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Heirloom and Hybrid Corn in the American Corn Belt: an Ethnography of Seed Saving Practices

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by

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ABSTRACT

HEIRLOOM AND HYBRID CORN IN THE AMERICAN CORN BELT: AN ETHNOGRAPHY OF SEED SAVING PRACTICES

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This ethnographic study examines the practices and context of contemporary heirloom corn seed saving practices and projects in the American Corn Belt. It examines heirloom corn conservation and hand pollination practices at Seed Savers Exchange in Decorah, Iowa in 2015. From there the study extends to interviews with heirloom farmers, breeders and gardeners in Wisconsin and Illinois. The findings indicate that the lines between the mainstream and the margins of corn production are highly blurred, and that there is a considerable amount of cross-pollination of ideas and practices between alternative corn farming and dominant industrial hybrid production in the American Corn Belt as they exist in proximity and utilize similar public spaces and resources. The results of these cross-pollinations of ideas are differing visions of sustainability that farmers, breeders and seed savers use to frame their heirloom corn growing projects and maintain the marginal spaces required for them to grow in the Corn Belt. The author explores the histories of hybrids and heirlooms in the Corn Belt and the contemporary evolution of USDA Organic Corn Production to illustrate this point.

Dedicated to my Grandmother, Margaret “Peggy” Jeffrey.

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[1] Also, thank you for introducing me to the Imperial Radch Trilogy, it is truly wonderful and one of the few series that I have read through multiple times.

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Introduction

The Midwest United States sits directly in the American Corn Belt which is an area of massive industrial agricultural production of corn. Corn is everywhere. The American Corn Belt is a region that developed after the Blackhawk War in flurry of government land grant programs, speculation, boosting and influxes of immigrants from the Eastern states, the Southern states and Europe. The image of the independent American Farmer and the dream of the family owned, and operated farm were built here.

In the Midwest United States, corn farming industrialized along with the meat industry both taking shape under the influence of modernist and productionist ideals. As territories became states, they touted the total amount of corn grown per acre – emphasizing their farmer's productivity and efficiency. Corn breeders here developed hybrid varieties through public university programs and disseminated those varieties through large scale commercialization. Industrial corn farming, focused solely on higher yields, quickly mechanized and became dependent on specialized inputs including hybrid seeds, fertilizers, herbicides, pesticides and fossil fuels. Agricultural science, modern breeding and corn farmers in the Midwest grew together, informing and informed by the dominant culture of corn which focused on growing as much corn as possible per acre.

Before the commercialization of hybrid corn, farmers kept their own corn varieties. In the fall the farmers would select ears of corn from plants they liked, store it over winter, and that would be their seed stock for the following spring. Sometimes this corn was kept throughout the lifetime of the farmer, passed down from one generation to the next and traded with neighbors, and other times the farmers would simply switch to a new variety. Farmers were selecting and

saving seed each year, and this created many different corn varieties throughout the region. Some farmers took ears from their varieties to be judged at county fairs and corn shows to see who had bred the most outstanding corn. Crop scientists were able to connect with farmers at these competitions and throughout the region, comparing a vast number of varieties, to get the seeds that would help them with their new corn improvement projects.

Corn was the first commercial hybrid and the American Corn Belt is where hybrid corn was first introduced and accepted by farmers. The modern seed industry was cultivated here. The fast-paced push of industrialized agriculture changed the American Corn Belt and the lives of farmers. These changes did not go unnoticed or unchallenged by the residents – farmers and non-farmers a-like. The organic movement, a loose network of ideologies challenging the ideals of modernism, consumerism and industrialism, formed the basis for the alternative food movement as a way to take control of the social, economic and environmental changes that they saw occurring.

Seed Savers Exchange in Decorah, Iowa is a grassroots organization started in the 1970s. The founders saw backyard seed saving practices and older varieties being replaced by hybrid varieties, modernization of farming and commercially produced seed. This replacement of practices and plant varieties represented the extinction of specific varieties, but also the loss of the history and their heritage that they saw as connected to those varieties. The organization hosted and organized a seed exchange forum for gardeners and farmers across the United States to share the seeds that they had saved with other gardeners. The name Seed Savers Exchange points to the act of seed saving, but it also emphasizes the larger mission of the group to preserve family heirloom crops, share them widely and keep these varieties alive in people's home gardens. In the process, they also sought to preserve a social sphere of self-sufficiency in

America's heartland. To their credit (and possibly partially to the predictability of commercial production) the act of seed saving has become synonymous with a rebellious form of conservation, rejection of commodified seeds, a statement of independence and a way to remember and recreate a more idyllic way of life.

In the same way that alternative food systems and the organic movement developed in contrast to industrial mainstream farming, heirloom varieties are defined in contrast to hybrid and genetically engineered (GE) varieties.[2] Hybrid and GE varieties are valued for the amount they produce per acre, their transposability from one place to another, and the scientific expertise required for its production. The heirloom variety is valued for its unique features and flavors, its local situated history and a more "common sense" expertise that produces it.

Industrial commodity corn production using hybrid and GE seed is the dominant paradigm of corn production in the American Corn Belt. However, alternative methods of corn production, such as organic corn production and heirloom corn production, exist in close proximity to the dominant corn paradigm. This is partially because the resources needed to maintain heirloom corn populations in this area are often closely associated with the dominant paradigm; access to land, labor, equipment, institutional resources and the know-how required maintain the heirloom corn populations. However, through this research I show how farmers, gardeners and breeders create and maintain marginal spaces where they can grow and keep seed from their heirloom corn. Both hybrid and heirloom corn production have developed in many of the same institutions (in public breeding programs, *ex situ* conservation centers and organic programs) and there is often cross-pollination of ideas that occur between individuals growing

[2] GE also known as genetically modified or GMO. I am purposefully using the term GE and explain why near the end of my introduction in the section outlining the Organic Section of this thesis.

and maintaining these different types of corn. Alternative corn production exists right next to conventional corn production – in the same "fields" – even as it tries to distance itself from it, challenge it and even replace it.

The questions guiding my research project were: How are farmers, breeders, plant scientists, and gardeners in the American Corn Belt growing and maintaining their heirloom corn and how do they see their projects within the field of industrial dominant corn production and alternative corn production. To answer these questions, I used ethnographic methods and interviews to examine and describe their work through an understanding of seed saving, marginal spaces, and multispecies ethnography. Through their seed saving and breeding projects we see how their goals, practices and visions of sustainability are shaped by the continuing cross-pollination of ideas and practices between dominant and alternative corn production systems in Wisconsin, Illinois and Iowa.

Seed Saving in Anthropology

For anthropologists, Mexico is an attractive place to study the traditions and practices surrounding corn because the crop has been cultivated here for thousands of years. It is also what plant scientists would call both a center of crop origin, and a center of corn diversity. Elizabeth Fitting studied the way campesinos in the Mexican countryside were contesting the introduction of GE corn varieties and the effects of neoliberal corn regimes on campesino livelihood (2011).[3] Her study captured the way corn's value changes in the post-NAFTA Mexican countryside and the negative implications this has for the prospects of campesinos and the rare varieties of corn

[3] Campesinos are Latin American rural peasants but the identity is becoming complicated by neoliberal work relations that have pushed many self-identified campesinos into commercial farming or wage labor (Fitting 2011:24) Fitting discusses the re-working of this identity in the wake of the neoliberal trade agreements and the ways it is being invoked as an identity of protest (ibid: 24).

that depend on them (Fitting 2011:11).[4] John Hartigan, on the other hand, studied plant scientists in Mexico, as they worked on mapping the corn genome (2017). His study highlighted the way that the researchers' subjects shaped the way they viewed the world and also how human domesticates shaped ideas about race and species (2011: xiv).Both of these studies examine the contemporary lives of people growing and maintaining corn, one in the fields of the campesinos and the other in the laboratory. Mexico is an important site for corn, it is considered the site of domestication and it is an agrobiodiversity hotspot, or as many plant scientists call it: a Vavilov Center.

Vavilov Centers are named for Nikolay Vavilov, a Russian plant scientist who identified these places of domestication and diversity for crops across the world and established one of the first modern seed banks in Russian before World War II (Nabhan 2009). Interest around Vavilov Centers has intensified as modern crop varieties and farming practices have been exported worldwide – replacing traditional practices and varieties. The loss of traditional crop varieties in Vavilov Centers represents a threat to the reservoirs of genetic diversity which are the basis of modern breeding projects. The loss of genetic material– called genetic erosion – is seen as a threat to continued food system sustainability (especially as climate change continues to progress) and is an issue of interest to plant scientists, social scientists and policy makers. Ethnographic researchers report that in many areas where farmers adopt modern crop varieties many of them continue to cultivate traditional and "old timey" varieties in the margins of their fields or in their gardens (Brush 2004; Nazarea 2005; Zimmerer 1996). These findings do not

[4] NAFTA is the North American Free Trade Agreement and it is a trade liberalization policy that opened up Mexico to the neoliberal corn regime (dominant corn paradigm that exists in the American Corn Belt) (Fitting 2011). Trade liberalization is key feature of neoliberalism where nation states make it easier for corporations to work across borders and gain access to purchasing and labor markets.

suggest that genetic erosion is not a problem, just that there is more resilience than previously thought.

Stephen Brush looks at Vavilov centers worldwide for major crop varieties and sees that it is the heterogeneity of farming systems in those locations that limit the effects of genetic erosion and preserves traditional varieties because modern varieties simply do not fit into or make sense in those more specific farming contexts (2004: 174). These heterogeneous – marginal – systems, maintained by small farmers, create resistance to genetic erosion; that leads Brush to determine that progression of genetic erosion is highly determined by context and thus requires more research (ibid: 174).

The American Corn Belt is not a Vavilov Center. In contrast, it is the birthplace of industrialization of corn production and modern varieties including hybrids and GE varieties. This area is the archetypal example of agrobiodiversity loss – where modern hybrid varieties have been widely adopted to replace traditional varieties – that has informed theories on the progression of genetic erosion. Brush and Virginia Nazarea have both conducted ethnographic research that shows that genetic erosion, agrobiodiversity loss and conservation are more heterogenous than previously theorized and that the margins, places on the edge of political and economic influence and production, can serve as harbors for diverse farming systems and diverse varieties of crops even under pressure from homogenizing forces (Brush 2004; Nazarea 2005)

In the United States, where industrial food system dominates, conservationists (including anthropologists) have been trying to help build alternatives. Campbell and Veteto, for example, have been facilitating and bolstering seed saving networks to help foster "food sovereignty based in place-based bio-cultural heritage" (2015: 461). They are putting into action what anthropologists already know about the benefits of homogenous farming systems and becoming

active participants in seed exchange networks to help slow genetic erosion and building resistance.

In *Heirloom Seeds and their Keepers: Marginality and Memory in the Conservation of Biological Diversity* Virginia Nazarea observes how backyard gardeners and Seed Savers in the American South produce a powerful force of cultural and biological conservation by simply propagating plants that they enjoy (2005). "My objective in this book is to illuminate seed saver gardens as repositories of ambiguities and alternatives that can effectively counteract homogenization and avert cultural and genetic erosion" (ibid: 16). Nazarea agrees with Brush that anthropologists need to continue to examine seed savers to better understand resistance to genetic erosion and agrobiodiversity conservation but states that anthropologists need to study seed savers as "actors in the field" instead of just examining them as "heterogenous farming systems" if we are going to gain a greater understanding of what makes seed saving practices so resilient (ibid: 19-20).

As it was noted above, reports of seed saving and growing traditional varieties in the margins of mainstream industrial farming systems is widely reported (Brush 2004, Nazarea 2005, Zimmerer 1996). To Nazarea, the margins allow "for the less integrated to hold their own," and provide an opportunity to expand that marginal space even when pressured by homogenizing forces, such as industrialization of agriculture (ibid:14). Examining and identifying the margins and how seed savers occupy them and keep doing what they do in those spaces becomes an interesting question. Nazarea prompts researchers to pay attention to the hardships that marginality causes for people and how they negotiate between "marginality and mainstreaming" (2005: 156). I utilize Nazarea's concepts of "actors in the field" to frame my examination of the farmers, breeders, seed savers and plant scientists I encountered. My

informants gave me insights into their actions, their practices and their projects but they also laid out for me their different visions of sustainability

Methods

My study started at Seed Savers Exchange in the Preservation Department with my internship in 2015. My goal was to try and understand how the department at Seed Savers Exchange was maintaining their collection and how the people who worked in that department understood the work they were doing. My primary task as an intern was to help with hand pollinating corn but I also did a round robin of other tasks throughout the Preservation Department. This gave me a better understanding of their collection, how it was being managed and how the Preservation Department was encouraging members of the Exchange to interact with their collection.

By being a member of the hand pollination team, I was able to see how care of the corn collection was being conducted that year and the different factors that influenced it. The plant scientists who work in the Preservation Department employed and discussed a range of seed saving techniques to best maintain the varieties in their care. Those negotiation of these techniques and discussion of their goals demonstrates a distinct understanding of what it means to maintain their heirloom corn by preserving the genetic integrity of each variety. During this period of research, I got to know a few of the employees at Seed Savers Exchange very well and we discussed their home gardening projects and seed saving endeavors. This allowed me to see a difference in the way they practiced seed saving at work and at home and to compare what aspects of the plants they valued in these different places.

My internship lasted from May to August 2015 and I worked in the Preservation Department five days a week for the majority of that time. Going through my day I would work with members of the Preservation Department and ask them questions about their work and how they understood what they were doing in the larger context of agricultural work and conservation. Participating gave me a greater understanding of the work because much of it was physically intensive, repetitive, or both! It is one thing to know the process of hand pollinating corn or setting up large isolation cages, but it is another to do that work and gain an understanding into the physicality of it. After hand pollinating corn for a summer, I didn't have to ask my other informants why they decided to try less conservative methods of isolation that required less hands on work.

My continuing education in the Museum Studies program at the University of Wisconsin - Milwaukee helped me understand the work at Seed Savers Exchange as museum work and gave me a frame of reference for understanding the care of their collection. Here museum work refers to collections care and maintaining the connection between that collection and the public through access and educational programming. The staff in the Preservation Department had a very open-door policy and purposefully encouraged access to their collection and their facilities. After my courses in collections care I was able to more fully appreciate the unique collection at Seed Savers Exchange and the specific demands that were placed on the Preservation Staff.

Corn became the main crop that I focused on for a few reasons. I opted to narrow my study down by crop type because different crop types have different seed saving practices and there are significant differences in how different crops are used and dispersed. At the end of my

field work I had the most notes on corn hand pollination and was most familiar with that crop.[5] I used corn seed saving practices as a way to anchor my study, to show how my informants negotiate the dominant and alternative realms and what they take and use from each of them. The second reason was geographic and economic. The Midwest United States sits directly within the American Corn Belt, which is where the dominant form of industrial corn production came to fruition.

After my time at in the Preservation Department at Seed Savers Exchange I wanted to know how heirloom corn was being grown outside of Seed Savers Exchange. I found farmers, gardeners and breeders who were working with heirloom corn varieties in Wisconsin and Illinois. I travelled to their farms, homes and offices to do formal interviews with them and learn about their projects, their practices and how they were using heirloom corn in their endeavors. Some of my informants identified themselves as breeders and others as farmers, or gardeners. Breeding is a specialized profession and breeders usually limit their breeding projects to a few different crop varieties. Two of my informants were corn breeders and a third was an educator who managed a breeding project. I was linked to them because they are using heirloom corn varieties as part of their breeding stock or have been connected to Seed Savers Exchange at some point. The breeders are different from the farmers, gardeners and seeds savers because their goal of their work is primarily different in two ways. First, their goal is to create new or improved varieties. A breeder takes a variety (or a few varieties) and purposefully changes it in relation to

[5] I also considered potatoes and garlic. Potatoes because of the in vitro reproduction taking place at Seed Savers Exchange, the USDA gene bank specializing in potatoes is located in Wisconsin, the anthropological focus that potatoes biodiversity has received in Peru, historical precedence of monoculture calamity (Irish potato famine) and the recent introduction of new and different potatoes to the market in the United States. Garlic because I love to eat garlic, I appreciate the way it grows and how it survives as a plant, it has a weird following among seed savers, monoculture among commercial growers is very severe, the collection of varieties from all over the world has a close connection to a member of Seed Savers Exchange.

a larger project; such as making corn that can grow well under organic conditions. Secondly, breeders distribute their seed for wider production, either by increasing their seed stock and distributing the seeds or making the varieties available to commercial seed houses who will grow and distribute the varieties. The breeders that I talked to also worked within institutions and they breeding programs were structured within the goals of those institutions. This is distinct from gardeners who produce primarily for home consumption, and farmers whose primary product is food, not necessarily seeds. In this study I have tried to let my informants self-identify their role and the role of their projects in relation to the wider context of seed saving, breeding and corn production.

My ethnographic research and interviews focused on examining the practices and views of my informants who were growing heirloom corn varieties. This research methodology let me listen to the in-depth responses and descriptions given to my by my informants. It also allowed them to describe their practices, their projects and concerns surrounding them in their own terms. My time at Seed Savers Exchange also let me become immersed in the practices of hand pollination and the routine maintenance of their biological collection. The familiarity with everyday life makes it easier to recognize and understand the implications of events and disruptions. My example of one such disruption at Seed Savers Exchange was when we found "pod corn" in with one of the varieties and the reaction that the staff had to that event. The limitations of these methods are that findings are not always generalizable because the researcher is describing a unique emergence or community and the sets of relationships they exist in.

My analysis and framing of my research has been influenced mainly by Virginia Nazarea's discussion of seed saving in the margins and viewing seed savers as "actors in the field" (2004). Many of my informants discussed how they see their work and their projects in

relation to the prevailing trends of industrial and alternative farming and give their own accounts of negotiating between marginality and mainstreaming. In this work I emphasize how each of my informants is an "actor in the field" and how they navigate the world of government regulations and programs, non-profit organizations, markets and a range of skill sets and knowledge needed to do the work that they do. This anthropological perspective is valuable because it clarifies the structural challenges they face, and the agency they exercise.

By allowing them to describe the world that they navigate, I also let them describe the "fields" they are acting in. To understand what my informants were telling me about their projects and the specific locations they were occupying I followed up my ethnographic research and interviews with historical research on the development of the corn industry in the Midwest, aspects of the organic and back to the land movements, and current USDA Organic corn programs. I present this research along with my ethnographic research to help contextualize the many fields in the American Corn Belt occupied by plant scientists, breeders, seed savers, farmers and gardeners.

Nazarea's use of marginality in her studies in the United States focus primarily on the gardens of seed savers in the American South (2004). Here the margins are those spaces that are out of the mainstream economic sphere of activity. In my study I start with the idea that heirloom corn (and open-pollinated corn) are marginal to hybrid and Genetically Engineered (GE) corn which make up the core of commodity corn production. From here I examine the places where heirloom corn exists and identify the marginal spaces that it occupies and how the people that grow it and incorporate these varieties into their projects maintain those marginal spaces. I preface this use of marginality with the statement that many of my informants occupied locations that were actually very close to the core of the dominant corn production and locations imbued

with wealth. For example, they were involved in institutional hybrid breeding programs, worked on large family farms that previously produced conventional corn, they had access to high-end restaurant markets in Chicago. However, they and their corn projects utilize different locations in the mainstream and the margins to support their projects.

To help make sense of the relationships between heirloom corn, open-pollinated corn, hybrid corn, genetically modified corn, and the systems of production that support them I turned to techniques used by Anna Tsing in her multispecies ethnography, *The Mushroom at the End of the World*. Tsing thinks through the Matsutake mushroom to help understand how the communities surrounding this mushroom exist in the ruins of capitalism (2015:3). To do this, Tsing utilizes multispecies ethnography by thinking about the other-than-human actors as active participants in their relationships with humans and looks more closely at the living entanglements between these beings (ibid: 4). Throughout this thesis, I show how corn is an active and willful actor in its relationship with its human cultivators. I use what I have come to understand about its reproductive strategies and how they are manipulated and controlled to understand the populations and generations of ideas that are cultivated around this plant and its production. Cross-pollination is used as a metaphor to show how ideas float from one place to another, even between the dominant and alternative corn production systems, leading to unique visions of sustainability that growers use to frame their heirloom corn growing projects and justify their maintenance of marginal spaces.

Organization:

The Creation of the Modern Corn, gives a brief overview of the history of corn in the Midwest to familiarize the reader with how the Corn Belt was formed. In this chapter, I highlight how one of my informants recalled and utilized the history of his family farm as a model for

community sustainability through intergenerational stability. Here, the family farm is introduced as a place of remembrance of an earlier time and as a foundational aspect of sustainability. This chapter also shows how corn seed saving and breeding changed from farmer bred varieties to modern breeding projects. The chapter highlights how the American Corn Belt emerged through state, university programs and farmers working together to increase the quality of their corn through a common understanding of increased production as a greater good. This chapter lays a foundation for understanding the relationship between heirloom and hybrid corn in Corn Belt and an understanding of the institutional closeness with which they exist.

The chapter on Seed Savers Exchange revolves around my time at Seed Savers Exchange in Decorah, Iowa and explores how the employees in the Preservation Department manage and maintain the heirloom corn varieties in their care. This chapter is comprised of three different sections that demonstrates different aspects of Seed Savers Exchange. The first explores the history of the organization, showing how it formed as a grassroots seed exchange forum into an "accidental seed bank." The second section details the work being done in the Preservation Department at Seed Savers Exchange and how they are working to maintain the varieties in their collection. This section looks at how the varieties in the collection are being cared for and how the Preservation Department connects the varieties in their collection to the members of the Exchange. This section gives an overview of the Preservation Department and sets up the third section on Corn Hand Pollination. The third section of this chapter concentrates on my work doing Corn Hand Pollination for the last few months of my internship. It takes a close look at isolation practices and management practices used in 2015. This section highlights the work needed to keep these varieties maintained, genetically isolated from other varieties and viable, and the negotiations that go into determining how that is done.

Throughout this section we see cross-pollination; the literal risk of cross-pollination that looms over each accession during their grow outs and metaphorical cross-pollination that has resulted from Seed Savers Exchange existing a the nexus of marginal practices and more mainstream collections practices.

In Growing and Saving Corn, I lay out the conversations that I had with heirloom corn growers in Wisconsin and Illinois. After my time in the Preservation Department at Seed Savers Exchange I wanted to go out into The Exchange and beyond– to see where these plants were being grown "in the wild." This section highlights their projects and practice and how those involved understand their place within alternative agricultural movements and mainstream corn production. This chapter highlights the cross-pollination that takes place between the mainstream and marginal corn worlds and how my informants occupy and move through mainstream and alterative production spaces. I highlight here their descriptions of maintaining the marginal spaces required for heirloom corn to grow and how they carve out space for their projects. It was through these interviews that the importance of the organic movement, USDA Organic regulation and organic corn production became apparent.

Producing Organic Corn shows how USDA Organic regulation and organic corn production is a place where we can see regulations being negotiated and new demands for different kinds of corn breeding projects emerging. The first section in this chapter provides some background on the organic movement generally and then the formation of USDA Organic regulation through the Organic Food Production Act of 1990. I provide a brief interlude where I share some of my experiences working on an organic farm in southern Wisconsin during my "gap" year. The second section of this chapter looks at three different battles within USDA organic regulation and how they are influencing corn breeding projects and how heirloom

varieties are being utilized. This section also highlights how corn breeders and farmers move their projects either into or out of the mainstream based on how they interpret with it being in line with their ethics of production. This chapter also highlights the cross-pollination that occurs in spaces when the alternative and dominant production models come together and the resultant blend that emerges from that contact.

The conclusion of this paper reviews important details gleaned from the ethnographic and interviews and sets up an explanation of how the marginality of heirloom corn production can be understood in the context of the American Corn Belt and dominant commodity corn production. The margins are formed under pressure from a homogenizing force and at the center of hybrid corn production that pressure is very high and the margins are maintained though the everyday practices of farmers, breeders, plant scientists and seed savers and their visions of sustainability formed from a continual cross-pollination of ideas between the dominant production and the alternative movement that continually critiques it.

Chapter 1:The Creation of Modern Corn

"Corn is King!" boasted Robert W. Furnas (governor of Nebraska 1873-1875) at the "World's Industrial and Cotton Centennial Exposition" in New Orleans in 1884; poking fun at wheat and prodding at the southern industrial giants cotton, tobacco, and sugar (Furnas 1886: 5). In an 1886 speech to a collection of County Agricultural Societies in Nebraska, Furnace stated – in one very long sentence – all of corn's blessings:

> "I am bold to assert the belief that among all the factors of culture in the United States, corn takes precedence in the scale of crops, as best adapted to more soils, climates and conditions; is used for more purposed; furnishes more nutritive food for man and beast; has more commercial, cultural and economic value; gives more grain to the acre than any other cereal; more fodder than any other of the grasses; puts our beef in prime order; fattens our pork; is the basis of our butter and cheese supply; furnishes immense manufacturing material; has twice the value of cotton; worth fifty per cent more than wheat; its influence on the prosperity and wealth of the United Sates is greater than that of any of any other cultivated plant; and to the transportation companies, has "millions in it."(Furnas 1886: 6)[6]

Furnace was one of many corn boosters – corn evangelists – who espoused the potential economic and social benefits of increased corn production to the American Midwest and had a hand in the formation of the American Corn Belt. As Furnace declared above, corn is versatile

[6] Furnace delivered this speech to Cass, Adams, Kearney, Seward, Johnson and Clay County Agricultural Societies in Nebraska in 1886.

and can be used as the basis for other industries which meant it was a sure sell for farmers – there would always be buyers. Furnace was looking to built and bolster the new American economy and make sure that his state was producing the raw material at the foundation of that economy. The key was to convince the farmers who owned the land to start growing corn and later make sure the farmers were growing as much as they could per acre.

This chapter examines the formation of the American Corn Belt and industrialized modern corn production. Industrial modern corn has two key features that I emphasize in this chapter. The first is the systematic and scientific breeding programs that produce the varieties and support the industry.[7] The second is the primacy of yield above all other traits.[8] The chapter highlights how the American Corn Belt emerged through state, university programs and farmers working together to increase the quality of their corn through a common understanding of increased production as a greater good. This chapter lays a foundation for understanding the relationships between heirloom and hybrid corn in Corn Belt and an understanding of the institutional closeness with which they exist.

Historian Allan G. Bouge sees the formation of the Corn Belt as one of the great human agricultural achievements and in his book, *Prairie to Corn Belt: Farming in Illinois and Iowa Prairie During the 19th Century* he examines settlement and the development of Midwestern farming after the Blackhawk War (2011). Bouge emphasizes the work of the individual pioneers,

[7] These programs are institutionalized, organized and have specific breeding goals. They function largely through reductionism – by concentrating on bringing out specific genes in populations. Searching for genes and control of genes led to breeding techniques that would produce hybrids and then to techniques that would allow for genetic engineering

[8] The primacy of yield means that breeding goals concentrated on how much each ear produced and how much could be produced per acre. The goal of the plant then is to produce as many kernels as possible and to create the largest ear possible. To facilitate this, scientists helped the plants out by taking superfluous biological duties away from the plants, such as pest resistance, the ability to soak up nutrients and the ability to outcompete weeds and allocated those duties to chemical and mechanical inputs. This left breeders free to focus on yield.

farmers and farm technology innovators, especially mechanical innovators, that contributed to this feat (2011). In this chapter I focus on innovations and changes in corn breeding. I discuss how corn varieties were kept and maintained by farmers by examining Reid's Yellow Dent – a corn variety popular in the 19th and 20th century – and then how varieties were produced by university breeding programs in Iowa and Wisconsin. Through this examination the reader will get an introduction to corn isolation and seed saving techniques and a quick history lesson on the development of hybrid corn.

My informants, and the discussion around heirloom variety corn more broadly, draws on the histories of farmers in the American Corn Belt and midwestern family farms. The early settlers and farmers played an active roll, as the farmers do now, in creating modern corn by selecting what they grew on their land and working with university and state programs. I try to include the farmers and discussion of farmer decision making that I found in the historical record. I examine the early days of the Corn Belt in Illinois, Wisconsin and Iowa to provide context for the discussion of family farms.

Spence Farm – The Oldest Family Farm in Livingston County

Spence Farm has the distinguished title of the oldest family farm in Livingston county, Illinois. When I pulled up the to the farm, I saw the family cemetery across the street, a fenced in area with one large central headstone surrounded by smaller greying, lichen covered stones. Marty Travis and I primarily talked about the corn he grows and the seeds he saves but we also talked about his thoughts on community sustainability and the importance of intergenerational opportunity within the community.

Marty Travis: "We see over and over and over again in small rural

communities, the kids will grow up, they will go off to school to college and not come back. There's not that next generation of farmers. And part of that is, you know a lot of the parents say that, ‘There's not enough land for them to make a living, you know, we farm 3,000 acres and there's just not enough land for them to make a living.’ Umm, you know, ‘There's not enough profit.’ There’s not enough this or it is too hard. You know all those things and so we began thinking about that and breaking it down and saying, Yeah but if you have, if you've got sons and daughters who want to stay in this community who want to have an opportunity, who like being outdoors and on a farm, let's figure out how they can do that. And so, we've had one family that their son started when he was eleven or twelve years old and on one acre he was making twenty thousand dollars a year on his one acre garden.

Rachel: Wow!

Marty: At twelve, thirteen years old!

Rachel: [laughs] What is he growing?

Marty: “Tomatoes and peppers and black berries and spinach and carrots and sweet potatoes and he was nailing it! And his sixteen-year-old sister now, has taken over because he has gone to school, gone to college and she has taken it over and she is doing the same thing. Amazing products, part of it is, we are looking to try to find opportunities for these kids that, if that is what they want to do or at least give them the experience of how to grow

> great food. But if they want to stay on a farm, let's give them an acre, let's give them five acres and if the dads and moms can't find five acres out of 3,000 to give their kid, that you know if the kid can make twenty thousand an acre, give em' three of four acres. They could make a living! That's a decent living.
>
> And there's ways to do that, that honor the family. That honor the soil and the land and that help build a community. That's what we are really focusing on is trying to keep those who want to stay in the community and want to have their hands involved in some kind of food production that, we have an opportunity for them to sell that." (interview with Marty Travis, August 25, 2017)

Travis sees a major part of his responsibility to help facilitate these opportunities by helping small producers in Livingston county connect to high paying markets in Chicago. For Travis, the idea of sustainability is rooted in economic opportunity and a vision of community sustainability that is built on intergenerational opportunity and continuity. Intergenerational farm ownership through land inheritance is one thing that makes a farm, a family farm. Like Travis, many advocates of alternative food systems in the Midwest use the image and history of the family farm as a model for small producer food systems and the loss of family farms as a measure of instability caused by industrial farming.

The idea and image of the family farm and its value is rooted in a history of land settlement, of immigration and independent property ownership. Many people in the Midwest can tell you about the family farm that existed in their family a generation or two ago. But as

Travis stated, the larger historical pattern in the 20th century has been that the kids leave the farm. There is an image of slow decay as the farm slowly declines and is eventually sold off.

For Spence Farm their identification as a family farm recalls their roots and the history of the community in Livingston County. Travis, an established wood worker, has been restoring historical buildings on the property and during our conversation we went into an old schoolhouse on the property– small old-fashioned desks sat in the corner and a wood burning stove stood at one end. It reminded me of a schoolhouse I went to on a field trip in third grade; we learned about life of children in the 1800s by playing as students in a reconstructed environment, my favorite part was ringing the old bell. The farm itself is used as a teaching tool to recall a history of small farms in the county dating back to 1830 when the farm was established. The first thing that you will see on the farm's website is the following paragraph about the history of the farm: "In 1830, our fourth great-grandfather Valentine Darnall came to Illinois from Kentucky. He bought 160 acres from the government for $1.25 an acre. By the late 1800's, his grandson Malachi Martin Spence was in charge of the farm business and the land comprised nearly 1,000 acres. There were 36 buildings on the property including barns, sheds, milk houses, chicken houses, and tenant houses." (Spence-Farm LLC 2018). While painting a picture of intergenerational continuity, the statement also reveals changes that occurred between 1830 and the late 1890s. In the span of two generations the family acquired 1,000 acres, there were buildings, and they had tenants!

The image of the pioneer, the settler and the family farm are all wound together to recall an idea of American self-sufficiency on par with the western explorers and cowboys. This image of the pioneer and the family farm is utilized by homesteaders, seed savers and farmers to recall a heritage of production and a relationship with the land. Interestingly, the image of the pioneer

and the Midwestern farmer is also used to signify developers and adopters of technological innovation. For example, the first hybrid corn company was named Pioneer. The following section examines the historical record in Livingston County, the beginnings of Spence Farm and development of the American Corn Belt. This historical vignette is meant to ground the conversation on the development of Corn Belt (give us a starting point) and give the reader a vision of the land and the times that is often recalled and used in modern discourses.

From a "Barren Waste" to a Kingdom for Corn

"In the Fall of 1830, a single emigrant wagon drew up at the head of the grove of timber, afterward named by the whites Indian Grove, and the owner of the wagon, or "prairie schooner," as the big "covered wagons" of the emigrants were sometimes called, proceeded to pitch his tent on the banks of Indian Creek, which has its source in the vicinity. This early pioneer was Valentine Martin Darnall, recognized as the first actual settler of [Livingston County]" (Le Baron 1878:351). The winter of 1830 was harsh in Livingston county and it was not long after Darnall built his cabin in Indian Grove that he was forced to make his way back to his house in Pleasant Hill where his wife and four children were living along with the livestock (Le Baron 1878: 350). Darnall lived into his eighties and the smoke house that he made (without using any nails) was still standing in 1878 (ibid: 352)

Livingston County, Illinois was sparsely populated by white settlers in the early 1800s primarily because it was mostly prairie which was considered undesirable. Darnall and other southern settlers from Virginia, Tennessee and Kentucky, first settled in Indian Grove – a wooded strip along the river named for a band of Kickapoo who were very recent previous inhabitants of the grove (Bouge 2011: 8). Wooded areas were desired because they provided wind breaks, fuel and building materials. Additionally, in the early 1800s, there was some

controversy about how to tell the fertility of soil and some conventional knowledge was that fertility could be predicted by the types of trees that grew there – so the prairie, lacking trees, might be considered less fertile (ibid: 7). “Mr. Darnall says that, when he settled in the country, he entertained not the remotest idea of ever living to see a settlement made on the prairie” (Le Baron 1878:354). In the 1850’s, one man from Pennsylvania (considered a lunatic by the local townsfolks) did settled in the “barren waste,”– but then “got disgusted and left it” (ibid:354).

The vision of the prairie as a “barren waste” would soon change and the fertility held in the deep perennial root systems of the prairie grasses would be used to start growing small plots of corn. Corn production in the early 1800s was greatly constrained by the physical labor required to plow the fields and plant the crops, everything was done by hand. Planting corn was called “dropping” and consisted of dropping individual seeds into rows and covering them with a hoe (Le Baron 1878: 276). It was considered suitable work for school-aged children with bendy, resilient backs: “The ancient farmer who was so unfortunate to have no grist of children was in a bad row of stumps” (Le Baron 1878: 276).

By the late 1870’s the corn belt was already forming and in Indian Grove Township, corn was the main crop and it was grown in “immense quantities [that] would probably equal the entire crops of the Nile-washed lands of Egypt” (ibid: 336). The rise in corn production was multifaceted but two major factors were the development of markets in Chicago and the revolutionary innovations such as mechanical corn planters and the John Deere steel plow (Le Baron 1878: 276; Bogue 2011: 149). The John Deere steel plow was a solution to farming corn on the prairie because the fine prairie soil did not stick to it like it did to other plows (Bouge 2011: 149). Freeing the farmer from stopping and clean his plow every few steps. Mechanical innovation greatly reduced the amount of physical labor needed and increased the number of

acres that could be farmed. This would have helped farmers who were already well established, such as Darnall's daughter Mary, her husband William Spence and their children, including Martin Malachi Spence, in expanding their acreage from beyond the wooded lots out into the prairies (Le Baron 1878: 790).

Indian Grove Township and Livingston County were on the eastern most side of the territory opened up for white settlers after the Black Hawk War. The Black Hawk War was a conflict that took place in the summer of 1832 between a band of Sauk led by Black Sparrow Hawk and American forces including the Illinois militia (Wisconsin Historical Society 2019). Black Hawk and his followers had been re-settled west of the Mississippi in 1829 by a government order (ibid). In the re-settled location, they experienced severe food shortages and Black Hawk and a group of 1,200 men, women, and children decided to move back to their village east of the river to harvest their corn and were met by the Illinois militia and U.S. government troops (ibid). The war, which was really more a series of retreats, ended in Bad Axe, Wisconsin.[9] There Black Hawk and his group of men, women and children retreated over the Mississippi and attempted to surrender but were fired upon by an armored steamboat and then slaughtered by Sioux combatants on the western bank of the river (ibid). Of the 1,200 originally in the group only about 150 survived. This conflict ended any ambiguity about the spaces that were being opened up to settlers and where native American groups in the area would be tolerated.

Settlers and farmers were moving west in large numbers in the mid-19th century and the number of individually owned farm units in Illinois and Iowa steadily rose until 1900 before the number started to decline (Bouge 2011: 12). Farming successes and failures were both prevalent

[9] Bad Axe, Wisconsin, has since been re-named Genoa, Wisconsin, after the birthplace of Christopher Columbus by the immigrants who settled there, many who were from northern Italy.

in this newly opened territory, but particular personal stories of the success were important to attracting European immigrants:

> "[…] most important [to the number of immigrants] were the "American letters" which poured into old European communities, telling people of the good life in America Frequently printed in old country newspapers, such testimonials from old friends and acquaintances carried a conviction that the advertising of land-grant railroads could hardly equal" (2011, 18).

Between 1830 and 1900 the prairies, grasslands and woodlands of Iowa and Illinois were shaped into farm lands: unwanted flora and fauna removed, tilled, connected and occupied. All the work was done by the surge of immigrants, many of whom were starting to grow more corn. One reason was corn was considered a good beginner crop for new, poor farmers with a small amount of land because startup costs were low when compared to beef or hogs (Le Baron 1878: 278). Another was growing demand for corn by other industries.

The 1860's were a tumultuous time for the United States - the Civil War raged and threatened to tear the country in two - but this was a fortuitous time for many Midwestern farmers. Increased food demands by Union troops and the hay day of the "Land Whale Era" (hogs were being processed for lamp oil) meant that there was a consistent market for their hogs (Fussell 1992: 73). With the help of railroads, increased processing in Cincinnati and then Chicago and increasing international trade, many farmers in Illinois and Iowa started to increase the number of hogs that they raised and also started to increase the amount of corn they grew to feed it to those hogs (Fussell 1992: 73; Bogue 2011: 281). After the Civil War an agricultural depression began that would continue until 1890s; during this time some Midwestern farmers fell

on hard times, others prospered tremendously and the price of hogs stayed relatively stable – making acres dedicated to corn production a sound investment (Bouge 2011: 283).

Robert Furnace and other statesmen could see that corn was going to be a major staple in the new industrial economy and it was important for their states to play a roll in that in whatever way they could. The land was transformed into a "kingdom for corn" and the immigrant farmers and their families were the dynamos responsible for shaping the land. With new states interested in increasing their production, a different kind of pioneering began to dominate the landscape – the application of western science to plant breeding.[10]

Modern Industrial Corn: Creating Modern Corn and Hybrids:

In 1893 Reid's Yellow Dent – a mixture of a Northern Flint corn and a Southern Gourdseed first developed in the 1850s – won the grand-prize at the Chicago's World's Fair for being the world's most beautiful corn (Fussell 1992: 73). The title, "most beautiful corn," tells us how corn was being judged at the time – by the appraisal of the corn's physical traits. This section highlights the changing way corn was appraised, and the changing way it was bred and produced. Reid's Yellow Dent was adopted by many farmers across the Midwest between the 1890s and 1920s and many farmers to drop varieties they had been growing for years (ibid: 86).

Reid's Yellow Dent was a mixture of two distinct types of corn (sometimes referred to as landraces or races of corn) that developed in distinct geographic locations with certain sets of traits. Reid's Yellow Dent was not a variety like we think of a variety it today, that would be produced by a seed company and purchased each year. Reid's Yellow Dent was a general type of

[10] There were also many large events that had corn at their center, corn shows were held, corn palaces were created to show off the bounty of the community and corn husking competitions were popular annual events. The immense culture of corn is not something I have time to go into here but it is immensely interesting and a rich field of study.

corn that was grown by many farmers across the United States after it was developed in the 1850s (ibid, 74). An excerpt from a publication from Ames Experimentation Station in Iowa from 1913 explains this well:

> "[…] a grower may take any variety of corn, Reid's Yellow Dent for example, and by persistent selection along certain lines [seed saving] so change its general type in a few years that the average grower of Reid's Yellow Dent will not recognize it as of this variety. And just so we have in Iowa hundreds of strains of Reid's Yellow Dent Corn. While most of these resemble each other in certain respects, many have, through the years of selection in adapting them to grow under special conditions, or to meet certain ideals, been so changed from the original type as to be quite unrecognizable. And yet all these strains go under the common name Reid's Yellow Dent corn." (Hughes 1913,92)

Farmers growing Reid's Yellow Dent selected and saved their own seed each year which caused variation between farms. Reid's Yellow Dent did replace many older varieties that farmers had grown for many years and had possibly received from neighbors and family members. But it was being saved from year to year and farmers manipulated and personalized their varieties through yearly selection to suit their preferences and growing conditions. Reid's Yellow Dent was not the only corn that was being grown at the time; Silver King was a type of white corn that matured quickly and was well suited to the shorter growing season in northern Iowa and Wisconsin. The production and distribution of this variety by the Iowa Agricultural

Experimentation Station shows how this system was working at the beginning of the 20th century.[11]

The Farm Crops division of the Experimentation Station located in Ames, Iowa was tasked with evaluating, developing and distributing corn to farmers that would do well in Iowa (Hughes 1913: 75).[12] H. D. Hughes was the Chief of this division and recounts how Silver King was chosen by surveying farmers in northern Iowa and by reviewing nation-wide contests where it had won awards as early as 1884 (ibid: 78, 79). In the 1870s, Silver King was created by a corn breeder named H.J. Goddard in Fort Atkinson, Iowa and Goddard bred the corn to mature early, to produce less stalks with more ears and to have a higher yield (ibid: 79). The variety was passed on to other corn breeders and farmers across Iowa, Wisconsin and even Ontario and started to win more and more contests gaining notoriety (ibid: 81-83). In 1904, the Agricultural Experimental Station located in Madison, Wisconsin, started to produce seed for Wisconsin No. 7 – a strain of Silver King specifically for Wisconsin farmers (ibid: 86). The Experimental Station set up 1,200 seed production centers across the state to start adapting the strain to Wisconsin conditions and producing enough seed to supply farmers (ibid: 85).

