, 19–22. Extension division, University of Saskatchewan.

Rennie, D. A. (1976). Conserving our soils. SARM land use conference. *Rural Councillor*, *11*(9), 30–38.

Rennie, D. A., & Ellis, J. G. (1978). *The shape of Saskatchewan*. Saskatchewan Institute of Pedology.

Rennie, D. A., Campbell, C. A., & Roberts, T. L. (1993). Impact of macronutrients on crop responses and environmental sustainability on the Canadian Prairies. *Canadian Society of Soil Science*, 527.

Ricoeur, P. (1992). *Oneself as another*. Chicago University Press.

Ricou, L. (1973). *Vertical man, horizontal world: Man and landscape in Canadian prairie fiction*. University of British Columbia Press.

Rodale Institute. (2020). *Regenerative organic agriculture*. Rodale Institute. https://rodaleinstitute.org/why-organic/organic-basics/regenerative-organic-agriculture/

Ross, S. (1957). *As for me and my house*. McClelland and Stewart.

Rossiter, M. W. (1975). *The emergence of agricultural science: Justus Liebig and the Americans, 1840-1880 (Studies in the history of science and medicine)*. Yale University Press.

Roussin, D. M., & Binyamin, J. (2018). Historical precipitation characteristics in the Palliser's Triangle region of the Canadian prairies. *Prairie Perspectives: Geographical Essays*, *20*, 36–48.

Salamon, S. (1992). *Prairie patrimony: Family, farming, and community in the Midwest*. The University of North Carolina Press.

Sanders, R. (2012, April 2). Fertilizer use responsible for increase in nitrous oxide in atmosphere. *Berkeley News*. https://news.berkeley.edu/2012/04/02/fertilizer-use-responsible-for-increase-in-nitrous-oxide-in-atmosphere/

Saskatchewan Agriculture. (2021, February 13). *Agriculture Development Fund*. Saskatchewan Agriculture. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/agricultural-research-programs/knowledge-creation/agriculture-development-fund

Saskatchewan Agriculture. (2021). *2021 guide to crop protection: For the chemical management of weeds, plant diseases, and insects*. Saskatchewan Agriculture. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/crop-guides-and-publications/guide-to-crop-protection

Saskatchewan Agricultural Services Co-ordinating Committee. (1984). *Guide to farm practice in Saskatchewan*. The University of Saskatchewan Division of Extension and Community Relations.

Saskatchewan Institute of Agrologists. (2018). *What's an agrologist?* Saskatchewan Institute of Agrologists. *https://sia.sk.ca/whats-an-agrologist/*

Saskatchewan Pulse Growers. (2015). *Over + above leading the way for pulses: Saskatchewan Pulse Growers 2014/2015 annual report*. Saskatchewan Pulse Growers. https://saskpulse.com/files/annual/report/151210_Final_Annual_Report_Low_Res.pdf

Saskatchewan Soil Testing Laboratory. (1971). *Introducing expected yield increases [Soil testing bulletin No. 3, Extension Publication No. 214]*. Extension Division, University of Saskatchewan.

Saskatoon StarPhoenix Obituaries (2012). Herbert Sparrow. *Saskatoon StarPhoenix*. https://thestarphoenix.remembering.ca/obituary/herbert-sparrow-1066578093)

Savage, C. (2011). *Prairie: A natural history*. Greystone Books.

Savage, C. (2012). *A geography of blood: Unearthing memory from a prairie landscape*. (N. Flight, Ed.). David Suzuki Foundation.

Schlosser, E. (2005). *Fast food nation*. Harper Perennial.

Scott, J. C. (2017). *Against the grain: a deep history of the earliest states* (Ser. Yale agrarian studies series). Yale University Press.

Scott, J. C. (1998). *Seeing like a state: How certain schemes to improve the human condition have failed* (Ser. Yale agrarian studies). Yale University Press.

Shenstone, W. A. (1902). *Justus von Liebig: His life and work (1803-1873)*. MacMillian and Co.

Shildrick, M. (2001). "You are there, like my skin": Reconfiguring relational economies. In S. Ahmed & J. Stacey (Eds.), *Thinking through the skin* (pp. 160–174). Routledge.

Shochat, G., & Fournier, S. (2019, March 12). Court documents reveal Monsanto's efforts to fight glyphosate's "severe stigma." *CBC News*. https://www.cbc.ca/news/health/glyphosate-monsanto-intertek-studies-1.4902229

Siegert, B. (2015). *Cultural techniques: Grids, filters, doors, and other articulations of the real* (G. Winthrop-Young, Trans.). Fordham University Press.

Silvasti, T. (2003). The Cultural Model of "the good farmer" and the Environmental Question in Finland. *Agricultural and Human Values*, *20*(1), 143–150.

Silversides, W. (1966). New developments in the fertilizer industry. *Selected Addresses on Summerfallow, Agricultural Chemicals, & Fertilizers from the 34th Annual University Farm & Home Week*, 23–24. Extension Division, University of Saskatchewan.

Siminovitch. (1986). *The vigorous hybrid: A history of the Chemistry and Biology Research Institute*. Research Branch Agriculture Canada.

Smil, V. (2001). *Enriching the Earth: Fritz Haber, Carl Bosch, and the transformation of world food production*. MIT Press.

Smith, H. (1947). Rain follows the plow: The notion of increased rainfall for the Great Plains, 1844-1880. *Huntington Library Quarterly*, *10*(2), 169–193.

Soil at risk workshop ten on land degradation. (1985). *Proceedings of the Soil at Risk: Soil Conservation Conference*. Alberta Agriculture.

Soil Research Laboratory Swift Current, Sask. (1942). *Report of investigations*. Dominion of Canada Department of Agriculture, Experimental Farms Service.

Solnit, R. (2003). *River of shadows: Eadweard Muybridge and the technological wild west*. Viking.

Sonntag, B., & Lindwall, W. (2010). Building on lessons learned. In W. C. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 213–219). Knowledge Impact in Society.

Sparrow, H. O. (1984). Preface. In the Standing Senate Committee on Agriculture, Fisheries, and Forestry (Ed.), *Soil at risk: Canada's eroding future* (p. vii). Government of Canada.

SSCA. (1993). *Saskatchewan Soil Conservation Association Inc. Annual report for the 1993 calendar year*. Saskatchewan Soil Conservation Association Inc.

Statistics Canada. (2020, November 24). *2016 Census of Agriculture*. Statistics Canada. https://www.statcan.gc.ca/eng/ca2016

Statistics Canada. (2021, January 12). *Number and area of farms and farmland area by tenure, historical data*. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210015201

Stead, R. J. C. (1908). *Empire builders and other poems*. W. Briggs. https://www.canadiana.ca/view/oocihm.991692.

Stefanik, J. A. (2015). *Squaring Palliser's Triangle: The normalization of nature in the Canadian Dry-land Prairies 1860-1940*. Carleton University.

Stegner, W. (2000). *Wolf Willow: A history, a story, and a memory of the last Plains frontier*. Penguin Books Ltd.

Stepphun, H., & Curtin, D. (1992). Approaches toward improving saline soils. *Alberta Soil Science Workshop*, 41–56. Department of Soil Science, University of Alberta.

Stockdale, E. (2018, January 8). *Fact sheets: Making sense of chemical indicators*. http://www.soilquality.org.au/factsheets/making-sense-of-chemical-indicators

Strand, K. (2019). From partner to consumer: The changing role of farmers in the public agricultural research process on the Canadian Prairies. In J. W. Gibson & S. E. Alexander (Eds.), In *defense of farmers: The future of agriculture in the shadow of corporate power* (pp. 249–287). The University of Nebraska Press.

Strand, K., & Barney, D. (2019). Sowing the seeds: The cultural reproduction of ideology in the Canadian Prairies. In D. Laycock (Ed.), *Ideologies and conceptual travel: Multidisciplinary perspectives*. UBC Press.