The Iowa station started their Silver King breeding project in 1910 and built up their breeding stock by selecting the best ears from breeders and farmers across the state (ibid: 87).

[11] Hughes's description of the distribution of Silver King indicates that it was being given (not sold) to farmers so the farmers could try the varieties and compare them to their current crops (Hughes 1913:91). It is unclear how the university distributed their pedigree varieties later (if seed way being sold or given away). During this time the crops were still experimental and being grown to increase overall seed stocks.

[12] Experimental Stations operate out of land grant universities to help fulfill their charge of conducting public agricultural research. Many of the agricultural experiment stations started with the 1862 Morrill Act but were not fully tasked with their research duties until the 1887 Hatch Act which opened up more research funds administered by the USDA (Committee on the Future of the Colleges of Agriculture in the Land Grant University System 1995). In 1914 the Smith-Lever Act established the Extension system which is responsible for distributing knowledge and findings to the public (ibid:8).Land grant universities, their Experimental Stations and Extension programs have been key players in developing the American Corn Belt by connecting farmers and researchers along with state and federal goals.

The stock of ears was narrowed down to 300 total ears and corn was grown from these ears at three different farms in Iowa. Here the corn was selected further for traits such as number of non-productive stalks, percentage of ears that filled out all the way, strength of the stalk, and height and placement of the ear (ibid: 89). What the breeders were looking for was uniformity in these specific traits before they would start to increase their seed stock and start distributing it to farmers across Iowa. Hughes stated that by 1913 the Experimental Station in Ames had over 150 bushels of pedigree Silver King and some was going out to farmers – to grow and compare for superiority with the varieties they were currently growing – and some was going to be grown to increase their stores so they had more to offer farmers the next year (ibid: 91).

Hughes stated in his report that even though they were introducing these new and improved varieties to farmers, the locally grown and adapted varieties were actually preferable to introduced varieties (ibid: 91). He explains:

> "In looking for better varieties of corn, it must be remembered that extensive and oftrepeated tests have established that seed corn grown in the community in which it is to be planted is wholly preferable to imported seed. It is very likely that if the best of these local varieties could be had for general planting into the community that the problem could in this way, best be solved. Too often, however, men with really good corn do not select more seed than they need and very often their neighbors would not appreciate the quality of their corn, even if available" (Hughes 1913: 91).

Hughes points to quantity of locally adapted seeds as an issue: farmers with good seed are not always making and saving enough to share with their neighbors. While stating that local varieties are preferable, Hughes also states that there are strains or varieties that are simply better than others – as corn shows and judging had shown for many years - and it is preferable if those

varieties are adopted by the farmers in that area to increase quality and quantity of corn produced. Hughes addressed farmers resisting adopting their neighbor's varieties, or "not appreciate[ing] the quality of their corn," even if it has been proven or judged as superior (ibid: 91). This issue is interesting because it hints at the farmers who were more resistant to giving up their varieties initially – or more specifically would not want to give up their varieties for their neighbors. Hughes points out these main problems with utilizing the local varieties to increase overall production. The Experimental Station that he worked for was working to solve these problems by finding the highest quality corn in different communities, creating pedigree varieties, producing large amounts of seed and distributing these varieties for farmers to try for themselves. The Experimental Station was tasked with creating corn that could be appreciated by farmers across the state and would be more likely to be adopted by them to reach the goal of increasing production in Iowa.

The examples of Silver King and Reid's Yellow Dent show how corn was being grown during the late 19th and early 20th century in the Corn Belt and how breeding programs were developing. Farmers were primarily selecting and saving their seed from year to year. Corn contests were influential sites used to identify varieties that were superior in some way – the exact qualities vary and were primarily based on the qualities of the ear after harvest. Specific varieties were being developed and introduced through state and federal programs aimed at increasing corn production in the Corn Belt and these varieties were distributed to farmers for them to use.[13] These varieties would then be grown, selected and saved by the farmers.

[13] It remains unclear from my sources if these varieties were being sold or given away to farmers. As it was stated in the previous footnote, it seems like in the early days of experimental production the varieties were given to a small number of farmers for them to grow and compare to their own varieties to build up its reputation and to possibly increase seed stocks for further distribution.

At the beginning of the 20th century The American Corn Belt was well established and fully immersed in the zeitgeist of better genetics, production and manufacturing. There had been strides in production and distribution of certain varieties, but the majority of seed keeping was still being done by farmers in their fields. The farmers selected their seed stock from plants that they thought did well that year and changed the population a little bit each year. Specialized plant breeders would become increasingly important to creating strains of more productive corn as the science of genetics began to develop and was applied to plant breeding techniques.

Charles Darwin dabbled in artificial selection in addition to natural selection and in 1876 he published a book espousing the value of "hybrid vigor" based on experiments that he did using corn (Fussell 1993: 71). Corn is an ideal plant for breeding experiments because the male and female parts of the flower (pollen producing and pollen receiving parts respectively) are separate from one another. The male part is called the tassel and is on top of the plant and the female part of flower is the ear, the part that you eat. This means that the two parts can be easily isolated from one another.

At the Michigan Agricultural College in 1877, William James Beal created a system of bagging and controlled pollination (that author Betty Fussell described as being "as cumbersome as safe sex") that allowed him to create isolated breeding lines that could be crossed when desired to produce hybrids (ibid: 71). Before this process of bagging, controlling pollination and mixing varieties was done by proximity – growing two varieties next to each other and letting them intermingle. This is how Reid's Yellow Dent corn was created, two corn varieties

happening to be next to one another, that happened to produce very productive offspring. Beal gave scientists and breeders a way to exercise control over the pollination of individual plants.[14]

Discoveries in genetics in the 1900s led to modern plant breeding projects which focus on identifying and amplifying desired genes within a population to make a more perfect organism (Wilkes 1988:73). Plant breeding went from a wishy-washy process based on subjective decisions to one that could be precisely controlled by finding the genes that determine desired traits. Genetics allowed corn breeders something tangible to look for within populations and experiments in breeding revealed the techniques to do just that.

Highlighting the importance of the scientific experiment to improvement of crop production is the story of sixteen-year-old Henry A. Wallace. Wallace grew up around farmers, plant breeders, professors and politicians in Iowa at the turn of the century. He grew up following botanist George Washington Carver around on plant collecting expeditions for Iowa State College and doing things like attending lectures on appraising corn – he was considered a bit of an odd child (Brown 1983: 168). At the tender age of sixteen, he asked Professor Holden, the famous corn evangelist and friend of his grandfather, how you can know for certain that the appraised corn will indeed yield the most and best corn? (Crabbe 1947: 144). The young Wallace was not convinced by any of the answers that were given to him by Holden or his father and he was encouraged to test it out for himself by growing the blue-ribbon wining corn, some close contenders and the losing corn and measuring the results (ibid: 145). Wallace's experiment in 1904 found very little correlation between the appraisal of the corn and actual yield – many of the top corn varieties actually yielded less than average. This marked the beginning of his work

[14] Beal's process of bagging to isolate corn is still in use today and is the isolation process used to keep the heirloom corn varieties pure during their grow outs at Seed Savers Exchange.

as a corn breeder, an advocate for yield tests and a vocal critic of corn shows (ibid: 145; Fussell 1993: 73). The story of this sixteen-year-old boy was remembered because Henry A. Wallace would go on to become the Secretary of Agriculture, Vice President of the United States and the founder of Pioneer seed company. His path from the odd child attending lectures about corn to these prestigious roles is well documented and can be used as a reference point to understand the development of hybrid-corn in the Corn Belt during the early 1900s.[15]

After his initial experiment in 1904, Wallace continued growing corn over many seasons and in 1913 he started experiments with hybrid corn (Brown 1983: 170). Breeders and scientists were equipped with the ideas of hybrid vigor, a knowledge of how genes influence traits and are passed down, and isolation techniques to control the flow of genetic traits. Their goal was to create stable breeding lines that could be crossed with one another to reliably create vigorous and productive hybrid offspring (Crabbe 1947: xvii).[16] If Reid's Yellow Dent was a vigorous variety created through a happy meeting of two varieties in the farmer's field, then breeders were looking to increase the likelihood of these happy coincidences and make them predictable and replicable. The key to making the breeding stock more predictable was to reduce variation in the lines you were crossing. As Professor Hughes from the Iowa Experimentation center explained:

> "In developing hybrid corn we have searched through our old open pollinated corn and selected outstanding individual plants to serve as parent stock. This parent stock has been purified by self-fertilization, which we usually call

[15] What is also interesting about the way that Wallace's story is told is the way his experiment as a sixteen-year old boy sets the stage for the Corn Yield Tests and the rise of scientific authority in plant breeding. It has an almost Biblical vibe to it with the young prophet challenging the conventional wisdom of the institution before going on to help construct an entire new following of his own.

[16] Inbreeding, breeding a plant to itself, is a way to isolate the genetics in that plant so they don't get all scrambled up with another plant. This allows for certain traits to be made more prevalent within a population. For breeders this was a way to isolate or uncover specific genetic traits unique to a certain population.

> selfing or inbreeding. After a satisfactory degree of purification is achieved, we refer to this parent stock as an inbred. These inbreds are used exclusively as breeding stock in producing the good hybrids planted by our farmers." (Crabbe 1947: xvi).

However, Wallace's experiments in making hybrids were variable and he considered the process of making hybrids to be too labor intensive to be worth the work (Crabbe 1947: 146). The first problem that Wallace and other corn breeders were running into was that not all inbred when crossed created a hybrid with the desirable amount of vigor, the breeders had to find just the right crosses and this is the most time consuming and laborious part of hybrid-breeding (Smith and Pratt 2019: 13,16). The second problem came from isolating the corn to make the hybrid cross. Isolating corn and making controlled crosses on a small experimental level could be done using bagging and hand pollination but increasing the scale to production required more labor and different techniques. The third problem was that even when a good cross was made, it was difficult to produce enough seed to supply farmers each year because the inbred lines suffered from inbreeding depression – they were funny looking little plants with very low yield (ibid, 11:38).Even with his doubt about their large scale potential, Wallace continued to use his families publication, *Wallace's Farmer*, to discuss hybrid breeding projects and to criticize corn shows that appraised corn exclusively on the appearance of the ear (ibid, 145; Brown 1983, 170). On more than one occasion he challenged the winner of a corn show to a "grow off" between their corn and one of his hybrids:

> "[…] one of Wallace's delights was to take one of his inbred nubbins that had been crossed with another so that when planted it would produce a vigorous single cross hybrid and suggested to the winner of the [blue ribbon at the corn show] that his runty,

twisted little ear would, if planted, produce a better crop of corn next year than the big beautiful ears in his winning corn show exhibit." (Crabbe 1947, 145)

The idea that a runty ill-looking "inbred nubbin" would actually hold the genetics that would create a big productive crop of corn the next year was counterintuitive to the corn show and seed saving logic which dealt with the appraisal of phenotypes. The "pretty" corn shows and their logic started to wane as hybrids – with their hidden genetic factors – started to gain momentum. Wallace and Iowa State Professor H. D. Hughes started the Iowa Corn Yield Contest in 1920 and within a few years it was the dominant corn competition in the state and would become the main venue for comparing older farm raised varieties with new hybrid varieties (Crabbe 1947: 148).[17] The Iowa Corn Yield Contest really changed the appraisal of corn and the ways corn populations were thought about. The "beautiful corn" was about the phenotypic evaluation but it was also about the evaluation of the variety as a stable, predictable and productive population that reliably generated these excellent, beautiful individuals. The reliability of the variety, its intergenerational potential was also being evaluated, so the farmer could be sure that he would get a good crop each year. The switch to hybrid corn meant that evaluation of the variety was decreased to a single generation. Instead of relying on the intergenerational potential of the population and their own seed saving skills, the farmers were relying on and buying into the reliability of the producers of hybrid corn seeds to supply them with productive, good seed each year.

Wallace continued to exchange ideas and seeds with farmers, college educated folks working for land grant institutes, and breeders working at experimental stations set up by the USDA

[17] Like the previous corn shows, the Iowa Corn Yield Contest was used by breeders to identify the most productive farm raised varieties (open-pollinated) that could be used in their breeding projects. Farmers would also attend these events, hear about the results, and sometimes pick up a new variety.

(Brown 1983: 172). As corn breeding programs were established, there was a constant flow of seeds, experimentation, and communication between private seed breeders and public programs (ibid: 172). At the Connecticut Experimental Station, Douglas Jones started conducting experiments with Double Cross Hybrids that would be the key to hybrid-corn commercialization and the domination of modern corn in the 20th century (Crabbe, 147). Even as Wallace had his doubts about the future of hybrid corn, he created a double cross hybrid called Copper Cross which helped pave the way for his seed company that would grow into the agrobuisness giant, Pioneer Hi-Bred International, Inc. Corn was the first cereal to use hybrid seeds in widespread commercial use in 1933 and by 1941 almost all of the corn produced in Iowa was hybrid corn (Warman 2003, 180-181).

Conclusion

This section introduced a few story lines, a few threads, that continue through the rest of this thesis. First, it introduced the image of the pioneer and the family farm that are often recalled and remembered by many farmers and seeds savers as part of their heritage. These complicated ideas about this heritage are woven throughout the next few chapters being recalled, remember and informing ideas about production.

Second, it shows a history of farmer bred corn (now referred to as heirloom corn) and hybrid corn in the American Corn Belt. I wanted to highlight the beginnings of hybrid production and how evaluation of crops changed from the county fair corn shows to the Iowa Yield Test. The objective evaluation of yield per acre became the dominant force driving hybrid production and the commercialization of seed production. This thread sets the stage for the response from the alternative agricultural movements in the next chapter and foreshadows the effect that genetic engineering will have on the commercial seed industry and the alternative farming movements.

The third story line concerns the American Corn Belt as a contextualized place of entangled growth and of domination and resistance; this challenges the idea that the American Corn Belt should be used as a general model of genetic "wipe out." The American Corn Belt is sometimes used as a model of agrobiodiversity loss, which predicts a wholesale flip from old, traditional varieties to improved varieties once the new ones are introduced (Brush 2005, 154). Instead of seeing the American Corn Belt as a deterministic progressive model, it should instead be understood as emerging out of a very particular historical and cultural context (Warman 2003, 180-181). The history of the American Corn Belt, the family farm and the creation of modern industrial corn grew together and are entwined. The corn boom, which was a very big boom, in the Midwest could not have happened without the simultaneous action of military action removing indigenous populations, immigration, settlement of the prairie, and industrialization of food production.

The creation of modern hybrid corn through specialized breeding programs was made possible because of state interest, corn shows and contests, and because of the seed saving practices of a multitude of individual farmers. The plant scientists in the young university programs had access to a plethora of distinct corn varieties that they could evaluate and use as breeding stock for their new varieties right as the science of genetics was starting to be explored. It is also during this time period that we see the growing relationship between individual family farms, university programs and state government programs – a network of production that is part of farming and agricultural heritage as well.

This is not meant to belittle the immense amount of loss that has occurred under the current industrial agricultural paradigm but to highlight and contextualize the specific conditions that set the stage for the dominant paradigm and resistance to that paradigm. The majority of

farmers switched to hybrid corn and the landscape of the American Corn Belt is now dominated by monocropping industrial farms. However, many farmers and people in the Midwest kept older varieties and still work through the same networks of production (state universities and government agricultural programs) to negotiate and challenge the ideas about modern industrial agriculture. For many people keeping older corn varieties, Seed Savers Exchange offered them another place to bring their seeds, a place to find new ones, and a place to bring their thoughts and arguments about the dominant food production paradigm.

Chapter 2: Seed Savers Exchange

A History of Seed Savers Exchange

Seed Savers Exchange has built a name for themselves through a legacy of saving and exchanging rare and endangered garden varieties for over forty years. Currently the organization manages a large seed bank with over 20,000 accessions, publishes a commercial seed catalog and the yearbook for the Exchange, provides seed saving educational materials, and assists other seed saving organizations all over the world. The organization started as a small "mom and pop" shop and grew in spurts through a mixture of well-timed partnerships, financial opportunities, and organizational goals that grew the organization into a central point of heirloom conservation in the United States.

Diane Ott Whealy and Kent Whealy started The Exchange and Seed Savers Exchange organization in the late 1970s. The creation of this organization developed from a specific set of beliefs, experiences and talents of these two individuals that made Seed Savers Exchange possible. In her memoir, Diane describes her early years meeting Kent and living in Colorado, Oregon and Kansas. It was during this time that she started collecting canning recipes from "old timers," foraging for fruit in Oregon and longing for a garden of her own (Ott Whealy 2011: 20, 27) Diane describes the perspectives that her and Kent had in the late 1960s and early 1970s as the following:

> "Kent and I never felt we could be categorized as hippies – we were neither rebellious or outrageous enough. And we didn't look the part: Kent had short hair and I shaved my legs. But we did believe in the virtue of living

> modestly off the land, and we did question the controlling social, economic, and political principles of our society, so in a sense we were anti-establishment." (ibid: 21-22)

In 1975, the Whealys purchased land in Missouri with a couple they met while they were living in Oregon. They started building their own home and maintaining a garden and orchard that would produce enough food to support the family (ibid: 40) For these two families the virtue of living modestly off the land and questioning the prevailing systems led them to pursue self-sufficiency at the household level, which is commonly known in the United States as homesteading

The goal of homesteading is to produce as much at the household level as possible and to rely on store bought inputs as little as possible because the prevailing economic system is deemed unstable (Plunket-Black 2017). Saving seeds is seen as another resource that can be produced at home rather that purchased from an outside source. True seeds, varieties that can produce reliable offspring each year in contrast to hybrid seed, were resources that Kent saw as essential to homesteading projects and projects of sustainability (Whealy 1975) He stated that in 1975 he was influenced by the warning of scientists like Jack Harlan and Garrison Wilkes that agricultural trends could lead to a "genetic wipe-out," a reduction in the genetic diversity of crops that could threaten worldwide agricultural systems (Whealy 1986: 83; Whealy 1986: 120). Homesteading and seed saving can be seen as utilitarian ways to reduce dependency on a system deemed unsustainable – a reasonable action contributing to self-preservation. But they can also be seen as virtuous actions that allowed for "modest living off the land" which contrasted with participating in and propagating a system that was creating instability.

In addition to the virtues of modest living, the utility of true seeds and the looming threats of genetic wipe-out, the Whealys also had a very personal experience which motivated them to seek out heirloom seeds. Before Grandpa Ott passed away in 1974, he entrusted his seeds to Diane and Kent. They felt this was a tremendous responsibility, but this also got them thinking about all the gardeners that did not have anyone to give their seeds to (Whealy 1986: 409). There was a "separation of the generations," caused by the mobility of the younger generation that was leaving many heirloom varieties endangered (ibid: 409). Kent wrote letters to a few different homesteading magazines to try and find other people who were saving heirloom seeds and by 1975 the Whealys mailed out a publication listing twenty-nine gardeners who were willing to share their seeds with other gardeners (Ott Whealy 2011: 42). The Exchange had begun!

By 1977 there were 140 gardeners participating in The Exchange and Kent and Diane were the "focal point for all correspondence and communication" (Whealy 1986: 411). Kent, who has a degree in journalism, organized the publication of semi-annual books that featured heirloom seeds available for trade, news updates, transcribed interviews with seeds savers, and articles and letters from members (Whealy 1986: 3). In the 1979 Yearbook, Kent called members of The Exchange "mailbox friends," and was encouraging members to reach out through their local newspapers to find more people who were collecting, keeping and willing to share their heirloom seeds (Whealy 1979: 1). The Exchange was significant because it was an organized forum that allowed gardeners, who were already growing heirloom garden varieties, to connect with other gardeners and distribute their seeds (Ott Whealy 2011: 53).

As the Exchange started to grow, more and more people involved with seed saving, plant breeding and gene banking started to hear about Seed Savers Exchange. In her memoir, Diane recounts an anecdote about an older woman who mailed some tomato seeds, squirted onto a

newspaper, to the National Seed Storage Laboratory (NSSL) in Fort Collins, Colorado (Ott Whealy 2011: 50-51). The staff at the NSSL decided to forward the seeds to Seed Savers Exchange. "They seemed pleased to work with a grass-roots organization," wrote Diane (ibid: 50-51).

Another example of the NSSL making use of grass-roots organizations during that time period is when the NSSL received the bean collection of Burt Berrier. Berrier donated over 400 varieties of beans to the NSSL, but the quantity of seeds per variety did not meet their collections policy and they passed the immense collection on to Wanigan Associates, the bean collecting organization run by John Withee (Mother Earth News Editors, 1982). Grass-roots organizations and government seed saving operations were not seen as oppositional but as separate systems that could supplement one another and serve different purposes (ibid).[18] It was during the Seed Banks Serving People Workshop in 1981 that Kent and John Withee met and this led to Withee donating his collection of over 1,200 heirloom bean varieties to Seed Savers Exchange. This huge donation would come to accelerate changes within the organization (Whealy 1986: 111-132). It is around this time, it seems, that the ideas of homestead level sustainability started to give way to a broader sense of sustainability; that Seed Savers Exchange could be part of changes that could help stabilize an unstable system.[19]

[18] I remember my surprise when interviewing Kathleen Plunkett Black and hearing her say that one of the main complaints of early organic farmers – many who were anti-establishment, back to the land folks – was that they wanted the USDA and universities to provide them with more resources for organic farming. They saw it as the duty of these government organizations to play this roll and to provide these services to them. I think this surprised me because I am more accustomed to contemporary rhetoric that sees an anti-establishment viewpoint as completely oppositional to government and the support of public institutions.

The Collection and Growers Network

The early 1980s was a busy time for the Whealys. They inherited John Withee's bean collection, became a federally recognized non-profit organization, managed the new Growers Network, wrote and published *The Garden Seed Inventory*, continued to manage The Exchange, published yearbooks, started hosting the annual Campout and then moved to Iowa with over 4,000 beans and four children (Ott Whealy 2011: 53, 56, 80; Whealy and Adelmann 1986: 131).[20] The Exchange continued to grow and the annual Campout marked a time when some of the seed savers could get together and meet. Kent and Diane both reminisce about the first Campout in 1981 and recounted a particular moment when some of the other women noticed that Diane's peas needed to be harvest. Diane and all the women harvested the peas and brought them inside and shelled them; there is a photograph of the women sitting around a table shelling and smiling that Diane includes in her memoir and Kent included in an edited volume (Ott Whealy 2011: 57; Whealy and Adelmann 1986: 43). Part of the appeal of this moment is that it was a group activity that was not planned or orchestrated but emerged out of a recognition of this common aspect of their daily lives. When the peas are ready they need to be harvested and shelled.

The Campout was a success and continued to grow each year. Members of The Exchange liked getting together with other people who share their interests and it was a place for the group

[20] The campout started as a get together at the Whealy's Missouri homestead in 1981 where about twelve people showed up and everyone just got together and talked about their seed saving projects and then traded seeds (Ott Whealy 2011, 57) By 1983 there were 50 "seedy characters" in attendance and by 1984 the campout had moved to Iowa and more involved question and answer sessions were being conducted (Whealy and Adelmann 1986, 51; Ott Whealy 2011, 62). The Campout and Conference became an organizational tradition that allows members of The Exchange to get together and do face-to-face seed swaps, to talk and listen to each other about their projects and to just have a good time! The Conference and Campout is a major organizational event and the event's development is deserving of mention during this critical time in Seed Savers Exchange's growth. The event itself could be the subject of an entire ethnography.

of long distance friends to get together (Ott Whealy 2011: 59) The Exchange was becoming popular because it was a place to get good seeds and the Whealys were seen as a safe place for seeds to go, causing their Collection to continue to grow.

When faced with the challenge of maintaining the John Withee bean collection, Kent declared in the 1981 Fall Harvest Yearbook, "This is the greatest challenge our organization has ever faced" (Whealy 1986: 138). In response to this challenge, Seed Savers Exchange started to develop its Growers Network (ibid: 135). The members of the Growers Network would receive a couple of varieties from Kent, grow the plant, save some seeds, send some back to Kent and save the rest (ibid: 135). This would be a way to maintain the budding collection without over stretching the resources of the Whealys and their garden. Kent also stated that they were being contacted by people who did not have any heirlooms but were interested in starting to participate in The Exchange (ibid: 136). The Growers Network was a way that new growers without their own heirloom varieties could start their own collections and offer them in The Exchange (ibid: 138). Another program that was developed was the Heritage Gardeners Network. The plans was for it to be similar to the Growers Network but help provide historical museums and living history museums with period appropriate varieties of heirlooms. The organization would save seed from the varieties and send some back to Seed Savers Exchange.

I want to emphasize here that Kent wanted to *maintain* varieties that were in his collection of heirlooms and to "maintain" had a specific meaning. Maintenance can be thought of as keeping the heirloom viable and keeping it from changing drastically. The Grower's Network was initially brought together because the beans received from John Withee needed to be grown out or they would start to lose their viability. Older seeds do not always grow as well as newer seeds. This loss in viability is usually measured as their germination rate: the percentage of seeds

that germinate under ideal conditions. If they are not growing a variety out each year, seed savers are always conscious of the time between plantings and plan their gardens around the need to replenish their seed stocks.

Seed Savers has prevented drastic changes in their heirloom varieties by using isolation techniques. Kent stressed isolation practices to the members of the Growers Network in the Yearbook multiple times from 1981-1984 (Whealy and Adelmann 1986: 135-145).[21][22] The idea of maintaining varieties contrasts with breeding and developing varieties. To show how this contrasts with less formalized backyard gardening I will use a general example given to me by Kathleen Plunkett Black: If a gardener is planting a variety of pea with a shell that is difficult to remove but she noticed that one year it produces an off-type plant that is easier to shell she might keep seeds from that plant and include it in the next years crop until there are more plants each year that are easy to shell (interview 2017). In contrast, someone who is looking to maintain this variety would discard the off-type pea because it could be an indication that the plant was cross-pollinated or could change the variety more generally.

Anticipating the needs of their growing organization Kent and Diane applied for tax-exempt status and by 1981 Seed Savers Exchange, Inc. was recognized as a 501 c (3) non-profit organization by the IRS (Ott Whealy 2011: 23). The 501 c (3) status allows tax deductible

[21] Isolation techniques and methods to prevent cross-pollination were also part of the basic "Seed Savers Guide" that was a section of the Yearbook.

[22] What is still unclear is how the roll of selection was being thought about in these days in terms of maintenance and preservation. In the 1979 Yearbook Kent emphasizes the roll of selecting to the entire seed saving process. He emphasizes that each year the plant is grown out there will be changes to the plant in reaction to the environment and it is the responsibility of the seed saver to select not only the best plants but enough plants to maintain the genetic diversity of the population. So selection and change are thought of as part of the process. Kent was addressing other backyard gardener seed savers through the Yearbook and was addressing how to keep varieties that would continue to produce reliably. It is difficult to discern if he wanted to continue to apply this seed saving methodology and ethos to The Collection as it grew over the years or if he moved towards a more conservative definition of preservation that saw selecting (as opposed to random selection or non-biased seed collection) as the key difference between heirloom maintenance and plant breeding (Whealy 1986: 55).

donations to be made to the organization and allows then access to more grants. In 1981 Seed Savers Exchange earned a relatively small grant from the Soil and Health Society in Emmanus, Pennsylvania and it helped jumpstart a few different programs including, writing and publishing *The Garden Seed Inventory* and allowing Kent more time to manage the Growers Network (Ott Whealy 2011: 53).[23]

The Garden Seed Inventory was a publication listing all commercially available varieties that "grow true" – such as heirlooms – that were in seed catalogs (Whealy 1986, 102). Growing true means that the plants characteristics are stable and predictable from one year to the next. Here is an example. If I grew a Cherokee Purple tomato last year and saved seeds from a few plants then the Cherokee Purple tomatoes that I planted this year should be very similar to the plants I grew the year before. Because the Cherokee Purple tomato is stable from one generation to the next (assuming good seed saving practices) it would be considered a variety that grows true.[24] The idea of growing true contrasts with the intergeneration growing patters of hybrid seeds. Hybrid seeds do not grow true. The plants grown from hybrid seed will instead reflect a mixture of the traits from the inbred lines used to create the hybrids.

The goal of the publication was two-fold. The first was to document the loss of these varieties after amendments to the Plant Protection Act was passed in 1981 that expanded the patenting rights of breeders. There was concern that increased patent protections for plant varieties would incentivize large seed companies to buy out smaller companies, encourage agriculturally focused petrochemical companies to do the same, increase the use of hybrids and increase seed exports to the Third World (Whealy 1986: 111-132). This was seen as a potential

[23] Diane also notes that the publication of *The Garden Seed Inventory* would also create revenue for the organization.
[24] This is a delicious and beautiful tomato. Highly recommended.

catalyst that would increase the rate of the "genetic wipe-out" that was already occurring. The second was to create a list of varieties that were endangered and needed to be adopted by the organization to prevent their extinction (ibid: 415). Seed Savers Exchange did not intend to just document the loss of these heirlooms, they also planned to help save them. An excerpt from the 1981 Winter Year Book shows the organization's commitment to conservation action through their new programs:

> "NOTICE: Shortly before congress adjourned, the Plant Patenting Amendment passed the Senate and became law. […] Our work is now cut out for us. I will immediately start working full-time to inventory vegetable varieties, distribute endangered varieties through our new Growers Network and secure samples for freezing in our Heirloom Seed Bank. Your support of and help with all of these activities is desperately needed. These vegetables will either die or live on with our help." (ibid: 91)

The Withee bean collection had created a need for the Growers Network and the impetus for the central Seed Savers Collection. The Plant Patenting Legislation was also causing concern which justified growing the Collection and utilizing the Growers Network. So, in addition to hosting The Exchange – the network of gardeners that maintained "old-timer's" heirloom varieties through a forum of correspondence and exchange – Seed Savers Exchange was formally beginning a central collection and a network of gardeners to help maintain that collection.

In the initial grant the Heirloom Seed Bank was seen as a temporary solution to maintain the viability of the collection until the organization was able to conduct yearly grow outs of all varieties (ibid: 414). Kent suggested that a freezer would be used or other techniques to help

extend the life of the seeds, but he emphasized that these would be temporary measures until they were able to grow the entirety of their collection out *each year* utilizing the resources of the organization and the Growers Networks (ibid: 414).[25]

Once the Growers Network started, Seed Savers Exchange (still just Kent and Diane) were tasked with distributing varieties each year, receiving them at the end of the growing season and processing them into the collection. This proved a more time-consuming task than originally anticipated. Withee had managed the Wanigan Associates grower's network and advised Kent on the details of running the Growers Network (ibid: 137). Multiplying John Withee's bean collection was the Growers Networks focus but the program started to expand with The Collection. In the spring of 1981, the first spring of the Growers Network, they distributed 404 packets of seeds to 74 growers. In the fall, Kent encouraged members of The Exchange to send varieties – along with a description of the variety and its history – to Seed Savers Exchange if they would like those varieties maintained by the Growers Network (ibid: 138).

In 1982, they distributed 2,400 seed packets to 351 gardeners (ibid: 139). The growers included members of Seed Savers Exchange, Wanigan Associates and the Backyard Researchers with the Rodale's Soil and Health Society (ibid: 137). Kent emphasized the importance of documentation to members of The Exchange that were sending varieties to the Growers Network and created Seed Data Forms that were to be filled out with any donation (ibid:140, 141). Especially important was the source of the seed so they could identify and reduce the number of

[25] Attempting to grow out the entire collection each year is a goal that shows that they did not want to maintain their varieties in a freezer even though germination rates can be maintained for decades within a freezer. One school of thought poses that varieties are better maintained if they are allowed to grow out each year and compete with pests and diseases. This allows for resistant plants to be selected and seeds to be saved from those plants. The argument against keeping plants frozen for twenty plus years is that they get left behind and pests and diseases go on evolving and will have an advantage over the variety the next time it is grown out.

duplicates that were coming in. Additionally, the historical information would allow the variety to be evaluated for the Heritage Gardeners Network; the program that engaged living history museums and gardens with the Seed Savers Exchange Collection (ibid: 416). For the distribution of 1983 Kent decided that he would only send out beans, tomatoes and peppers to the Growers Network because these were easy to save seed from and had a relatively small chance of cross pollination (ibid: 140).[26] The cross-pollinating varieties – such as corn – would be maintained by growers that had a good track record of successfully keeping these varieties pure using hand-pollination isolation techniques (ibid: 140).

"The Growers Network Seed Collection has grown very rapidly these last few years. The SSE is currently maintaining over 3,500 endangered vegetables and garden seeds (2,000 beans, 500 tomatoes, 200 peppers, 200 squash, 140 corns, 100 muskmelons, 100 potatoes, 100 lettuces, 100 peas etc.)," Kent wrote in the Fall Yearbook in 1984 (ibid: 144). Kent realized that the Growers Network needed to be restructured because the current workload of distributions and processing returning seed was becoming unsustainable (ibid: 144). The Growers Network changed from a system of growing and returning seed to the gardener agreeing to maintain the variety for a minimum of five years and making the variety available to The Exchange through the Yearbook (ibid: 145). By 1988 The Collection had over 5,000 varieties and the Growers Network was officially turned into the Curator's Network (Ott Whealy: 139).

The goal of the Growers Network was to disperse the work needed to maintain varieties in the Collection and it relied on experienced and inexperienced gardeners who were involved in The Exchange (Whealy 1986: 138). In the Yearbook Kent published seed saving guides

[26] Different plants require different isolation methods. Some, like tomatoes and peppers only require a small bag around the flower before it opens to keep the fruit free of foreign pollen. Other plants, such as squash and corn, get a bit more complicated and have a higher risk of cross-pollination.

instructing new gardeners on ways to isolate these varieties and keep their varieties pure. However, he eventually decided that they needed to rely primarily on experienced gardeners to help maintain the Collection (Whealy 1986: 136; Ott Whealy 2011: 139). The Curator's network relied on Seed Savers Exchange – which by the late 1980s had staff members that could help grow out varieties each year – and a few highly dedicated members that specialized in different crop types to maintain those varieties for the Seed Savers Exchange organization (ibid:139).

The Heritage Farm and MacArthur Grant

Diane and Kent both stumbled on the same idea to create a place to showcase their collection, a place for members of The Exchange to visit and a place for the wider public to experience the diversity they had accumulated (Ott Whealy: 75). The story that Diane tells is that they were on a family road trip to visit Kent's family in Kansas and they were taking the backroads through farm country instead of the main highways and interstates (ibid: 75). "White board fences surrounded pastures and lined driveways leading to magnificent barns and houses surrounded by beds of daffodil or hyacinths. Behind the fences, horses of chestnut, sorrel, black, palomino, white, grey and dun reminded us of our calico beans" (ibid: 75).[27] While passing through this landscape, she and Kent had the simultaneous thought of a show farm for the Collection. A place where members of Seed Savers Exchange would be welcome to see, taste and experience the diversity of their collection and share in their sense of wonder (ibid: 75).

Nazarea describes the gardens of seed savers as, "a space on the side of the road for reflection, transcendence and transformation," and a place to access countermemory and

[27] Every time my wife and I pass by these kinds of horse boarding places with their white boarded fences and beautiful horses in their little jackets she says, "so much money." To me they represent this odd mixture between an American agrarian ideal and an English estate. These are not marginal spaces, these are spaces infused with wealth.

alternatives to the norm (Nazarea 2001: 153). The Whealys recognized these qualities in their gardens and from their collection and wanted to make that available to more people. What they also recognized on their journey through Kansas was a way to frame their collection to help visitors access an appreciative, reflective state. The white board fences, rolling hills and beautiful barns inspired something in Kent and Diane and they knew it could do the same in others.

With this idea and the pressing need to move their ever-growing collection and organization, Diane and Kent decided to move from their isolated homestead in Missouri to a place where they could develop a home for Seed Savers Exchange and themselves (Ott Whealy: 75). They chose Decorah, Iowa as the location where they would find enough land to grow out The Collection and have access to amenities such as grocery stores, medical care, reliable water and schools (ibid: 78). They moved to Decorah, Iowa in 1984 but it would not be until 1986 that they would find the property that would become the Heritage Farm (ibid: 111). Over the next four years Seed Savers Exchange continued to grow at the Heritage Farm. They would go on to plant an Apple Orchard, continue to host campouts and start publishing more books – such as *Seed to Seed* by Suzanne Ashworth (ibid: 124, 132). With the organization's growth came increased recognition for their work and their mission which would lead to Kent receiving the MacArthur Fellowship or "Genius Grant" in 1990 (ibid:142).

The MacArthur Fellowship granted Kent Whealy $275,000 over five years which allowed him to start Seed Savers International (Ott Whealy 2011: 142). Seed Savers International expanded the mission of the organization across borders and expanded the scope of The Collection. The organization worked with the Vavilov Institute in St. Petersburg and small national seed banks in former Soviet states to bolster preservation efforts as new hybrids were being introduced to the areas and instability in states after the fall of the Soviet Union threatened

existing collections (ibid: 144). From 1993-1997 collection expeditions led to 4,000 more heirlooms being added to The Collection, many of which were garlic varieties that would need to be planted every year (ibid: 144).

In 1995, Seed Savers Exchange moved their operations out of the family farmhouse and rented space into an office of their own (ibid: 150). They built temperature-controlled storage rooms, a root cellar and – the hallmark of seed banks – an underground walk in freezer (ibid:151). Seed Savers Exchange started to offer seeds from The Collection through a seed catalog and the catalog successfully helped with financing and attracting new members (ibid: 184). By 2001, The Exchange had over 1,000 listed members offering 12,000 varieties to more than 8,000 gardeners (Whealy 2001: 1). In 2008, a new seed house was built to accommodate orders coming through the catalogue and the website, orders for members of The Exchange were delegated to the basement of the "old office," which became the Preservation Office I would work in during my internship.

From the 1990s Seed Savers Exchange built up the Heritage Farm into a beautiful, idyllic place to grow out and show off what they had gathered. The Conference and Campout continued to grow and has turned from an informal gathering to an organized event, with nationally known speakers, gardeners and food activists. As you drive by on Winn Road, gardens sprawl across the front lawn and Grandpa Ott's Morning Glories can be seen scaling up the red barn. Visitors are welcome to walk through the gardens, buy seeds, books, or gardening gear from the Lillian Goldman Visitor Center or take a walk through the valley and catch a glimpse of their Ancient White Park Cattle. In the fall, visitors are welcome to explore the Orchard and taste test hundreds of varieties of apples and grapes that they will never see anywhere else. The dream that Diane and Kent had to create a space for people to be immersed in the glory of their Collection has

been realized. However, the growth of The Collection led to challenges managing it, which would lead to major changes for the organization.

Figure 1: SSE Preservation Department staff members, Phil and Steffen, giving a class on garlic at the 2015 Conference and Campout.

Figure 2: Conversation and discussion about garlic. Phil and Steffen selected a spread of garlic from the Collection for class participants to see and taste test. Garlic samples were roasted, and they were delicious.

Figure 3: Steffen discussing garlic with one of the younger class participants.

Preserving The Collection

Tor Janson, curator of the Preservation Department in 2015, commented to me about the the lack of documentation between 1995-2007. As noted above, this was the time when 4,000 new varieties were taken into The Collection and the organization was attempting to grow out a large number of varieties per year. Employees did not document information about grow outs or procedures, and if notes were taken they were not saved systematically. During this time there was also mounting tensions between Kent and the board of directors that ultimately led to Kent being fired from the organization in 2007 (ibid:222: 226). Diane took the position of associate director and left behind her involvement in day-to-day operations of the organization. It was a rocky time as they made the transition from a "mom and pop" style organization to a more formal one. Going forward the board of directors prioritized the maintenance of The Collection.[28]

From 2007 to 2012, Collections Curator Shanyn Seigel focused the efforts of the Preservation Department – the department in the organization tasked with maintaining The Collection – on systematic collection management and created the Evaluation Program and the Lot Check system. The Evaluation Program was developed to document the horticultural characteristics of each variety and to compare those findings to information they had on the varieties. The Lot Check system was a way to see if the variety was effectively isolated during its most recent grow out, it was a way to check their work. After Shanyn, the Assistant Curator Jenna Sicuranza became the Curator and Tim Johnson was hired to manage the lab staff. The Preservation Department also employs a Seed Historian who maintains and manages donor

[28] Diane and Kent were divorced at this point. This is only important in understanding why she would stay involved with the organization after Kent was fired. Their story of founding SSE is deeply personal but the move away from a "mom and pop shop" to a more formalized organization was independent of their family issues. I wanted to include this note for explanatory purposes only.

information about the seeds in the collection. The Accession Policy was adopted in 2013 which narrowed and prioritized the scope of their Collection and determined criteria for de-accessioning varieties. For some longtime members of The Exchange and the Curators Network these institutional changes were out of step with how they think the Collection should be managed.[29]

The Exchange, started in 1975 with just a few members, as of 2016, has about 12,000 members with over 16,000 heirloom varieties listed in their yearbook (Seed Savers Exchange 2016). The organization grew explosively over a short number of years with its Collection and Exchange membership. The organization was able to access grants and funding because they articulated the need for specific collection priorities (through publications) and then subsequently grew. The Collection is the main focus that is presented to the public, but The Exchange has always remained the organization's foundation. During my internship at Seed Savers Exchange I was shown how the work of the Preservation Department maintains the Collection and maintains the connection with the The Exchange.

[29] Glenn Drowns and Will Bonsel are probably the best examples of members that cut off ties with the organization after this change. Glenn Drowns continues to preserve heirloom vegetables and poultry in Iowa. He states on his website that he will not turn his preservation farm (for lack of a better term to describe it) over to a non-profit board. Will Bonsel stopped working with the organization because of philosophical differences involved with the in vitro propagation of potatoes.

Internship in the Preservation Department

The Heritage Farm located outside of Decorah, Iowa is the central point of Seed Savers Exchange and was formerly the home of the founders of the organization Kent Whealy and Diane Ott. The farmhouse still stands and serves as an office and housing for guests – like myself. The historic red barn is used to teach classes and for some storage but the upper loft is used to host presentations, classes and barn dances. The Lillian Goldman Visitors Center is in the valley and it is surrounded by gardens that showcases a portion of the bountiful collection kept there. There is one garden by the barn that Diane Ott still tends.

There is a path that goes from the farmhouse over a bridge, past an immense Burr Oak and up through the woods to a group of buildings where much of the daily care of The Collection takes place. While there is an enormous amount of time and energy put into the care of the varieties when they are being grown in the gardens, the majority of the seed's time is spent in the storage rooms and labs of the Preservation Department – waiting their turn to be grown at Heritage Farm or mailed out to a member of the Exchange. The Preservation team is slowly working their way through the collection that has been amassed over the last forty years. They are systematically reviewing the accessions, prioritizing and planning grow outs to maintain seed viability, evaluating for plant health and testing for diseases. Additionally, they are building and maintaining an archive that is meant to engage members of the Exchange and encourage the dispersal of seeds from their collection. Part of this archive is preserving the historical record of the seeds that come into the collection.

I went to Seed Savers Exchange to work in their Preservation Department as a Summer Intern with my main task being Corn Hand Pollination. In exchange for my labor I was given lodging at the farmhouse and I was able to conduct my research. This section examines work

done by the employees in the Preservation Department to maintain the heirlooms in their collection. Maintaining the heirloom has two distinct parts. The first is keeping the germination rate high and keeping the variety genetically similar to how it was when it entered the collection by not allowing it to cross pollinate with other varieties. The second is to make the variety available to Exchange members in the Yearbook.

Part One of this section centers on my time being introduced to the Preservation Department and doing a round robin of different tasks. I was, basically, a floating intern during this time. This gave me an overview of work in the Preservation Department and how the different subsections of the Department (Field Crew, Germination, Evaluation etc…) work together.

Part Two is all about Corn Hand Pollination. I was part of a crew of three to five members whose entire job was to monitor and pollinate the different varieties of corn that we were growing. This section examines the hands on, daily work of this task and how it was being done during the summer of 2015. This section also examines some of the issues that can go wrong with the crops in the collection when previous growers did not successfully isolate their crops during grow outs and how the crew and staff members considered ways to remedy a crossed accession.

Part 1: Maintaining the Heirloom in The Preservation Department

The description of my first day and tour highlights some of the changes, recalling the history of the organization laid out in the previous chapter, that have been made to the organization since its beginnings. It also gives a little bit of an overview of the Preservation Department and introduces some of the people that worked there.

May 26th 2015: A Tour and introduction to lab work.

The Seed Bank Manager, Tim Johnson, started my day first day by giving me a tour of the Preservation Department, and he introduced me to their facility and the people I would be working with. The basement of the building is a lab with work stations dispersed throughout the space. I will start with the part that Tim seemed most excited about. Tim was really excited about Emma White – their database that they developed "in house." Emma V. White was a Minnesotan seed saver who owned and operated a seed house in the late 1800s. Emma White, the database, had taken two years for them to develop and was replacing the Oscar Will database, who was also a prominent seed saver.

Tim mentioned that there are other gene bank database systems that are being developed - such as the GRIN Global database system – but these databases do not meet their specific needs.[30] Emma White was designed to retain cultural and historical information associated with each accession as well as track a seed lot as it is split and dispersed for different purposes[31]. Tim

[31] Before my entry into the social sciences I worked in the medical field and was very interested in how Electronic Medical Records are being designed (as databases) and what kinds of data they allow and how they track patient histories. This made Emma White an intriguing starting point for me. It is interesting to think about databases a part of the major infrastructure of an organization that potentially enable and limit organizational goals. The two major functions that Emma White enables are the splitting up of seed lots (seeds collected from a specific grow out) into different packets while retaining the historical information (including Eval notes and testing information). Tim also preprogrammed Emma White to calculate how many seeds go in each packet based on germination rate, seed type and other variables. An examination of their database and others like it could be an entire ethnography. I will only

described their accessions as "varieties with histories," which differentiates their collection from other gene banks.[32] The histories and the stories associated with each variety is the key distinction between a variety that will remain an accession and a variety that will be de-accessioned.

Tim introduced me to Zack and Sara who worked side by side in a corner of the office. Sara is the Seed Historian and oversees the Collection Origins Research Effort (CORE), a program aimed at determining if accession histories meet their new policy.[33] Her job also includes collecting and archiving original documents from donors, letters that accompanied the donation, and contacting donors to fill in any missing information about the variety. Zack's main job is distribution and working with the Exchange. One aspect of his job is to receive requests for seeds from members of the Exchange and then mail the seeds out to those members. Requesting and mailing seeds is one of the most basic components of seed exchange. In fact, Zack described Seed Savers Exchange, the organization and their collection, as a *member* of the Exchange. I found this interesting because, up until that point, I had thought of Seed Savers Exchange as more of a host of the Exchange instead of a member of the Exchange.[34]

In another nook, we encountered Phillip. He works, almost exclusively, with the tuber collection. Seed Savers Exchange has over 700 potato varieties and they were working with the University of Wisconsin – Madison to rid their tubers of viruses. Potatoes need be grown out each year to maintain their viability, so at Seed Savers Exchange the potatoes are reproduced in

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touch on it here but I wanted to mention that it is there and it is impressive just in case anyone is inclined to study databases.

[32] Accession is a term that means that an object (defined broadly) is part of a collection and is owned by that organization. De-accessioning means that an object will be removed from the collection, ownership is turned over to someone else, and it is usually a delicate issue with potential negative re-percussions for an organization.

[33] The CORE name was though up by their librarian – a longtime volunteer – who stated that, "a program is only as good as its acronym."

[34] Thinking about themselves as a member of the Exchange, just another name listed in the Yearbook, is more understandable if you know the roots of the organization.

the lab instead of in the field. Phillip does the majority of his work in a special closed off room that is equipped with a special filter that assures that bacteria and fungus are not growing along with the potatoes tissue cultures.

I got a brief tour of the upstairs which includes HR, Finances, Marketing and Social Media, and we ran into Diane Ott – one of the co-founders of Seed Savers Exchange. We had a brief introduction and exchange of pleasantries before moving on. Dan "the apple man" also works upstairs. He officially falls under the Preservation Department but was moved out of the basement because he had "too many books." Dan was working to complete *The Illustrated History of Apples in the United States and Canada*, which was the culmination of thirty years of work.[35] Dan is their apple specialist and is in charge of their extensive orchard.

We went up another flight of stairs and Tim and I reached the library. The librarian is a "lifetime volunteer," who kept their collection of seed catalogs and books organized while also maintaining a bowl full of M&Ms. After that we descended back to the basement and Tim left me with Alex the Germination tech. Alex would be my primary guide and friend for my time at Seed Savers.

Alex's desk was right next to a large window that let you see the tree line and the path leading up from the Director's House. The desk was located at the intersection of the storage rooms, the historian's corner, the stairs, an entryway and Tim's office. It was a busy place early in the morning, but it settled once everyone got their work stations. Alex and I sat behind the desk, our backs to the window, as we "pulled" tomato seeds for future germination testing.

Alex had a multi-page list of seeds that needed to be pulled for germination testing. Pulling seeds means randomly selecting a certain amount of seeds from their primary storage

[35] Daniel J. Bussey, The Illustrated History of Apples in the United States and Canada, ed. Kent Whealey (JAK KAW Press, 2016).

packet and putting them in a temporary packet where they can warm to room temperature over a few days before they are tested. First, we went into Storage Room 3 – which is the coldest storage room besides the freezer – and used the list to find the tomato varieties that we were looking for. Most of them were already in order in long skinny cardboard storage boxes (about two feet by three inches). Once we had two pages worth of varieties we brought them over to Storage Room 2. Room 2 is a little bit warmer than Room 3 and this gives the seeds a chance to warm up before they are brought out into room temperature.

To open a seed packet, a thin strip is cut off the bottom of the packet to preserve the label and allow the packet to be resealed and reused multiple times. Alex and I counted out one hundred seeds and weighed them. We entered the Hundred Seed Weight into the electronic record, which uses the weight to estimate the total number of seeds in the packet which determines the number of seeds we can use in the germination test. We will use 100, 60, 40, 20 or no seeds in the germination test. If the supply is too limited then you will not do a test.

After the brief introduction to pulling seeds, my task was to count tomato seeds. They are fuzzy, tiny, and they stick to each other in clumps. Alex instructs me to use a small wooden poker to pick up the seeds and move them around. I counted seeds very diligently for a few hours. It is a slow process. I felt like I was going especially slow – speediness is not one of my attributes – and I apologized for it. Alex said that accurate is better than speedy, which made me feel much better.

In the afternoon Tim asked for our help in Green House 1 to collect samples so they could be tested for Squash Mosaic Virus. Tim told us that the test was sensitive so we only needed a small sample from each plant, “half of a pinky fingernail,” he said and I and the other workers took a quick glance at their pinky fingernails, before looking back to Tim for the rest of

our instructions. The test was also sensitive to other contamination so we had to switch gloves between each sample.

From each variety of squash we pinched off a piece of their cotyledon (the "leaf" that sprouts from the seed before true leaves develop) from thirty-six individual plants. We created separate packets – A, B, C, D, E, and F – that each contained six samples from different plants. Tim was going to use the total mass collected from each packet to make a solution and run the virus test. If solution A tested positive he would go back and test each individual plant in order to see which tested positive. He said he was doing an ELISA test on them. Everyone was stooped over the flats of seedlings carefully collecting their samples – Tim turned his baseball cap backwards as he worked – each person switching out their gloves between each samples and diligently marking the sample packets.

After we were done collecting samples Alex and I went back to germination work. The germination test takes place on a damp paper towel. Alex had rulers with marks for evenly spacing the seeds based on the number of seeds in the test. After the seeds were placed on the paper towel (it is a slow process) it was sprayed with water and folded up, identification information was written on the towel and then the seeds get to bask in ideal conditions for a week or two before the results are read and documented.[36]

The lab work – testing for viruses, germ testing, and in vitro tissue culture – seemed very far away from backyard gardening until you think about (more broadly) what it means to be a good trading partner and how to connect The Collection to other gardeners. Seed Savers Exchange, as a member of the Exchange, offers seeds from their collection to other gardeners.

[36] For the germination test the seeds are kept in an incubation refrigerator that expose the seeds to light and temperature cycles conducive to germination. They had a variety of warming and cooling incubators for different lab work and tests. They had a refrigerator stocked with pollinators – bees and flies for example – that they released into the isolation cages later that summer.

The exchange of seeds from garden to garden can be risky because of the potential for disease transfer from one garden to another that can be difficult to eradicate. Throughout my time at Seed Savers Exchange I would pick up more instances of what it meant to be a good member of the Exchange from the Preservation Department and their practices.

They were in the process of testing the germination of all of the varieties in their collection. This would help them know what needed to be grown out and would allow them to include germination rates in the Seed Savers Exchange catalog. Germination tests are also required if the seeds are going to be sold, so before the seeds can be made available in the commercial catalog they need to be tested.[37]

From field notes: *"Ok more stuff happened but I am super tired. I am off to sleep. (10:14pm) 2 hours notes"*

My first working day at Seed Savers Exchange introduced me to the organization, the layout of the workspace and some of the people working in it. One of the main ideas that stood out to me was Seed Savers Exchange (the organization) being thought of (or framing itself) as a member of The Exchange. Another idea that stood out to me was The Exchange being a separate entity than the organization of Seed Savers Exchange. Zack stated this outright during my initial tour and it would frame my understanding for much of the work being done by the Preservation Department. While framing Seed Savers Exchange as a member of the Exchange emphasizes

[37] The commercial side of Seed Savers Exchange manages a separate seed house that produces more seeds that can be sold and dispersed in their commercial seed catalog. The Preservation Department helps identify varieties that might have wider public appeal that could be used in that catalog. This allows people who are not members of the Exchange access to heirloom and heritage varieties that they may want to try. It also offers a familiar format for gardeners who are accustomed to purchasing their seeds from a seed catalog instead of requesting them in a seed exchange.

their goal of dispersal, it also sets up useful and challenging ideas about what a seeding saver is, what preservation looks like and how gardeners should maintain their own varieties.

The Yearbook, which is basically the same publication started by Kent and Diane back in the 1970s, continues to link members of The Exchange with each other and is published through Seed Savers Exchange. The Preservation Department is responsible for listing varieties from The Collection. To "list a variety" means to create a profile for it in the Yearbook and offer it up to The Exchange. Then interested gardeners can request seeds from you. Creating the Yearbook listings is a bit like creating a small museum exhibit. They are taking an artifact from their collection, cleaning it up a bit, doing some background research and giving it a pedestal and a spotlight. It is the job of the Yearbook listing, along with the show gardens and the Seed Savers Exchange publications, to engage gardeners and members of the public to get them to engage with their seeds.

Each listing represents a culmination of coordinated work from the different members of the Preservation Department: germination testing, extensive field planning, growing, weeding and harvesting more seeds for distribution, adherence to strict isolation practices, archival research, calls with donors and collecting trips, virus testing and plant pathology checkups, evaluation for descriptive characteristics and variety purity, taste testing, label making, more label making, freezing, thawing, making packets. All accompanied by documentation.

Tim's excitement over Emma White, their database, was understandable given the complicated workflow and coordination that is needed to systematically process, evaluate and care for the massive collection that they are now responsible for. The collection housed at Seed Savers Exchange, "the accidental seed bank" as Tor calls it, is comprised of over 20,000 accessions. Emma White allows them to track and keep data on the accessions and the branching

lives of different generations of those accessions from different grow outs that go to different packets for different purposes.[38]

The main work of the Preservation Department is to maintain the collection for the purpose of seed dispersal. They disperse the seeds to gardeners through the Exchange and to the USDA seed bank system and the seed vault in Svalbard. Many people might think of a seed bank or a gene bank as the end of the road for seeds. But at Seed Savers Exchange they see the Exchange, that network made up of many gardeners and their backyards, is actually the place where preservation happens. The Preservation Department is merely serving as a way station for their accessions.

[38] I will review what seed packets they produce later in this chapter and what they are used for.

Work in the Preservation Department

The next section overviews the work that is done in the Preservation Department to prepare the accessions for their Yearbook appearances and their dispersal into the Exchange. It highlights the work in the lab to test germination, the organization of the collection and some of the logistics of dispersal as well as some of the variety evaluation and historical research being done to acquire more information about the different varieties. I have set up this section chronologically to take the reader through portions of my time and work at in the Preservation Department. The headings of each section will let the reader know what aspect of work is being discussed.

I include excerpts from my time doing field work for a few reasons. One is to highlight the physical aspects of the work being conducted outside the lab. It is important to remember the amount of labor that is needed to grow and take care of the varieties. It is also important to remember that when we talk about "growing out varieties" that the work – from planting the seedling, to weeding, to isolation practices and harvesting - is done by people. Finally, working in the field was really fun some days. It was a time when people talked to each other and I could ask questions without interrupting workflow. I offer it here to balance out the sections on archival and lab work.

May 29, 2015 :Field Work

It was not raining today! So, we were able to plant all day long. The first part of the day we went up to Pasture Road and weeded the garlic for about four hours. An email was send out yesterday requesting all permanent staff to help with field work if they could. So we had everyone from Preservation out of the lab and in the field. Alex, who I worked with in Germination on Tuesday, said that getting to work out in the field and getting to do science was

one of the best parts of the job. I asked Phillip, who works mostly with tissue cultures, if he enjoyed coming out and doing field work too, he answered with a smile, "everything in moderation." That does seem to be one of the drawing points of this work. That the staff, many horticulturists and biologists, get to do scientific lab work from their field that is intellectually stimulating. Testing for Squash Mosaic Virus, evaluating germination, investigating characteristics from varieties from seed catalogs from the 1800s, as well as getting to go outside and planting, setting up gardens and working in the fields.

As we were picking weeds in the garlic area there was time to chat. I asked Alex why they (preferred personal pronoun) wanted to work at Seeds Savers. Alex had heard about Seed Savers when they were twelve and has been saving seeds and gardening since they were a small child. Alex is a biologist by degree but also loves gardening, seed saving, cooking and canning food.

We weeded in the garlic patch while Bryan, the field manager, went with other crew members to the gardens to plan and lay out where all the plants were going for the day.[39] Many of the gardens are spread out across the property to prevent cross pollination in many of the open varieties. This is the part of the season when plants are being transplanted from the greenhouses out to the gardens. The plants are moved from the comfy greenhouse outside to a “hardening off” area that lets the small plants adjust to outside conditions before being transplanted to the field.

We were hand transplanting corn today. Multiple varieties in each garden but spaced out about 100 yards apart. We planted at least four or five varieties today and were working in teams. The seedlings were about an inch or two high in thin plastic containers. Kevin, a member of field crew, was working "Tilla" the rototiller through the gardens first. After it was tilled Gabe

[39] This was already planned in the field plan for the year, it was just double checking that everything and all the locations were ready to go.

and Korbin were going though and laying down the jiglines - orange string wrapped around a fiber glass pole – that would make sure that we were planting in straight rows. A fiberglass pole with a tag indicating variety information was placed at the beginning of each section. They continued on, moving to the next area that was being tilled.

Then the planting crew brought the flats of seedlings over to where they would be planted.[40] It was important to double check the tags on the fiberglass pole and the tag in the flat of plants to make sure that all the information matched. Sometimes there were varieties that had the same name but had different numbers – were different accessions – and they had to be kept separate. You did not want to plant a variety in the wrong place or mix in one variety with another. That would be very bad.

One or two people would take the white plastic buckets full of fertilizer called “Sustain” – also just referred to as "turkey shit" – and spread out fertilizer along the jiglines. Then a person or two would take the seedlings out of the flat and spread them out down each row about seven to eight inches apart. Bryan told us a good way to approximate that distance was to use the "hang loose" sign. The pinky and thumb extended out to the sides and middle three fingers curled in towards the palms.

"It's about seven to eight inches for most people," Bryan said.

After all of the plants were laid out and everything looked spaced correctly, it was time to get the seedlings in the ground. Bryan told us to use the “two finger method” to plant them. This consisted of taking two fingers stabbing them in the nice freshly tilled soil and scooping out the dirt. Then the seedling was put into the shallow hole and then dirt was pushed in around and

[40] A flat of seedlings refers to the container that they are grown in while in the greenhouse. A flat can contain anywhere from thirty-six to over a hundred seedlings depending on the size of the plant. Most of the corn transplants were in flats of thirty-six plants.

patted down. The seed bulb always needs to be covered. This was Bryan's most important thing. If the seed bulbs are not covered this means that the plants will die. Bryan shows us how to do this once slowly and then started scooting down the row on his knees quickly getting the plants in the dirt. He is super fast.

Each person started at the top of a row and just worked their way down putting the little seedlings in the ground. Dig in, scoot the dirt, put plant in, pat down. Repeat. If one person finished before another person they started at the back of another row and met other person at some point. The planting went super quickly. After a variety was planted they were "watered in." One crew member stayed behind and used a hose attached to a water buffalo to water the plants.[41]

June 2nd: Germination testing

From my notes:

"Seed Lab Practice Definition of Germination:

Germination is the emergence and development of the essential structures of the seed embryo that, for the kinds of seeds in question are indicative of the ability to produce a normal plant under favorable conditions."

Today Alex and I read germination tests. This was interesting because these were the germination tests that we set up last week for the tomatoes. We put on our blue gloves and took the moist paper towel packages out of the plastic container one by one. On the outside of each paper towel packet the plant type, plant number, the germ test identification number and the test repetition number were written.

Germination test procedures are based on the Association for Official Seen Analysis. They publish a hand book that Alex has in the office and it is used often to reference the

[41] A Water Buffalo is a water tank on a trailer. It is used to transport water to different fields for watering.

standards for different crop varieties. The Germination Tech, or whoever is conducting the tests, must attend a course. This is standard for anyone who is selling seeds in the United States. If seeds are being exchanged they do not need to have germination tests done. However, it is seen as a good practice to offer seeds with a good germination rate – or to inform people of a bad germination rate – if you are exchanging seeds. This is an unofficial "good practice" among some seeds savers that the Preservation Department follows.

Alex taught me about reading seeds and determining if they are normal and abnormal so we could determine the germination rate. This was super fun. It was fun learning about all the things that could go wrong with a seed. Below are notes transcribed from my notebook showing how assessments are made:

Notebook:
Association of Official Seed Analysis: Big book of rules.
Alex went to a four day class at Iowa state on seed germination testing procedures
Rules for cotyledons: 50% good
Spray [paper towel] with lots of water to keep them viable
Abnormal reading: decay at the point of attachment between the hypocotyl and the healthy looking cotyledon.
Rhizopus – genus name-
Fungus found on dead seeds, "eats the sugars released from the dead cells" fuzzy white fungus.
2° infection – lesions where the seed coat/neighbors seed coat was touching it, otherwise healthy. These still marked as normal.
1°[infection] from inside the seed. Look for brown lesion
A.Niger: black fungus around the seed, little dots
Blue fungus – probably penicillium
Seedling in the fold of the paper towel. Had a thicker area, purple-ish coloring, root and emerging cotyledon looked good. Normal – abnormalities caused by test conditions.

Suspected dead seeds are prodded with forceps, if they are dead they expel a white substance (like a zit) No official term, I will call it exudate. Good looking seeds with Rhizopus around them will be moved to a clean spot on the towel.
Gravitropism – the root not going in the right direction.
Counting – so much counting
Germination tests don't test vigor but it can be noted, "smaller than the rest but still has all the same parts"
Paper towel germination test – certain types tested certain ways.
State law and federal law state that seeds for sale have to be tested.
Does not test vigor – there is an entire other vigor testing handbook.
Goal is to establish the maximum plant producing potential for a seed lot.
Unknown: 2nd week if perfectly fine looking seed doesn't sprout under ideal germination conditions.

June 2nd: Yearbook

In the afternoon I worked with Zack. He is in charge of yearbook distributions. The Seed Savers Exchange Yearbook is the seed catalog for the entire Exchange.[42][43]Members of the Exchange can get the yearbook and order seeds from different members. Not all members of the Exchange are "listed members." Listed members have a listing in the Yearbook which means that they are saving seeds and they are offering those seeds to other members.[44] A paper copy of the yearbook is published each year with the listing information for varieties being offered from members of the Exchange. The Yearbook is organized by crop type. Listings give information on

[42] This is separate from the Seed Catalog that is put out by the commercial side of Seed Savers Exchange.
[43] The Yearbook has a part of SSE since 1975 and the annual publishing of it is no small endeavor. The role of published materials in the organic movement is interesting. I found out more about this when I was looking into the Organic Chapter, that major players in the early organic movement were publishing materials that cemented them as key players in the movement and spreading specific sets of ideas. Dan the Apple Man was still working with Kent Wealy in 2015 because Kent was able to get Dan's apple books published.
[44] Members can decide if they want to offer their seeds to all members or only to listed members based on how rare the seeds are. If a member is already listed this means that they have a track record of saving seeds and offering them and are more likely to propagate and share the rare seeds. There is a beautiful rare zinnia that I saw while I was at SSE that is classified like this. I am waiting until after graduation to get some seeds saved (probably some peppers), and list them so might be able to get some of those zinnia seeds.

the offered varieties ranging from strictly physical attributes of the variety (early, good flavor) to lengthy descriptions of the history of the variety and what it is best used for. The Preservation Department creates the listings for Seed Savers Exchange and they are listed in the Yearbook just like any other member. Their listings code is "IA SSE HF." This stands for Iowa, Seed Savers Exchange and Heritage Farm. Heritage Farm is the name of the entire plot of land that is owned by the organization. For other members of the Exchange their code is determined by their state, last name and first name. Suzanne Ashworth from California would be (CA AS S).

To create a listing for a variety the Preservation staff use information gathered by Eval and from historical data collected in the Collection Origins Research Effort (CORE) program. Zack said in 2015 35% of their listings had historical data and that 75% of yearbook requests came from that 35%. This means that listings with historical information are significantly more likely to be chosen by members of the Exchange over listings with just descriptive variety information. Zack said that this is one of the reasons why the CORE project is so important and why the work that Sara does is critical to their efforts.

This is the first year for de-accessioning process. Zack said that they are framing the de-accessions as Stewardship Opportunities for other members. They will have a list of varieties that are being de-accessioned and these varieties will be listed in the Exchange for other members to pick up.

June 8th : Organization and Logistics: Mass to Packet

From my note:

The seeds move from the field – the water and the dirt – to the silver packets and the freezers. The smooth silver packages look like the brushed steel of all the futuristic equipment depicted in 1950s Sci-Fi movies.

I am picking the carrot seeds out of the corners of the beige canvas sack and dropping them into the plastic deli tub sitting on the desk. This particular variety is very aromatic and I take a moment to sniff and appreciate their flowery smell before continuing with my task. The seed bags are used "inside" out so the seeds don't get stuck in the frayed fabric where the bag is sewn together. I pour some of the seeds onto the plastic weigh boat on the scale. The digital numbers bounce around and I recheck the amount of seed I need for this packet.

My task for the day is Mass to Packet. This is where I take the list of varieties and weigh out a certain amount of seeds and put them in their new storage packet. The seeds that I am working with have been examined by the curator, their germination has been tested and their moisture content is low enough that water crystals will not damage the seeds when they go into the storage freezers. Once seeds have passed all these tests, they settle in the temporary storage rooms until Tim has decided – based on a number of factors including their germ tests and the number of seeds – how many seeds are going to go into what type of packets. After Tim enters this information into the database it populates a report that Zack prints off. Two labels are printed off for each individual packet; an adhesive label for the outside of the packet and a plastic identification tag that goes inside the bag.

Inventory Packets: Divide Seed Lots into different packets.
E- Extra – can be given away to members for promotions
P- Preservation – first packet to get filled, only for emergency, use only for increase grow outs
D- Distribution – often the largest packet. put away enough for at least 10 distribution (varies by type/germination rate)
Bu- Backup USDA
Bs – Backup Svalbard
C - Lot Check – Put away and grow out next year to make sure everything is squared away (eval).
L- Legacy: don't have much notes on these.

After an Increase grow out a Preservation Packet gets filled first. In this packet there should be enough seeds for a minimum of five grow outs based on factors like germination rates and longevity. The Backup Packets are the next to get filled. The first for the USDA seed banks and the second for the Svalbard the seed bank in Norway. The Lot Check Packet is created next which prompts an Evaluation grow out for the next year. During the Evaluation grow out the accession will be examined through its growth cycle to evaluate it for off-types or crossing with other varieties that may have happened in the previous grow out.[45] After Evaluation a Distribution Packet will be created with enough seed for at least ten distributions in the Exchange.[46]

[45] I will go over this more in the section for Evaluation.
[46] The amount of seeds that are kept in the Distribution Packet is based on many factors (germination rate) one being the size of the seed. SSE has limited storage space. Accessions with smaller seeds, such as tomatoes and peppers, can have larger amount of seeds in smaller packets.

June 9th:Evaluation of Varieties

From the notebook:

Slobolt lettuce variety "never bitter" says the description in the database. "So bitter," says my notes.

Today I did Germination in the morning and then finished up doing the Mass to Packet from yesterday. In the afternoon I went out with Phil and Steffen to Evaluate some lettuce. This was super fun

Phil and Steffen make up the Eval Crew and are tasked with monitoring the grow outs from the Lot Check packets. This includes checking each variety for specific traits during its growth and development. For the lettuce we were looking to see if it was starting to form a head and if it was becoming "market mature." They brought their laptops into the field so they could input measurements for different varieties and read off descriptions to see if they matched or if there were any off-types. One person would go through and take measurements for the width and length of the leaves and the other person would input them in the database.

As we were out in the field we occasionally munched on some leaves and taste tested. This was one of the best parts of being out with Eval, getting to taste test a bunch of different varieties.

Tomorrow they will do a lettuce taste evaluation. They will go out in the morning to pick the lettuce because lettuce tastes better if it is picked when it is cool outside. The samples of lettuce will be put in coolers and transported to the office for the convenience of the tasting volunteers. They will have “Lettuce Evaluation” sheets that staff members can fill out. Steffen explained to me that previously they would have people just taste test and give them a sheet of paper with their thoughts and feelings about the variety but they ended up with too much a variety. “Tastes like an Asian grocery store,” was the favorite example of comments that they received. To counter this, Steffen developed taste test sheets using established "taste test" lexicons for those crop types. These are then measured on a scale. Bitter, Sweet, Carroty on a scale from 1-5. This gives the Eval Crew quantifiable data to work with that is standard across a crop type.[47]

Figure 1: Eval Lettuce grow out. Each stick represents a different variety being grown. "If I had a bunny, I would bring him out here," said Phil when we were on break.

June 10th : Organization and Logistics: Storage and Dispersal

Finished up the Mass to Packet with Zack today by putting the seed that I put in packets on Monday and Tuesday into the freezers. They were all assigned locations in the different

[47] I did a lot of work with Eval but my notes were not super great or descriptive of their work. Phil and Steffen do a wonderful job of finding interesting aspects of the varieties in the collection because they are examining them using the historical information and observations. I recommend checking out the Seed Savers Blog from 2015. At that time Phil and Steffen were doing a series called, “Step up to the Plate,” where they showcased different varieties that they were growing out that year. It is excellent and informative.

freezers. Tim was very excited about this and used this as a photo opportunity as we were putting USDA and Svalbard packets away in Room 3 and when we went down into the super cold freezer (-18°C) down below the potato cellar.

The USDA and Svalbard seeds were said to be in "limbo" when they were in Room 3. It would not be until they were shipped out that they would be assigned official locations. Zack mentioned that the seed sending and receiving policies in Norway are very strict and that Seed Savers Exchange has special permission allowing them to send their seeds there.

As we were putting seeds away, Zack could reach the top level of the shelf easily and I reached the top using an "Osha approved stepstool" (as Tim called it), Zack was removing a few of the seed packets from the Svalbard boxes and relocating them in the USDA box. He shook his head a little and said that over the winter they had work study students.

"They were eager, but they were not always great with details."[48] Ultimately, this is not a huge deal since all these packets will have to be rechecked before they are shipped out but it is an example of simple mistakes that can happen when using interns, students or volunteers.

As we were putting some of the seed packets away, I stated that the system that they have in place was really great and asked if Zack had helped design that whole process.

"No this was all in place when I got here," he said, "Aaron was in charge of [distribution and seed organization] before and had organized all of this. He is now running the mailroom."

"Wow, he must be very good with logistics," I said

[48] At SSE they had many volunteers, interns and student workers. This is not uncommon for a non-profit group but they emphasize accessibility as part of their distribution mission. There were often tours coming through the Preservation Department or SSE would host gatherings – like the amazing, raucous gathering of horticultural librarians. The house that I was staying was specifically for visiting guests and while I was there a man named Ian who was associated with the Diggers Club in Australia stayed for a couple nights along with a few other people from all over the United States. Most of these visitors were coming to learn more about managing collections, creating seed distribution networks through libraries and more generally how to teach people how to garden and save seeds.

"Really, really organized. And also one of the kindest people you will ever meet," Zack said with a smile.

Before taking the packets to the freezers they must be assigned a location, their address. The first batch that we did were the Preservation Packets. These were going into boxes in the chest freezer that is in the front room of the potato cellar. The chest freezers are not ideal because they turn off and on as the temperature rises and falls. However, they have limited storage space and since it is more difficult to organize the chest freezers they have decided to use the chest freezers to house their Preservation Packets which will not be accessed anytime soon. The location that these packets are assigned to is "Seed Savers Exchange, Heritage Farm, Freezer Chest 1 -B -37." The "B" stands for Box, meaning Box 37. Inside, Box 37 there is no real order because they are pressed for space. Zack says he plays "Tetris" and tries to get as many in the box as possible. To assign the packets to their location in the walk-in freezer in the potato cellar, he is more systematic.

"On a very slow day around Christmas I spent almost all day in the freezer and went through all of the boxes and figured out where we had more space," he said as showed me the Excel spreadsheet that he had created that was entitled "Freezer Map 1" that he used to track and organize this process. The reason that organization is so important is because this is where the Distribution Packets are kept. The Distribution Packets need to be accessed most frequently so they need to be easy to find. These packets also have the largest quantity of seeds and they are kept in the coldest, most stable environment.

After he assigned homes for the new packets we put on the parkas and the large gloves and took the odd walk down the road in our arctic gear. Before we went into the freezer we put on a “life alert” necklace that would allow us to call for help if we get locked in the freezer.

Inside the freezer it looks like any other industrial freezer – like the one at the fast food restaurant I once worked at – except that it is filled almost completely with shelves and boxes holding thousands of those little silver packets. The freezer is -18°C and the parka and gloves are doing a good job keeping me warm but the idea of getting stuck down here is still unsettling. The shelves are on wheels that allows them to be scooted so you can get between them, it is a little like a puzzle game figuring out where to move the different parts to get where you need to go. I take the long boxes down from their spots on the shelves and place the new packets at their new address and then return the boxes to their shelves.

After we put all the packets away Zack is excited because it was time to go back to Step 1 of the entire process. We need to "pull seed" (take seeds out of the freezer) for this year's grow outs. Zack decided that to fully appreciate this process we should go talk to the curator, Tor. Tor is the one who goes through the accessions and decides what is going to be grown out at their yearly grow outs. He is the one who puts the names of the seeds on the list that Zack uses in order to pull the seeds, which then go to Amy in the greenhouses, Bryan in the field, tended to and harvested by the Field Crew, tested by Alex for germination and seed moisture content, reviewed by Tim and assigned new packets, evaluated by Phil and Steffen and put back into storage or distributed to members.

June 10th Continued: Field Planning and Collection Considerations

Tor's desk has books and papers covering most of the surface. He has two screens right next to each other and up on one is an excel spreadsheet and up on the other is Emma White. Zack asks him if he has time to talk to us about the Seed Regeneration process and he says that he can. Toby had mentioned to me that when asking Tor a question, even one that requires a two sentence answer, prepare to get a detailed two page long email. I was very excited to get to ask

him questions. Tor had worked Evaluating accessions (Steffen's current position) and moved up to Assistant Curator and now Curator.

Tor explains that they have 28,000-30,000 accessions in the Collection and deciding what they can grow out each year is based on how effectively they can isolate the varieties during the grow out. To determine what can be grown out, first the Field Manager, Bryan, makes the field plans. The field plans show how much space they have in the gardens and which varieties can be planted in which location based on their current standards for isolation distances. They also account for how many isolation tents they have and what is available for certain crop types.[49] Another consideration is the human resources that they have available to do things like Hand Pollination for corn.

"We will only grow out twenty varieties of corn per year because it is important not to overwork the staff and the space," Tor explains. I nod in agreement. The work that the Preservation Staff does in the field is physically demanding *and* detail oriented. Both of these types of labor can cause people to make mistakes and mistakes in these scenarios can result in unintended pollinations which will compromise the purity of a specific variety.

After space and resources, the next considerations that the curator looks at are which varieties need to be grown out and which varieties meet their current Accession Policy. Tor says that any accession without a Distribution Packet that also meets their Accessions Policy is a good candidate for being grown out. This is easy to look up in the database. All you have to look for is "Active Status" meaning that the accession meets the current standards and look at the listed packets for the specific accession. However, currently only around 1,200 of their accessions have

[49] Isolation tents are put over an entire plot. We used these to house squash which produce big large flowers that pollinators love to get into. Using a cage means that field crew doesn't have to individually pollinate that crop. It is more work at the outset but it helps guarantee that those varieties are isolated from each other. For plants that require pollinators they order pollinating insects that are released into the cages.

"Active Status." This is one of the reasons that the CORE (Collection Origins Research Efforts) program has developed, to do research on each accession, determine if it meets the new policy and switch the status from “Active by Default” to “Active Status”

They would like to be on a Century Schedule for each accession. This means that the variety gets grown out every 100 years so that the seeds stay viable. For their minor crops such as celery, leaks and some of the collards they are doing this easily. However, for their major crops such as corn, beans, peppers and tomatoes – which make up around half of the collection – Tor says, “they are not even close.” During our conversation he kept repeating the idea that they are focusing on the "long term sustainability" of the Collection.

Part of trying to accomplish the Century Schedule without putting huge strains on their staff and organizational resources has been to implement their Accessions Policy (See Appendix).[50] The Accession Policy limits what they will take into the Collection and outlines criteria for de-accessioning. It defines their primary goal as collecting American Heritage varieties and deprioritizes modern cultivars (Seed Savers Exchange Collections Committee 2015). This has been a cause for controversy, as de-accessioning usually is.[51]

The topic of conversation moved back to growing out the varieties and the topic of selection.

"We don't practice selection here," Tor said. Their goal is to keep the genetics of the variety like it was when it was donated, preserving the genetic diversity. However, he goes on to

[50] I will go into more detail about the Accession Policy when I discuss working with Sara and CORE.
[51] De-accessioning is a big deal in the museum world. This is because once an object is determined to be an accession it is owned by that organization and they have responsibility for it. If an object is de-accessioned this means that ownership and responsibility for the object is being transferred to another entity or ownership is being relinquished. However, because it was their first year de-accessioning (and because I did not yet understand the implications of de-accessioning) I do not have many notes or reflections from 2015 on the subject. A detailed examination of changing collection policies regarding the Seed Savers Exchange Collection is an interesting subject and could be the basis of another study or paper.

say, in practice, gardening is about selection. A gardener selects the varieties that you want based on characteristics that you like and then you select the seeds from those varieties for the next generation.

He gave the example of carrots. The genetic characteristics that give them their specific shape – he made his hands come together and make a “V” shape in the air – are only there because they are selected year after year. Once you stop selecting for that shape then the carrots start going back to more "wild" shapes

He also gave me the example of the Selser Purple Radish. This variety grows in purple and white and pinkish every generation but the selection of the purple radishes only has been passed down with the seeds, which is why they call it the Purple Radish. So, if they stop selecting the purple radishes this will slowly degrade the variety. The selection process also has to be passed down with the variety. Because of the inevitability of genetic change with each grow out they try to grow their varieties out as infrequently as possible – hence the Century Schedule. *Ex situ* conservation (seed banking) is imperfect and many seed banks do not have great practices even though they are trying their best he states.

"*In Situ* Conservation is the most important," Tor said, “it is a wellspring of genetic diversity." He goes on to say that part of the Seed Savers Exchange mission needs to be helping other seed savers and seed saver groups to support the cultivation of landraces and heirloom varieties that are adapted to specific environments.

I learned a lot from Tor in one conversation. My notes from that conversation are multiple pages of me just trying to keep up with all of the things he was saying.

Managing any collection means working with and dealing with the people who worked there before you – through the repercussions of collecting policies, how they cared for the collection and how they documented what they did.[52] The "documentation blackhole" that Tor mentions can be thought of as a period of time lacking historical documentation causing the present-day staff to rely on extracting information from the physical objects that were left behind: the seeds in the collection.[53] The Collection is massive and there are many unknowns that the Preservation staff deals with on a daily basis. The corn growout of 2007 is still remembered because there are still bags of corn with unknown quality and purity sitting in one of their storage rooms.

Tor's history lesson helped me better understand the emphasis put on certain aspects of everyday work and new organizational policies. Limit the corn grow out so the staff doesn't get over worked. Emma White's ability to track and document what is done during each grow out and the ability to track that information to specific seed packets. Adopting an accession policy that limits what can be included in the collection which helps the Preservation Staff maintain standards of care that have been put into place. In the Preservation Department they acknowledge the great accomplishments of the organization through its history but also acknowledge the repercussions of past actions that are felt in their daily work.

Previously, I had been introduced to the idea of Seed Savers Exchange as a member of the Exchange. That they were just like any other member of the Exchange offering up seeds from their collection. However, Tor also made the distinction between the *ex situ* conservation being

[52] There is also the issue of changing ideas, standards and practices. The present-day evaluation of the previous care of the collection may be critical but that is because the standards of practice have changed. Tor stated that SSE was an accidental gene bank. That the collection was started without the intention of being a gene bank or to practice *ex situ* conservation. There is still the question of what initially was going on at Seed Savers Exchange and what ideas they had about how to preserve genetic resources beyond amassing a collection.
[53] It is a little bit like an archeological exploration of their collection.

done at Seed Savers Exchange and *in situ* conservation that was occurring outside of the organization, including in the Exchange. By stating that *in situ* conservation is a "wellspring of genetic diversity," Tor is conjuring an image of a bubbling spring, of a constant flow. The constant flow is contrasted with the freezing stasis of *ex situ* conservation, that holds a portion of that flow in place. The goal at Seed Savers Exchange is not to change their accessions through selection but to try and maintain that variety until it can find a place to "rejoin the flow."

From this conversation I was also given the idea of long-term sustainability of the collection to consider and how they were thinking about it.

June 18:Field Work

My scheduled time helping in the Greenhouse is turning into time spent with the field crew, now dubbed the "Crik Chubs." Today the Crik Chubs are setting up the foundations for the large isolation cages that will go around the large squash varieties and the watermelons.

On either side of the small squash plant we put down black landscaping fabric that is about three feet wide and goes the length of the row. These are held in place by ground staples that you push through the fabric into the ground. Pushing the staple in with my hand over and over and over again made my hand sore.

Before the large cages are set up, we create a tunnel over them to keep the Cucumber Beetles and other insects from munching away at the small plants. To make a tunnel we set up wire framing

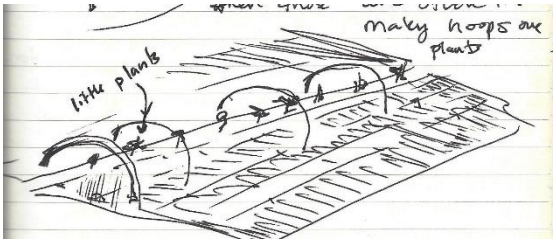

Figure 2Drawing of framing for Agribon tunnel

using wire half hoops. Before we put the covering on Bryan gets down and stick his fingers in the dirt a few inches to make sure it is damp enough.

"Center the Agribon," Bryan tells us. There is a label indicating the middle of the fabric that will help keep everything straight and nice looking.[54] There is a theme with Bryan, he likes his fields, his gardens and everything in them to be straight and exact. His background is in organic agriculture and he comes from a farming family. As we cover the tunnels you can hear the Crik Chubs laughing and starting to say things like, "center your Agribon," "align your Agribon" "Open your mind and center your agribons." As we lined them up and then used ground staples to secure the fabric. It is a little bit like making a bed, if your bed were fifty feet long.

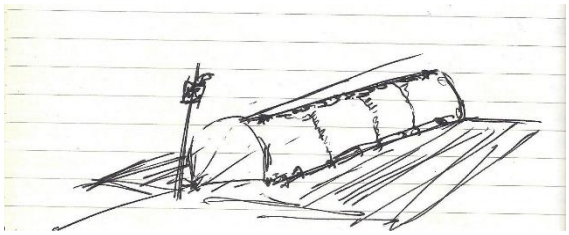

Figure 3 Drawing of Agribon tunnel protecting the seedlings.