Strand, K., Arnould, E., & Press, M. (2014). Tillage practices and identity formation in High Plains farming. *Journal of Material Culture*, *19*(4), 355–373.

Stubbendieck, J., Flessner, T. R., & Weedon, R. R. (1989). Blowouts in the Nebraska Sandhills: The habitat of *Penstemon haydenii. 11th North American Prairie Conference, Proc.*, 223–225.

Taylor, J. S. (2005). Surfacing the body interior. *Annual Review of Anthropology*, *34*, 741–756.

Taylor, J. S. (2008). *The public life of the fetal sonogram: Technology, consumption, and the politics of reproduction*. Rutgers University Press.

Thair, P. J. (1968). Man in the backwash. *Farm Families in Transition: Summaries of Papers and Symposia Presented at the 36th Annual Farm and Home Week*, 1–3. Extension Division, The University of Saskatchewan.

Thomas, D. S. G., & Middleton, N. (1994). *Desertification: Exploding the myth*. Wiley.

Tickell, J., & Tickell, R. (2020). *Kiss the ground*. Benenson Productions, Big Picture Ranch, and the Redford Center.

Tsing, A. L. (2012). On nonscalability: The living world is not amenable to precision-nested scales. *Common Knowledge*, *18*(3), 505–524.

Tsing, A. L. (2015). *The mushroom at the end of the world: On the possibility of life in capitalist ruins*. Princeton University Press.

Turner, F. J. (1972). The significance of the frontier in American history. In G. Rogers (Ed.), *The Turner thesis: Concerning the role of the frontier in American history*. D. C. Heath.

Turner, T. S. (2012). The social skin. *HAU: Journal of Ethnographic Theory*, *2*(2), 486–504.

Tynan, A. (2020). *Desert in modern literature and philosophy: Wasteland aesthetics*. Edinburgh University Press.

Ukrainetz, H. (1966). Fertilizer practices for Saskatchewan. *Selected Addresses on Summerfallow, Agricultural Chemicals, & Fertilizers from the 34th Annual University Farm & Home Week*, 15–18. Extension Division, University of Saskatchewan.

United Nations Environment Program. (2011). *Global drylands: A UN system-wide response*. www.unep-wcmc.org/resources-and-data

United States Department of the Interior Bureau of Land Management. (n.d.). *Cadastral survey.* https://www.blm.gov/programs/lands-and-realty/cadastral-survey.

University Archives & Special Collections. (2018). *Honorary Degrees: James Bishop Harrington*. University of Saskatchewan. https://library.usask.ca/archives/campus-history/honorary-degrees.php?id=147&view=detail&keyword=&campuses

University of Saskatchewan Department of Soils (1946). *Fertilizers in Saskatchewan* (Agricultural Extension Bulletin No. 122). University of Saskatchewan.

University of Saskatchewan, Saskatchewan Department of Agriculture, and Experimental Stations Canada Department of Agriculture (1954). *Guide to Farm Practice in Saskatchewan.* Saskatchewan Co-operative Agricultural Extension Program.

University of Saskatchewan, Saskatchewan Department of Agriculture, and Experimental Stations Canada Department of Agriculture (1963). *Guide to Farm Practice in Saskatchewan.* Saskatchewan Co-operative Agricultural Extension Program.

University of Saskatchewan, Saskatchewan Department of Agriculture, and Experimental Stations Canada Department of Agriculture (1966). *Guide to Farm Practice in Saskatchewan.* Saskatchewan Co-operative Agricultural Extension Program.

Vaadeland, G. (2019). *Grasslands, forests & wetlands—Nature's carbon capture & storage solution*. Canadian Parks and Wilderness Society. https://cpaws.org/grasslands-forests-wetlands-natures-carbon-capture-storage-solution/

Vervoort. (2006). "Towers of silence": The rise and fall of the grain elevator as a Canadian symbol. *Histoire Sociale Social History*, *39*(77), 181–204.

Ward, B., Smith, D., Shaw, G., Haak, D., & Fredette, J. (2010). Policy and program response to land management issues. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 15–23). Knowledge Impact in Society.

Water Science and Technology Directorate. (2011). *Presence and levels of priority pesticides in selected Canadian aquatic ecosystems*. Environment Canada. https://www.canada.ca/content/dam/eccc/migration/main/eaudouce-freshwater/5eef7087-5907-4e79-8efe37e6541e6fcf/presenceandlevelsofprioritypesticidesinselectedcanadianaquaticecosystems-20final-s.pdf

Weinberger, M. (2004). Mike & Tillie (Anton) Weinberger. In Fox Valley/Liebenthal History Book Committee (Ed.), *Fox Valley Liebenthal remember when...* (pp. 1171-1173). Friesens Corporation History Book Division.

Welland, M. (2015). *The desert: Lands of lost borders*. Reaktion Books.

Wendel, C. H. (2004). *Encyclopedia of American farm implements & antiques*. Krause Publications.

Wheeler, S. (1919). *Seager Wheeler's book on profitable grain growing*. The Grain Growers Guide Limited. https://archive.org/details/cihm_991508/page/n5/mode/2up

White, C. A. (1983). *A history of the rectangular survey system*. United States Department of the Interior Bureau of Land Management.

Widtsoe, J. (1920). *Dry-farming: A system of agriculture for countries under a low rainfall*. The Macmillan company.

Willerth, G. (2010). The early adopters. In C. W. Lindwall & B. Sonntag (Eds.), *Landscapes transformed: The history of conservation tillage and direct seeding* (pp. 98–101). Knowledge Impact in Society.

Wood, S. (2020, July 31). *Meet the people saving Canada's native grasslands*. The Narwhal. https://thenarwhal.ca/carbon-cache-grasslands/

Worster, D. (1979). *Dust Bowl: The southern plains in the 1930s*. Oxford University Press.

Xenophon. (1938). *"Memorabilia" and "Oeconomicus"* (E. C. Marchland, Trans.). Harvard University Press, Loeb Classical Library.

Zarrillo, S., & Kooyman, B. (2006). Evidence for berry and maize processing on the Canadian plains from starch grain analysis. *American Antiquity*, *71*(3), 473–499.

Zentner, R. P. (1977). Economics of soil conservation in western Canada. *Proceedings of the 1977 Soil Fertility and Crops Workshop*.

Zeidan, D. (2019). *Organic agriculture in the Prairies*. Canada Organic Trade Association.

Zentner, R. P., Tessier, S., Peru, M., Dyck, F. B., & Campbell, C. A. (1991). Economics of tillage systems for spring wheat production in southwestern Saskatchewan (Canada). *Soil and Tillage Research*, *21*(3–4), 225–242.

Zimdahl, R. L. (2015). *Six chemicals that changed agriculture*. Elsevier.

APPENDIX ONE

Written Consent Form

Purpose of Research

This research explores the relationship between farmers and agricultural scientists in Saskatchewan by establishing how both groups create knowledge about farming and how this knowledge flows between farmers and scientists. This research explores the historical development of wheat farming in southern Saskatchewan and how agricultural science contributed to this long-term process.

Procedures

The principal investigator (Katherine Strand) would like to invite you to participate in her project, which will largely consist of her accompanying you as you carry out day-to-day activities. These activities will be documented from July 1, 2014 through August 31, 2015. Documentation will include written notes, audio recordings, and photography.

You may be asked to participate in one or more interviews. If you provide consent, the interviews will be audio recorded. The audio recordings will only be used by Ms. Strand to transcribe into a written form. Ms. Strand will be the only person will access to the audio recordings and written transcripts. You will be asked questions about your methods of farming, your history on the farm (for farmers) or your history working for the research stations (for scientists), and your experience working with farmers and agricultural scientists.