Steve and I were on our hands and knees weeding through thistle and lamb's ear and I asked him about the Crik Chub name. He said that a Crik Chub is a small fish found in rivers and someone mentioned them the other day and everyone thought the name was hilarious. Thus, the Crik Chubs were christened. I also asked him about the term "shit stain" that had just come into use for the fertilizer Sustain, as in, "yeah this row is ready for shit stain" or "please pass the shit stain."

"It's interesting, you are part of this story actually," he said smiling, "you yelled over one day when we were out and asked me for the Sustain and one of the guys was like, 'did she just

[54] Agribon is the brand name of a light, white fabric that is used to cover crops and protect them.

call you shit stain?'" And now this is what it is called. This seems like a fun example of how an anthropologist changes the field by being in it.[55]

June 29: Field Work:

Weeding Day. Mostly boring. However, even in a mostly boring day there are interesting things happening when you start thinking about them.

During our 10 o'clock break Hannah and I watched a very large bee bumble its way around a wilting brasica. It kept hitting its wings on the plant and falling. Or it would try to hold on to the plant and land but it was too heavy and just fell off the plant. We saw it do this a few times and then struggle to take off.

"They just don't look like they should be able to fly," she said, and then proceeded to do an impression of the bumble bee struggling to stay in flight, legs and arms dangling. We had a good laugh.

Later we were assigned the duty of putting up deer deterring fencing around a variety of corn named Baird's Bloody Butcher.[56] This variety was in the Lab Garden located directly behind the Preservation Department. Tor and Tim decided the variety needed a little extra looking after which is why it was assigned to the Lab Garden. After we put up the fencing we started looking at some of the other plants growing in the garden and we located an oat variety named Otana.

[55] I want to add here that this was basically the extent of any profanity. It could have been because I was a researcher and everyone knew that but overall it was a very professional workplace and people were always respectful of each other.

"Otana, the laziest name for an oat," Hannah said in her usual quite voice. Her normal speaking voice is about mine at a whisper. "Always present, not always at full volume," is something that I heard her say in my first week. She studied Anthropology at Luther College and got a part time job at Seed Savers with the field crew. She would like to go barefoot but the organizational rules say that all employees must be shod on the job, so she wears Vibrams 5 Finger shoes. One day when we were out weeding garlic for hours she pointed out a noise – a bloop, bloop like a droplet of water – which was the call of the Cow Bird.

The Otana Oat Variety caught my attention because its leaves had orange spots on them and parts of it were turning red. You start to notice these things if you work with people who are evaluating plants all day long. Hannah and I both went over and looked at it. I looked at the little orange marks on it and they looked raised, so I rubbed by fingers across it. My fingers turned a little orange. We both examined the "seed part" of the oat as well and there were some that were missing, and it looked like the seeds were already falling. I was wondering if this was a problem with the variety or if it was what was supposed to happen. Bryan was right around the corner, so I brought it to his attention. He walked over and said that it was probably rust. He examined the leaves and turned them over and ran his fingers over it.

"It’s a fungus, they get it. It isn't that big of a deal. It isn't something that is passed down in seeds." He told me that there were many different kinds of fungus and that a plant pathologist or Google could give me more information. He did say that the oats dropping their seed this early wasn't really normal. That they usually don't do that until the plant is completely dead and turns that nice tan color.

Hannah and I were looking at the barley that was planted near Otana and Hannah said, "The thing that I like about grasses is if you go this way," she pulled her fingers up the fine thin

grass (from the base up) sticking out of the top of the barley, I did the same thing and it felt like very thin smooth wires.

"But if you go the other way it is like a cat's tongue." We both tried to drag our fingers across them the other way and our fingers caught on the tiny teeth on the grass. I scooted down to eye level with the grass and tried to focus on the tiny grabby teeth. They were so small that I could barely see them yet I could still make out the faint outline.

"Cool!" I said and then we started examining other grasses, trying to find their "teeth"

The "toothy-ness" of grasses is something I would experience later while working with corn which I learned was just a really large type of grass.

June 30: Saving the Heirloom

Tor sent out an email thanking us for our work with the Bloody Butcher variety. I include it here because he tells the story of the corn and reiterates the purpose and importance of the work that everyone is doing.

Tor's email:

> Thank you to everyone who helped build the fence around 'Baird's Bloody Butcher' corn yesterday. It was getting munched on by deer, to a degree that threatened the growout's success.
>
> This is a variety that is on the brink of extinction. We have planted all our Collection seedstock this season, because we had fewer than 100 seeds to work with. Corn is very susceptible to inbreeding depression, so we went 'all in' to try to mitigate inbreeding depression. That leaves us up on a high wire without a safety net for this growout.

Due to the low quantity of our inventory, this winter and spring our Seed Historian, Sara, investigating whether we could find other stewards of this variety to re-obtain it. She discovered that the Baird family no longer maintains it, nor do other people who previously stewarded it. Our seedstock, though less than ideal, is the last known seed of this variety. As of today, no seed for this variety exists--we planted it all. If we don't get a seed return on the plants growing in those raised beds, this variety will be lost forever.

Thank you for helping SSE preserve this heirloom corn.

Here's a summary of the history for 'Baird's Bloody Butcher'. It was discovered and saved by Wade Wofford, a deceased SSE member. Wade went to amazing lengths to track this variety down and save it:

Documentation of this accession was found in Glenn Drowns' off-site curator files. Glenn originally received the variety from SSE member Wade Wofford (CA WO W, deceased). In an undated letter to Drowns, Wade Wofford described how he originally purchased the variety in the fall of 1990. He bought five ears from a roadside stand off the expressway in Oklahoma City, OK. Wofford wrote: "The proprietor said he'd bought it as "colored corn" at a farmers mkt, in sealed gunnysacks - and to his chagrin it turned out to be almost all red dent, and harder to sell." The proprietor said that he had bought it from a farmer named Beard or Bard or Baird near Stillwell, OK.

Wofford was able to locate this farmer at "Baird's Farm" in Stillwell and bought more, "enough ears to get a good genetic sample." Wofford's letter also

states: "the Baird family of Stillwell, Oklahoma has grown this for 3 generations, starting with the grandfather of the current farmer. He called it Bloody Butcher & said it produced ~65 bu/acre in poor, rocky soil. It started as a feed & cornmeal crop, but in his time has been grown mostly for feed & sale as an ornamental.

July 7th: Virus Testing

Tim was super excited today about his quick Squash Mosaic Virus test kit. He was running around showing all of us in the office. He came over and explained it to me. The solution was already premixed in a little baggie so all he had to do was grind up the leaf and stick the little "pregnancy test" in. It ended up being negative, which is a good thing because it means the squash isn't virused, but it means that there might also be something else wrong with the squash. He was also very excited about how his Garden is coming along right now. He wanted people to come over and see how his cucumbers and tomatoes were doing. Pretty awesome.

July 2: Collection Organization: Accession Acquisition and Evaluation.

Zack has a Museum Studies Degree and has worked in display and design at the Iowa Natural History Museum. I asked him about museums and the types of museums that he likes.[57] He likes interactive ones. He likes museums which beg people to come play with them. The City Museum in St. Louis is his favorite.[58] Others are tech museums with interactive displays. Getting people to understand ideas through interaction and participation was a job that he did before, and

[57] When someone tells me they are an enthusiast or a specialist I always ask them what is their favorite aspect of their subject or what in the realm of that subject is their favorite and why. This has developed from a general conclusion that I came to when I was younger that everyone you meet knows more about something that you do, might as well figure out what it is.

[58] My wife and I spent a day there. It was great. It was a little bit like House on the Rock but you get to touch everything and find secret passageways. It was funny to see parents try and wrangle their children from the tunnels and hidey holes. Toby lived in St. Louis and visited the City Museum often. She told me about a woman there who tells ghost stories while you do paper craft (paper snow flakes but with animal designs). I still have the ones we made tucked away somewhere. It was delightful.

it is a job he is still doing. He also has an eye for presentation and design. He is good at looking at an accession and finding the light that would be the most flattering and most interesting to the public. This is the kind of person that you want working at the intersection of your collection and the public.

Right before lunch today Toby came up to Zack's desk and started to chat. Zack stopped what he was doing to show her one of the newest inductions he was working on; an heirloom safflower from Genoa, Wisconsin.

"This is going to be the best documented heirloom ever," he said and he started to bring up his lengthy email correspondence and they started talking about a certain email in which the woman described a recipe for “Rizzot,” the family risotto recipe. Zack emailed her back and asked her about the original recipe because it was different than other risotto recipes he had seen because they don't use rice. They used another crop as a substitute for the rice. The explanation the woman gave was that that her ancestor really wanted to make the risotto so he made do with what he had and improvised.

"It’s a classic immigrant story," Zack said to Toby. The recipe was passed down, as was the heirloom crop and the story of their relative’s voyage from Italy to the United States.
In Genoa, Wisconsin now there are many people whose families came from the same region of Italy and every year they get together and make this dish and have a party. Zack said that he and Tim were going to go and check it out this year and then see if they could go get some film footage next year.

"I think I'm going to cry. I don't know why," Toby said sincerely with a smile across her face. Toby is a very expressive person and I understood her happiness at that moment. It was

great to see an incoming accession that was not being rescued or on the brink of loss but was integrated into a community and meant something to them.

Zack and Sara are tasked with collecting the histories and building the stories for the new accessions. The histories are not just "cute stories" for the heirlooms but can be thought of as the best lighting when putting these varieties on display.[59] They are helping build displays through narratives that will help draw the public into interaction with the Collection. This is one of the keys to fostering the practices of *in situ* conservation to help compliment the *ex situ* conservation activities that go on at Heritage Farm

Later that afternoon, I learned how to help the Sara, the seed historian, determine if any of the cucumber accessions meet the criteria to be considered "Exchange Heirlooms." This is one category of heirlooms outlined in their accessions policy that helps them determine the parameters of their Collection (See Appendix). An Exchange Heirloom is a variety that has been in the Exchange and offered by a member other than Heritage Farm (Seed Savers Exchange organization) for more than 20 years. In the database I search by status, finding cucumber accessions that are "Active by Default." If they have been in the Exchange for twenty years then I can change their status to “Active.” This consists of me going through the Yearbook Database and counting the number of years they were listed. I keep tally

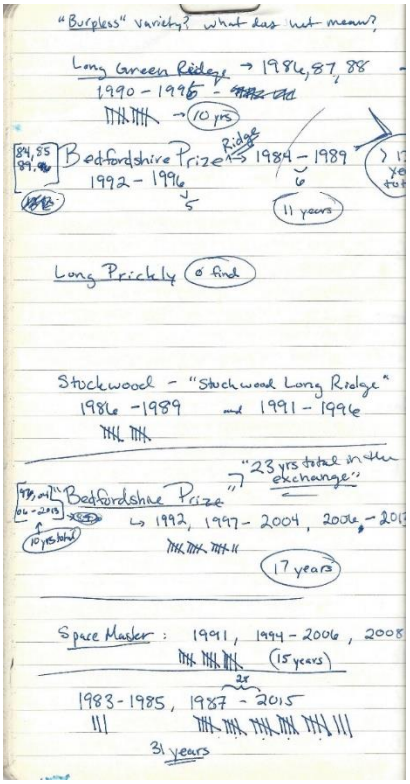

Figure 4 Counting years the cucumbers were offered in the Exchange.

[59] The Preservation Department received a phone call from someone who was angry about their accession policy. They argued against the requirement of a “cute story” to go along with accession. Their argument was that the accessions were genetic resources and shouldn’t that be enough to keep it in the collection?

marks to keep track of the total number of years. It is another slow job. But it is interesting looking through the names, reading the descriptions and seeing who offered which varieties at what times.[60] This task was part of the CORE project and is used to evaluate seeds to determine if they were going to remain in the collection and be maintained by the Preservation Department or if they might be deaccessioned. If they are deaccessioned and the seeds are still viable, un-crossed and free of disease they will be offered back to the original donor or a living relative (Seed Savers Exchange Collections Committee, 2015: 3). If the seeds or plant materials can not be given to the original donor then they will be made available to The Exchange through the Yearbook for one year (ibid:4).[61]

While going through the Yearbook Database I keep seeing names repeating. Longtime members of the Exchange such as Will Bonsall, Glenn Drowns and Suzanne Ashworth. I can't believe how many varieties they kept for such a long time.

July 9th: Field Work: A moment to complain.

I have the funk. Whatever sickness is happening around here I have it. Thankfully, it is just some kind of cold or sinus thing and not something crazy like malaria or something else anthropologists get in the field. I am sore from digging the trenches for the isolation cages for the squash and other crops that are being grown for increase. Tim made a really awesome stop motion animation video of us putting one up, but it really does not capture how hard that work was. Especially doing it all day long. Crap.

[60] After working with the cucumber collection for a while we switched over to the garlic collection. I really enjoyed working with the CORE project. However, the majority of my notes were from working with CORE were just tally marks. It was a straight forward kind of task and even though I got to look through some historical information about the accessions it was really more about updating their database. They have so many accessions that this seems like an endless task, a bit like the germination testing.

[61] 2015 was one of the first years that deaccessioning was being put into place so I did not have much information about how the process was going. It would be interesting to follow up and see how repatriations have gone and how deaccessioned varieties have been distributed through the Yearbook.

Conclusion:

This section reviewed the work that is being done in the Preservation Department to organize and evaluate the Collection and to create Yearbook listings. I wanted to give an overview of the immense amount of work being done to try and systematically organize the collection and bring the accessions up to the professional standards that have been determined by the staff.[62] This includes reviewing the collection through the CORE program, virus testing, germination testing and evaluation. This section was meant to show and explain how the Preservation Department is maintaining their collection and maintaining heirlooms.

It is also important to see how the Preservation Department is maintaining their varieties and how they are determining what stays in the collection. Adopting an accessions policy is always controversial, and an accessions policy that limits what can come into the collection and outlines the process for de-accessioning can be especially contentious. However, it was seen by many of the staff members as a way to responsibly take care of their collection. The focus on collecting and maintaining varieties with stories is not because they are genetically superior or more valuable but because there is a greater chance that they will be picked up in the Exchange and grown in different gardens. Narratives are an important marketing device, but they are also part of preserving specific ideas about stewardship and a way of life that incorporates cultivation and community as a part of that heritage as well.

[62] During my research I was shown how some aspects of professional standards are measured and maintained. For example, the official rulebook and class that the germination technician had to comply and the number of plants that need to be grown out to prevent inbreeding depression in a population. I do not have data from my research on how they developed their system of management for botanical and biological collections and what organizations they drew from to create their own standards. I spent the majority of my time working as a member of the staff and not at management levels – so I was able to gather data and observe their practices but I not familiar with what other professional organizations they drew from to create their current standards.

The need to get the varieties into the Exchange, or into more gardens more broadly, is – as Tor told me – because Seed Savers Exchange at Heritage Farm is a seed bank. What I gathered from my conversation with Tor was that a seed bank can maintain a collection for a period of time, but it cannot maintain genetic diversity more broadly. Their policy of non-selection and reduced grow outs is meant to slow down any changes that would occur to the genetic makeup of the varieties they are working with – essentially freezing them in time. Their decision to grow a variety out and choosing to keep it frozen, potentially risking lowering germination rates and lack of adaptation to the environment, is based on their ability to keep that variety isolated and maintain the genetics of the population.

Seed Savers Exchange as a seed bank and as a member of the Exchange is interesting because they are practicing a different kind of conservation than they are encouraging to take place in the gardens of Exchange members. At the same time, they are modeling seed saving and seed exchange etiquette as a professional organization staffed by subject matter experts. This includes an awareness of plant pathology, sharing information about germination rates, isolation techniques and the inclusion of historical information about the seeds they offer in the Exchange. They are a member of the Exchange, but they are a different kind of Exchange member. They are limited in their roll because they are not able to grow out and select their varieties. Their process of non-selection (random selection) means that we were encouraged to try and identify biases and actively work against them, this will be looked at more in the next section when I work specifically with corn.

The next section looks at the work that I did with the Corn Hand Pollination Team, nicknamed the “Kern Chubs,” and examines in more depth what it means to conserve heirloom corn in the American Corn Belt at Seed Savers Exchange.

Part 2: Corn Hand Pollination

Email to Advisor August 15, 2015:

"I am sorry I did not give you an update over the last [two] weeks. It was a busy and hot week full of corn pollinations and chronic dehydration! There were a few days when I basically came home, cooked my meal, worked [wrote] as much as I could and just fell asleep before eight"

When I arrived at Seed Savers my Internship Schedule had been a tentative guide to my day. The schedule let me know what task I would be doing during the work day: I helped Zack distribute and package seed, found out more information on the Garlic collection for the CORE project with Sara, prepared germination or Seed Moisture Content tests with Alex, took measurements and descriptive notes on plants in the field with Steffan and Phil, sowed seeds in the greenhouses with Lydia and Amy, or joined in with the Field Crew for field preparation, planting, weeding, or harvesting. Starting on July 13th, Corn Hand Pollination - written CHP – spanned across the last four weeks of my internship schedule. When I signed up for the internship, I understood that I would be a member of the Corn Crew who would closely monitor and the corn as it matured into its pollinating stage and perform hand pollination. The corn crop required its own crew because hand pollination is demanding work and, as I would find out, a lot can happen if you are not monitoring it.

Corn Hand Pollination is an isolation technique that attempts to maintain a variety of corn by physically excluding extrinsic pollen from the pollination process. On the Grow Out Schedule the varieties of corn that we were responsible for were marked as "increase," indicating that they were being grown to increase the quantity of seeds so they could be distributed. Our task was to

produce seeds that could be distributed that would not be pollinated – or "crossed" – with any other varieties of corn.

The goal for increase was to get at least 200 ears pollinated per variety that we could guarantee had only been pollinated from within the variety. The ears would ideally come from different individual plants but if we ended up getting more ears off of one plant to reach our goal of 200, that was acceptable. We wanted to maximize crossing *within* the population and to try and maintain the genetics of the population through random selection. The corn that we would grow would be kept in the freezer where it could remain for almost a hundred years without being grown out again. It would be distributed to the USDA, the seed vault at Svalbard and throughout the Seed Savers Exchange network.

While our goal was to keep the corn from crossing with other varieties of corn, the plant has other ideas. Corn is promiscuous, meaning it is a very "out-crossing" species. It has evolved to spread its pollen far and wide and to receive as much different pollen from as many different pollen donors as it can. We and the corn have very different ideas about what we want to happen here. I imagine it was a bit like being a summer camp counselor and trying to limit the amount of unwanted "mingling" that occurs between campers. There are strong wills involved working at cross purposes and we could not be everywhere at once; you turn your back for a second and a tassel bag has flown off or some silks have exposed themselves.

In this section I am going to derscribe corn hand pollination and how it was practiced at Seed Savers Exchange in 2015. I will also give in-depth descriptions of the work and what it was like to work with so many different varieties of corn. By being in the field and being part of the Corn Crew I gained a better sense of the challenges of the work. The specific incidents that make

the Seed Savers collection so extraordinary – that they have so many different varieties – is also what makes it unruly and difficult to manage.

Our Corn Hand Pollination Team consisted of three to four people who were assigned to this task exclusively. Alex, our group leader and permanent staff member; Connor, one of the full time summer field crew workers; Hannah, another seasonal worker who joined us midway through the Corn Pollinating Season; a volunteer who came once or twice a week part of the way through the summer and myself.

The Basics of Corn, Bagging, Bulking and Hand Pollinating

Monday, July 13th – The first day with the corn.

We were not anticipating starting Corn Hand Pollination for a few more weeks but the three Mandan varieties started to mature more quickly than anticipated. Tor explained to us that these varieties were developed in North Dakota and that they were hardy, short season varieties. "They don't always produce a lot of corn but they will produce something regardless of conditions," he said.

Figure 5: Alex and Connor with Mandan Nuetta

The first variety worked we with was sweet corn called Mandan Nuetta. It was a short corn, maybe only three feet high at the most. Alex started off by showing us the stalk and the leaves and then pointing out where the shoots were going to come from at the juncture of the leaf and the stalk. The shoots are the beginning of the ear, which is the female (pollen

receiving) part of the plant. Finding the main stalk of a corn plant might not seem that difficult since we usually only imagine corn as one large stalk. However, Mandan Nuetta and many other varieties of corn have multiple stalk like structures that come off the main stalk near the base. These are called tillers. We wanted to pollinate the ears on the main stalk first because these were most likely to grow first and fully develop.

Then Alex showed us the tassels, which are the male (pollen producing) part of the plant; these come out of the top of the corn plant and form long, well…tassels, which house little anthers which release pollen as they mature. The tassels develop first and then the shoots start to grow out of the stalk leaf junctures. The tassels can be used to indicate when we will need to start checking a variety for shoot development.

"So, what we are going to do today is go around and check the shoot bags that were placed last week and make sure they are still in place. Also, we will be bagging new shoots on the plants as well."

Alex moved to a plant that had a few little bags on its shoots. "Here you can feel the texture through the bag if there are silks being produced" Alex said, taking the top of the little thin black and white paper bag between their pointer and thumb and moving it back and forth. I did the same motion on the bag and the silks felt a little slippery inside the bag. You may be familiar with silks if you have ever shucked corn before, silks are that mess of stringy stuff underneath the husk. Alex drew a squiggly blob on the bag with a fat red permanent marker, "the mark will tell us that there are silks on this ear, and it is ready to be pollinated."

Figure 6: Mandan Red with shoot bag. The red marks indicate that those shoots are producing silks that are ready to be pollinated. The middle tassel has dark red anthers that are starting to shed pollen.

First, we checked to see if there was a shoot starting to grow and we saw a little green shoot starting to poke up from the space between that leaf and the stalk. The leaf was removed to make way for the bag. Alex removed the leaf by grabbing the leaf near the stalk and pulling downward in one quick motion. This caused the leaf to break at the joint where the shoot was starting to grow out. The trick was to leave enough of the leaf that was growing around the stalk to give support to the corn stalk. The bag was then slid over the developing shoot to protect any emerging silks from pollen that might be drifting in the air. The most important factor is covering the shoots before they start producing silks. Once the silks are exposed to open air there is a chance that they could have been pollinated by any other corn variety in the area that is releasing pollen.

Our task for the rest of the morning was to go through and check each plant for shoot development and put bags on them. Connor, Alex and I all worked quietly going through row by row and examining every shoot and shoot bag to make sure that they were secured well and to see if there were any silks and then mark the bags. If I felt a bag and could not tell if there were silks, I would lift the bag off of the shoot to visually check for any silks. Once the silks were outside the shoot bag, I had to cut the exposed silks off with a pair of scissors and quickly replace the bag to make sure that no pollination occurred. When we moved from one variety to

the next, we sprayed the scissors and our hands with a 70% ethanol mixture to eliminate any pollen that may have been tagging along.

Afterwards we went through and counted how many shoots there were and how many of them had silks. Alex then determined, based on the number of silk producing shoots if we would do a pollination the next day. It was expected that each variety would be pollinated multiple times to get to the magic number of 200 pollinated ears. If there were at least 100 silk producing shoots, then we could plan on doing a pollination the next day[63].

Tuesday, July 14th Tassel bagging

Bryan, the Field Manager, joined the Corn Crew for the day and gave us further instructions on how to bag the tassels so we could collect pollen from them the next day. He started by showing us how to evaluate the tassels. When tassels first emerge, they are tightly packed and then they spread out and open up before they start shedding pollen. The anthers, which open like little mouths, hold the part of the flower that produces pollen. After a few days of opening up and shedding pollen, the anthers

Figure 7 Mandan Red's super pretty purple tassels

[63] Alex determined that we would do a pollination the next day and we then spent the afternoon evaluating and bagging tassels. The three Manda varieties – Red, White and Nuetta – were all about ready to be pollinated and we would prepare for a pollination the next day by identifying tassels that were likely to be shedding pollen the next day and securing a large brown bag over them. I lack notes on the instructions that Alex gave us that afternoon and will rely on the notes that I took the next day on tassel bagging given to us from Bryan to explain the process here. However, we did bag tassels on Monday and do at least one pollination on Tuesday that Bryan assisted with and gave us instructions on.

dry up and become brown. We wanted to catch the tassels the day before we anticipated they would be opening in the hopes of catching the most amount of pollen from that plant. Bryan found a plant with tassels that he liked the look of and tore the leaves from around the tassels to make room for the bag. Then he told us to give the tassels a good shake or to use your hand to grip around the tassels to pull off any open anthers with your palm. Then he opened up one of the bags and gathered all of the tassels together into a bunch and shoved them in the bag.

"Now get the bottom of the bag nice and square" Bryan said, “then you use both hands, one at the top and one at the bottom of the bag. Fold in the sides of the bag so that there is a nice crease going down the middle and then the corners are folded up into a little triangle by the base of tassels and held in place by a paperclip. Folding and securing the bag are important to reduce the chance of the bag catching a gust of wind, being ripped off and flying away.”

Bryan handed me one of the three-inch-long Mandan Nuetta ears that had not been bagged, "It's so little!" I said.

"Yeah," he said, "it is like one of the little Chinese corn. Each one of those little pieces of corn [undeveloped kernels] is attached to a silk" he said as I looked at it.

"Really!" I examined it closer, took a bite, and then looked at it again, "that is so cool, so each little corn kernel is individually pollinated?"

"Do you know the parts of flower really well?" he asked.

"A little" I said honestly, "I am starting to get the hang of it."

"Well in most flowers you have the ovary, which has a tube coming off of it called the style, and then a kind of receptive landing pad for the pollen on the end called the stigma, can you guess what the silks are?"

"Uhh the stigma?" This was only partially a guess because I had heard Alex say the other day that the silks were receptive up their entire length.

"Yeah! The entire silk is a modified stigma," he said.

"That is awesome, there is so much potential for genetic diversity," I said, realizing that each individual kernel could be pollinated by pollen from a different source.

"Yeah" he said. And then we went on continuing to bag the tassels of Mandan Nuetta.

On break Bryan told us about the gardening he did when he was a child.

"I remember having to pick from one hundred bean plants in my grandma's garden when I was little, and then sitting out on the porch, 100 degree weather, shelling beans for hours. Then I would help her can them. Those are good memories, well the memory is good. I hated it then," he laughed, "but as an adult it seems kinda romantic." I nodded. As we looked out across the field of Alfalfa being turned into giant rolls by the large green John Deere tractor. The sun was warm but there was a strong enough breeze that it didn't actually feel hot.

July 15th Collecting, bulking and distributing pollen

> *"Thick clouds created a haze over the green hills and the dew stuck to the grass and the crops. We were going to have to wait longer than 10 o'clock in order to pollinate the corn today. The dew would not dry and let the pollen fly free until later in the day."*

It needed to be a dry morning for us to do a pollination. If it was warm with a steady breeze and no precipitation it was likely that we would be able to start pollinating earlier in the day. Generally, Alex told us to wait until thirty minutes after the un-tasseled bags had started to shed pollen before going and collecting bags. Additionally, we had to wait for the dew on the bags to dry too because dampness caused the pollen to clump and made it difficult to work with. Once Alex determined the bags were dry enough, Connor and I would start on opposite ends of

the variety and start collecting bags. This ended up being one of my favorite aspects of the entire process because it had a simple, easy rhythm to it.

The first step is to walk into the field and find a plant that had a bag on its tassels. Then bend the stalk and the bag so that the pollen collected in the bag cannot drop out the bottom while also not damaging the plant. I would use my left hand to hold the stalk in place while giving the bag a few slaps with my right hand to shake loose more pollen from the anthers. It was just a quick succession of taps on the bag that made a pleasant "whap, whap, whap" sound. Next, I remove the paperclip, place the paperclip in the apron and remove the bag by grabbing the tassels through the bag and sliding the bag off, removing any additional pollen that might be on the tassels. I then folded the top of the bag closed and put in the apron. Connor and I would do this until we met in the middle, each of us having thirty to forty bags shoved in our apron pockets. Then we would head to the truck for the bulking process.

The bulking process had to be done in the truck with the windows closed because we wanted to avoid getting outside pollen into our current batch of pollen. We would also spray the inside of the truck down with the 70% ethanol to eliminate any pollen we brought in. This process also had to be done quickly because the increased temperature in the trucks would cause the pollen to clump. Plus, it was also really hot in the truck. Sweat rolling down your back, face and legs kind of hot. Everyone was very motivated to get this done as quickly as possible.

We piled in the truck with the windows up and each person consolidated the pollen that they had collected into a single bag. There would be short comments about how much people were or were not getting and if one person finished before the others they would ask for more bags to keep the process moving along quickly. Then we sifted the pollen using a sieve to remove anther, bugs and other debris. The pollen was then distributed into smaller bags –

usually the same bags that we used for bagging shoots because they had a good pouring edge – that we would carry with us into the field to do the pollinations. In the field we would look for the red marked shoot bags that had ready silks underneath.

The first pollination we did Bryan was trying to show me his technique for corn pollination. Those quick intentional movements he had. Removing the ear bag, giving the little pollen bag a quick "tap tap" with the pointer finger and then replacing the ear bag and squeezing it, making the ear bag all crumbled which was the signal that the ear had been pollinated. I tried imitating him, but my coordination failed me – as it can do when I am being supervised doing a new task – and I felt like I was doing it backwards or with the wrong hands. Bryan tried showing me again and I tried again with the same slow, clumsy movements. "I don't know…it's just awkward," he said and left me to figure out how to pollinate less awkwardly. I eventually got it. Mostly because there was ample opportunity for repeated practice with each variety needing at least 200 ears pollinated. Once all the pollen was used up, we would tie flag tape around the pollinated ears and re-bag them with larger bags that they

Figure 8 Mandan Red. Lower brown bags are covering pollinated ears that are marked with orange flag tape indicating they are part of the same pollination. Tassel bags on top of the plant so we can collect pollen for the pollination the next day.

could grow into. The ears needed to remain covered for a few more weeks because the silks are still potentially receptive to pollen until they all dry up. Even after we pollinated them there was still the risk of them being exposed and pollination from external pollen. The larger bags were the same bags that we used for the tassels, we kept the tassel bags that we collected that morning and use them to cover the freshly pollinated ears. The bags would be slid over the ear and then the bag would be stapled behind the stalk securing the bag in place.

After a few weeks Connor, Alex and I have a work rhythm. When we come in in the morning Connor and I go and get the supplies that we need from the shed. We grab the blue plastic bins with tassel bags, silk bags and our work aprons. Grab the the red and black tool box and make sure we have enough flagging tape, staples, paperclips and scissors. Two stirrup hoes (one large and one small) just in case we need to weed. Fill up the orange water cooler so we have cold water all day.

Alex will bring out the plastic container with the sieves that were washed the night before along with a clipboard with all of the information for the day. As we drive out and Alex tells Connor and me which variety to get started on, usually shoot bagging or checking the shoot bags of a variety while Alex goes and does the rounds to check on all of the corn varieties. Connor and I split up and start working from either end of the corn.

This is the introduction to the steps and procedures of corn hand pollination as it was practiced at Seed Savers Exchange in 2015. After pollination, ideally all of the bags will stay in place and provide a perfect barrier from the pollen inundated summer breeze. The process does work, and we were diligent in our efforts and overall successful in our goal of increasing the number of isolated seeds for the collection. The process is simple in theory and far more complicated in practice. Part of the challenge (and also the joy) of working with many different

varieties is that you don't know what they are going to do. Just like the Mandan varieties matured earlier than expected, many of the varieties had unexpected quirks that we needed to adjust our practices to.

The Joys and Irritations of Diversity

"Today I came back from vacation to the Mandan Nuetta Massacre. Half of the hand pollinated ears, the ones that we had spent so much time caring for and helping along, had been eaten by raccoons. They had used their little hands to rip open the bags and devour the sweet little developing ears of corn. I don't blame them really. They are delicious. Bryan offered me one of the [uncovered] ears and it tasted like the sweetest, freshest baby corn you ever had. The silks also tasted good". 7/27/2015

Mandan Nuetta is a hardy, short seasoned corn that can develop in inclement weather, but it turned out to be very susceptible to a racoon attack. It is on the edge of the garden, the ears are very low to the ground, it was sweet, and because it was the first to develop it was the first available for predation. Our defenses – electric fences – were designed with deer in mind and there were gaps at the bottom that a racoon could scurry through. Bryan and the field crew remedied this problem. For the rest of the season we kept a close eye on grass growing near the fence which threatened to short out the fence or to any signs of critters in the gardens.

That same day Connor and I were sent to work with a variety that had been knocked over by the wind – which is called lodging. One of us would hold the plant upright while the other shoveled a mound of dirt around the base to support it. Lodging can impact how the corn grows but it also just makes the plants harder to work with because they are no longer in their nice neat rows. As the summer went on and the plants got larger and leafier, the varieties that lodged (even

with correction) were still a little more difficult to navigate in than the varieties that were able to stand up[64]. We would also find out that some of the plants had stronger stalks than others and were more susceptible to breaking especially in the areas where we would remove the leaves to access the shoots. After finding some broken stalks in a few of the varieties we were all more careful with how much leaf we broke off.

From the notes: "Hannah and Rachel I know as short people it might be tempting to have selection bias against the tall ones but try to get them too. Don't only get the short ones, but you know we don't want to push the population one way or the other," – Alex warning us against selection bias while we were putting tassel bags up in Bighorse Spotted.

Bighorse Spotted was our first taller variety (maybe about six feet tall) but as the season went on the tallest varieties that we worked with started to mature and they presented their own sets of problems. Most notably we had a few Bloody Butcher varieties that were over tell feet tall and one variety in the greenhouse that could only be tassel bagged by Connor (six feet tall) on a six foot ladder. On the very tall varieties even being able to see their ear shoots was difficult because you had to bend the stalk down to see it. We also learned that these varieties tend to have silks that grow super quickly and will outgrow their bags in a few days if not monitored closely. This meant that we had to start checking the bags with silks and cutting those back until there were enough ears for a pollination.

Getting tassel bags on the taller plants also meant hauling ladders through the garden. We placed the ladder in between a few plants that looked like they had tassels that were ready to go and climbed up to evaluate them. Then we would put on as many bags as we could reach from

[64] The tendency for a variety to lodge was irritating for us but I later found out that many of the farmers that I talked to consider it an unacceptable trait. For farmers and breeders they want their corn to stay standing up.

the ladder. The tassels on these plants were also much larger and required larger bags which were sometimes more difficult to handle. Pollinating the Bloody Butcher varieties was a challenge. To reach the ear to pollinate it I had to bend down some of the plants. I would pull the plant towards me bending the plant down, trying not to snap it, put my left forearm around the stalk so my left hand could lift the ear bag off and expose the silks. In my right hand I held the bag of pollen in my palm tapping the back of the bag with my pointer finger to encourage a small amount of pollen out. I then used my left hand to replace the shoot bag and crumble it over the ear and then release the stalk gently so it could return to its upright position. I was glad that I had gotten better at doing pollinations on the short varieties first because the large ones were much more challenging. We also had a few Bloody Butcher ears that grew right through their bag after pollination. They just busted right through that bag overnight and exposed their silks to the world. It was impressive but a little disheartening.

Indian Blue Corn was pollinated last week or the week before, however we only had around 170 pollinated ears. This variety was about five to six feet tall, most of the tassels were at eye level or within easy reach.

"It Rapunzeled!" Alex said looking at the strands of silks poking out the bottom of the brown paper bag. This was problematic because once the thin golden silks made their way out of the protective bag they were exposed to all of the pollen floating around the Upperfields and we could no longer use those ears. Alex decided to check these ears to make sure that they were developing normally.

Figure 9 Indian Blue Corn. The silks on this variety kept growing long after it was pollinated and they worked their way out of the bag Since we could not guarantee that it was only pollinated from within the population we could not save the seed.. Hannah braided the silks and secured it with the flag tape.

"I was thinking that the reason the silks were not drying out was because they were not pollinated enough," Alex said, pulling the layers of husk off of the ear exposing pale plump kernels. We compared the Rapunzeled ear to an ear that was unbagged and exposed to all of the pollen, which means that it had been pollinated sufficiently. The Rapunzeled ear was further along which meant that it had been pollinated sufficiently but the silks were still just growing anyway. Alex said that the silks were "letting their hair down" continuing to grow to try to "reach" more pollen.

The Indian Blue Corn ended up having a very long pollination window. The silks on this variety were longer than most other varieties and they stayed receptive longer than most other varieties. Also individual plants within the population matured at different rates. Instead of the entire crop maturing within the same week a portion of the population matured one week, then the next week and then the next. We ended up doing more pollinations with fewer ears being pollinated. This variety also had many tillers that had pollen producing tassels that matured after the tassel

on the main stalk. This is an excellent example of diversity within a population. Many of the other varieties that we worked with had been selected to pollinate during a shorter timespan or to mature all at once. The Mandan's are an example of varieties that were selected for faster rates of maturity making them early developers or short season varieties. If you wanted to create an "early" Indian Blue Corn then you would only save seed from the individuals that matured during the timeframe that you are looking for and this would increase the likelihood that the trait would be present in the next generation. However, a long pollination window could also be beneficial if there are factors that reduce pollination viability during one part of the pollination window – such as too much rain – then the population will still have many other chances to reproduce[65].

Alex also discussed the potential for selection bias because of the policy to only do 200 pollinations. Should we continue to do pollinations the entire time that a variety is shedding pollen and producing ears? Are we inadvertently selecting for earlier maturation by only saving seed from the first 200 ears that we pollinate?

"I think some of this corn wants us dead," Connor said as we took our water break. Alex and I nodded in agreement.

Connor and I were sent out to put shoot bags on Bighorse Spotted (Corn 989). This corn was taller than me in most places, I started putting shoot bags on it earlier but had only completed one row and about a quarter of the second. The variety produces many tillers and some of the stalks were curving in response to the wind. In addition to its many tillers and its

[65] For breeders a long pollination window could also mean greater plasticity if they are trying to push a variety earlier or later. Hazzard said that it is easier to manipulate a population if there is more variety there. If the variety has already been heavily selected for a certain trait it is more difficult to "go the otherway" without adding in outside genetics.

height this variety also had big broad leaves. This made the middle row between the first and the second row really crowded.

The wind whipped the broad leaves in my face and the plants jostled and swayed while I tried to check silk bags and look for new silks. “Bother! Bother! Bother!” I said as the corn hassled me and I push my way through, frustrated at the decreased pace of my work.

As I am working my arms start to become irritated and I think it may be sunburn. However, there are one or two times that I notice the corn leaves catching on the skin of my forearms as make my way through the row. I emerged from the corn patch for our 3:00 break and said that I think the variety was irritating my skin. Philip is sitting on the ground drinking from his water bottle and simple says, “Trichomes.”

A few weeks ago, Hannah and I were working with some oats and she was telling me about the little “teeth” on grasses which are pointed in one direction. If you go one way on the grass leaf it is soft and nice; however, if you try to go the other way your fingers will catch it will feel a little bit annoying to your fingers. Apparently, the official name for the “teeth” is trichomes. The trichomes on Bighorse Spotted were a bit more prominent than in most of the other corn varieties that we had worked with thus far. Essentially it was like having high grit sandpaper dragged over my skin over again until my skin was sensitive with tiny scratches. From then on I made sure to roll my sleeves down and try to protect my neck when working in that variety.

At one point while we were shoot bagging we heard Korbin singing one of her Crik Chub hymns in the other field.
"Allleeeeeaaaaaaaaa Criiiiiiiiiiikkkkkk Chuuuubbb AHHHH ahhhhhha!!!!" High pitched and in the style of catholic hymns that reminded me of how older women would sing in church when I was younger. High vibrato, over exaggerated but with feeling. Hannah applauded from the next garden over.

Today at the Upper Field Northwest gardens there are new flashy ribbons spread across parts of the gardens, tied to the fence posts and hanging across the width of the garden. When the wind gusts across the field the ribbons start to hum, making the wind sound louder than it is. The ribbons are a defense against blackbirds that have been feasting on something in the garden. A few days ago, when we drove up a large flock flew away. One bird was stuck in the netting that was put over some peas or beans being grown out for increase. I noticed it and said something and when we turned off the fence Connor led the way over to the trapped bird. He tried lifting part of the netting on the far end, but the bird was scared of him and started flapping desperately away from him. It found its way out under the net and flew away, scared but it appeared unharmed.

The day in the garden started off slowly, quietly. The Corn Crew - Alex, Connor and myself – were in the garden and the Crik Chubs soon followed. They were a small school today. Kevin wasn't there which made it a quieter bunch. Steve tilled up an area in the garden that another variety was just harvested from.

"What is being planted?" I asked Korbin.

"Fall crops for Eval," Korbin said as she was measuring out the rows, placing painted fiberglass poles equidistance from each other marking where the rows would be. In each row there might be two to three poles placed, marking where another variety would be planted.

The morning was a little bit sunny but as the day moved on the clouds rolled in on the gusting wind, obstructing the sun and muting its heat. We were thankful.

After lunch Philip, Sara and Zack were standing by the Corn Crew truck. Helpers for the afternoon! I had heard Tim and Alex discussing earlier how Alex might need the help of some of the other full-time staff members for what needed to be done today. When we got out there Alex started giving Philip, Sarah and Zack instructions on shoot bagging as Connor and I both tassel bagged 60 of the plants in that same variety.

"We should have a height requirement for corn," Sara said jokingly. She was kneeling next to a small plant, maybe only three to four feet high. The short varieties never bothered me at all. I preferred the short varieties to the larger ones.[66] I mentioned the corn variety that we had seen earlier today growing in huge pots in the greenhouse. It was so tall it was almost touching the ceiling inside the greenhouse. It was at least fifteen feet tall. Alex said that they could not even reach the shoot without a step ladder. The name of that variety is Beasley's Whittley County Corn.

"That is a Ward Corn," Zack said. He and Sarah went back and forth both offering up some details about the corn and the donor. Philip mentioned that it was a little scary how they knew that off the top of their heads.

"It is a new donation" Zack said, and I recalled he and Sara corresponding with donors and working to make sure donations fit within the Accession Policy.

[66] I will clarify that statement. I preferred working with the short varieties at SSE because we had so many to deal with, it was just easier. However, aesthetically I love the gigantic varieties. Someday I want a monstrous garden with towering, ridiculously huge varieties of corn, sorghum, sunflowers and squash.

Figure 10 Connor securing bag after pollination on Beasley's Whittley County Corn.