Confidentiality

The principal investigator, Katherine Strand, will be the only individual with access to the written notes, audio recordings, and interview transcripts. These materials will be secured on a password protected computer and locked file cabinet. The information collected from this project will be used to complete Ms. Strand's dissertation and used in future academic journal publications and professional conferences. Participants may choose to opt out of allowing their data to be used in future studies, in which case all transcripts, photographs, and other project materials relating to the participant will be destroyed within a period of 7 years. Pseudonyms will be used in the dissertation, publications, and professional conferences unless the project participants specifically request the use of their names. If photographs are used in the dissertation, publications, and conferences, pseudonyms will be used unless project participants request the use of their names. The dissertation will be made available to the provincial and federal governments to assist in policy decisions regarding rural planning, climate change, and food security. Ms. Strand will not ask for personal identification information such as Social Insurance Numbers or specific financial information. Ms. Strand will only use general information to describe the location of farms (i.e. northeast of Swift Current).

Potential Benefits

This project provides a platform for you to share your views on why you use specific practices when farming or conducting agricultural research. It provides an opportunity for you to give your opinion on the current state of wheat farming in Saskatchewan and how this is impacted by numerous factors including agricultural science, privatized research, genetically modified seeds, new technology, the Canadian Wheat Board, and the railways. This research may be used by the provincial and federal governments to improve the working relationship between farmers and agricultural scientists.

Potential Risks

There are no foreseeable risks to project participants.

Participation and Withdrawal

Participation in this project is completely voluntary. You will not be compensated and you can choose to withdrawal at any moment. If you sign this form, you are not required to participate for the project's full duration and can withdrawal at any moment. You can refuse to answer questions during the interviews. You can ask Ms. Strand not to audio record the interview. You can ask Ms. Strand not to take photographs.

Identification of Principal Investigator and Supervisor

Please feel free to contact Ms. Strand and Dr. Vaccaro at any time to ask questions about the project.

Katherine Strand
PhD Candidate in Anthropology at McGill University
Phone: 307 399-5395
Email: katherine.strand@mail.mcgill.ca
Mailing Address: PO Box 703
Rawlins, WY
82301 USA

Dr. Ismael Vaccaro
Associate Professor in Anthropology at McGill University
Phone: 514 398-5832
Email: ismael.vaccaro@mcgill.ca

If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Manager at 514-398-6831 or lynda.mcneil@mcgill.ca.

Signed Consent

I consent to participating in this project. Please indicate yes or no by marking X below and signing the form.

Yes:_______________No:_________

Signature:______________________ Printed name:________________________ Date:_______

I consent to being identified with my legal name in publication materials (i.e. dissertation and academic journal articles). Please indicate yes or no by marking X below and signing the form.

Yes:_______________No:_________

Signature:______________________Printed name:_________________________Date:________

I consent to having my interview audio recorded. Please indicate yes or no by marking X below and signing the form.

Yes:_______________No:_________

Signature:_______________________Printed name:_________________________Date:________

I consent to having myself and my work environment photographed and consent to the use of these photos in future publications. Please indicate yes or no by marking X below and signing the form.

Yes:_______________No:_________

Signature:______________________Printed name:_________________________Date:________

I consent to allowing my information to be used by Ms. Strand in future related studies. Please indicate yes or no by marking X below and signing the form.

Yes:_______________No:_________

Signature:______________________Printed name:_________________________Date:________

APPENDIX TWO

Ten Commandments of Dryland Farming (Palmer, 1912 as quoted in Jones, 2002, p. 137)

1. Thou shalt Plow Deep.
2. Thou shalt Keep the Surface Soil Loose and Level and Lower Soil Compact.
3. Thou shalt Add Organic Matter to the Soil.
4. Thou shalt Summer Fallow When Rainfall is Less Than Fifteen Inches.
5. Thou shalt Grow Corn or a Cultivated Crop Every Two to Five Years.
6. Thou shalt Grow Clover, Alfalfa, or Some Leguminous Crop Every Few Years.
7. Thou shalt Grow Early Maturing Crops.
8. Thou shalt Keep Down the Weeds.
9. Thou shalt Keep Stock.
10. Thou shalt Plant Trees.