Figure 11 Bloody Butcher being very tall. The pollinated ear bags are a few feet above eye level with orange flag tape under them. There are a few tassel bags all the way up on top. We needed ladders to reach the tassels.

Figure 12 Alex and Connor working with Mandan Nuetta

Pod Corn

Each kernel of corn looks pretty similar when it is going in the ground but as it grows throughout the season the unique aspects of that variety make themselves known. This might be its size, silks, color, maturation rates, taste or any other number of traits. Each one has the potential to be surprising because besides the descriptions that we get from donors – some are more detailed than other – we really don't know exactly what we are getting. Each accession that is donated is unique even if it is the same general variety. The Bloody Butcher corns are a good example of this. In 2015 we grew three different Bloody Butchers: Bloody Butcher 25, Bloody Butcher 77 and Baird's Bloody Butcher. Each accession had a different donor, came from a unique background and was slightly different. Individual lines of stewardship come with their own sets of surprises that need to be managed. The following section is taken shows how Alex, Tim and Tor reacted to a rare and possibly very problematic off-type trait that emerged from Bloody Butcher 25.

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"I found pod corn and fasciated corn in Bloody Butcher 25," Alex said as they pulled out the small ear of fasciated corn, yellow with tiny kernels and what looked like a few little fingers coming off the top (Figure 16). The other ear of corn was larger with and was mostly green still even with the husk removed.

Figure 13:Alex showing me some fasciated corn.

Alex had been removing open-pollinated (OP) ears from Bloody Butcher 25. Open-pollinated means that the silks were exposed to the open air at some

point. By removing the OP ears the plant can allocate more resources to the ear that we pollinate. Usually the OP ears are taken off and just tossed aside. But today Alex looked under the husk.

"This is the pod corn," Alex said, "you can see that each kernel has an individual husk."

Figure 17 Alex holding pod corn (left) and a non-pod corn ear (right). The original photo was a little bright and the pods were less visible. I darkened the photo to make the pods more apparent. If viewing this on a computer zoom in to see the individual husks. Compare to non-pod corn on the right, the kernels are bright yellow and lack an outer husk.

"What?!" I said looking closer at it, working one of the little husks open to try and see the little kernel inside.

"I will have to take these in at lunch to show Tim" Alex said.

We didn't take lunch until after one o'clock because we had not been able to start on pollinations until ten because the bags hadn't dried out from the rain the night before and we were operating as a two-person team that day. After lunch Alex brought the podded and fascinated ears to Tim's office. Tim was sitting in his office at the computer with the door open.

"Tim?" Alex said at the door way.

"Yeah, come on in" Tim said without looking up from his computer. When we came in he stopped what he was doing and looked at the ears of corn that Alex was presenting to him.

"I found these in Bloody Butcher 25" Alex said handing him the corn.

"Pretty sure that Bloody Butcher isn't a pod corn," Tim said. Alex explained how they had found these by pulling off open pollinated ears to examine how they were developing.

"Yeah, that's not great" Tim said, "Since it is on the ear it is a maternal trait, I think pod corn might also be a dominant trait, but I'm not sure," Tim said, "I can't remember the genetics."[67]

Since we had just pollinated this variety this morning there was the threat that we had used one of the plants with this trait to do the pollination. If it was a dominant trait that would mean that in the next generation, we would possibly have an entire lot of pod corn. Alex said that they had only found one plant with this and that it wasn't in either of the rows that we had collected pollen from.

Tim suggested that we take the corn over to Tor so he could see it. He also thought that Tor could confirm if the pod trait was dominant. When Alex showed Tor the pod corn, he looked at it quickly and stated that it looked like it hadn’t gotten pollinated. Last Friday Tor and Steffen had been examining one of the corn varieties and had taken off an ear or two that had remained covered and had not been pollinated. He had shown one of them to us, under the husk they were pale green and skinny, the kernels undeveloped and deflated against the cob. The ear that Alex

[67] Mendelian inheritance breaks traits passed along from parents to offspring as either dominant or recessive. So, if the podding trait is dominant then the non-podding trait is recessive. This means that if one parent passes along the podding trait it will mask the recessive trait and the corn will show the podding trait. The offspring will need to receive two non-podding genes from their parents to show the non-podding trait.

presented had the same pale look, the kernels hidden under the tiny husks. Alex pointed out that it was pod corn and Tor's eyes got big and he examined the ear more closely.

"Pod corn? How did we get pod corn in here" he said and he broke off a chunk at the end of the corn, took one or two off of the cob and opened them. He even put one in his mouth. Rolled it around. He asked Alex if they knew the exact plants that it had come from.

"No, but I know the area that it had come from," Alex replied. Tor recommended that the plants that were producing pod corn be identified and rouged out. Tim walked up and they confirmed that the pod corn trait was dominant. This would mean that any plant that had the trait could be easily identified and removed from the population. Dominant traits can take over a population quickly, but, since they are easier to identify they are easier to take out of a population in the first place.

Tim said that they could use the tassels to identify the off types too. The tassels of the pod corn would be bigger and "beefier" than the rest of the Bloody Butcher. The tassels were also more likely to be hermaphroditic, which meant that they would have silks and anthers on the tassels and would form kernels. This would be helpful because the tassels would develop before the ears so we would could identify possible off types earlier and try to avoid using pollen from them.

"What percent can I rouge?" Alex asked. Tor and Tim both said that Alex could rouge up to about half of the population.

"But it really should not be that bad" said Tor, "Pod corn is pretty rare and it should only be a small amount of the population." Tor also started to wonder if we had gotten the seed from a specific donor that had stewarded many, many different types of corn and was possibly the only

person Tor could think of that might have grown a pod corn. Tor and Tim said that the fasciated corn, the ones with the little fingers, was more common and that people usually just selected against it.

"I want to get in contact with some of the people who grow this variety to see if fasciation is just something that happens. It usually takes a few days to get information from donors but until then we can keep the ears that were pollinated from the plants with fasciated ears but we can remove the tassels. I will get Sara to get ahold of people," Tor said. We could later decide if we wanted to keep or discard the ears that developed little fingers on the end.

Tor complimented Alex on finding the off types. It really was a chance thing that Alex had been looking at just a few plants and those happen to have off-types. It was a lucky catch, but it was also because Alex had taken the time to examine the corn.

It was well after two o'clock when we drove back out to the gardens. We still had two more pollinations and we would be there until at least four thirty. We were both a little bit excited about finding the pod corn. Alex mentioned that even though it was unfortunate that we were encountering a problem that they really enjoyed being able to diagnose the problem with Tor and Tim and start to figure out solutions.

Later when we were doing the pollination for Bloody Butcher 77, another tall variety with tons of ears that took forever, Alex said that they kept looking at the OP ears thinking, "what is under that husk?" But we also felt the pressure of having to finish up all the two pollinations before we had to go home so they didn't check any.

"I am an uninterested ear bagging machine!" Alex said and I laughed. We had been making jokes about Alex being an android earlier and about some other sci-fi stuff.

"You have to stop running your Curiosity Programming," I said.

"My Curiosity Program is always on," Alex said as they made their way down the line of corn, flagging, bagging and stapling. I believed them and could relate.

We ended up working until five. We did pollination on three of the Bloody Butchers and I suggested that it might be a good idea to check all of the Bloody Butcher varieties for off-types. They agreed.

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Hannah and I started our morning in checking ear bags in Bloody Butcher 77. These were very silky varieties and the silks needed to all be cut back before the pollination tomorrow. This is something that had been difficult to work with on Monday. The silks were long which made pollinating them more challenging, we had resolved to cut all of them back before the next pollination. Alex was on their way through Bloody Butcher 25 and was examining at least one ear on every plant to try and figure out which ones were producing fasciated ears or pod corn.

Later in the afternoon Alex and I were on ladders behind the Preservation Department in the Lab Garden tending to the tassels of Baird's Bloody Butcher. This was the rare Bloody Butcher that Hannah and I had put fencing around a few weeks ago. We had already done pollinations on the variety and most of the pollen was already gone but we wanted to capture as much pollen as we could. The seeds produced from these pollinations would be used in a more substantial grow out next year.

"Hey Rachel," Alex called up to me from the shorter ladder, "do you know what time it is?"

"It is about 4:10" I said.

"Oh good. I will have time to talk to Tim," Alex said and we continued putting the tassel bags up on the thirty some plants we had there.

Alex and Tim stood in the manager's room in the Preservation Department. Tor sat at his desk, one ankle resting lightly on his knee as he sat in his rolly office chair. Alex updated Tor and Tim on the pod corn situation. The plants with pod corn were not tasseling yet, which was great because it meant that we had not used it in the last two pollinations we had done. Alex brought in another ear of pod corn that was found in Bloody Butcher 77.

"This is a chronic issue with some of the corn accessions," Tor said. Tim and Tor explained that isolating varieties by distance or timing was popular as well as a technique called blocking[68]. They considered these riskier isolation techniques and said that it was likely that many of the accessions were crossed.

Tor suggested that they increase the number of pollinations over 200. This would give them more cushion if they needed to rouge out some or get rid of some of the ears. Part of the problem is that there are many unknowns. The exact pollen donor cannot be tracked with the current method of corn hand pollination that they are doing because all of the pollen is bulked together.

"Are we selecting for earlier pollination by only pollinating up to 200 ears? Are we going to push the next generation towards earlier pollination?" Alex asked. All three of them considered this idea and discussed changing their policy to go beyond 200 pollinations and do pollinations until the variety is done tasseling. Tor also suggested a more conservative method of hand pollination called "sibing." This was a technique in which each ear was pollinated using

[68] Blocking consists of planting a larger number of plants and only saving ears from the center with the idea that the number of plants would block out other pollen.

pollen from the plant directly beside it. This way each ear had one donor. This would be a way to track each individual pollination and reduce contamination and possible off-types. It would also require a new numbering system when it came to tracking the corn. Tim suggested that they work off a grid system: for example, they could say that corn twelve was used to pollinate ears on plant twenty-eight. Tor was also starting to get concerned about other maternal off-type traits – pod corn and red pigmentation were examples of these. He said that there were many traits that they would need to look for.

They were also considering how to keep the genetics of the populations diverse enough while also making sure they were not using crossed plants. Tim said that they would all sit down at the end of this season and do a full re-hash of the corn pollination process.

The pod corn presented an interesting problem because it needed to be selected against so aggressively. It also highlighted the problem of corn being crossed within their collection and how that was being dealt with. This incident was also important because it demonstrated how working with this kind of collection can be challenging but also really interesting. There are surprises and new things to learn. While the majority of the time is spent sweating profusely and doing highly repetitive work, there is also a high likelihood that something strange will take shape in front of you that will present its own set of challenges and delights. It also shows the challenges the Preservation Department is faced with during the corn growouts. Rouging (removing certain corn plants) and examining the corn took time and extra work. We put in extra hours on days when we were already very busy, and it was incredibly physically taxing.

At the beginning of this section, I stated that corn is a very out-crossing plant. Over the summer I saw what that meant as the plants continuously exerted their will intermingle with each other in new and unpredictable ways. Meanwhile, we were tasked with thwarting their efforts,

trying to predict the best course of action and adapting our techniques to tendencies of the different varieties. Alex, Tim and Tor were working with the same technology for isolating and manipulating corn that was developed in the early 1900s. But they were having to continually negotiate new ways to apply these techniques to get the outcomes they wanted: uncrossed corn. It is interesting that the techniques used to create hybrid corn (by allowing plant scientists and breeders to more reliably control pollination and create inbred lines) were the ones that were now being used to preserve heirloom corn.

Conclusion

The mission of the Preservation Department and the standards it has put in place necessitates professionals who are educated in intraspecific variation in crops as well as plant genetics. It also takes the dedicated work of field workers, lab technicians, archivists and historians to manage and maintain the collection. The Preservation Department is maintaining the Collection in three main ways: maintain the genetics of their accessions by preventing them from changing as much as possible, maintaining an archive of historical information associated with the heirloom varieties, and maintaining a connection between the Collection and the Exchange.

The "Hail Mary" grow out for Baird's Bloody Butcher is an extreme version of the overall mission of Seed Savers Exchange. With only 100 seeds left, they grew out all of it to produce enough seeds for a larger grow out next year. Tor's email details the history of the variety. The specific place and family that it came from and how it was used and its history within Seed Savers Exchange – how it was found by Wade Wofford and passed on to Glenn Drowns, and now how it was grown out and multiplied in 2015. Baird's Bloody Butcher represents an accession that fits within the new accession policy because of the combined history as a family heirloom and as a Seed Savers Exchange heirloom. Baird's story arch also feels like an underdog story or a story of salvation – coming back from the brink – that piques our interest and satisfies us with a with a familiar narrative.

I don't know the fate of Baird's Bloody Butcher. Either we grew out enough to help stabilize the population or there wasn't enough produced, and the population will succumb to inbreeding depression and start to decline. It might either be a story of loss or salvation. If it is a story of loss then it's story might be integrated as an anecdote in larger narratives of extinction,

genetic erosion and precarity. On the other hand, if it is a story of salvation it can be kept at Seed Savers Exchange and eventually distributed through the Exchange. The history and the near loss will be included in the plant's profile along with the technical information provided by the Evaluation Team that will increase the likelihood that this variety will be chosen over other red dent corns that people might be looking at. It then has the potential to go on and collect more stories: Baird's Bloody Butcher that was saved by Wade Wofford, passed to Glenn Drowns, brought back from the brink at Seed Savers Exchange, chosen and grown out by a family that then passed it on to someone else. The variety accumulates a history within this community that is a genealogy of care and stewardship. This is part of the heritage that is highlighted and created at Heritage Farm.

I asked Alex why they thought the work at Seed Savers Exchange was important. Alex answered that biodiversity is the stabilizer of ecosystems. Diversity is a core value because it allows for there to be more than one answer to a given ecological problem. They started telling me about Vavilov Centers and how they wanted to travel to them to witness the world's farming diversify firsthand.

Vavilov Centers are named after Nikoli Vavilov, a Russian scientist who lived from 1887-1943 and theorized that the geographic origin of a crop could be determined by the genetic diversity of the crops at those locations (Harlan 1995, 50; Nabhan 2009, 4). The more varieties and diversity at a location the more likely that location was the origin of that crop's domestication. In the early 1900s, genetics was still a budding science but it was being fully utilized in agriculture. Vavilov travelled all over the world and identified areas of crop diversity to gather varieties to form a base of material for his breeding projects and these regions have come to be known as Vavilov Centers.

Vavilov, called the father of modern plant breeding, was the head of the breeding program in Russia that hoped to utilize seeds from all over the world to create the best of the best varieties for Russia and to ward off famine and hardship (Nabhan 2009, 33). Among seed conservationists and plant scientists, there is still a reverence for Vavilov, his collections and the early plant scientists who guarded and maintained the seed bank there through the Siege of Leningrad from 1941-1944 by Axis forces during WWII (ibid: 4). During the Siege of Leningrad, 1.5 million people died, hundreds of thousands of people starved to death and even more died of sickness (ibid:4). Throughout these hardships the plant scientists working at the N.I. Vavilov All-Russian Scientific Research Industry of Plant Industry (nicknamed VIR) guarded and maintained hundred of thousands of seeds; many of the scientists died taking care of their seeds until they died of starvation or sickness (ibid: 8). Vavilov was not in Leningrad but was a political prisoner held captive by the KGB until his death in 1943 (ibid:8).

Remembering Vavilov and his achievements is about remembering the history of his explorations and the beginning of seed banks, but it is about retelling a narrative about a professional heritage and an ethic of collection care and conservation. Vavilov's seed bank was founded on the premise of preventing famine through better plant breeding and his travels abroad highlight the way in which those seed banks are dependent of the work of farmers across the globe to make that goal a possibility. In a similar way, many of the plant scientists in the Preservation Department had a deep respect for members of the Exchange and the seed savers who made the Collection possible. This location is an interesting meeting place of professional plant scientists, historians and the thousands of random, marginal seed savers who show up at their doors with seeds. It is a rich site of cross-pollination because the staff appreciates the work of the Exchange and the seed savers who occupy it and recognize their expertise. This does not

mean that tensions don't exist between people with different ideas about how seed saving should occur or be practiced but it is a site of increased receptivity, where many people can come together and share their seed, their ideas and their practices.

Seed banks are useful for plant breeding and are currently seen as a very specific form of conservation that prevents extinction and can be used as a last resort against genetic erosion. Before I left Seed Savers Exchange, I had a conversation with the Seed Bank Manager Tim Johnson. I asked him what was the most important factor for agrobiodiversity conservation and he simply said, that more people needed to grow these varieties. He saw the work of the Preservation Department as important to maintaining the Collection, but he also wished that they did not have to do the work that they did. This highlights the understanding that Tim had that the Exchange, and seed savers more broadly, were the most important aspect of biodiversity conservation. Following this logic, it would seem that cultivating Exchange members through an idea of shared heritage (and shared responsibility), and people who grow these varieties more broadly, is the most important aspect of conservation being done at Seed Savers Exchange.

Heritage Farm as a member of the Exchange is interesting because of the position they hold as a central figure in the Exchange and as setting a standard for what constitutes a good member and a good seed saver. Being open about germination rates, not giving your trading partner seeds with diseases, giving them the varieties that they are expecting (not crossed), keeping your collection genetically viable by growing out the correct number of plants, and making them available for others in the Exchange. But they are a seed bank, they are explicitly an organization that practices *ex situ* conservation and have relegated themselves purposefully to

practicing non-selection as much as possible.[69] Through their *ex situ* conservation practices, isolation techniques and processes of non-selection that are maintaining a kind of marginal environment for their heirloom corn varieties to exist in. As was described in this chapter, the creation and maintenance of these marginal spaces for the heirloom corn takes a great deal of work, time and resources to accomplish.

After my time at Heritage Farm, I felt like I only had a very small portion of a much larger picture. I was curious about the people who were growing heirloom corn in the Exchange and more broadly outside of the Seed Savers Exchange organization. How did they see Seed Savers Exchange, how were they growing and utilizing heirloom corn and how were they saving and selecting their seeds?

[69] What the Preservation Department does not do is instruct about how selection is done beyond the narratives that they give with the varieties. They do not really give new members a road map to the playful, chaotic, and ad hoc world of *in situ* conservation. Part of this could be that it is not their job, their job is collection maintenance. If I were going back to Seed Savers Exchange, was interested in how the more playful aspects of in situ conservation are being discussed, I would start by looking at beans, tomatoes or peppers where their might be more of an opportunity for purposeful, backyard experimentation.

Chapter 3: Growing and Saving Corn

After my time at Seed Savers Exchange I was interested in how corn was being saved and conserved beyond their walls. Tim Johnson, the head of the Preservation Department, said that the work going on at Seed Savers Exchange was important, but they could not do it alone. To truly preserve and conserve agrobiodiversity the crops needed to be adopted into the everyday lives of people[70]. The corn, tomatoes, peppers and pumpkins needed to find their places in backyards and farms where they could be grown out each year and adapt to their new environment. How was open pollinated corn being grown out in the world?

Corn was one of the crops that the staff members had said they were having difficulty getting people to grow and adopt. Corn is difficult to grow for a few reasons. The first is the number of plants required for conservation, at least 100 individual plants per season, which means that a large section of land must be available and dedicated to the crop. The second is that everything likes to eat corn at every stage of its development. I learned this lesson at Seed Savers Exchange and when I attempted to grow Bear Paw Popcorn for my mother one summer. As a young plan,t when it is just two or three little sprigs of green, a rabbit will happily nibble away at it. As it grows larger and the first ears develop, before it gets any kernels on it, the baby corn is nice treat to a passing deer. When the ears have filled out and the kernels are plump and sweet a family of raccoons will fill their bellies with the delightful snack. If the kernels make it to the last stage in their development, dried out within their brown crunchy husks, a flock of blackbirds

[70] Which people? Who? Is something that my adviser asked me. I don't know who the potential adopters are or if Seed Savers Exchange has targeted a specific group or demographic of potential adopters. That is not a topic that I discussed with staff members in the Preservation Department but it might be a good question for their higher management or marketing.

would be happy to help themselves to the tasty seeds. In short, predation is an issue. Everything loves to eat corn. Why shouldn't they? It is a very common plant in the Midwest that makes up a large portion of the environment for deer, raccoons and birds. An electrified fence is one of the only ways to keep raccoons away from the corn. A third barrier to corn adoption is the amount of work that goes into isolating the plants and keeping the seeds.[71] A fourth barrier is that corn isn't valued the same as other backyard varieties because of its commodity status.

Corn is cheap and readily available in the Midwest. During the summer there are large bins in grocery stores with sweet corn being sold for ten ears for a few dollars. One of my friends cans corn and we went to a farm stand and she was able to purchase an entire garbage bag full of sweet corn for a few dollars. Why would anybody go through the trouble to grow it at home?[72] My new research goal was to find the people who were overcoming these barriers and who were adopting diverse varieties of corn, saving their seeds, and sharing them. I also wanted to know how and why they were adopting the corn varieties that they did. What were the projects that people were pursuing and how did corn fit into those projects? What made the adoption of these varieties possible?

I conducted interviews with six people who were growing open-pollinated varieties of corn[73]. In northern and central Wisconsin and southern Illinois. These interviews provide information about each grower and offers snapshots of how corn is being incorporated into different projects. Through their lives we can begin to see commonalities, influential forces that

[71] See Section on Hand Pollination in previous chapter. Isolating time by timing, distance and gametophytic incompatibility will also be covered later in this chapter and in the next chapter.
[72] Corn contrasts well with peppers and tomatoes. At Seed Savers Exchange I asked a few members why they grew tomatoes and peppers and they said because specialty tomatoes and peppers are expensive in the stores. The difference in taste between backyard peppers and tomatoes is very noticeable. These plants are also easy to grow and maintain in the ground or in planters or buckers.
[73] This of course is not an exhaustive sample but this was the number of interviews that fit well with the size of my study and the amount of time that I had.

shaped their projects, and where they diverge from one another. It also helped me to become familiar with institutions, groups, and events that populated the area and how they connected to one another in a network of production. In the following chapter I focus on the projects of each person, what they are trying to accomplish and how corn cultivation fits into those projects. If we think of *in situ* conservation as a crop being grown and maintained "in its place" what does that mean for corn being grown in the American Corn Belt, where hybrid corn production and modern breeding is part of this place and the culture of corn that developed here? How are the margins of dominant corn production used by alternative corn production and where do these systems of production cross-pollinate with each other and how do these influence the growers visions of sustainability?

Kathleen Plunkett Black

Seed Saver, Educator and Homesteader

Plumb Creek Seeds, Arkansaw, Wisconsin.

I found Kathleen in the online Seed Savers Exchange catalog. She was one of the few people in Wisconsin that listed corn for exchange and had varieties such as Reverend Morrow's Purple Sweet Corn, Mandan Bride and Garland Flint[74]. She invited me to her home in Arkansaw, Wisconsin. This is north western Wisconsin, close to Minnesota and the Twin Cities. The region is hilly and forested with fewer large farms than southern Wisconsin. On the ride home, after the interview, Kathleen and her husband recommended that I take the road that follows the Mississippi south to get a good look at the bluffs and the river as afternoon turned to evening.

[74] To gain access to the online exchange you need a Seed Savers Exchange account, which you can sign up for on their website. They have developed better search choices and the website has gotten better from 2017 to 2018.

Kathleen let me know in an email that GPS sometimes has a difficult time finding their house and gave me detailed instructions. I followed her instructions through small towns and various turns and made my way up the steep, unpaved driveway through a wall of trees into a clearing. My car was greeted by very large fluffy dog who accompanied me to the front door of the house. Kathleen and her husband built the house in the 1970s with no electricity or plumbing. The gardens took up most of the clearing surrounding their house, beyond that trees surrounded the property creating a feeling of snug isolation. Kathleen met me by the door and invited me inside. We sat at the kitchen table next to a large wood burning stove seated prominently in the middle of the kitchen, it warmed the room nicely on the chilly April day. I started the interview by asking Kathleen to tell me about her early life and how she started saving seeds:

> Kathleen: I grew up just helping my dad in the garden. It never occurred to me that you could grow your own seeds. You just went to the hardware store and you got your seeds every spring. We [her and her husband] were sort of back to the landers in the early 1970s. And there were a lot of back to the landers and then there were a lot of the back to the city-ers. We had a next-door neighbor who had moved out build a geodesic dome[75] and started a garden and then about in August or so they said, 'this just isn't working' and went back to town. So they just picked up and left and that fall we were going for a walk and we kinda just walked passed where there garden was and I saw these bean plants with dry pods on them and seeds and I went 'Oh! Maybe we could save these seeds and grow them next year!" So that was the first and I don't have that variety anymore.

[75] A type of alternative housing. Sometimes call "geodesic domes homes," they are now sold in kits with instructions so that people can put their homes together themselves.

It was probably in the 1980s that I heard about the Seed Savers Exchange and it was a pretty new organization at that point and I really joined because it sounded like you could get some really cool vegetables [laughs] at that point it was just the exchange, they didn't have the catalog. Pretty soon I found out that they had this camp out down in Decorah every summer and went down there with, I think it must have been 1984, my second son was about a year old and I went down with two kids and it was a very small group at that point. There was a guy named Glenn Drowns from Iowa there who was demonstrating how to hand pollinate squash and just a lot of people talking about what they were doing and that was when I started to get really excited like, I could do all of this stuff! Gradually over the years started adding different crops and different varieties.

Many years ago, someone asked me, and I started counting and I got up to 200 [researcher: woo!]. We were the back to the landers, the whole economic system is based on nothing, it is all going to collapse any minute so we have to feed ourselves. So once I started growing seeds I really tried to grow some of...any variety that I really liked, well I would like to grow seeds for that. So I have 20 different kinds of lettuce, about 10 squashes, 20 different beans, the biennials that need big isolation distances and big populations, so I am growing three different varieties of carrots, three onions and a couple of little bunching onions. 4 cucumbers, so it is kind of a range. The easiest things to start with were the beans, tomatoes and the lettuce. So those I have a lot. It is, part of the challenge is getting them grown out enough before the seed is done in. (Kathleen Plunket-Black, interview with the author, April 27, 2017)

For Kathleen, saving seeds is about being self-sufficient. Saving seeds is about freeing yourself from the modern economy in a way similar to getting off the electric grid. But later in the interview she also mentioned a few different ways that she sees seed saving as a valuable practice. It is also about fostering long term sustainability by preserving agrobiodiversity that can be utilized to develop varieties that can cope with changing climate conditions. Seed saving and the preservation of local varieties is a key steppingstone to creating local food sheds. Kathleen also mentioned, very practically, that she did not want to be dependent on a national corporation for her seeds because sometimes they just stop offering the seeds.

Her association with Seed Savers Exchange was about being able to give away some of her seeds, get some new varieties and connect with people working on similar projects. Sustainability for Kathleen is about long term viability and self-sufficiency. At Seed Savers Exchange she and others started discussing best practice for saving seeds, including how to avoid the negative effects of inbreeding depression by having adequate population sizes. Now Kathleen is a resource for nearby libraries that want to start seed libraries and she gives talks at the Renewable Energy Fair in Custer, Wisconsin on seed saving. Kathleen manages every aspect of the care and preservation of her seeds. From storage to, field planning, planting, harvesting, germination testing, isolation practices and making sure her seed stock remains viable by maintaining a planting schedule. She also puts together the seed catalogue for Plum Creek Seeds, her small seed company, each year and maintains entries in the Seed Savers Exchange catalogue. I want to emphasize that this is an immense amount of work that takes a lot of planning.

Compared to the number of beans, tomatoes, squash and lettuce that Kathleen has, she has a small number of corn varieties. While seed saving plays a central role in Kathleen's sustainability project, corn does not. Part of this could be that Kathleen said that she likes to eat

fresh food, eat with the seasons as much as possible and does not like canning and preserving food that much. They have a root cellar that helps them through the winter and have a solar dehydrator that preserves through drying. If sweet corn is going to be saved it needs to frozen or canned. Making flour out of corn can be done but it is a lot of work to process the corn. When I asked her about her corn varieties, she described corn as being a difficult crop:

> Kathleen: Corn is pretty challenging because it is Wisconsin, I tried doing hand pollination on corn for, once or twice early on and it was just…Squash you go out there [to hand pollinate] early in the morning and in the evening when it is nice and cool and you pollinate a few squashes and you get a ton of seed. Corn you need a huge population and you need to go out there in the middle of the day to collect the pollen and spread it around and it's just… [it] is no fun. So basically, if I want to grow corn seed, I was going to need to only grow one variety of corn in any one year so I have one flint corn called Garland, I am growing a flour corn called Painted Mound that is actually relatively recent, the guy named Dave Christenson in Montana developed it within the last 20 years probably. And then I have a sweet corn called Reverend Morrow's Purple Sweet Corn that he actually crossed sweet corn and a purple popcorn and it's not, I have a friend that says, "we call it the not very sweet, sweet corn" [both laugh]. But I am still growing that but it's hard you know. I can not guarantee that there is not pollen [from other corn], we are pretty isolated here because we have trees all around and when I do corn, I try to get it planted early in the hopes that it will be pollinating before most of the field corn. But that might be something that I just decide that I have to give up on, it takes a lot of place and time, cultivating and

> weeding. So anyway, I am still trying to hold onto them for the moment. That's another one where I have done, grow it in multiple different years and pooled the seeds so I would have a bigger population for the next generation.

. As she stated, she does not practice hand pollination but uses a mixture of timing and distance to isolate her crops. She can not guarantee that her corn is not crossed by surrounding corn which makes her system of growing and saving seeds different than the standard set by Seed Savers Exchange. However, she is growing and saving seed which, as Tim stated, is the most important thing for conservation.

With all of the other aspects of Kathleen's sustainability project, corn might not fit into her project much longer. The payoff for all of the work involved has to be greater. Kathleen's comments made me think about scale of production. Corn might just be a difficult crop to grow at the household level, especially if, like Kathleen's project, most of the work is done by hand instead of with combines. Kathleen was the only person that I interviewed that grew corn at the household level. All of the other people that I interviewed were either running farms or they were attached to institutions which gave them support.

My short time with Kathleen also gave me a little view of the early days of Seed Savers Exchange and the supporting roll that they played for people experimenting with seed saving. For Kathleen Seed Savers Exchange was a way to access seeds and to learn from others to help develop the skills and knowledge that she needed for her sustainability project.

Professor Bill Tracy

Sweet Corn Breeder

University of Wisconsin-Madison, Agronomy

"My vocation is my avocation."

Professor Tracy runs the sweet corn breeding program at the University of Wisconsin—Madison. The Agronomy building is an old brick building and as you walk along the side walk outside and look up, most of the office windows have potted plants sitting in the sills, leaves pressed against the glass. Professor Tracy's operation was similar to the Seed Savers Exchange operation in terms of scale but very different in terms of purpose. While Seed Savers Exchange made a great effort to not select, Tracy's program was all about working with different populations, selecting and changing them[76]. However, both share similar concerns about genetic erosion and the availability of genetic resources. The sweet corn breeding project and Tracy's collection started about 25 years ago shortly after he started working at the University. He was concerned by the lack of sweet corn that he found in the National Germplasm, which is the United State's main seed collection:[77]

[76] This issue is covered more thoroughly in the previous chapter. At Seed Savers Exchange a major tenet of their Preservation Department is to try to preserve the variety as it was when it was donated. What this means is that they try to avoid gene drift and bottle necks by growing the variety as infrequently as possible and when they did grow the variety to select seeds through random selection instead of through selection based on types. Selection only occurs if there is an off-type that does not match the description of the normal population and then that plant will be culled. Conversely, Tracy's breeding project is based on purposeful selection to increase desired traits within variety populations. Breeding projects have a stock of different varieties with known traits that are utilized to make desired new lines of crops. The two project utilize much of the same equipment and their fields may look very similar but Seed Savers Exchange is looking to minimize change and Tracy's program is looking to increase change.

[77] The U.S National Germplasm System is a federal and state run network of laboratories and research facilities dedicated to preserving seeds, tissues and plants that are seen as important to the U.S. agricultural economy (Committee on Managing Global Genetic Resources: Agricultural Imperatives 1991). These are national seed banks

Tracy: When I went to the [National Germplasm system] and searched for the word "sugary," the gene sugary, very few, incredibly few, things showed up and that concerned me. Not only concerning varieties or cultivars but also inbreds [inbred lines]. So, very few things showed up and that made me think, well somebody needs to collect these things and make sure they are safe.

I made an effort to gather all of the open pollinated sweet corn varieties that I could find and Seed Savers was the richest source… I think all together I gathered sixty and about three quarters [3/4] came from Seed Savers. So, we did some research on their morphology and things like that, then we increased the seed then shipped them off to the national germplasm system. I kept samples of everything but there were some that I continue to play with, work with or breed.

Rachel: What are you working on these days?

Tracy: I breed sweet corn and new varieties of sweet corn and as a University professor with a large research project on various aspects, we breed for disease resistance, insect resistance, we breed for endosperm quality which is what you eat, flavor tenderness, things like that. In the last ten years, we have started breeding for organic systems as well. And as part of that project, we have released one of the few, another guy in Oregon has done it as well, we released one of the few open-pollinated varieties that has been released in the last hundred years or so. That was an interesting process, it was a process of participatory plant

that are often used by plant breeders to source materials. These institutions do not usually give or receive seeds from members of the public which is part of the reason why Seed Savers Exchange is so important as a “people’s seed bank.”

> breeding where we worked closely with a farmer to develop the corn and then we released it to High Mowing Seed Company and they are selling it and the whole point of that is that farmers, people can buy the seed, save the seed and adapt it to their environment. So, it is kind of an old-fashioned idea or process. I am right now working with a few other small farmers seed savers, we have given them some early sweet corn material and they are going to breed it on their own land and develop their own varieties. So that is more related to I think what your subject is.
>
> Rachel: How are those projects going? What are the common issues?
>
> Tracy: Common issues are all biological. Corn is really easy to propagate and really easy to save seed but it's also really easily outcrossed. So, problems of isolation and hand pollination and things like that are the problem with corn. Yeah, no other real problems. It is mainly can the seed saver actually keep the stock relatively pure. (William Tracy, interview with author, April 10, 2017)

Tracy's work and hobby is to grow corn and create new kinds of sweet corn that can be utilized by farmers, seed companies and researchers. His motivation for finding and preserving different varieties of landrace corn varieties was to preserve and protect them so that they could be utilized in breeding projects. His experience with the National Germplasm system highlights its shortcomings and the importance of the work being done by Seed Savers Exchange and their members. The history of his project also shows that finding many different types of varieties to use as the base of breeding stock is a key to beginning a breeding project. Breeding projects are built on the successive gathering, manipulation, and refinement of the genetic materials. To build one of these projects a breeder needs access to a wide variety of diverse seeds.

Tracy describes the development of open-pollinated corn, non-hybrid corn, that farmers can grow out each year, save seed from and adapt to their environments. The biggest issues that the farmers are having is with isolation and making sure their seed stock doesn't mix with other varieties. Tracy is skeptical that any other than the "hard core" seed savers will actually save and propagate their corn because it is difficult and time consuming. This is a common theme that we will see with other farmers that don't practice hand pollination but use other forms of isolation such as timing and distance.

These participatory projects involve the university and its programs working directly with farmers and the farmers having a significant roll in the project. These kinds of programs illustrate how a public breeding program can utilize their resources to help farmers develop varieties that work well for their farms. However, this is a very small aspect of their program. Developing open-pollinated corn is not a main priority of the University's sweet corn breeding program. It is more of a side project, an old timey novelty. The primary goal of the sweet corn breeding program is to create varieties (hybrids or inbred lines) that will be adopted by seed companies and sold to farmers. Tracy is an advocate for public plant breeding programs as a way to promote agroecology and sustainability, "what is best for our environment and our economy." Here we see the use of the term sustainability in a way that differs from the way Kathleen used it. Sustainability here does not mean personal self-sufficiency that may lead to a wider system change but a term that is used to reference environmental *and* economic long-term viability.

We also discussed Genetic Engineering (GE) and how it compares to classic breeding techniques. To Tracy GE technology is markedly different than classical plant breeding and people who state that they are the same either don't know what they are talking about or are being dishonest. He emphasized that they are different processes:

Tracy: Engineering is very limited in what it does, but on the other hand when it can do something well—like with BT corn, umm you know people have been breeding corn to be insect resistant for hundreds of years and the success was rather limited and very quickly using this tool [GE] they could make corn resistant to the European Corn Borer, in that sense it can make changes really quickly. But they are different processes. And the process is quite different and um the implications of that difference is important. To just say that they are the same, is either real misunderstanding of plant breeding […]

Halaska: What are the implications?

Tracy: In a sense GE is a dead end. You put the gene in, it works until the pest overcomes it, then you have to go find another gene, breeding, all of the diversity that you see around you is the result of essentially breeding or selection. Natural or artificial selection. If you look at life on earth, like 500 million years ago, nothing you see here existed. But I don't think you could have… 500 million years ago, if you had the tools of GE, you could not have created an African Violet [references potted African Violet sitting on the table]. Now it did not take 500 millions years to get the African violet but that's what breeding, selection does. You couldn't do that with engineering. I think , that is why I say that [breeding is much more powerful] because it creates things that we could not imagine before we actually see it. Even in a breeding program like mine we will just see things like, "oh that is a surprise" and if you are an engineer, whether you are an engineer that builds bridges or an engineer that engineers plants you don't want those surprises. You don't want a surprise when you build a bridge, "oh that

didn't do what I thought it would do," that is not a good thing. That is what I mean when I say it is a different process.

Tracy's discussion of plant breeding and GE is interesting because he described them as technologies for changing plants and compared their strengths and weaknesses. Tracy's critique of GE does not have anything to do with economics, food purity or power but only with its inability to generate something new. Surprises that emerge from the corn during breeding projects are valuable because it is an example of a hidden feature of the population – a rare unknown gene – that becomes known only by growing the corn. Revealing these hidden genes are potentially the most valuable findings because one of the most important resources of breeding projects are genes that can be utilized and amplified to create new varieties.

Tracy's project is very well established. His position at the university breeding a critical commodity crop means that he has access to resources to help preserve the varieties in his collection and maintain his overall project of developing new breeds of sweet corn. This is also an example of how integration within an institution can help assist an individual's project. Through the institution Tracy has access to land, facilities to keep his seeds, tools, and the human resources (student employees!) to hand pollinate the corn each year in grow outs.

To Tracy selection, isolation, manipulation of genes and maintenance of populations are a matter of skill and expertise. You have to know how to manage the materials that you are working with, so they do not decline or decay. Kathleen emphasized this as well during our interview, that she is constantly learning how to better maintain her varieties. Where Kathleen and Tracy's project greatly differ (besides institutional context) is the goal of their selecting and saving. They are both manipulating populations through selection, but Kathleen is developing many different kinds of plants that will grow best for her homestead, year after year, for her

purposes. Tracey's project is focused in content, only growing sweet corn, but has the goal of creating many different varieties by amplifying specific genes or traits from a large collection of diverse varieties.

Dr. Walter Goldstein

Plant Breeder, Organic Corn Specialist

Mandaamin Institute, Lake Geneva, Wisconsin.

Dr. Walter Goldstein grew up in Seattle and became interested in farming early in his life. He worked on organic and biodynamic farms as much as possible while working on his degree in Botany in the 1970s. After he earned his degree, he went to Europe for four years and worked at research institutes learning about doing research on farms before returning to the United States to earn his doctorate in Agronomy. He then moved to Wisconsin and worked as the Research Director for the Michael Fields Agricultural Institute for twenty-five years. The Michael Fields Agricultural Institute is a non-profit organization that was founded in East Troy, Wisconsin in 1984 and is focused on changing the farming food system by dividing its efforts into three categories; crop research, education and public policy (Michael Fields Agricultral Institute 2016). Goldstein founded the Mandaamin Institute in 2011 and the non-profit organization focuses specifically on researching and developing non-genetically modified corn and wheat. Mandaamin is the Algonquin name for corn which means "wonder seed" and highlights that corn is a creation of indigenous groups and their cultures over the course of thousands of years (Hans Goldstein Media 2018). The name is also used to signify an understanding about corn that is differentiated from a purely technical or essentialized

understanding of corn to one that emphasizes corn as an entire being and the partnership between corn and human culture.

The Mandaamin Institute office is in Lake Geneva, Wisconsin. I walked in the front door into a mostly empty room with a concrete floor and saw Dr. Goldstein at his desk focused on a very large computer screen. He walked across the room and shook my hand before cracking open a door to a back room – a warehouse type area I presume from the outside structure of the building – to tell a few people that he was going to be talking to me in his office. Dr. Goldstein sits down in a faded red, squashy looking armchair in the corner of his office. There are bookshelves on each side of him and a few other chairs facing his armchair. He crosses his legs and gets comfortable for our interview, a steaming mug held in his hands. There is a casual yet erudite feeling to the encounter. I ask him to tell me about when he started growing corn.

> Goldstein: I had been [at Michael Fields Ag Institute] for a year and half, we had a field day we were doing some things with farmers, with some funding from the state and I was surrounded by a group of older organic farmers who told me that I should breed open-pollinated corn.
>
> Halaska: Okay. What was their reasoning?
>
> Goldstein: Their reasoning was that they discovered that open-pollinated corn had more nutritional value and more taste and that animals preferred it. And I heard all sorts of stories about livestock or animals just wandering through farms and passing by all the conventional corn to get to the little patch of open-pollinated [chuckles]. And since then I have experienced that myself. And so, these farmers knew from experience that there was something to this stuff, but it

> wouldn't stand up, it would fall down and they wanted to have someone breed it so that it would stand up[78]. And I didn't have funding to work on that project so I bootlegged it, just did a little project got a little corn from, I wrote to all sorts of companies and universities and the wonderful Plant Introduction Station [Ames, Iowa] that we have, that has a tremendous collection of corn. And we began to experiment and learn about growing corn, and for about fourteen years I think it was, I bred open-pollinated corn. There were a small clientele of farmers that would take the varieties and grow them. Often they would disappear and I would never hear anything but occasionally I would hear "oh, so-and-so in California is growing your variety for twenty five years," so I know that they are still out there. Umm but I continued to develop open-pollinated corn so now we have some new ones that we think are very good yielders, and they stand well, and also have high methiamine [an essential amino acid]."(Walter Goldstein, interview with the author, October 10, 2017)

Goldstein has had a close connection with organic farmers for years breeding corn in the margins of the fields and in available spaces on his own time. While he worked with more open-pollinated varieties in the past he is now focusing the efforts of his institution on creating corn varieties that can be used by organic farmers which are mainly hybrid varieties. He is breeding for a whole host of traits – yield, taste, nutritional value, and growing under organic conditions. The Mandaamin Institute, the Research Station in Ames, Iowa, Practical Farmers of Iowa, and University breeding projects are all working together to develop inbred and hybrid lines for

[78] Lodging – when corn falls down for any number of reasons. It is a common problem. It will not always kill the plant but it causes it to grow slanted (not in neat rows) and can crowd out other plants.

organic farmers.[79] The hybrid lines are favored because of the significant yield boosts and the majority of farmers will not accept any varieties that have yields that are significantly lower than the industry standard. What the farmers will and will not grow influences the projects of the breeders. Goldstein and Tracy both stated that they have worked with farmers that will grow open pollinated varieties but the majority of farmers, including organic farmers, prefer to grow hybrids. Goldstein's breeding stock is built on many different varieties of corn including older landraces and more modern inbred lines.[80]

Goldstein's focus on producing for organic systems is rooted in his assessment that the largest threat to our food system and the environment is dependent on nitrogen heavy fertilizers.

> Goldstein: What really needs to change is that we need to regulate the use of nitrogen fertilizer. That is a big thing. We need to put stops on it. It's polluting our water, it's causing global warming, it's polluting our oceans. We simply have to regulate it. That will change the whole situation. Farmers would grow less corn, or they would grow corn with less fertilizers. We would have less pollution and they would start shifting towards more nutrient efficient corn. Right now, it is cheap. Cheap fertilizer, cheap from the standpoint of financial picture, it's not an expensive input, and [the farmers] can use it as a conduit for a cheap insurance

[79] Practical Farmers of Iowa is a farmer-led organization that started in 1985 during the farming crisis (Practical Farmers of Iowa 2019). I have a very limited amount of information about the group but as a producer group promoting their own vision of sustainability, they would be an interesting group to look into in future research. It would be interesting to see how producer groups such as the Grain Guild and Practical Farmers are utilizing similar and different resources, how they run and operate and what kinds of strategies they are using to help their farmers.

[80] An interesting point about building breeding stock and developing cultivars is that any variety – modern inbred, landrace, or heirloom – needs to be adapted to specific growing conditions before it can be considered a "finished product." Breeding stock is the raw material that is used to create a finished cultivar. Goldstein uses modern inbred cultivars in his breeding program but they need to be adapted to organic conditions which is very difficult because those lines of corn have been adapted to an environment that includes supplemental nutrition resistance against pests. It is necessary to view any cultivar that is going to be used in a seed saving project as the raw material that is then worked by the selector (breeder) over the course of many years.

> policy but it is bad for this nation, for our water, for our air. [Producing nitrogen heavy fertilizer] uses about half the energy that is used to produce corn [… even with] tractors driving back and forth and everything, half the energy used to grow a crop of corn is used to make that nitrogen fertilizer. So I think what we need to do is put stoppers on that. We need to say, 'no' and we need to say it's time for regulation and enough of this […] chemical industry. It's bad for all of us. So you know pollute wells and oceans and fisherman can't make a living anymore and global warming, we all have to say stop. We are going to regulate this. So that is a big one and that is a societal decision. That is not just a farming decision. But it has to come with some guts because you are fighting the chemical industry which is very strong.

Goldstein's project is now very focused on creating corn varieties that can be used in organic agriculture that can help ween corn production from its nitrogen dependency. From his quote we can see that he has determined that nitrogen fertilizers are central to a myriad of issues that divide into many other problems. Which means that solving this one issue could have an impact on water pollution, climate change and issues of human health. Additionally, Goldstein is working on creating a fiduciary system to help keep the Mandaamin Institute afloat that is not completely dependent on grants and donations. This system would utilize a for-profit branch of the operation to sell seeds and create a purchasing club that would help offset the cost of the breeding program by having a percentage of seed buyers' profits go back to Goldstein.[81] Goldstein's project is interesting because of its focus. He is focused on developing corn cultivars

[81] The creation of a corn club or a co-op is one aspect of Goldstein's project that is most related to Bill Davidson's project. Both are focused on creating producer groups to help strengthen the long term viability of small scale and alternative farming systems. These groups, Mandaamin Institute and their corn club, along with Bill Davidson's Grain Guild (to be discussed next) could be interesting field sites to examine alternative producer groups.

that will help reduce the amount of nitrogen fertilizers that are used. To accomplish this goal he is working closely with the USDA's organic program that is focused on producing new inputs but not necessarily to change the structures of industrial farming in the United States[82]. Goldstein's goal is not radical, it actually works very well within a system dependent on purchased inputs, but it could have a great impact on environmentally degrading processes and could potentially help lead to the regulation of nitrogen fertilizers.[83]

Bill Davidson

Seed Saver, Corn Breeder and Local Food Systems Educator.

University of Illinois – Extension serving Livingston, Mclean and Woodford Counties

Bill Davidson's office has a few plants growing in pots snuggled up to the window, a few hanging from the ceiling with long leafy arms hanging down and, colorful ears of corn and jars of seeds sitting on his desk. The green plants break up the florescent lights and beige pallet that dominates the office building located in the middle of Bloomington, Illinois. Davidson has been gardening his entire life and operated a CSA farm in central Illinois for seven years. It was during that time that he started saving seeds. He recognized a similar problem as Kathleen Plunkett-Black, sometimes seed companies will just stop offering a variety that you enjoy growing and this motivated him to save and mange his own seeds. He started learning about seed saving through the Seed Savers Exchange catalog. Davidson moved on to work with a CSA coalition in Madison, Wisconsin where he met many farmers and dabbled in a few other jobs before landing at the University of Illinois Extension Program. Davidson specializes in education

[82] I go over this in more detail in the next section on Organic Agriculture.
[83] After examining organic agriculture and the creation and enforcement of regulation within that realm it is more likely that regulation will be passed to step down the use of nitrogen fertilizers only after a replacement has already been made that is commercially viable.

related to local food systems, short supply chains within a specific geographic area, and has turned his focused to local grain production. For our interview, he has brought out the jars of seeds and ears of corn and begins by telling me about the different cultivars he grows:

Figure 18: The flint corn composites have pointier kernels while the dent corn (1st and 3rd ears) have kernels with the top sucked in.

Davidson: I can tell you that I got started because of this one here, Chapalote, it's one of the oldest races of corn. I read an article by Gary Nabhan about that. So I ordered seed from his company down in Arizona and they said "Well we are not sure if you can mature it in Illinois so let us know if it works." Because it is listed as a 120-day corn. Normally [in Illinois] we are around 100-110 days, so I planted it, just a little plot and the plants were huge and super vigorous and kind of wild and crazy, but it matured beautiful ears so that just got me thinking about diversity in corn

Figure 19: Bill Davidson's composites continued. Davidson wanted to show me the breadth of the diversity that he was working with.

and wouldn't it be nice to capture some of that vigor and add it to our existing crops [….]

So these are for food, so the red one, this is Floriani Flint Corn this is the basis of the mix, this is another Italian corn, these are American dent corn that have been bred for nutrition. I have about fifty varieties from all over the world that are folded into this. What is called a composite. So the ideas was get as much genetic diversity into it as we can and then select it. Any farmer can grow it, save seed and adapt it to their farm.

Halaska: Which one?

Davidson: All of it. This is a white composite. This is an eight row flint corn. So this is from the USDA seed bank in Ames, Iowa, so like a Long Fellow probably. So the breeders gave me the [accession] numbers for about twenty six northern flint corn types, so a bunch of these, this is South American here and just from all over the world, folded in. There is some Hopi Blue which stands out. So anyway it is all mixed up so now it can be adapted to specific locations.

[…] The white corn is Hickory Cane, which is amazing, you can see the yellow kernels this is Bianca Perla from Italy so those are two corns that are considered to have great flavor. So I mixed those and those are being grown out.

So that has a seperate culinary application that chefs would value so we are trying to develop a white corn like that.

Mandan Lavender, it is just an example of the diversity of corn. So this is a corn that you can put in a hot skillet and it will, it won't pop like popcorn but it will expand, like corn nuts kind of thing. But it is only this color corn you can't do it with any other corn. So there is something with the composition of the kernel that allows it to do that. Which I thought was interesting but we can't even get people to eat *any* corn so this really doesn't matter at all. This is just a green corn from Mexico, which is just interesting because of the color. This a black popcorn from Prairie Road Organic Farm in North Dakota they spent a long time selecting for dark color. So it is just an example of diversity in corn. The thing with corn is that there are so many options and colors, and one of the farmers that I worked with he just had Brazilian chef give him corn from Brazil and the plants are like fifteen feet tall and the stalks are huge.

Halaska: Is it growing well up here?

Davidson: Uh, no ,well it is super vigorous but the ears are like seven feet off the ground and some have ears and some don't but you could work with corn like that, you could keep seed each year and shorter and lower the ears and it is just a matter of time and effort. (Bill Davidson, interview with the author, September 1, 2018.)

Davidson's collection of corn showcases the versatility of the plant and the many ways it can be consumed. The parching corn with a kernel that expands but do not pop, the dent corn

bred for nutritional content, the Bianca Perla and other white corn cultivars that are known for their flavor and favored by chefs. Additionally, there are the different colors and structures of the plants and different locations that they are adapted to. Composites, as Davidson explained, are cultivars that are made by cross breeding many different varieties with similar desirable traits into one population. The composite corn cultivar is created to be utilized as an open-pollinated variety; it will be grown out each year, selected and adapted to the new environment and the purposes of the farmer or grower. The main idea is to start with as many different varieties, adapted to as many different places as possible to increase the possibility that the cultivar can become adapted to the growers' land and possess the traits that that want. Creating composites can be seen as the opposite of creating an inbred line. To create an inbred line a single population is bred to itself through many generations to expose and exaggerate specific traits within the population. The goal of creating an inbred line is to have specific traits that can be crossed with other inbred lines with another set of specialized traits in order to create a single generation that has all of the desired traits and expresses them reliably throughout the entire population. Hybrids are complete and single use products for farmers. In a composite, there is a vague type that is created based on a class of phenotypes – white corn adapted to northern environments – that encompasses many different similar cultivars. It is the task of the farmer to uncover the specific traits within each annual crop population that meets their needs and to save seeds and manage the population in a way that works for them[84]. Davidson remarks, similarly to Goldstein, that

[84] I think of the difference between hybrids and composites (or any other variety that encourages seed saving) as similar to the difference between Macs and PCs. The Apple operating system iOS does not invite modification and has specific protection, including the user agreement, that restrict modifications and which apps can be downloaded. To get around these restrictions some users "jailbreak" their devices which allows them to tweak and download apps other than those approved by Apple. With each update Apple attempts to fix whatever loophole was used to allow jailbreaks to occur. Many PCs can run Microsoft or Linux as their operating platform and invite users to modify the operating system, although specific skills are still needed to access some information. However, the success of Macs and of Apple products in general is based on their easy usability, you don't have to be computers savvy to use them, they are ready to go right out of the box and generally more simple to use. Users tend to forget that they are

farmers are reluctant to adopt open-pollinated varieties and that they are most comfortable with hybrids because of their uniformity and high yields.

> Davidson: The hope for [the corn I am growing] is that we can get it into modern diets. Problem is people don't eat whole foods anymore really so we have to figure out how to navigate it. So it is going to alcohol which is kind of sad but that is a viable market. Whiskey and beer. Then chefs, high end chefs. But if we want to break out of this 1% of the market, which is what the local food market is, then we have to have mainstream consumers to eat it. That is the trick, how do you get people who don't think about it and appreciate it to eat it. And then you end up replicating the system where you turn it into corn chips and tortillas and whatever. I don't know how to get around that (Bill Davidson, interview with the author, September 1, 2018).

Davidson is not just concerned with creating open pollinated corn cultivars, he also works with small grains and dried beans. He is trying to figure out how to change the use of staple crops so they can be supplied by local farmers and so that people are eating them without making the conscious decision to do so. Davidson's job is split into two main areas, helping farmers attain varieties that will work for their farming systems and the other is to connect them to markets where they can sell their products. Throughout our conversation Davidson expressed frustration about the lack of whole foods in consumers diets and the reluctance of farmers to grow open pollinated varieties. Part of this problem is being addressed by the Grand Prairie Grain Guild, a group that Davidson created in 2014. The Guild is centered around a forum run

computers. An aspect of control of the device is given to the producer in exchange for a product with easier usability.

through a Facebook group that allows for conversation regarding grain production and connects growers to local processers, bakers and interested consumers (Davidson, 2014; Young 2017). Beyond the Guild and grains, he is interested in a wider movement to create a more sustainable farming system based on diverse production instead of monoculture[85]. He calls this Regenerative Agriculture and it involves utilizing livestock, row crops, grains and woody polyculture (fruit and nut trees) together on one farm to help diversify production and create a more stable farm overall[8687]. `

After our conversation in his office Davidson and I took a field trip out to a local park. In this park Davidson has been working with the community to create a Food Forest which works as a model for how fruit bushes and trees and nut trees can be integrated into production as well as a place where people in the community can forage. The Food Forest had a mixture of berries, currents, grapes and trees all artfully arranged in a circular garden pattern. There were still many berries on the bushes, and we picked and ate some as we were walking along. For me, it reminded me of the scene in Willy Wonka when he opens the door to the room where everything is "eat-able." To Davidson it is difficult to change the food system because of consumer taste, palates are accustomed to processed and industrial food – which are designed to push our buttons in terms of fat, sugar and salt content – and consumers are inexperienced with fruits and vegetables. "It starts with the schools, the Food Forest, we started that with kids in mind. That we need to get kids outside, eating berries off a bush so that they can experience what they taste

[85] Part of the conversation that we had was about "switching frameworks" and the inability to change a system while working within it and using its language. I think this is interesting as a potentially common theme in alternative agricultural projects, the need to find a new framework or way of defining themselves outside of the dominant discourse.
[86] Davidson doesn't believe that Organic agriculture can help meet these goals so a new label or system has to be created and named. I will go over this more in the next chapter.
[87] Davis mentioned that the Savannah Institute is instrumental in creating the goals for Regenerative Agriculture and including diversifying agriculture. He also runs a group called Regenerate Illinois.

like so hopefully when they grow up they will be a consumer that can discern the difference between a good strawberry and an industrial berry." The Food Forest will help set the standard for kids of what berries taste like. Berries are supposed to taste like this berry that comes off a bush, the berries that are purchased in the store, those are the exception.

I asked Davidson how well the Forest has been going "It is what I hoped it would be. If I go out there to work there are just kids running around, laughing and eating berries [laughs]. And they grab their mom and they are like, 'mom, this yellow one is my favorite.'" Davidson is working with and between consumers and farmers, he moves back and forth between trying to understand how to get each group to adopt certain foods or crops and is constantly running up against barriers. He is one of the administrators for the Grain Guild and directs other groups that work to connect small farmers and consumers and allow for changes in the farming system. There were times when he sounded frustrated about the lack of progress that they had made so far, that farmers don't want to adopt open-pollinated varieties or that in general people don't want to eat grains, vegetables or other whole food and these factors are getting in the way of larger, necessary changes to the food system. Despite these barriers, the Food Forest seemed to give him some hope. "It's working," he said with a smile.

Marty Travis

Seed Saver, Farmer and Cooperative Organizer

Spence Family Farm, Fairbury

When I arrived at Spence Farm, I didn't even have to double check the address or instructions on how to find the house. It was the only farm that I had seen since I got off the highway that wasn't just growing field corn and soybeans. There were a few different types of

corn growing in small swatches by the house, rows of peppers and tomatoes, fields of wheat across from the house. Behind the house that was a wooded area that was the only large patch of trees that I had seen for miles. During our conversation Davidson stated that a social barrier to farmers adopting open-pollinated varieties was that they would stand out against their neighbors, that it would be very visible that they were doing something different. Spence Farm stood out. With farming operations your business is on display for neighbors and anyone else who drives by to see and even from the road it was obvious that something different was happening at Spence Farm. Marty Travis, his wife Kris and their son Will operate Spence Farm and manage a farmer cooperative that sells specialty crops to high-end chefs in Chicago.

Spence Farm has the distinction of being primarily owned and operated by the same family since 1830s and their website states that they are the oldest family farm in Livingston County (Spence Farm, LLC 2018). There is a fenced in family cemetery across from the house with a large family headstone surrounded by smaller greying, lichen speckled stones. Before he started farming Marty Travis built Shaker reproduction furniture for clients such as The White House, Oprah and The Smithsonian[88]. But Marty didn't feel completely fulfilled by the work.

> Travis:"I never build anything that anybody really needed. They were things that they wanted. What we do now goes to a different level of being a food citizen and a farmer, to produce good food for people. It is something everyone needs and to have the opportunity to eat really healthy food. We have worked at developing an entire

[88] I would like to do a follow up interview with Marty about the similarities and differences between breeding and creating specialty crops and constructing Shaker reproduction furniture. What similar skills do you use? How do you use expert advice and consultation? How is the contemporary construction of heirlooms similar between vegetables and furniture? Both are rooted in the value of historically significant objects and access to specific markets that can pay for them. His example of doing business with the White House, Oprah and The Smithsonian also conveys his familiarity with working with clients in positions of political, economic and cultural power.

community of small farmers that are doing that and keeping young kids on the farm and giving them opportunities, those kinds of things resonate for me personally and with people in the community much better."

For Travis, the work of creating specialty crops for chefs is more significant than making furniture because he is helping other farmers in Livingston County access markets that allow them to maintain a more stable income that can make farming an option for the younger generation.

Soon after I pulled up at the farm, Travis pulled up in green van and jumped out to greet me. He talked excitedly, and we started walking quickly over to his plots of corn. The varieties that Travis showed me were all in different stages of being improved or worked. Travis was selecting seeds and pushing for specific traits within the populations and attempting to grow our more seeds.

Travis: This is [Hopi Blue] so when we started most of our ears were only 2-3 inches 4 at the most. [This ear is about a foot long] And now we have been saving seed and also we've been really saving and selecting for a brighter blue, bluish purple color. Because we take this corn, one of the things we do with it is mill it into corn meal and if it's just not as vibrant it turns into kitty litter grey [chuckles] not so appealing to our chefs. But if we can continue to build this vivid purple iridescent color then we get a really bright blue corn meal

Figure 20 "See this is what I am talking about, that vivid color," Travis said, pointing out the bright blue color of the ear. He also highlighted the size of the ear which they have been working at increasing through seed saving over many years.

Halaska: That's beautiful. So that makes very good corn meal for your chefs?

Travis: It does. It really does. We have one grocery store that has a "from scratch" in-store bakery and they do five different kinds of corn breads using this. The only difference is that they change the corn, and this is one that they use and every corn bread tastes so different because the corn is different (Marty Travis, Interview with the author. September 1, 2017.)

Figure 21: Chapalote. Stalks were about 12 feet tall and each plant had about five to six tillers making the small patch looks very dense and lush. On the right hand side of the photograph Huitlacoche is growing where two ears should have grown. Travis said these mushrooms are a delicacy in Mexico and are delicious when sautéed.

After looking at Hopi Blue Travis hurried over to another patch of corn that was so large and so lush that it made me laugh[89]. He introduced the variety as Chapalote and each plant was about twelve feet tall and had about five or six tillers. The plot was a dense mess of leaves, stalks and ears all oversized and swaying together in the wind. This was the variety that Davidson had grown and admired for its "vigor," it was pleasing to see that vigor firsthand. Travis and Davidson are both working to push Chapalote, a variety from the south west United States, to earlier maturation:

[89] I want to grow Chapalote. I am not sure what I am going to do with the actual ears but I want to grow it because it is huge, aesthetically pleasing and there is the possibility of edible mushrooms. The idea that a mushroom can be born randomly from corn grown in my yard is very exciting!

"Will and I noticed on some of [the Chapalote plants] we were noticing some of these had six ears on them. And that's a bunch! They are coming. This corn does not finish maturing until almost November [and] this was planted in May. So part of what we are working on then, as we go through we are probably going to tag ears like this [an ear that is more mature] it will be one of the earlier maturing ones. And save seed from that and see if we can take even five, ten, fifteen days off of the maturity we can get it to mature fasted. But it is a tall corn." (Marty Travis, Interview with the author. September 1, 2017)

The last variety that we looked at was a short, scraggly looking corn. Even as it was drying down reddish streaks could be seen on the leaves and some of the tassels had a deep purple color. Its color and stature reminded me of Mandan Red, one of the corn varieties that was grown out while I was at Seed Savers Exchange.

Figure 22: Double Red Sweet Corn. This variety is currently being developed as a red sweet corn, which is very rare, that can either be milled into flour or can be eaten as corn on the cob.

Travis: This has gone passed, it is passed its sweet corn stage, I can probably find some that aren't. This, this is called double red, Double Red Sweet. It isn't as sweet as it would have been two weeks ago. [Travis looks over the ear and finds a specific kernel]

Halaska: Looks like pomegranate. Oh yeah! That is sweet.

Travis: Yeah that has some sugar in it.

Halaska: How did you know that that kernel was going to have sugar in it?

> Travis: It was softer than these at the end. So what we are growing this for is, [number] one, the seed. Because it is a beautiful plant but we started with about this much [a handful of seed] two years ago. So we have been saving our seed but I want to let this go until it has dried, shell it, freeze the kernels and then send them through our mill to make bright pinkish red cornmeal, and it will be sweet. And there was a ceremonial, traditional cornbread that was made by the Native Americans in the Southwest and it was called Piki Bread and I really think that this would lend itself to that bright ceremonial color.
>
> Since we want to use it as a corn meal [in the meantime] if we have enough of it available to use it as a sweet corn with our restaurant and chefs that we sell to, nobody has seen red sweet corn and to have something that intense on a plate would be remarkable. If you catch that corn just right and cook it with the butter your fingers become bright purple, there are so many antioxidants that come off of that. Turn your kid's fingers purple

Travis is currently growing out the Double Red Sweet Corn to increase the total number of seeds, to find traits that he likes, and to experiment with different ways to use the corn. He described a similar process with the Hopi Blue and Chapalote, each fall finding ears that were expressing traits that he wanted –ear size and length or maturation –and saving those to plant in the spring. He practices isolation by timing because they don't have the time or labor available to practice hand pollination. Travis also worked with peppers, tomatoes, and wheat varieties that he cultivates for individual chefs. His goal is to take crops that are usually imported, either from out of country or just at a distance, and grow them in Livingston County to make them available to chefs in Chicago.

Travis and his wife were gardeners before they started farming and he referred to what they do as, “big gardening.” He was a member of Seed Savers Exchange for many years and has been ordering seeds from seed catalogues since he was in his teens. Travis has a familiarity with where and how to get seeds that allows him to act on the requests of the chefs. He knows how to read catalog listings for specific traits, he is well established enough for John Swenson from the USDA (and a prominent member of Seed Savers Exchange) to send him varieties that he thinks Travis will appreciate[90]. Travis has experience with variety conservation as illustrated by the following story:

> Halaska: You explained a little bit about how you get your seed. From small seed houses or something like that. Can you kinda, a chef comes to you and says, ‘I want this thing or I want something with these properties,’ how do you go about finding that?
>
> Travis: So that is wintertime work. Definitely. But let’s just say umm, it may be so we had a chef Rick Bayless, they were getting this particular kind of white corn from the Iroquois Nation in New York, their chief died and the tribe decided not to grow it anymore. Rick came and said, "Do you guys think you can find it?" I said, "Sure! We will see what we can do." This is, twelve years ago. And I found two companies in North America that sold the seed. One in California, they went out of business two weeks before we called. The other one

[90] Travis’ access to seeds has been increased because he has an established record of keeping and maintaining seeds. As explained in the previous chapter, within the Seed Savers Exchange Network anyone can request seeds, but if there are rare seeds or seeds with low population numbers, those seeds will only be given to specific members who have established that they can grow and save seeds.

was in Canada, called them asked them if I could get some seed, they said it would be $50 a pound for the seed, a pound and a half is what we started with

Halaska: What is usually, what is the usually going rate for seeds.

Travis: Oh I would have thought $12 per pound maybe. Umm and so we grew, eight rows 200 feet long out of that. Saved the best of it for seed and had sixty-three pounds of corn meal that we took to Rick and he said, "This is it! This is exactly it. So I am going to need 1,200 pounds of this." Okay, I went back, called the company in Canada told them that I needed, I don't know – well I needed to plant like I think I wanted to plant an acre – so I would have needed like, fifteen pounds. And they said, "Well we don't have that much." And I said, "Okay what do you have?" "Well we sell it by the kernel now. $20 for 100 kernels." I said, "Wait a minute, I bought this amount from you last year," I said, "I am really looking if I could even get six pounds." They said, "That is all there is is six pounds." I said, "I will buy it all, whatever you need to have for it I will pay." Because they went out of business then two years later.

So we were able then to take that and grow it on, we then send some to Seed Savers, to [the] Seed lab in Iowa, USDA all over, to farmers all over the country and we are still doing it. We don't want to lose this. (Marty Travis, Interview with the author. September 1, 2017)

The white corn was in a precarious position because of multiple groups all ceasing to grow it all at the same time, but it was also a story of resiliency as the corn was picked up,

multiplied and distributed.[9192] Stories like this help highlight the value of the work of seed savers and the potential loss that exists without their work. The central hubs of *ex situ* conservation - USDA, the Seed Lab in Iowa and the freezers at Seed Savers Exchange - are all utilized as long-term, stable holding facilities; while the seed is also distributed to farmers to encourage *in situ* conservation. The goal of this type of conservation is to stabilize the variety by increasing the number of locations that it is being grown and multiplied in. What this story also highlights is Travis' position between multiple parties and his ability to navigate those spaces. His ability to reach out to the different seed companies, to find where the corn was located and then distribute the corn to people and groups that could help maintain the variety. Travis' ability to work between people is best demonstrated through his role in the farmer cooperative in Livingston County.

"[We] realized within two weeks [of working with the chefs in Chicago], Oh my gosh, there is no way we can provide everything that they want. So, we began talking to some of our friends in the community." The high demand for local products from chefs in Chicago has caused Travis to look beyond his own farm and to help coordinate sales between other farms in Livingston County and the Chicago markets. The involvement of the community is the aspect of this entire project which seems to have resonated with Travis the most. He emphasized the need to figure out ways to "keep kids on the farms." Davidson mentioned that there are many people that want to farm, that enjoy growing food, but they can not sell it and make a living. For Davidson this is a socio-cultural problem that is rooted in the majority of the population not

[91] This conservation tactic can be understood through metapopulation analysis (Brush 187-193).
[92] The explanations for why each group stopped growing the white corn or why their business failed is another rabbit hole that could build context around the lives of seeds and the people that grow them .The story also reminds me of when Seed Savers Exchange deaccessioned varieties from their collection and they were immediately picked up by other gardeners in their seed saving network.

eating what farmers have to offer and instead eating highly processed foods. Davison mentioned the market of high-end chefs but dismissed it as too small of a market to enable large-scale change. For Travis, high end chefs in Chicago are a perfect unsatiated market to support a local food economy that gives farmers the chance to start diversifying their businesses. Travis helps facilitate the exchanges between farmers and chefs by consolidating the marketing, ordering and delivery process down to a single point. Travis is a broker who has the ability to translates the resources of the farmers (land and ability to grow food) and the resources of the chefs (money and the ability to work with raw products) between each other.

> Travis: Cooperative of people working together. These relationship models. So that was my conversation right before I came here this morning. I am going to Toledo to work with chefs and farmers and try to set up whole system like we have in Chicago in that Northwest Ohio area. I have done that in South Dakota with seventy some farmers, you know that is part of this vision of creating these pods all over the country and it is happening anyway. It is happening in Wisconsin. But there are a lot of people and there are a lot of farmers and there is a lot of opportunity that is being missed." (Marty Travis, Interview with the author. September 1, 2017)

Missed opportunity here means unmet demand caused by two groups of people unable to find each other and see where their needs overlap. Travis has said that the most important thing that he does is listen, he listens and then he finds what it is that people want. He connects groups of people and he connects people with crop varieties. He finds something unique, like the red sweet corn, and brings it to his chef as something that no one else will have, . He listens for specific traits that his chefs are looking for and then scours seed catalogs and databases until he

finds a match. For Travis, there is not a lack of people who want to utilize heirloom and open pollinated varieties there is just a lack of ability to find what they need and use it.

Travis is distributing the relationship models, the "pods" that he talked about, that they have developed in Chicago to other areas across the United States. To connect farmers and chefs so that the opportunity for collaboration are not missed between those two groups. The goal of this distribution - like the distribution of the white corn to seed banks and farms across the United States - is the continued conservation and survival of a specific population. In this case, that population is rural farming communities composed of family farms.

Hopi Blue, Chapalote and Double Red Sweet Corn are currently going through the selection process on Spence Farm. They are being worked so they grow well and have the traits that Travis and his chefs want. The ability to bring varieties from their "rough" beginnings to a variety that grows well on your farm, and displays the traits that you want relies on the grower's ability to select seed and their access to the resources – time, land, equipment and labor – that is required to develop them. In the previous sections we saw that Tracy, Goldstein and Davidson had these resources available through their respective institutions and public funds. Plunkett-Black has land and time. But she lacks the labor and equipment which makes it much more difficult to grow the corn at a larger scale that might make it more "worth it.". Travis had all of these resources; land, income that allows him to use his land flexibly, buyers that are okay with waiting years while the varieties are developed, and the equipment and space needed to harvest, dry and store the grain. Travis and Andy Hazzard are the only farmers that I met so far that

practice seed saving with their heirloom corn varieties.[93] Hazzard's operation has many of the same characteristics that Travis does that allows her to develop varieties.

Andy Hazzard

Grain Farmer and Seed Saver

Hazzard Free Farm, Pectonica, Illinois

Hazzard lives in an older farm house on a section of her family's land about a ten-minute drive from the land where she grows the majority of her crops. The entrance room had a large wood burning parlor stove, like one that I have seen in Streets of Old Milwaukee at the Milwaukee Public Museum or in a recreated early 20th century living room at House on the Rock. Dogs bounded around and circled, tails all whipping with excitement. There were large colorful abstract paintings on the walls. To the left, an entire room filled with house plants, possibly a loom (I did not clarify) and a case for a bow and a case for a hunting rifle sitting next to the couch. She showed me to a little kitchen table and she offered me some coffee she was preparing on the stove. She explained that they had *really* hard water out here which destroyed all of the previous coffee makers, except for a really old one that would not lime up. She was wearing a sweatshirt and a jacket, snow pants and boots as she bustled around the kitchen. A big white dog sat next to me and I absent mindedly pet his head. Andy served our coffee and then sat down across from me. I thanked her for the coffee, took a sip and asked:

Halaska: How is the season going?

[93] I state that they are the only farmers that I worked with because both of them are growing their corn specifically for market sale. While the work that Plunkett-Black, Travis, and Hazzard do is very similar in terms of their day to day work (field planning, preparing fields, planting harvesting, etc…) most farmers and gardeners differentiate themselves based on what they do with the final product.

Hazzard: This was the year where it was super wet in the spring and we couldn't get fieldwork done. It wasn't just me, it was also my brother. So ,we had to wait to plant until he was finished, he finished on the ninth of June planting corn, which is insanely late. It was just too wet, you can't plant when it gets that muddy. I planted my corn on the ninth and tenth of June and I have corn ranging from seventy to 115 [days to harvest] because I planted popcorn this year. That is really long day.

That being said, everything went well, emergence went great, weeding went well. I think the corn got rained on once and then it got dry. Everybody pollinated and then it was like in September it was still not, it hadn't formed black tip on the kernel, and it didn't look like it was going to make it. Like it wasn't going to make it to adulthood because it was planted so late."

Halaska: Black tip on the kernel?

Hazzard: When the kernel dries down enough that it hardens over, it disconnects from the mothersource of the cob and the plant and when that happens the kernel can begin to dry down because the gateway for moisture between the kernel and the cob is shut off. I was pretty concerned, we started joking that, ‘Well we will just chop all the corn for silage and we'll like buy some cattle,’ and you know that is how we will get our money, but it turns out that we had wonderful weather in September. During the day and night temperature changes to make it dry down and all that. And in good weather like if it is sixty degrees [Fahrenheit] you should lose about half a point [of moisture] a day assuming that the humidity is low. If they temperature is around sixty or seventy

> degrees and the humidity is pretty low, which we had in September, it is ideal drying weather and we did have that this year. So we got lucky [sing song voice]. Thank god. (Andy Hazzard Interview on October 24, 2017)

Hazzard has to pay attention to when other farmers are planting their corn because she doesn't want their corn to cross pollinate with hers. Hazzard practices isolation by timing and selects her seed by examining the colors of the kernels which helps her know if it crossed with another variety. By selecting ears that have only been pollinated from within the population Hazzard is also selecting for a shorter pollination window for her corn varieties. While I was at Seed Savers Exchange it became apparent that some varieties of corn (such as the Indian Blue Corn that we worked with) are susceptible to pollen or shedding pollen for weeks, while other varieties matured and finished pollinating within the week. A long pollination window can help a population of corn make sure that some members will pollinate even if there is inclement weather (such as super wet weather that may dampen pollen flight) during a portion of their pollination cycle. However, for Hazzard's varieties longer pollination windows mean an increased risk of cross-pollination with surrounding crops which will impact the quality of her harvest. Because Hazzard needs to be able to plant her crops around her brother's schedule (similarly to how Travis needed to plant around his neighbors' planting schedules) she plants varieties with shorter times to maturity so that her planting dates can be flexible.

Hazzard grew up on the family farm, did 4-H, and studied agricultural science in her first year in at Western Illinois University[94]. Between her sophomore and junior years, she did a lot of hiking and camping with her friends and fell in love with trees and switched to a degree in

[94] Hazzard described her family farm as previously being more diverse but during the economic farming crisis in the 1970s and 80s they were forced to simplify their production to "weather the storm,"

Forestry. From there she went on to do prairie restoration, worked at AES, then she started her own landscaping business. It was through prairie restoration and gardening that Hazzard learned to save seeds. While she was working as a landscaper, she felt like she was getting away from what she really wanted to do so she started vegetable farming in 2006. She approached her father in 2008 with a business plan to grow "Identity-preserved grain products."[95]

Hazzard: He met me with a flat no. And then several years went by and my vegetable business grew and I ended up selling in Chicago and it went really well, and then in 2011, he kinda brought it up because he stepped back from the family operation so that my brother could take over and the timing was right to [grow and sell Identity-preserved grain]. So we jumped in with both feet in 2012. Then in 2013 in May of 2013, we opened the mill.

By then I was running two operations, at two different farms that were completely different and it became apparent pretty quickly within that first year that this was not, couldn't continue, so I had to make a choice: so are you going to be a vegetable farmer or a grain farmer? And I went with the grain. Because that was really where, it is where I felt our land, the talent, the resources I had around me were more geared towards that...

Halaska: What do you mean by, the land, the resources and that?

Hazzard: Our land is wonderful for vegetables, but to really grow as a vegetable farmer I would have really started to invest in a lot of specialized

[95] Identity-preserved grain is a blanket term that covers grains that are not grown as commodity crops. "IP corn production" would be the term used for heirloom corn products from the standpoint of dominant commodity corn production.

> equipment. Additionally, you know vegetable farming is like the gateway to farming, particularly for people right now. And so, it was becoming increasingly apparent, market forces, that there were a lot of farms popping up and grain was something that hadn't, that marketplace had only been scratched a little bit and it hadn't been done much. So it made sense to me, given that I had wanted to do it anyway and the resources that our farm had, the amount of land that I had, and the connection that I had with wholesale in Chicago, yeah this is the way to go. This will be something that nobody else really has. It would be harder for people to do, so I will have you know, a little marketplace where I can build myself and that is basically what I did. (Andrea Hazzard interview with the author March 23, 2017)

Like Travis, Hazzard has access to family land and buyers in Chicago that have the ability to consistently pay high prices for specialty grain products. Hazzard also describes the talent and the "resources of the farm," which she would describe later as the planting, harvesting and drying equipment. Additionally, she described the ability to utilize that equipment—not everyone knows how to operate large scale farming equipment or has the benefit of time to learn[96]. The resources that Hazzard had access to were the same resources that Davidson is looking to develop with the Grand Prairie Grain Guild. Grain farming is more difficult to get into

[96] The equipment that the family owns for commodity corn production is awesome. I use the term awesome here in the sense that it is truly awe-inspiring not that it is cool. When I visited her farm for the second interview in October she showed me the sixteen-row planter, their combines and their tractors. The planter is a baffling feat of engineering that combines GPS programming with super precise computer monitored seeding to make perfectly spaced rows of perfectly spaced plants. This makes weeding with a cultivator much easier because the person driving the cultivator doesn't have to worry about running through any of the rows. We climbed into the cab of one of the new tractors (literally climbed, you take a ladder up to the cab) which had a cushy seat, was temperature controlled and the seat is surrounded by buttons, switches and screens. It reminded me of the shiny new vehicles we operated while I was in the Army. Which made me think more about the similarities between commodity crop production and the military in terms of how it is invested in and utilized by the federal government as a service to the state. It also made me think about what American solutions look like, how is it that two different problems (growing corn and occupying a foreign country) can have such similar looking solutions?

than vegetable farming because it requires more investment in equipment, and you need more land. To grow and save seed requires fields that are not for production but for crop development. Both Travis and Hazzard had nursery areas where new corn varieties were being grown. Hazzard said she was adding a new long season (130 day) pink Mexican corn and trying a mixture of her white corn and Glass Gem.

Hazzard discusses her corn varieties and how she chose which varieties to propagate:

Halaska: Which varieties did you start with? What was your first hurrah into heirloom grains?

Figure 23: Amalthea's White harvested 2017. Hazzard shows me some ears from her recent harvest. Each of the ears that Hazzard is holding have undeveloped kernels at the top. She stated that this was most likely because they were planted so late in the year which leads to issues with development.

Hazzard: The first year we did conventional wheat. All the seeds were nontreated or organic, then we did some oats and barley and one kind of corn. So now, umm. Then I started having more kinds of corn. The corn is a good example, I have five kinds now. I have a red, a yellow dent and flint umm a white and a blue.

Halaska: What are the variety names on those, just so I ....

Hazzard: Bloody Butcher, Floriani Flint, Reed's Yellow Dent and, a white corn that I renamed Amalthea's White – started out

as Elliot's White – the blue corn is just a mix.

Halaska: How did you decide on those varieties? and where did you get them from?

Hazzard: I decided on them based on research, looking at the marketplace, talking to my chefs, what do they want. What were they using you know that kind of thing. What other people in the marketplace had, you know local grains and stuff like that. […]

Halaska: Where did you, just going back, originally get the seed?

Hazzard: The majority, I believe the majority of the three varieties that I was using, the Bloody Butcher, the blue and the flint, I got from Albert Lee [a seed house in Minnesota]. I couldn't get a lot of seed [because] it was very expensive. That was the other thing, like I knew that I, Albert Lee's doesn't list them in the catalogue which means they don't have them every year. It was kinda a one off.

Hazzard, like Travis, saves her seed out of necessity and to develop new products for the chefs she worked with. The chef's that she sells to want specific traits that are found in a few varieties that are not available regularly in large quantities or at low prices. Here we also see that Hazzard is working in the same marketplace as Travis and probably accessing many of similar networks.

Hazzard discusses saving her seed and working with her corn varieties as a project that she and Nature undertake together. "She does about 80% of the work and I do 20% of the work,"

Hazzard stated. I asked her to describe which traits fall under her purview and which traits Nature selects for:

> Hazzard: The 20% that I do comes from, what is it that I am looking for? What is it that I need in my business. What would make things more efficient. What's going to get this plant where I need it to be for a purpose that it is needed to serve. You know and for me, like moisture in the ear was a big problem at the beginning. We were coming back, using all heirloom varieties that haven't been selected much, worked with much it was you know, I had to really get on it and figure some of that stuff out.
>
> […] in the fall and looking at how the plants look and the disease pressure and the way the plant is growing, the sturdiness, the height of the ear, the way the ear dries down, is it up is it down, you know, what's the moisture content and I have gotten to where I can just feel the ear [it feels waxy]. In my hand and tell how it's coming along in terms of drying and stuff like that.

Hazzard's priorities with her corn are getting them processed efficiently. Moisture content is important because if it dries down well in the field it doesn't have to be dried as much after it has been harvested. High moisture content in the seeds also can lead to mold which can compromise a batch of grain. An example of what Nature selects for is the ability to grow to maturity on the farm (and at this latitude), the ability to resist pests and disease and to thrive given the nutrients available. Hazzard doesn't irrigate or use fertilizers or pesticides, so her crops are primarily on their own. In this sense she lets the pests, diseases and the general environment do the culling so she doesn't have to. I asked her about growing corn without pesticides in an

area surrounded by conventional corn and she describes the trials and tribulations of pest pressures:

> Hazzard: Part of the thing here was that, I, [all the farmers around me] are all planting corn that they can, that they can spray, and you know. They also have to plant […] catch crop areas so they have to plant a certain amount of corn that doesn't have the gene in it that will kill the bug. Whatever it is. And I think it's like 10% of the acreage or something like that. But what happen the first couple of years, it was pretty rough, all of the bugs came to my field and they were just, it was a pain. You would go out there and there would be thirty beetles climbing all over your ears and there's you know, the little ear corn worms are burrowing in and eating everything, and it was kinda a nightmare. But walking through the fields, I uhh, noticed that not every ear was that way. So those ones that weren't susceptible due to how outside leaves were around the ear or whatever, or what is was about the ears that they were a bit hardier, those were the ones that I had to pick. And I have to say, I mean at this point, it's like naturally like, there is still disease pressure, there is still bug pressure but it's not like it was the first years.
>
> Part of it too might be you know I think the corn getting used to my soil, being planted in the same soil year after year with fluctuating weather, they are just hardier. They've gotten used to, we have settled in together. We're familiar now. (Andrea Hazzard interview with the author. March 23, 2017)

Hazzard describes the basics that she requires of her corn varieties and the selection criteria of Nature and herself that are needed for the corn to start "looking good" and grow well and be useful to her. Once those criteria are met—growing to maturity, flourishing in her soils, not being devoured by pests, and satisfactory moisture content—then Hazzard says there are other factors that she can focus on such as breeding corn with higher protein content.

For Hazzard growing corn and saving seed is part of a project that makes her feel satisfied with the way she is existing in the world.[97] The daily work that she does with her animals her corn and other grains is satisfying in a way that landscaping wasn't. While Hazzard is not a back to the lander like Plunkett-Black, there is a similar self-provisioning – making more so you can buy less – that Hazzard practices. Her and her partner raise and slaughter rabbits and get their pigs butchered. They use the guinea fowl on the farm to manage ticks and to work as alarms for predators like coyotes. She also has chickens and sheep. All of these animals get fed some of the grains that she produces (plus other food sources too of course) but she is able to use corn that isn't up to market standards as feed for her animals. There is a hoop house and a garden near the house that was out of season, but Hazzard and I discussed freezing and canning techniques for greens. Hazzard asked me about my experience growing plants and I told her about my experience gardening and working at Seed Savers Exchange. I told her that for me growing plants was partially rooted in this need to just be in the dirt, which I find very satisfying. She nodded and agreed with me, "It just makes sense. Nothing else makes sense."

[97] I will discuss more in the next chapter Hazzard's opinion on organic agriculture and her connection to that movement.

Conclusion: Networks of Production

The interviews that I did shed light on the challenges of growing open-pollinated corn from each person's perspective, factors that influence farmer adoption and continued production of open-pollinated corn, and discussions of sustainability.

One of the dominant themes of these interviews (and my time at Seed Savers Exchange) is that growing corn and saving seed from it are very challenging in the Corn Belt. Many of my informants pointed out different aspects of why growing and saving corn is challenging based on their specific experiences with it. Plunkett-Black hand pollinated her corn to keep her varieties pure and to keep in line with the recommendations from Seed Savers Exchange but has also relied on distance and timing. Because isolation is so challenging and because the scale of her operation is so small, keeping corn a bit of a burden. At the household level is a gardener really going to get more for their efforts? If a gardener wants fresh sweet corn, there is no shortage of it during the summer here. There are farm stands on every country road and you can fill up a bag for less than a few dollars. For a home gardener there needs to be another reason to grow corn; a very specific variety that they like or perhaps another reason related to conservation ethic.

Tracy stated that the key restraints on many people growing corn and saving seeds were biological; corn is an aggressively outcrossing plant, and the Corn Belt is inundated with pollen in the summer that it is just too difficult for the lay person to maintain varieties. This is a specific challenge for farmers in the Corn Belt who are growing corn that they do not want to become crossed with GE corn or corn with traits that will degrade their quality. Hybrid corn and buying corn from seed catalogs each year removes this responsibility. It means that the farmer no longer has the task of isolating, selecting and saving seeds. Breeders like Tracy have access to institutional resources – such as a students looking for summer employment and a budget to

compensate them – that help make growing and saving corn an easier endeavor. Tracy did mention growing some open-pollinated varieties for farmers and working with farmers to develop those varieties. These projects represent the margins of Tracy's overall work. His primary work – besides running his department and being an advocate for open seed exchange – is focused on sweet corn varieties that will be used by seed companies to produce commercial varieties.

For Davidson, an aversion to open-pollinated varieties and a preference for hybrid varieties is learned and reinforced by social norms in the farming community. It has less to do with the difficulties of saving corn and more to do with farmers disliking the variation within the open-pollinated corn populations and a reduction in yield. Davidson states that because yield has been the ultimate indicator of success and desirability for so many years that any variety that doesn't boast the highest yield – or even states a predicted significant drop in overall yield – would be unacceptable. Goldstein also points to the decrease in yield as the most influential factor causing farmers to shy away from open-pollinated varieties.

Davidson also presented the idea of social pressure, that trying something new that represents a break from conventional corn production might be stigmatized within the local farming community. As we saw with Hazzard's operation, her father gave her a "flat no" when she presented him with her business plan for Identity-preserved grain (non-commodity corn). Later on he gave her the go ahead but his initial reservations to let her take on this project on a small portion of family land might represent an aversion to risk taking. Hazzard discussed how her family weathered the farming crisis in the 1980s by simplifying production[98]. The farm went

[98] Hazzard just mentioned in passing her family farm and how they made it through the farming crisis. We did not go into great depth discussing the impact that the event had on her family and other farmers in the area. For more

from having a mixture of operations to focusing mainly on hybrid corn production. Adding new operations or projects to the farm might represent risk to the farmer. If that farmer has had past experience with economic hardship and precarity they might be more hesitant to take on a new project. However, he did let her go forward with her business plan eventually which might signal that some more conservative farmers are willing to start diversifying if the right business plan comes along.

Tracy, Davidson and Goldstein are all breeding corn and need to pay attention to farmer decision making and what farmers want to grow to develop varieties that the farmers will use. All of them mentioned that open-pollinated varieties are challenging to introduce to farmers in general because of the expectations set by hybrid corn varieties which have dominated in the Corn Belt for more than half a century. The breeders gave interesting insight into the realm of corn farmer decision making that also highlights the need for more research in this area to further contextualize how farmers these days are deciding what kinds of corn they are going to grow. Hazzard and Travis were both growing open pollinated varieties and saving their seeds. They offer insight into how these operations can function and what factors might be influencing farmers.

The first and most apparent feature that Hazzard and Travis share is a history of seed saving the predates their corn saving endeavor. Hazzard gained experience saving seed while she was doing prairie restoration work and working in her own garden. Travis has a long personal history of gardening and saving seeds and is well established with Seed Savers Exchange and members of the Exchange. This experience gave them the technical skills needed to start saving

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information about the farming crisis in the 1980's see *Debt and Dispossession* by Katherine Dudley. Katherine Marie Dudley. *Debt and Dispossession : Farm Loss in America's Heartland.* Chicago: University of Chicago Press, 2000.

their corn seed. While neither of them practice hand pollination, they both utilize isolation by timing and use color variation to help determine which of their ears is most desirable for either seed, milling or livestock feed. Hazzard and Travis are both working within the same market. Both are specialty grain farmers working with a niche market of bakers and chefs in Chicago. This is a market that has the resources to pay premium prices for their products, values the different varieties that the farmers make available to them, and have the skills to use the products.[99] In addition to working with chefs and bakers directly, Travis sells wholesale to grocery stores and Hazzard maintains an online store where she makes her milled products available along with different baking mixes.

Hazzard and Travis both had access to family land and resources that helped create a foundation for their grain farming. The Travis family was living at Spence Family Farm when they decided to stop renting the land out to other farmers and to start farming it themselves. Hazzard had access to twenty acres of family land to start her farming operation, has utilized seeding and harvesting equipment (and her brother's operating expertise), and is well aware that her operation is subsidized by her families conventional corn operation. A history of land ownership could be contrasted with first generation farm owners or farmers that rent land.[100] The amount of land that is also owned and the availability of equipment for planting, weeding and harvesting also influences the scale of corn production which impacts how easy it is to grow and save seed from it. Plunkett-Black owns her land and produces enough corn for home use and to make seed available through her seed catalog and Seed Savers Exchange. However, she is

[99] This is not to say that this is the only market available for specialty local grain farmers. It is very likely that Hazzard knows of Travis and Spence Farm because they operate within the same market and because I used my informants as my main resource for sampling, the two interviews are biased that way. It could be interesting to review specialty grain farmers and see what different markets are available and how they intersect.
[100] See Stephen B Brush.. *Farmers' Bounty : Locating Crop Diversity in the Contemporary World*. Yale Agrarian Studies. New Haven: Yale University Press, 2004.

limited by labor and land to only producing a small amount. For Hazzard and Travis, they can produce “more for less” in a sense because of the availability of equipment for planting, harvesting, sorting and drying. It is also their ability to grow a larger crop that allows them to do isolation by timing and distance which gives them lower savable seed but a higher amount of marketable finished crops for less work.

The availability of land and equipment resources also has another advantage beyond volume of production – it allows for experimentation. Hazzard and Travis both have nursery areas where they introduce and develop new varieties of corn. Open-pollinated varieties (such as varieties that have been kept in seed banks for long periods of time) that have not been worked with or are not accustomed to a specific region need a few generations to adapt to their new environment. Hazzard and Travis are both working with long season varieties – a pink Mexican corn and Chapalote, respectively – and each generation they get a few ears that mature in the relatively short Midwestern summer and those are used the next year. This kind of wiggle room allows Hazzard and Travis to work with varieties that are not “finished.” This is the work that has been picked up by breeders and seed houses, to take varieties from gene banks or other areas and make them available locally. Because Travis and Hazzard have this ability, they are not limited to what is being developed by breeders and seed houses. They have the ability to make something novel.

Figure 24 Glass Gem Experiment. Hazzard is trying a mixture between her white corn and a very aesthetically pleasing variety called Glass Gem. This one is a little bit stunted because there was some flooding in the nursery area during 2017.

Visions of Sustainability

Sustainability, in a few of its different forms, was another theme that I picked up on in these conversations. Plunkett-Black and her family started their project as part of a movement that critiqued the sustainability of the environmental and economic structures of modern society. The solution to this was to foster sustainability at the household level and to not participate in the larger unstable economy. However, sustainability at the household level does not mean that their practices and the effects of their work are contained to that realm. Plunkett-Black teaches seed saving, subsistence gardening, and general back-to-the-land knowledge to others through local seed libraries, and events like the Midwestern Renewable Energy Fair in Custer, Wisconsin. She also sells her seeds through her own seed catalog, Plum Creek Seeds. Plunkett-Black discussed why she started her seed catalog during our interview:

> Plunkett-Black: Once you start doing this right and you start having a lot of plants, you start having a lot of seeds. At some point what am I going to do with all of these! I have a gallon of carrot seed here it's going to be dead in ten years and it is more than I could use in 100 years [with a] plant like carrots. I was offering seeds through the Seed Saver Exchange and trading that way, but I started doing this little, very local, mail order seed catalog business. Just saying, I got all these seeds I might as well share them around so that was the most recent piece of it.

Plunkett-Black's description of the start of her seed company and the examples of her trading seed, teaching sustainability, and participation with different organizations illustrates this kind of amazing overflow of seeds and knowledge that she has cultivated over decades. Her example illustrates how seed saving and household level sustainability practices both necessitate

and encourage the community engagement that enriches grass-roots organizations like Seed Savers Exchange.

Tracy is a member of the National Sustainable Ag Coalition and the Seeds and Breeds Coalition, which both advocate for public plant breeding programs by invoking economic and environmental sustainability. He helped organize the Summit on Intellectual Property and the Public Sector, which focuses on how intellectual property rights influence public plant breeding programs. His program is also involved with organic agriculture and with discussions about industrialization of agriculture and sustainability more generally. The most significant concern about sustainability that Tracy mentioned was the importance of the availability of different varieties to breeding projects. This concern goes right to the problem of genetic erosion, the loss of crop varieties and the ability to trade and exchange seeds globally.

It was the lack of varieties in the USDA seed bank – allegedly the best national resource – that caused Tracy to reach out to Seed Savers Exchange and gather varieties from other locations to source the foundation of his breeding project. Modern breeding projects, including hybrid breeding, are based on a continual availability of different varieties to enhance and change their seed stock and breeding lines. Goldstein corroborated this idea by stating that he is always looking for new varieties to add to his breeding stock. From this point of view, the view of the corn breeder, sustainable agriculture is tied directly to the sustainability of breeding programs.[101] Because public breeding programs are focal points of research, development, and

[101] There are a few things here that I think are interesting that could be followed up on. The first is how neoliberalism is influencing university breeding programs and if there is a push from the private sector seed companies and breeders against these programs in anyway. Or if private sector seed companies just think about them as discounted R&D programs. The second, is what long-term sustainability looks like for these breeding programs. If genetic erosion and availability of crop types is an issue what does a plan for sustainability look like beyond seed banks? Is importing genetic resources really sustainable? Or is it just a form of mining. What would a program look like that is based around generating genetic diversity?

production that work hand-in-hand with seed companies to create and distribute productive varieties to farmers.

Goldstein is working directly to create corn for the organic production system that will allow for corn to be grown without utilizing nitrogen rich fertilizers. His project is the most focused on a single facet of sustainability. To Goldstein the issue of nitrogen fertilizers has been identified, we know it is bad for the environment, but we don't have a way to replace that technology yet. Which is why he is focusing on creating corn varieties that can. Goldstein, like Plunkett-Black, has been involved with the organic movement and alternative food production for decades. He has used his plant breeding expertise to create varieties for farmers that work in organic growing environments (I will go into this more in the next chapter) and has worked for Michael Fields Agricultural Institute which lobbies for institutional and government resources for alternative farming systems. His current project with corn varieties that are not reliant on nitrogen fertilizers is part of a larger effort through USDA to create more varieties of corn that can be used within USDA Organic farming systems.

Davidson is working as a local food systems educator through the University of Illiois - Extension Program. Local food systems are seen as one way to make the agriculture more sustainable. To create more food within a smaller radius and to change from mass production utilizing high amounts of inputs and resources to more small-scale closed systems. He refers to this as Regenerative Agriculture and the goal is to create a recycling system on the farm to limit the amount of inputs needed. The role of corn and grains within this system is to change how and where people get their staple foods. To Davidson, sustainability is about changing agriculture, but it isn't going to be done through the niche local food markets. Davidson really wants to

figure out how to get people to consume local products without thinking about it – creating an easier more accessible path for sustainable production *and* consumption.

For Travis, environmental and economic sustainability within rural farming communities is the most important part of his project. The work that he is doing with the chefs and bakers is a great way to utilize his talents; but Travis sees the most important part of his work as maintaining and enriching his local community and communities like it. To Travis, farming communities benefit from the work of chefs and bakers who know how to use their produce and have the platforms to introduce their meals to a wider audience either through cook books, online resources, or through channels like the Food Network. Meanwhile, farmers and their families get to sell products for premium prices, gain experience farming, keep more members of their family working on the farm, and bolster their overall economic security.

Hazzard described a different "awakening" she experienced in terms of environmental degradation, climate change, social inequality and other issues of sustainability. Her education in forestry and experience with ecological restoration make her unique among the people I interviewed. To Hazzard issues of ecological sustainability are most threatened by humans and their tendency to stomp through Nature's systems – "make changes to her fabric" in the case of GE crops – without really understanding what the consequences will be. Hazzard is involved with the wider organic movement even though she is not USDA Organic certified. She has become more and more disheartened by the direction USDA Organic agriculture is going. Her overall evaluation of the future of sustainability can be summed up as, "I really don't want to see us eradicated from the face of the earth, but I am really concerned that we are headed in that direction […] I don't have a child. You know, I don't have offspring. So, you know I'm not doing

it [trying to live sustainably] for them. I'm doing it for me. Because I can't be in this reality and not fight for what I believe is right and not live as well as I can."

To Hazzard there is a balance that can exist with Nature and that is the foundation of sustainability. Currently, she thinks that balance is not being maintained. To Hazzard, growing her corn and grain, using her little plot of land to raise and eat animals, is part of living as well as she can and through this need and this drive she maintains the margins for her heirloom corn.

Each person I talked to described a slightly different vision of sustainability. What sustainability could potentially look like and what steps (both small and large) need to be taken to remedy threats and problems in the current systems of production and consumption. These visions of sustainability have helped them create and maintain the margins where their heirloom corn can grow. These visions of sustainability are all built from frequent cross-pollination of ideas centered around the ethics of production as they are negotiated between the dominate and alternative food systems.

The next chapter is dedicated to a closer examination of the organic movement and USDA organic production because it came up so frequently in my interviews with the breeders, seed savers and farmers that I talked to. USDA organic regulation can be seen as a central figure in the network of production that is influencing the projects of producers as they negotiate how they utilize heirloom corn and the goals of their projects. Understanding how they navigate these regulations is important to understanding how they are actors in the field and not just influenced by top down regulation.

Chapter 4: Producing Organic Corn

The farmers and breeders that I talked to have their own projects and they consider a multitude of ideas, resources, avenues and connections to help them with their projects. The USDA's organic program is a major factor that influences these ideas, resources and connections. The farmers and breeders that I talked to consider what it means to interact with the USDA organic program and negotiate and critique the USDA program against their own understandings of what organic means and their senses of sustainability. They thought about the markets that they could access or the resources that could be made available for their projects. An examination of the USDA's organic program can help us understand their considerations and can allow us to have a deeper understanding of such people and their projects.[102] In the earlier chapter outlining the creation of modern corn, I discussed the beginnings of a system of corn production that linked farmers, breeders, industrial production, commercial seed production, state governments, and wider regional and national projects. The creation and production of organic corn works within many of the same institutions that created modern corn and is a way to examine changing production as alternative and dominant processes of production come in contact with and interact with each other.

In this chapter I will introduce interviews describing the organic movement in the 1970s through the 1990s, a time which influenced the formation of USDA organic regulations. I will examine how farmers and corn breeders interact with USDA organic regulations, related

[102] Codes, laws, regulations and policies are all interesting focal points to examine because they create a more "solid" structure that you can see people react to. Observing and listening to how informants react to and interpret laws and regulations can help bring out the subtler ways that people approach the world. It can act as a contrast, or it can highlight specific cares, worries, ideologies or other norms and values that otherwise might be less visible.

organizations and structures, and the impact they have on corn growing and the selection processes. I will be examine the conditions dictated by USDA organic regulation and the resources that are made available to breeders and farmers in terms of selection pressures on the corn genome.

In addition, I will discuss how the difference between USDA organic regulations and the tenets of the organic movement affect how farmers and breeders interact with USDA organic regulation. The National Organic Program and the National Organic Standards Board attempt to define what organic is as a consumer brand through the continual negotiation of regulations, research goals and funding (USDA Agricultural Marketing Service 2018; National Organic Program 2015; 7 U.S. Code § 6518.National Organic Standards Board 2018). Some of the people that I interviewed see the difference between the earlier organic movement and how the USDA organic regulations have developed as significant enough to leave the USDA organic label completely and declare it meaningless. They believe that in the solidification process and in the subsequent interpretation and reinterpretation of the USDA organic regulations the true meaning of the organic movement was left out or has since been lost. Two of my informants discussed how to reclaim the organic movement or to create a new certification that more closely adheres to the tenets of the organic movement.

In the case of corn, organics, broadly is a movement and a set of regulations, outlines a set of processes, procedures, inputs, and interventions that influence how corn grows and exists today. Farming practices that are deemed acceptable and unacceptable influence the genetic makeup of each population of corn that is grown (or not grown) just as much as soil conditions and the weather during a growing season. The story of organics that I encountered features the active lives and ideas of people, as well as the lives and tendencies of chickens, cows, corn and

microbes. I am dedicating an entire chapter to this discussion because each farmer and breeder that I talked to grew and selected their corn in a way that was influenced by organics.

The organic movement and USDA Organic

I was born in 1988, two years before the Organic Production Act of 1990. The first time that I saw or recognized the USDA organic label is not a memory that I have, it just seems like it has always been there. I learned that the USDA organic label was a symbolic shortcut for food that was free of harmful chemicals, and better for animal welfare, and the environment. Through my lengthy (and continuing) food procurement education, I learned that USDA organic labeled products were preferable if I had enough money to buy them.[103] This kind of widespread recognition was the aim of the Organic Food Production Act of 1990 (OFPA), which sought to bring together varied definitions of organic production under one set of rules that consumers could easily recognize and trust (Organic Food Production Act 1990).

At some point in my teens in the early 2000s, when my brother and I could more or less function on our own, my mom started to get into taking care of herself and we started eating a lot more vegetables. Yoga and meditation were introduced to the household, and information about the quality of food that we were eating became a topic of discussion. Documentaries such as *Supersize Me* and *Food Inc.* were popularizing consumer consciousness about food choices, health and industrial farming practices in the suburban middle class. I was more interested in animal welfare issues and my mom was more focused on the health benefits of a wholefood diet. My mom, my brother and I all dabble in forms of a conscious diet, limiting meat consumption

[103] Chrzan (2010) suggests that buying organic might be linked to competitive demonstrations of caring for middle class suburban mothers. Chrzan examines the interpretation of organic as a process of food production and as an object (symbol of good care taking). See Janet Chrzan. "The American Omnivore's Dilemma: Who Constructs “Organic” Food?" Food and Foodways 18, no. 1-2 (2010): 81-95.

and animal products (my mom has been a vegetarian for about 10 years now) for health, environmental and animal welfare reasons and being vaguely aware of farming practices that produce our fruits and vegetables. In the early 2000s consumer understanding about the meaning of organic products was diverse but there was a general understanding among consumers that organic products were preferable for health, taste, the environment and animal welfare concerns (Hughner et al. 2007). My understanding of organic products mirrored that of many other consumers in the United States; organic produce was preferable because of health implications (it was grown without harmful chemicals) and there was a vague understanding that organic agricultural production was better than conventional agriculture.[104]

It was not until I was interviewing Kathleen Plunkett-Black, a subsistence gardener and long-time member of Seed Savers Exchange, that the origins of current USDA Organics came up in discussion. It was at that point that I realized that I had been taking for granted that the USDA Organic label had been formed out of something that predated it. Preceding this quote, we were discussing the Renewable Energy Fair in Custer, Wisconsin where Kathleen teaches about seed saving and organic gardening.

> Halaska: Do you see [the current] focus on renewable and sustainable as comparable to the back to the land movement?
>
> Plunkett-Black: I think it grew out of that. We have friends that were back to the landers –we focused on, we are going to feed ourselves and try to, instead of earning a lot of money we are going to try and not spend very much money [...] We have friends who were trying to sell commercial, market gardening back in

[104] This paragraph describes consumer understanding about the labels and does not make a claim about the benefits of USDA Organically produced products.

> those days [1970s]. You know, you would sit in a truck by the side of the road or try to sell stuff to the co-ops. Those people really invented organic in a lot of ways. And now there is all this support, all these people are there to educate, the [University] Extension is even doing organic education. I think, I see it more as a continuum of a lot of people who really didn't necessarily know what we were doing, I mean the Renewable Energy Fair is the same thing that has been going for 25 years or something, and of course you know just a few people in central Wisconsin got together and said, "we ought to do this," and it grew by leaps and bounds in the last few years. It has been getting smaller, I think because that information is just out there in the general sphere and people don't need to travel all the way to the middle of Wisconsin to find it out. It is encouraging to see people moving in that direction. (Kathleen Plunkett-Black , interview by author, April 27, 2017)

As Kathleen described, there were groups of people who enacted the values that they held about how they should interact with society and the environment by changing the way that they lived and practicing specific forms of food production. "Those people really invented organics in a lot of ways," she said about her friends who were market gardeners. These market gardeners were not only implementing a form of low input food production based on an idea of self-sustainability, but they were also making it available to the public and forming organic market systems in the 1970s. Earlier in the interview Kathleen described that in the 1970s, "there were a lot of back to the landers, but there were also a lot of back to the city-ers." There were people who believed in the values of the back to the landers, having a low impact on the environment and breaking away from industrial farm production but were not able to eke out a way of life

outside of the cities and towns. These people would have formed an important group of consumers for early organic products.

In this quote, and in my entire discussion with Kathleen, her descriptions of the groups of people in the 1970s and 80s—her family, her friends and the people that she knew at Seed Savers Exchange, the organic gardeners, the founding of the Renewable Energy Fair—give the impression of the fluidity and indeterminacy of these groups. The groups, the practices and how they were making their livelihood were all involved in a moving process that was shifting and changing as ideas, practices and people moved about. When I asked about the similarities between the movement of the back to the landers, and the current renewable movement I was thinking about them as two different entities. Kathleen stated that one had grown out of the other, described the movement as, "a continuum of people who did not really know what they were doing" (trying new things and experimenting) which, when viewed retrospectively and collectively formed the organic movement.

Kathleen's perspective on the organic movement is a snapshot into a sprawling, indeterminant, heterogenous field that stretched across the United States, through Europe, Japan and across the globe. People were sending out and receiving practices, knowledge and experiences; trying out different ideas, meeting new people, adopting some, forming bonds with others and disregarding what did not work. My interview with Dr. Walter Goldstein offered a similar perspective on early organic farming.

> Goldstein: I am from Seattle and there I got into agriculture, organic agriculture back in the 70s. As I was going to college I was working on farms, organic and biodynamic farms already then.

Halaska: Back then what was organic and biodynamic?

Goldstein: It was small, scattered around the country side and I would try to work summers on farms as I was pursuing my bachelor's degree in Botany and then I went to Europe for four years and I worked at different research centers and at different farms to learn about research on organic or biodynamic and also to learn more about farming, to practice farming. So, I worked with vegetables, a dairy farm, a mixed farming operation and did things like that. [I] worked on one large biodynamic farm down in Illinois at the time and then went back to college after Europe, after four years of Europe and um got my Masters and Doctorate in Agronomy at Washington State University[105]. There I became, I did a minor, I did a major in management and a minor in breeding. That is where I began selecting plants. Working first with legumes but also, I did work with wheat, winter wheat, and that is where I began my interest in breeding and so when I came to Wisconsin I got a job helping to start Michael Fields Agricultural Institute and I worked there for 25 years as research director (Interview with Walter Goldstein October 10, 2017). [106]

Goldsteins and Plunkett-Blacks' descriptions are very similar, "small operations, scattered around the country side." It reinforces the idea that there were small groups of people who were trying different ways to implement alternative farming practices and that as these

[105] Biodynamic farming is similar to organic farming in many ways—it rejects the use of synthetic chemicals and focuses on soil management—but it has a distinct origin history and has retained an independent third-party certification process. See Demeter Association, Inc. "Certification" in references.
[106] The Michael Fields Agricultural Institute is a non-profit organization that was founded in East Troy, Wisconsin in 1984 and is focused on changing the farming food system by dividing its efforts into three categories; crop research, education and public policy.

practices were developing and being shared. In the 1970s, Eliot Coleman, a prominent figure in the organic movement and Director of the International Federation of Organic Agricultural Movements, would host apprentices at his farm that would stay, work, and learn with Eliot and his family (Phillips 2018). Around the same time in England the World Wide Opportunities for Organic Farmers (WWOOF) was developed to connect volunteers with host farmers based on a system of non-monetary exchange (WWOOF International Ltd Association 2018). The apprentices and "woofers" were learning farming practices that were different from what they would have learned in agricultural schools at the time. Organic farmers may have been receptive (or not receptive) to worker-learners for many different reasons but part of it may have been the realities of needing manual labor to manage land and keep weeds under control without the help of chemical and mechanical inputs[107]. As a result of this heterogeneity and grass-roots development, there was some ambiguity as to what the term "organic" meant.

The USDA conducted a study in 1979 on the potential of organic farming to help maintain the good environmental and soil conditions and be able to keep producing a large amount of food and fiber that are essential to the economy (Study Team on Organic Farming 1980). The study found that across the United States the organic movement was varied and included a wide range of practices ranging from purists who regarded any synthetic inputs as non-organic to farmers who liberally mixed conventional and organic methods (ibid). The study found that despite the heterogeneity of practices there central tenets of the organic movement that emerged from their study: conventional agriculture is unsustainable, quality soil is the source of life, "feed the soil, not the plant," biological diversity in farming production is more stable than monoculture, personal

[107] From my own experience, some organic operations will eagerly exchange food, housing and answering a few questions for weeding labor.

and community independence from global supply and distribution chains, and anti-materialism (anti-consumerism) based on the concept of finite resources (ibid: 9). In these tenets the central concept of soil health and quality is emphasized as well as the role of people as consumers, producers and their relationship with food and the economy. The mention of independence from outside sources recalls Kathleen's vision of sustainability, not just as recycling of goods and nutrients but of disconnecting reliance on outside resources. In *Agrarian Dreams*: *The Paradox of Organic Farming in California,* Julie Guthman identifies the common undercurrent of the ideologies that fed into the organic movement as a critique of industrialized agriculture (2014:4). Different negative aspects of industrial agriculture such as incentivized soil depletion, compromised standards causing health problems, materialism and consumerism, and general environmental degradation were all identified by different groups as the main reason for implementing organic agriculture (ibid:4).

The 1979 study of organic farming marks a time when there was a large enough market and interest in organic farming that it started to get the attention of the federal government. It was also a time when the organic movement and the market of consumers that were interested in their products started to get the attention of food producers who used the term organic to market their conventional products at higher prices (Vos 2000). The popularization and demand for organic produce coupled with a lack of definition and control of the term organic led to confusion among consumers which was seen as a barrier to the growth the organic market (Study Team on Organic Farming: 82). Federal regulation was seen as a way to standardize between states, protect organic producers and boost consumer confidence (Vos 2000).

Another reason to consider federal regulation was funding and educational resources that could be made available. Some organic farmers reported that the USDA was neglecting their

responsibility to support organic farmers by providing educational programming for their farming operations (Study Team on Organic Farming: xiii). This comment reframes the decentralized knowledge seeking and independent problem solving reported by my two informants as a problematic necessity. While many organic farmers did not want to be connected to an industrial farming supply chain, they wanted the support of publicly funded research that they could apply to their farms.

In the ten years after the USDA study was conducted, legislation was formed and negotiated which culminated in the 1990 Farm Bill as the Organic Food Production Act of 1990 (OFPA)(See Figure 26 on page193 for a visual overview of what OFPA did). This new body of legislation was created to set standard regulations across the United States and get the standard products to consumers in an easily recognizable way. OFPA outlined the National Organic Program (NOP) as a new program within the USDA with the responsibility of determining organic standards for farming, handling and processing and enforcing those standards through the accreditation of third-party certifiers (SEC. 2107. [7 U.S.C. 6506] General Requirements 2018). The act outlines that synthetic chemicals and substances will be barred from use in the organic program while natural substances will be allowed unless otherwise specified in the National List of Allowed and Prohibited Substances (also just called "The List") (SEC. 2106. [7 U.S.C. 6500] National Standards for Organic Production). The List will be based on the recommendations of the National Organic Standards Board (NOSB) and will be amended by the Secretary of Agriculture only after a Proposed List is released for public comment (SEC 2118. [7U.S.C. 6517] National List 2018)[108]. The NOSB is a Federal Advisory Committee and is made

[108] The archive of available comments that is available is for each amendment and ruling is an interesting place to gather information on the interaction of different groups with the process of federal regulation and may be an interesting site for digital ethnography. For a recent example (January 2017) see the docket and commentary on the Organic Livestock and Poultry Practices Final Rule which was withdrawn by the Secretary at the beginning of the

up of fifteen members appointed by the Secretary of Agriculture. The Board has the following composition: four operators of organic farms, two owners or operators of organic handling operations, one owner or operator of an organic retail establishment, three experts in environmental protection and resource conservation, three members of the public representing consumer interests, one expert in toxicology or ecology and one certifying agent (SEC. 2119 [7 U.S.C. 6518] National Organic Standards Board (b)(c) 2018). Certifying agencies would be responsible for enforcing compliance with The List by implementing occasional residue testing for prohibited substances and a review of records tracking inputs on farms (SEC. 2112 [7 U.S.C. 6511] Additional Guidelines 2018). Certifying agents would have to work with farmers to establish Organic Plans that outlined how they planned on maintaining soil fertility and process and handle their produce and this plan would be reviewed during inspection through farm records (SEC. 2114. [7 U.S.C. 6513] Organic Plan 2018).

Through these policy structures OFPA constructed a way that federal organic regulation could be defined and enforced. The law was also written to allow for the term organic to be defined, redefined and contested by the NOSB and the public. On the next page is an image showing the official programs, committees and agencies that OFPA put into place and their responsibilities and relationships to each other. In this image I emphasized the role that each group has in relation to The List. The List is important because it is a site of continual negotiation (and conflict) to determine what exactly Organic is and how it can be produced. It is also worth recognizing that this image and the paragraph above only show the official structures

year. There are over 70,000 comments available. See "National Organic Program – Organic Livestock and Poultry Practices.

put in place by OFPA but do not address the host of different groups, usually termed The Public, that involve themselves in negotiations.

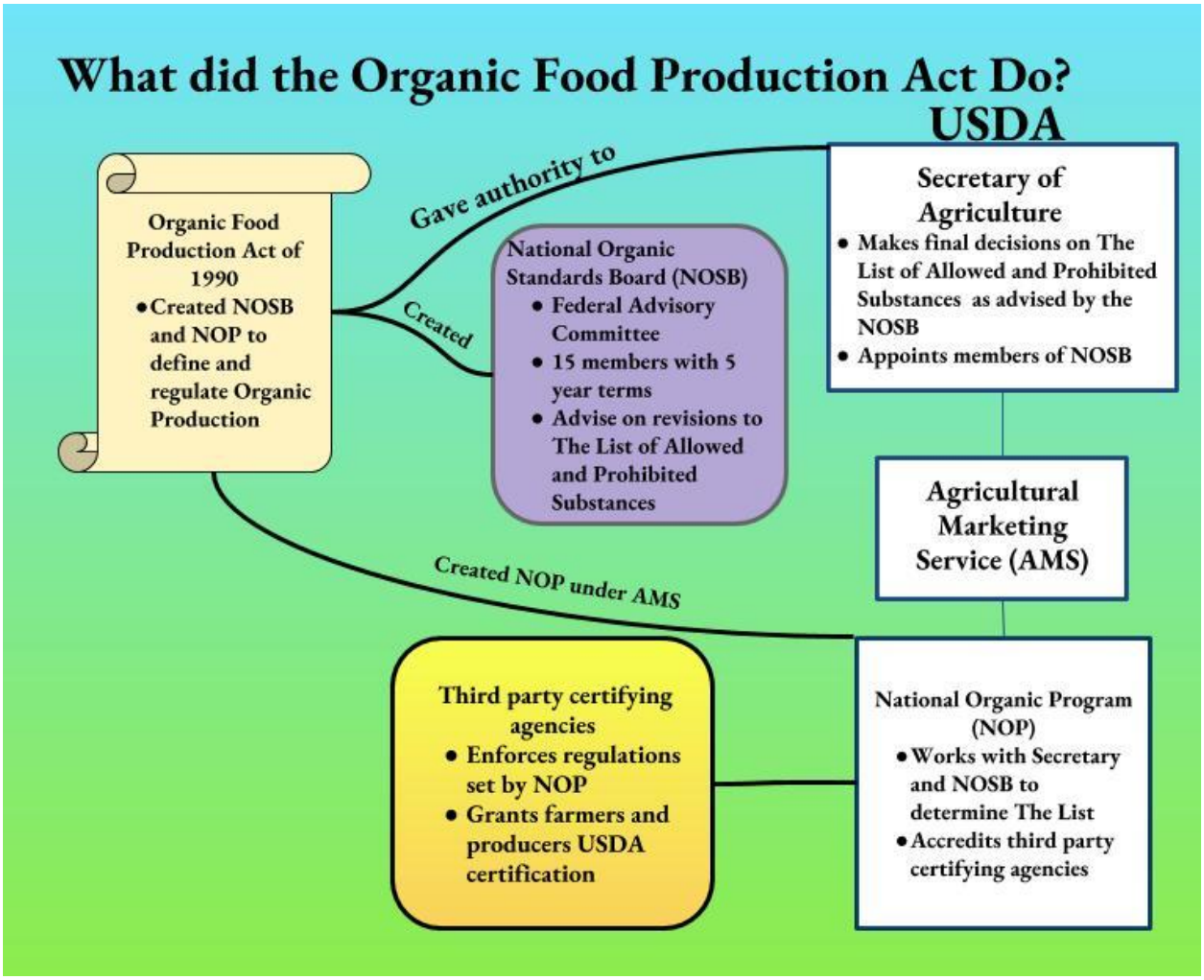

Figure 25: What did the Organic Food Production Act Do? This image shows that OFPA created the National Organic Program within the USDA. It gave authority to the Secretary of Agriculture to make decisions about the List of Allowed and Prohibited Substances and to appoint members to the National Organic Standards Board. OFPA created the National Organic Standards Board as a Federal Advisory Committee that is independent from the USDA but its members are populated by the Secretary of Agriculture. The third-party certifying agencies are accredited by the National Organic Program but they are independent from the USDA as well.

Before I turn to examples of amendments to the The List, definitions of organic and their impact on corn breeding I am going to take you on a detour into my gap year to illustrate what being USDA Certified Organic means to an employee on a small organic farm. In this section I will show how The List, the Organic Plan and record keeping processes are enacted and implemented on the ground.

Working on a Certified Organic Farm: How Organic Regulations are Enacted in Daily Practices

I worked on an USDA Certified Organic Community Supported Agriculture (CSA) vegetable farm in southern Wisconsin during my gap year in 2016.[109] The Community Supported Agriculture (CSA) model works well for Organic farmers because it offers a reliable point of sale for the farmers. In Community Supported Agriculture members buy a farm share in the winter to help cover the expenses for the coming year and then they will receive a box of produce for a set of weeks throughout the year. Whatever is available and ready is what they receive in the box.

I started out as a field hand but jumped at the opportunity to get more hours over the winter by working in the office. Over the winter the majority of the work was managing deliveries, keeping up with customer service issues, learning about the upcoming season and trying to stay warm in the farmhouse. Gene, the office manager, and I sat in the farmhouse office bundled in our coats, snow pants and winter boots, and he taught me about the record keeping

[109] Community Supported Agriculture represents a direct relationship between farmers and members. Members purchase a "share" of the farm at the beginning of the year and are given a portion of the harvest each week for a set number of weeks. Most CSAs run from the spring to the summer. A farm share can cost anywhere between a couple hundred to a couple thousand dollars for a year depending on the size of the share. Some farms offer payment plans while others have members pay up front.

system they had in place for Organic Certification. Gene spoke quickly and excitably about the tips and tricks to maintaining accurate records and I tried to keep up with him.

"Take pictures of all receipts and scan all worksheets to Google Drive, that way they are there are ready to go," he showed me the worksheets and the receipts from the previous year and how they were organized into different subfolders. He quickly showed me how to follow a seed with a specific lot number from the greenhouse, to the field, to records of inputs used on those plants, and to the exact date that it was harvested. "The problem becomes keeping up with the field workers and making sure that they are doing the paperwork as they harvest," he told me. He described having to track down and make worksheets after harvests and working backwards if paperwork wasn't done. Running around after new employees who didn't know what the worksheets were or finding stacks of paperwork in the cooler or greenhouse. The new 2016 folder was empty waiting for the spring when it would begin to be filled with pictures of seed packets, receipts and worksheets. I was learning that implementing and maintaining record keeping systems was a key aspect to running a certifiable farm. What it meant to be USDA Organic was to have your paperwork in order.

"The most important thing is that during an inspection we are able to show, for any seed that comes onto the farm, exactly where it went and what was used on it." The office manager made it clear that certification was not only maintained by having an Organic Plan and following The List of Allowed and Prohibited Substances. but by the everyday record keeping practices that transformed the messy, chaotic farm work into easily to follow worksheets and spreadsheets.

At this point I felt pretty confident that my experience as a Medical Assistant in a Primary Care Clinic, experience as an anthropological researcher at Seed Savers Exchange, and Company Office worker in the Army had prepared me well for keeping track of the life and lives

of plants. I understood the value of keeping good notes and tracking interventions and maintaining good files. I felt excited to be able to show off my ability to keep the farm's paperwork up to standards and ready for inspection.

Winter is a time of planning on farms. Some farmers see it as a break from the physical labor, but many see it as a constricting time of indoor activity where they painstakingly plan for the year. During the winter the farmer organizes the field plan. Field plans are incredibly complex for a vegetable farm that is planning on growing multiple crops in the same fields during a given growing year. If in one row of one field you are going to grow mixed greens in the spring, then peas over the summer, and then cold hardy carrots that can survive into late November. Your timing and crop rotations need to be thought out very well. There needs to be a plan for each row in each field. The farmer plans starting at the harvest time of the last crop of the season and works backwards. For example, carrots can be grown all the way into November so how many weeks do you need for carrots to be fully mature by the first week in November? Then you work backwards figuring out which other plants will work in that rotation based on how quickly they mature and what can be grown in that field based on proper rotation. This plan lets the farmer know when they need to start germinating seeds, when they will need to transplant them to the field and when they will need to harvest. In addition to this, weather is unpredictable, which can change growth rates of plants and when planting can occur. The farmer also needs to keep in mind the CSA members and what they will be receiving in their weekly box –there is an art to developing a well-balanced weekly CSA box that has a mixture of vegetables that can be utilized by members without overwhelming them.

The farm was organized in five different sections including one area that was just hoop houses (like greenhouses but without an active cooling and ventilation system – you had to roll

the sides up and open the doors if you wanted to cool down the plants). Every year crops were rotated to different fields so there was four years between growing a type of crop in an area. One field was cover cropped and unworked each year, giving it time to rest. For example, during one year we grew brassicas – kale, cabbage, broccoli –in Field A, brassicas would not be grown in this field again for another four years. This greatly reduces disease pressure that would come from funguses and bacteria that would have more of an opportunity to grow in the soil if brassicas were grown in that field year after year. It is a preventative way to fight disease pressure that does not use synthetic chemicals. This system of rotation is a part of the Organic Plan and during the yearly inspection the farmer needs to provide the paperwork documenting this rotation.

The farmer and the managers worked on the field plan over the course of a few weeks. Then one day the office manager told me it was done, and I took a look at a new Excel workbook on our shared drive. There it was. It took me a while to even begin to figure out how to read it. There were multiple tabs for different fields and hoop houses and each tab had different crops and variety names with suggested timelines. There was an overwhelming amount of information, colors, boxes and dates. I just focused on when germination and initial planting in the greenhouse would start.

In late winter, after the field plan was completed, the farmer started buying and ordering seeds. They arrived sporadically and I hunted them down and took pictures of the seed packets and the receipts and uploaded them. As I ran around the farm, I would often see the greenhouse manager in the barn, up on the soil mixer pouring bags of peat moss and other dirt components to make the mixture for germinating seeds. The greenhouse manager made the soil mixtures and would hand in a worksheet stating exactly what went into each batch of potting soil that she

made which could be connected with their receipts in our files. She had worked here for a few years and was familiar with the paperwork systems.

In early Wisconsin spring—which can be characterized as muddy, cold, blustery with a chance of surprise blizzards— it was time to germinate the seedlings in the greenhouse. The office manager showed me how to make the label stickers for germination flats, fields and harvesting bins and how to print them. When the greenhouse manager planted the seeds, she tracked which seeds from what packet were planted on which day and gave that group a batch number. In the "mudlicious" spring weather, in my winter boots and snow pants, I would tromp between the greenhouse and the office getting the lists of labels that she needed and preparing the stickers for her. The tracking and recording system require good labeling and part of my job would be to maintain consistent signage and labeling to make the worksheets easier to fill out for field employees.[110]

The seedlings sprouted and grew in the greenhouse and I took pictures of them for the weekly newsletter to CSA members. We all started to anticipate their growth. Everyone on the farm was starting to get antsy as the seedlings grew and grew and it was almost time to transfer them. The farmer started to watch the weather carefully: he was trying to anticipate when it would be dry enough to transplant the young plants into the field. My brother was working and living on the farm and I would text him to ask him if the farmer had said anything about planting that morning. "No, not yet. But soon." Some of the young plants have been moved to tables

[110] During this season we only had employees who spoke and read English working on the farm. In previous years there had been Cambodian workers and some of the old labels and worksheets were translated into Khmer. The office manager said that this greatly improved worksheet completion and adherence to labels.

outside the greenhouse to get used to the windy conditions and the more erratic temperature changes.

Then one morning I drove into work, the sky still pink as the sun was rising, and I saw workers in the fields moving the young plants to the dirt. It was happening! I parked and ran out to the field to ask what was being planted and where and to make sure that the correct paperwork was being filled out. No paperwork. I ran back to the office and got the paperwork and ran out to the field filled it out, noting the lot numbers on the flats and the field numbers.

When conditions are right for planting in the spring there is a frenzy of activity. Especially if it is a clear cool morning and the farmer is anticipating rain in the late morning or afternoon. Then there is no time for delay! After the plants are transplanted to the dirt, they need to be watered thoroughly to help their root structures develop and help them recover from the move. If it rains then the farmer doesn't need to expend any time or energy on irrigation. But it requires getting many people to work quickly. A few different plants were moved out in a flurry of activity that morning. I talked to the farmer and figured out which plants were being moved and made worksheets for each of them. We all planted together, dropping to our knees and moving along the row, feeling our hands in the dirt for the first time in months. Some of my fellow workers took off their shoes and reveled in feeling the dirt under their feet. The sun rose, the clouds moved in and the fields were sprinkled with rain and the young plants took root. All the paperwork was done and was taken back to the office and filed in its rightful place. This was a good morning on a USDA Certified Organic farm.

Each morning would be a bit of a surprise depending on the weather, who showed up and what exactly the plans were for the day. We were expected to be at the farm early and be prepared for whatever the farmer wanted us to do, he was not a patient man and when conditions

were right he would start planting on his own or have my brother out there with him. I made paperwork packets and put them in the greenhouse so that they could be grabbed by employees whenever they were going to move plants. I had conversations with each employee when I could catch them and told them how to fill out the paperwork and why. Most of the employees were new, there is a high turnover rate for field workers and many of them did not have farming experience but they did know how to fill out basic worksheets. When spring planting and summer was in full swing and there were many different employees doing different tasks across the farm, it was critical that each employee knew what paperwork needed to be done for each task and that it needed to be handed in and then recorded. Fulfilling the paperwork and documentation requirements is one of the most challenging aspects of Organic certification.[111] The difficulty of this is compounded when you have new employees that need to be trained or limited communication with your field hands because of language barriers.

Over the course of the summer my carefully made signage had to be diligently monitored as they were often taken by the wind, run over by the tractor or just lost. As the field crew became better at filling out paperwork and doing it consistently, I would often come into the office and see a stack of dirt speckled crinkled worksheets on my desk. On occasion I would have to run out and see what was being done or check on the days operations just to make sure I had all of the documentation. It was easier sometimes when I got to get out of the office and go weed or harvest with the field crew because I could see what was going on and I could complete the worksheets myself.

[111] While I was working at Seed Savers Exchange there were also paperwork requirements that needed to be fulfilled for Organic certification. However, the system of documentation established by Seed Savers Exchange to track seeds and inputs was more thorough than what was needed for Organic certification. Because most of the employees at Seed Savers Exchange had degrees in Biology or Horticulture they were already prepared for the documentation process. There was a difference in the difficulty of fulfilling the record keeping requirements at each location.

The record keeping requirements of Organic certification are organizationally demanding to design and implement but once you get a system going it can be followed and sustained. It stands out in my memory because it needed to be tended to on a daily basis, there was always the threat that something was going to be missed which could cause trouble during inspection. From the point of view of an employee tasked with maintaining the record keeping system, Organic farming is a system of paperwork and bureaucratic oversite that needs to be continually held together at the farm level. Paperwork and planning are two of the most apparent aspects of Organic certification when working on the farm, but other features of organic farming present themselves in daily farming practices that workers experience, mainly weeding and pest management.

From the perspective of a farm worker weeding can be experienced as one of the most mentally and physically frustrating and exhausting tasks. Crops and weeds bask in summer sunshine from five in the morning until after eight at night and they stretch, expand and sprawl at startling rates. A field that looks well maintained one day will explode with thistles, lamb's quarters, grasses and an assortment of other invaders that take advantage of the fertile ground and open spaces. It is daunting to be one of two people told to weed five rows of onions. That is a full eight hours of being crouched on the ground pulling and scraping at weeds and you might not even get done that day. Weeding is without a doubt one of the most expensive aspects of managing an Organic operation in terms of employee hours. Even with a variety of weed management techniques it took a lot of workers and a lot of time. We practiced cultivation, scraping away baby weeds before they have a chance to get too large and need to be pulled which is a more time consuming and exhausting process. Flame weeding, burning away weeds from an area where crops have been planted but have not come up yet. In the hoop houses

ground cover (basically a large plastic sheet) that formed a physical barrier that would smother the weeds and prevent their growth. The office manager told me that robotic weeding is going to be revolutionary for organic farming. Chemical weed killers greatly reduce the man hours and cost of weed management for a farmer and it makes sense why they have become so popular. There is no getting around it. Weeding, like Organic paperwork requirements, is an everyday consideration that needs to be managed and taken care of in addition to other crop growing considerations.

Like herbicides, most chemical pesticides are not allowed to be used on Organic Certified farms. Pest management can be taken care of in a few different ways. There are allowable non-synthetic pesticides that can be used in certain amounts and at certain times before harvest.[112] If enough bugs are spotted, a field worker would come in and record the mixture that they made, stating which chemicals were used in what proportions, and how much was used on which fields, in which rows and on which crops. The Organically certified natural pesticides can be expensive, so the farmer may not want to use them unless the infestation is severe. For example, potato beetles love eggplant leaves (see Figure 26). If a farmer can estimate when the potato beetles usually emerge they can delay the planting of their eggplants to avoid an infestation. This is pest management by timing. Another method is

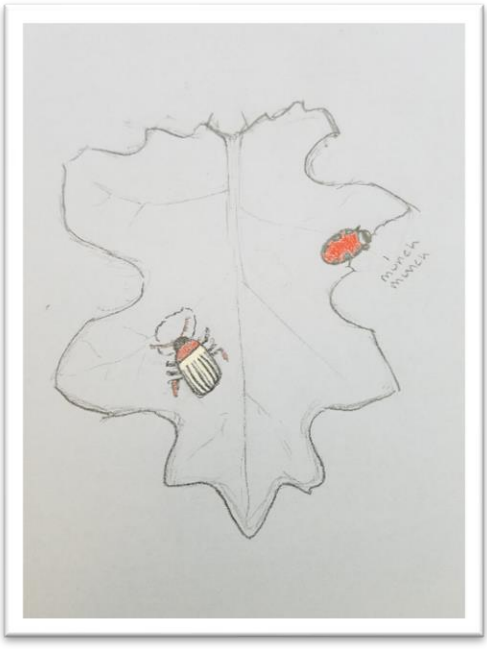

Figure 26: My sketch of Potato Beetle and Potato Beetle Larva.

[112] Many natural pesticides are biological pesticides instead of chemical pesticides. To get an introduction to biological pesticides I recommend the "Episode 104: Fighting Pest Strategically and Sustainably with Dr. Pamela Marrone" from the Future of Agriculture Podcast with Tim Hammerich

manually squishing, just let your workers know that if they see certain types of insects, potato beetles, tomato worms, to kill them on sight (See Figure 27). Like weed management in the absence of chemical and mechanical interventions and solutions, human manual labor is needed and used.

Figure 27: My sketch of "Manual Squishing." It is also popular to throw the pest on the ground and grind it into the earth with a shod foot.

Once the produce was harvested, chemical substances to preserve the produce could not be used. This means that the harvest time is based on how well the produce will keep in the cooler and the upcoming delivery days. If harvested produce goes bad in the cooler this represents the loss of all the work that went into the that produce as well as the produce itself. Harvesting is also a manual process that was very time consuming. Sometimes it is financially more beneficial to leave a row of cabbage in the field and till it in (go over it with the tractor and till it into the ground as compost) than to harvest it and let it go to waste in the cooler. It was difficult to see plants being tilled in, it just seemed incredibly wasteful, but that was why a good farm plan was key as is a reliable point of sale for produce. I can not emphasize enough the importance of having a reliable base of buyers for produce on an Organic farm.

Organic regulations changed what could be done on the farm. The higher prices that CSA members would pay for a USDA Organically certified product helped enable the higher cost of manual labor that is needed on an Organic farm.[113] For me, getting the completed paperwork and all relevant information from the field to its designated place in a folder or spread sheet was a

[113] In addition to wage labor the farmer had an arrangement with a nearby religious community that would pack boxes and work a certain number of hours in exchange for shares of food. Even for paid employees bringing home produce was a perk of the job, there was always more vegetables than could be distributed and sold.

huge source of stress. It was important to the continued certification of the farm (which was a source of income) and it was something that needed to be monitored and kept up with on a daily basis. There was also tension that existed if the farmer did not agree with a substance that was not allowed that he thought could help his crops. He is a health and environmentally conscious farmer and there were times that he resented that he could not use substances that he thought were harmless or could be managed well that would help the functioning of his farm.

The experience on the farm taught me about what being Organically certified means to a farming operation. After this experience I had formed a working definition of what Organic certification meant: paperwork systems, keeping prohibited substances off the farm and an increased need for manual labor. This definition came from what I saw was required for the farm to keep its certification, what measures were tracked and important to certifying agents and what work was required to keep the farm running. During an inspection the agents would check that you were rotating your fields and cover cropping but it was not mentioned if they would test for soil health. The majority of the paperwork and the tests that the agents would review and conduct were related to allowed and prohibited substances. All the paperwork is supposed to show that a crop was produced only using approved substances. During the inspection event the clamor of everyday farm life and work is simplified to the required forms that can be digested by the certifying agent who then determines if the farm can be certified or not.[114]

[114] I was not present during the inspection at the farm. A common strategy for inspection events is to limit the number of employees present during the event to have more control over the interaction between the farm representative and the certifier. However, this event would be an interesting anthropological site.

Processes of Inclusion and Exclusion

In the previous section, the organic movement was described as having a spectrum of definitions and interests that ranged from the exclusion of chemical products used on the farm, to the place of the individual farmer within a system of production and an interest in overall soil health. But how does that translate into a system of regulation? My time on the farm showed me that a significant aspect of USDA Organic certification is the creation of a paperwork trail that shows that certain substances are used and not others. USDA certified Organic has come to be defined predominantly as a process that uses some substances and excludes others (Guthman 2014).

Under the Organic Food Production Act of 1990 (OFPA) synthetic chemicals were prohibited unless they are approved of by the Secretary of Agriculture as advised by the National Organic Standards Board (NOSB) (OFPA 1990: SEC. 2118. [7 U.S.C. 6517] National List). This makes the NOSB and their work as an advisory committee an interesting place to start to understand how OFPA has been implemented. It also gives us a place to start to see how the wider community of organic farmers has reacted to the decisions of the NOSB and how it has affected corn breeding projects.

In this section I review how corn farmers and breeders have reacted to the rules and regulations passed starting generally with what an organic growing environment means for corn breeders, then showing specific cases of synthetic methionine and genetically modified corn. Each of these cases will demonstrate how different traits are integrated into the breeding projects based on regulation as well as influences from the wider community of Organic producers and consumers. In addition, I include a short examination of the hydroponic organic agriculture and

how the approval of this process helps us see how organic agriculture is defined and how producers evaluate it in terms of their projects.

Growing in Organic Conditions

On an organic farm, the jobs of the synthetic chemicals—to kill weeds, destroy pests, and fertilize— are primarily delegated to human labor. Hand weeding, picking bugs off plants, and pulling wagons filled with spoiled produce out to the field to compost – are all examples of tasks that need to be done on an organic farm that are done by chemical inputs in conventional farming. The introduction of herbicides, pesticides and fertilizers replaced many tasks and jobs that were done previously by farm workers. A similar phenomenon occurred in the breeding projects of corn varieties where these chemical inputs were used; corn varieties were no longer required to compete with weeds, fend off insects and take up and use nutrients efficiently. All of these tasks were taken care of by outside inputs and the plants were only required to grow large ears. This system of breeding and relying on potent inputs has allowed conventional breeders to focus on yield, which has led to monumental gains in production over the last seventy-five years (Interview with Bill Davidson 2017). However, these plants cannot grow well without the aid of chemical inputs which enable them to be so productive.

The 1980 study of organic farming systems stated that there was a lack of crop varieties suitable for organic production because they could not thrive in the harsh conditions of organic production (Study Team on Organic Farming, 1980). At meetings across the Midwest in 2000, Walter Goldstein was told by many organic farmers that they needed corn varieties to suit their growing conditions. With feedback from the farmers, Goldstein and Linda Pollock developed a breeding program that utilized landrace varieties (corn that had been adapted to specific areas,

usually grown with limited inputs) and crossed these with modern hybrid varieties.[115] The goal of the program was to create hybrid corn that could be productive under organic conditions. This is an excellent example of how restricting substances can influence and prioritize which traits are important to breeders. It also shows how regulation and input restriction can activate the need for agrobiodiversity and highlight its importance. OFPA left room for determining which substances can be used in Organic production by requiring that The List of Allowed and Banned Substances to be continually negotiated (OFPA 1990 SEC. 2118. [7 U.S.C. 6517] National List. (e) Sunset Provision). This means that the definition of Organic conditions continually changes and that breeders can re-evaluate their projects and how different aspects of the corn genome can be used to develop varieties for these conditions..

In addition to surviving organic conditions, corn has a role to play within the wider Organic production system in the United States – primarily as livestock feed.[116] Which means that regulations and decisions about substances not relevant to its immediate growing environment impact breeder's projects. The next section examines the petitions of the organic poultry industry to allow methionine (a synthetically created amino acid) under USDA Organic regulation to see how the push and pull between conventional and organic ethics of production creates a need for a specific kind of corn. Here we will also meet modern industrial chickens who, like modern industrial corn, were bred and selected for their ability to be productive within the bounds of conventional agriculture with conventional inputs.

[115] In our interview, Goldstein mentioned Linda Pollock as his partner in this project but I have not had a chance to speak with her about her work. She would be one of the next people that I would like to talk to if I was going to continue this research.
[116] Which mirrors conventional corn production.

Organic Corn that can Prevent Cannibalism! Read All About It!

More specifically, the corn would prevent a deficiency in methionine (an essential amino acid) which members of the organic poultry industry have claimed is likely to cause cannibalism in poultry populations. Cannibalism tends to get readers attention and is pretty well understood as something bad, which is why I used it in the title of this section and why members of the organic poultry industry stress this potential symptom of methionine deficiency. The deficiency also leads to poor immune system development, feather plucking, and reduced growth rate, and a slew of other symptoms that are problematic for poultry production (IFC International 2011). It has been difficult for some large poultry producers to maintain USDA Organic standards because of their reliance on large amounts of certified organic feed. High methionine corn could be used to help replace synthetic methionine that has been added to conventional and organic poultry feed for decades. An examination of the issue of synthetic methionine allows us to see how the National List is petitioned and changed and how corn is being bred to take up a task that is currently being done by synthetic methionine.

The National Organic Program Final Rule was passed in December 2000 and went into effect in February 2001, officially starting certified USDA Organic production (Agricultural Marketing Service [AMS] 2000b). Under the National Organic Program Final Rule organically produced feed was the foundation of organic livestock, including poultry (AMS 2000b). Synthetic amino acids were originally not approved of for organic production because they had not been reviewed by the NOSB; it was a synthetic substance, so by default it was not allowed in certified Organic production (AMS 2000c). A Technical Advisory Panel had reviewed a petition submitted in 1995 advocating for synthetic methionine to be grandfathered into USDA Organic production because of historical use in pre-regulation organic feed (Technical Advisory Panel 2001; Pierce

and Buresh 2005). The Technical Advisory Panel reported to the NOSB that under organic conditions—which include adequate access to pasture and forage—synthetic methionine should not be needed (AMS 2000b). This marked the beginning of continued negotiations between petitioners and the NOSB. These negotiations were a result of the way that the law had been written and developed for continual feedback from organic producers and the organic community. An excerpt from the National Organic Program Final Rule illustrates the intention of the National List to be minimal but also amended and reviewed:

> "The development and maintenance of the National List has been and will be designed to allow the use of a minimal number of synthetic substances that are acceptable to the organic industry and meet the OFPA criteria. We expect the maintenance of the National List to be a dynamic process. We anticipate that decisions on substance petitions for the inclusion on or deletion from the National List will be made on an annual basis. Any person seeking a change in the National List should request a copy of the petition procedures that were published in the Federal Register (65 Fed Reg 43259—43261) on July 13, 2000, from the NOP" (ibid).

This quote highlights the ability of multiple petitions to be made by organic producers and for those petitions to be reviewed by the board. The National List was made to be "minimal and amendable" and even when a synthetic substance is added it must be reviewed at least every five years to determine if it is still necessary (AMS 2000b). This provision, calling for The List to be minimal, has caused the organic poultry producers to continually have to justify the case for synthetic methionine and to show attempts to find viable alternatives.

After USDA Organic regulation and production were underway, the NOSB held its second meeting at the Best Western Hotel in La Crosse, Wisconsin on June 6th and 7th 2001 and a review of synthetic methionine was on the agenda (NOSB 2001)[117]. In October 2001 the NOSB made their decision on synthetic methionine and its use as a feed additive in organic poultry production: "The NOSB determined that these materials *are not consistent with organic agriculture but approved them for interim use,* until October 21, 2005, by the organic poultry industry to allow the phasing out of their use. (14 synthetic, 0 natural, 0 abstaining; 14 approve, 0 prohibit, 0 abstaining) [emphasis added by the author] (NOSB 2001). The Board approved of the substance for organic production even though it determined that it is not consistent with organic production with the expectation that the industry would ween itself off of the historically used synthetic material by 2005 (ibid).

On January 7, 2005 another petition was submitted advocating for synthetic methionine to remain in organic production. The petition was headed by Organic Valley, Tyson and the Organic Trace Alliance (Pierce and Buresh. 2005). The petition directly challenges the findings of the Technical Advisory Panel that reviewed the case in 2001 by stating that there were not viable organic feed substitutes for commercial use and that there is not proof that foraging could replace the need for methionine supplements (ibid). First the petition called for an extension on the 2005 deadline and to allow for organic producers to experiment with non-organic feeds to try and find viable options (ibid). The petition also points out that modern chicken breeds used in conventional and organic production are highly specialized and that production has shaped and developed around the "high efficiency breeds." The block quote below is included to show the

[117] The meetings are open to the public and individuals and groups are encouraged to come and make their case to the board. These events would make interesting research sites. I have not been able to find notes on the meeting that mention who attended (either groups or individuals) and what arguments were made.

language and concerns of the petitioners in their own language. This quote addresses a few different concerns including the breeds of chickens they use, commercial hatcheries, and how their business models relate to conventional agriculture:

> "Closely interacting with the above-mentioned alternative feedstuffs research is [research into] alternative breeds. As mentioned previously the organic poultry production model operates within the boundaries of the conventional industry in many respects (while rejecting many other conventional practices). In developing to the state that it has the organic poultry industry, both laying hens and broilers have relied upon conventional hatcheries for their stock. This practice has meant using animals bred aggressively for their growth traits within the conventional paradigm yielding several unfortunate consequences. Modern chicken breeds have had many traits that would benefit the organic sector, traits such as ability to forage and to digest diverse feeds, bred out of them in favor of maximizing feed conversion be it to meat or eggs. Part of the solution to eliminating [synthetic methionine] from organic poultry production lies in finding suitable alternative or heritage breeds as well as commercial hatcheries willing to produce sufficient quantities for the organic market.
>
> Another undeniable if unfortunate fact is that organic poultry producer's business models are built upon these rapid growing, high efficiency breeds. We highlight this fact because modern organic production is and will always be a balance of sustainability and profitability. Discussion of compromise related to cost of production, margin and market price need to be carefully considered with respect and compassion" (ibid: 6).

The petitioners saw the potential in alternative varieties of chickens that could flourish under organic conditions. They identified that the chicken breed that was being used was not able to extract nutrients as well as other breeds when they were given the opportunity to forage.[118] Heritage breeds needed to be identified and then breeders needed to be able to supply them in adequate quantities for the organic producers. At the end of the quote, the petition highlighted the dependency of the industry on the high efficiency breeds and methionine for their continued profitability. The industry seemed optimistic that current research projects into breeds and different feeds would be fruitful. In response to this petition the NOSB extended the use of synthetic methionine until October 2008 (AMS 2005).

In 2007 another petition was submitted to extend the use of methionine by the Methionine Task Force, which was comprised of representatives from twelve organic poultry producers that represented the majority of organic chicken production in the United States (Methionine Task Force and Coleman Natural Foods 2007). The Task Force had concluded that investigating new breeds was a dead end because the slow growing breeds had the same methionine demands as the fast-growing commercial breeds (ibid: 15). The Task Force was now focusing their attention exclusively on research into methionine in economical feed sources. The petition highlights research trials being conducted by the University of Minnesota and Organic Valley into high methionine corn that was developed by Dr. Goldstein (ibid: 20). At that time, the Task Force was helping fund research into developing organic corn varieties that could serve as a commercially viable solution to the methionine issue. The NOSB extended the use of synthetic methionine

[118] Modern animal breeds and crop varieties used in conventional agriculture can be thought of occupying extremely specialized niches. These niches are then produced to support the breeds and their performances on a massive scale. The investigation into alternative breeds showed that there were similar methionine demands in other breeds of chickens, but when given a low nutrient-diet and room to forage, alternatives breeds remained more healthy overall: (Fanatico et al. 2007)

until October 2010 with the justification that even though fully organic substitutes existed, they are not currently available in enough quantity to supply the organic poultry industry (AMS 2008).

In 2009 the Task Force submitted a petition to the continued use of methionine with two new requests: the first was that the substance remain unreviewed until 2015 and that the amount of allowed methionine be increased (AMS 2010). High methionine corn was still listed as the most promising alternative feed option even though the research was progressing slowly and with some issues. The Task Force reported that Goldstein had corn varieties with high levels of methionine but that they would not yield consistently, and this was a considerable barrier to commercial production (Methionine Task Force and Coleman Natural Foods 2009). Feed producers do not want to grow a crop that has a highly variable yield, they want consistency *and* high yields. The petition continued to challenge the idea that foraging and pasture would be adequate for the nutritional needs of their flocks (ibid 2009). They stated that foraged insects simply could not provide enough methionine for a large commercial flock—it should also be noted that in the research conducted by The Task Force, only two of the eight trials reported any outdoor access (ibid).

The NOSB Livestock Committee agreed that methionine would not be reviewed until 2015 and then it would be assessed via the NOSB's sunset review process instead of the petition process. The sunset review is the mandatory evaluation of all substances on The List that occurs every five years (AMS 2018). The review process examines new studies and findings about replacement products, the environmental impacts of the substances, implications for human health, and public commentary (AMS 2018). The review took place in 2015 and in a three to ten vote the NOSB determined that synthetic methionine could continue to be used in organic

poultry production (NOSB 2015a). The final rule was passed in 2017 by the Secretary of Agriculture; securing synthetic methionine's place in organic poultry production until 2022 (AMS 2017).

In 2015, the subcommittee review made the recommendation to the NOSB that synthetic methionine is still essential to organic poultry production because there is no commercially viable substitute and there are low risks from synthetic methionine to the environment and human health (NOSB 2015b). The animal welfare risks associated with low methionine were downgraded from potential cannibalism to "curling toes, bare spots and improper feathering" (ibid). The subcommittee stated that they continue to encourage, "aggressive industry and independent research on natural alternative sources of methionine, breeding poultry that performs well on less methionine and flock management practices that improved poultry animal welfare" (ibid: 281)

The committee made recommendations to the poultry industry that they could change procedures and standards as a way to wean themselves from synthetic methionine; a few of these recommendations were smaller flocks, access to adequate pasture, and better manure handling procedures (ibid). However, the National Organic Program is limited in its ability to enforce any of these solutions because animal welfare and farm procedures are not well defined within the regulation. What is well defined, and therefore enforceable and negotiable, is The List of inputs that can and cannot be used. Goldstein's corn continues to be one of the best solutions the organic poultry industry has for their synthetic methionine problem because it can be used as an input substitute. An input substitution does not require any changes to the processes and procedures of the organic poultry producers, which might be more costly.

The demand for organic corn within organic livestock production shows how the organic production system is mirroring the conventional agricultural system of production. In the American Corn Belt, corn continues to be used primarily as feed in industrial livestock production. USDA Organic regulation has just changed the demands put on that corn, the "jobs" the corn plant must do, in relation to what other substances can or cannot be used.

The corn that Goldstein is developing utilizes genes that will make it more nutritious. The corn is internalizing the task of the synthetic methionine and reduces the overall use of other inputs. As I stated earlier, developing corn varieties for organic production requires that the corn takes up the tasks that were previously done by other inputs such as pesticides, herbicides and fertilizers. This review of the synthetic methionine issue shows how the negotiations of allowed substances can reveal where the tasks of previously allowed inputs will be internalized (in the corn, in the pasture or in the chicken?) and what is preferred and enforceable within the current system of USDA Organic production.

This example also shows how Goldstein's breeding project, which was already focused on landrace and hybrid varieties of corn for organic livestock feed, can become even more focused within the boundaries of regulation and the availability of funding. Goldstein's project went from broadly developing corn for organic conditions and quality livestock feed to specifically breeding corn with high methionine that can be produced commercially. This example also addresses the challenges of creating a commercially viable corn; something that corn farmers with enough acreage and equipment to produce enough feed for the poultry industry will start growing.

Lastly, this section highlighted how decisions and negotiations within the organic production system can influence the projects of corn breeders and demand solutions requiring

agrobiodiversity. The next section shows how public concern about Genetically Modified Organisms (Genetically Engineered) and systems of verification influence which traits breeders need to incorporate in their corn varieties.

Drifting Apart: Planning Reproductive Incompatibility

After the Organic Food Production Act (OFPA) was passed, getting the National Organic Program off the ground proceeded very slowly. The first NOSB was appointed in 1992 and worked from 1994 to 1996 on defining allowed and prohibited substances for the National List (Vos 2000:247). The NOSB brought their recommendations to the USDA and the Proposed Rule on the National Organic Program was released in 1997. It was met with hostility from the wider organic community and during the public comment period the USDA received over 40,000 letters and emails (AMS 2000a). One of the main issues that many people had with the Proposed Rule was that it was considering allowing Genetically Engineered Organisms (GEOs) and their byproducts in organic production against the recommendation of the NOSB (Vos 2000:248; AMS 1997). Here a section from the Proposed Rule proposed by the National Organic Program (NOP) regarding the potential use of Genetically Engineered Organisms and the logic for considering them for organic production:

> "In the time since the OFPA was passed, GEOs [Genetically Engineer Organisms] and their products have assumed a more significant role in agricultural production. The policy of the United States Government is that GEOs and their products should be regulated based on risk, not on how they are produced. The NOSB has recommended to the Secretary as a policy matter that GEOs should not be allowed in organic farming and handling. Public comment is invited with respect to the use of GEOs or their products in a system of organic

> farming and handling. The USDA specifically invites comments on whether the use of GEOs or their products in organic farming and handling should be permitted, prohibited, or allowed on a case-by-case basis." (AMS 1997: 65875)

Vos stated that the Proposed Rule and the consideration of using GEOs in organic production showed a vast misunderstanding between the USDA and the organic movement as a whole; where the USDA stated that GEOs should be evaluated based on possible risk, Vos argues that GEOs are incompatible with organic production based on the tenets of the movement that limit off-farm inputs(Vos 2000: 248).[119]For the USDA, the control of substances being used was more about the risks that substances possibly posed instead of the distinction between on-farm and off-farm production, sustainability, and organic farmer independence from the larger industrial supply chain.

The NOP declared that GEOs were barred from Organic production in the Final Rule. It was also determined that Organic farms were responsible for maintaining Organic standards on their farms and keeping their produce isolated from banned and prohibited substances (AMS 2000c)[120] However, there is no verification process enforced by the National Organic Program that checks for GEO contamination (Leavitt 2018). What this means for a corn farmer is that they need to show, through record keeping, that their seeds are non-GEO and have not been treated with any GEO products. However, under USDA Organic regulation, the harvested corn is not subject to testing to verify it as non-GEO by certifying agents (ibid). Recalling corn's reproductive strategy

[119] This statement marks the differences of ideology within the organic movement that has only intensified within the realm of regulation. The major differences are between one side that is changing the inputs to lower risk, while the other side is more concerned with the system of production and limiting the amount of inputs that are used thus forcing the farm to become as self-sustaining as possible.

[120] It was not the responsibility of conventional farmers to keep their pesticides, herbicides, fertilizer residues away from certified Organic farms. The law only applied to Organic farms and therefore responsibility fell on the Organic farmer. However, there are laws regulating pesticide and herbicide drift that vary from state to state that can be invoked instead.

of sending a large amount of pollen far and wide, and if we consider that GEO corn's pollen carries the prohibited substance—modified genes— then contamination of organic corn can be considered very probable. Promiscuous pollen will not cause a farmer to lose their USDA organic certification, but it could influence how easily they can sell their corn. Some companies that purchase organic corn test for GEO contamination and can reject corn that does not meet their standards (Behar 2018). Many organic producers are using the "Verified GMO-Free" label on their products in conjunction with the USDA Organic label to assure their customers that their products are free of GEOs. This provides an example of how marketing organic corn goes beyond meeting the requirements of USDA certification and how the regulations made by the NOP are interpreted by organic producers and buyers.[121]

The demand in the United States for organic products is beyond the current capacity of production, which means that organic corn is being imported to the United States to meet that demand (National Organic Coalition 2016). In 2016, over 160 million dollars worth of organic corn was imported to the United States, much of it to be used as livestock feed in organic meat production (Economic Research Service, USDA 2018). There are many barriers for new farmers to grow corn and even more for new farmers to grow organic corn (National Organic Coalition 2016). One large barrier is that there are very few varieties of corn that have been bred specifically for organic conditions and for organic production systems. For example, a variety of corn that meets the demands of certified organic conditions will be able to grow well without the aid of nitrogen rich fertilizers, synthetic herbicides and pesticides. The corn varieties that are being created do not only need to grow under certified organic conditions, they also need to fit

[121] It also seems to make sense that if GEO-free seed is required to grow organic corn then organic producers and handlers also need to include in their Organic Plan how they intend to show that they are using GEO-free products.

into the organic process of production, which means that issues of isolation from GEOs is paramount to marketing and selling what they have successfully grown. The farmers and breeders that I talked to described a combination of isolation techniques that they most commonly used: isolation by distance, isolation by timing, using corn with distinct colors to easily show when there had been a cross and creating varieties that reject the pollen from certain types of corn. The ability of corn to reject pollen from GEOs is an interesting trait that is starting to be integrated into many organic corn breeding projects because it is conveniently built into the plant and substantially reduces the risk of crosspollination.

Bill Davidson used Frank Kutka as an example of someone who was creating organic varieties with traits that help keep them isolated from GMO varieties:

> Davidson: "Frank Kutka, he was at Cornell, he was at Minnesota for a while, now he is in North Dakota but he works for North Plains Sustainable Agricultural Society and other groups out there. They do a lot of seed saving. He is an expert on corn and corn breeding and has worked on open pollinated varieties. So he has created what he calls "synthetics" which is using modern genetics [inbred lines and hybrid varieties] mixing that and growing that as an open pollinated. Modern genetics, modern version of open pollinated corn. He's got one called Rebellion which has some incompatibility, like the ability to reject pollen from dent corn, to create an organic version of corn that you can grow. (Interview with Bill Davidson 2017)[122]

[122] Corn breeding terminology reminder: **Inbred lines:** these are created when breeder selects corn with very specific traits and breeds it to itself for many generation to bring out specific traits more consistently. This is like purebred domesticated animals, a population with a specific set of traits was bred to itself over many generations to bring out those traits consistently. **Hybrid varieties**: these are created by crossing two inbred lines. The offspring of the inbred lines (F1 generation) contains favorable traits from each parent across the population. Popular because it

Kutka has identified GEO contamination as one of the major inconveniences impeding expanded production and has developed lines of corn that he has marketed as "Organic Ready" because they carry the trait for gametophytic incompatibly (Kutka 2016). A plant that is carrying the gene for gametophytic incompatibility will reject pollen that is not a carrier of that same gene (ibid).[123] In trials this kind of isolation is highly effective at keeping out pollen from neighboring GEO varieties and even more effective when it is paired with other isolation methods such as timing and distance (ibid)[124]. This trait is controlled by three very rare genes, one has been found in a South American popcorn variety and two others have been found in teosinte, the wild relative to domesticated corn (ibid:1). The two genes from teosinte were crossed into dent corn populations by researchers at University of Wisconsin – Madison in 2001 and are being utilized by organic breeders. Walter Goldstein is also using popcorn genetics that promote gametophytic isolation in varieties that he is developing for organic production.

The inclusion of these traits into the breeding projects of many organic corn breeders has occurred because of the demands of organic buyers and the continued negative associations that many organic consumers have with GEO products. Like the genes that increase the amount of methionine in corn, genes that cause the rejection of specific kinds of pollen become useful because of the wider context of organic production. In addition, many other countries have not approved the use of GEOs, which means that organic corn growers do not have to worry about contamination and organic corn breeders do not have to breed that trait into their varieties. In the

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can produce hybrid vigor, where there is a massive jump in yield in this first generation. If seeds are saved from hybrids you will get a mixture of traits from the grandparent lines and you lose hybrid vigor. **Open Pollinated**: a variety or population of corn that is consistent between generation, the seed is saved from them each year with the farmer or grower selecting desired traits. These are also called Heirloom and Landrace varieties.

[123] If you are interested in more of the "nitty gritty" technical details of gametophytic isolation Kutka has a number of presentations and videos online that explain how it works. Link to video of presentation from 2015 in References.

[124] The suggestion to mix different isolation techniques for higher rates of contamination prevention reminds me of recommendations to use multiple types of birth control methods for maximum effectiveness.

United States, GEO corn is widely used, making methods for isolation a key aspect of growing organic corn. Varieties of corn that include a gene that rejects GEO pollen would help convince corn farmers that they could convert part of their production to organic corn with a minimal amount of effort and risk. Goldstein and Davidson were both working on a funded project from the USDA that is centered on creating corn varieties for organic production. Part of the incentive for the USDA to fund this research is because there is a demand for organic corn in the United States that is currently being met by imports.

Examining GEOs and their place in organic production and synthetic methionine allow us to see how certain traits and genes become favorable because of the inclusion and exclusion of substances from The List. It also allows us to see organic corn and its place within the wider system of production and the economy; corn is the potential carrier of methionine or GEO genetics, corn is an import that the federal government would rather have produced at home, corn is needed as the basis for processed organic products. Now I want to examine a decision that was made by the NOSB to include a specific process of production, hydroponic production, and how this could possibly impact growers' decisions to even participate in organic production and what that means for their corn growing and breeding projects.

Hydroponic Production and the Meaning of Organic Agriculture

Have you seen the pictures of the all indoor farms? Neat little bunches of basil or greens popping up from long white tubes that carry nourishment directly to the plants. Have you ever seen an indoor cannabis growing operations? They are indoor forest basking under grow lights, waving in the breeze of perfectly controlled HVAC units, and under the foliage a network of hoses delivering perfectly measured nutrients to each plant. These are examples of hydroponic agriculture. Hydroponics, aquaponics, bioponics, and container growing systems are all methods

of soil-free (or soil-lite) agriculture.[125] The majority of nutrients the plants consume do not come from the biological processes of decomposition in the soil but from supplements added to the water supply.[126] The recent decision by the NOSB to allow hydroponic production to remain certified organic has been considered by some the end of the USDA organic label and by others as a victory for the future of sustainable farming technologies (Recirculating Farms Coalition Blog 2018; Dixon and Helpsmeet 2018).

Corn can not be grown hydroponically. So, the allowance or non-allowance of hydroponic production has very little to do with the *actual growing* of organic corn. However, because the NOSB has decided that hydroponic production is organic it has made it very clear to some organic producers that the USDA's program has officially become incompatible with the tenets of the organic movement. The meaning of organic agriculture has always been a moving target, with different ideologies latching onto the term and to the practices to promote solutions to different problems.

[125] Growing Power in Milwaukee was an excellent example of aquaponic farming. Growing Power was a not for profit organization in Milwaukee. They were on a small plot of land on the north side of Milwaukee. The area is deep within the sprawl of the city but the plot of land was zoned for agriculture which allowed Will Allen to purchase it and start his farm. They were not USDA organic certified because their inputs came from uncertified places; restaurant waste, coffee grounds from local coffee shops, and brewery waste. They grew their soil through composting and vermiculture (using worms) and actually had composting piles mounded around their greenhouses and hoop houses to help with heating. On my last visit to the farm in 2015, they had just received a compost tumbler that turned compost and heated air that went through pipes under their greenhouses. In the middle of their greenhouses they had a series of above and below ground tanks, holding lake perch sourced from the School of Freshwater Sciences at UW-Milwaukee. The water from the tanks pumped to a bed of plants where it filtered through growing media (coconut husks usually) and fertilized the plants with fish waste. The water from the tanks helped keep the greenhouses warm and humid which maintained year-round growing conditions for sprouts and greens. The perch were sold off when they reach full size to restaurants that use them for fish fry, a popular Friday night event in Wisconsin. In terms of agroecology, Growing Power was one of the best examples I have come across. Critical research into Growing Power, their successes and their failures, could add valuable insight into the dynamics of class and race in the world of alternative food production. For more information about Growing Power see: *The Good Food Revolution*.by Will Allen.

[126] Bioponics uses microbes in the water and might be considered "more organic" because it uses water based biological systems instead of just nutrients.

At the time of my interview with Andy Hazzard, my knowledge of the National Organic Program was limited by experience as a consumer, a vague understanding of the organic movement, and my experience working on an organic farm. So I knew that organic produce was free of certain chemicals and had once been connected to a movement based on sustainability in the 1970s, and that it required a lot of paperwork. During our interview the issue of hydroponics came up:

> Hazzard: The organic movement grew and companies got swallowed up and it got watered down and now we see this whole hydroponics issue…
>
> Halaska: What's the hydroponics issue?
>
> Hazzard: They are certifying hydroponic farms as organic. Yeah, it's a huge issue right now.
>
> Halaska: Why? I just don't know anything about it, why is it an issue?
>
> Hazzard: Well because ultimately organics is building soils. It is written into the National Organic Program code. It's to feed the soil, not the plant, well hydroponics is exactly the opposite. There is no soil. And even when it is soil based, it is growing in a bucket. And I'm not saying that there isn't room for organically grown hydroponics but goddamn, put a label on it. (Interview with Andy Hazzard 2017).

Since the establishment of the National Organic Program, third party certifiers have been reading and interpreting the rules of USDA organic certification in different ways. Some certifiers have determined that soil-less production lies within organic production because they do not use any prohibited inputs, while others have determined that soil-less production is

fundamentally not organic. The differences in opinion have been brought to the attention of the National Organic Program a few times over the years but no new rules or regulations have been passed on soil-less production systems. The non-action of the NOP is one of the main frustrations that Hazzard discussed. That a process of production that she and others deemed as fundamentally un-organic could continue to be certified for years without any intervention from the regulating body was deeply disturbing to them.

Looking back to the 1979 study done by the USDA, "feed the soil, not the plant" was identified as a central tenet of the organic movement (Study Team on Organic Farming 1980; 9). However, this statement was not codified in USDA regulation. Which has left some wiggle room for the acceptability of hydroponics in USDA organic production depending on who is interpreting the law. In 2015, a task force was formed to do more research on hydroponic and related non-traditional soil-based growing techniques. This issue was so divisive that the task force split into three subsections that each reported their own recommendations; the 2010 NOSB Recommendation Subcommittee, the Hydroponic and Aquaponic Subcommittee and the Alternative Labeling Subcommittee Report (NOSB 2017). The 2010 Subcommittee determined the following:

> "Observing that the framework of organic farming is based on its foundation of sound management of soil biology and ecology, it became clear to the NOSB that systems of crop production that eliminate soil from the system, such as hydroponics, cannot be considered as acceptable organic farming practices. The 2010 Subcommittee of the Task force came to the same conclusion. Similar to the NOSB in 2010, we based our conclusion on historical founding principles of the organic farming movement, regulatory text in the Organic Foods Production Act,

> Regulatory Text of the USDA National Organic Program, good soil management practices, and international organic standards (NOSB, Hydroponic and Aquaponic Task Force, 2010 Recommendation Subcommittee Report 2015: 2).[127]"

The subcommittee states that they are basing their recommendations on the tenets of the organic movement, which emphasize the soil, and the law codified by the National Organic Program, which states that farmers *must*, not "may", *must* use soil management practices that maintain fertility(ibid: 18). This reading of the law supports Hazzard's point of view and her understanding of the law.

The Hydroponic and Aquaponic Subcommittee determined that after their review of OFPA and the current laws and regulations that there is not actually a definition of the word "soil" in the law and that there is nothing prohibiting soil-free agriculture (NOSB Hydroponic and Aquaponic Task Force, Hydroponic & Aquaponic Subcommittee Report 2015: 9). Their interpretation of the statements that organic producers "must" use soil management practices only apply if the farmer is utilizing soil, but according to the law utilizing the soil is not required by the law (ibid: 9). The subcommittee goes further to state that because they are not using soil, they cannot deplete the soil: "When there is no depletion, there is the status quo, thus maintenance" (ibid:9). To the subcommittee the intents of the law or the interests of the movement that predated USDA organic regulation are non-factors in reading what the current law actually allows (ibid: 11).

[127] This document is confusing without any supporting context. Each subcommittee submitted their own report with their own pagination. I have included the subcommittee name in the in-text citation to make it easier to find the page that I took the quote from. In the Reference section, I only reference the entire document and not the subcommittees.

In 2017, the NOSB voted that no new rules governing hydroponic and aquaponic production should be passed and that it could continue to be certified as organic (NOSB 2017). Hazzard and some other producers see this as a failure to protect the integrity of organics and as a portent of the USDA heading in an overall unfavorable direction:

> Hazzard:So they [NOSB] betrayed all the farmers, and here we are, we're like in a huge mess with them. And now we have a government too that wants to cut the USDA budget and [the government has some] ideas that are not in the direction that we would like to see things go and I'm of the mind let's cut and run. You know. Let's all of us get together and have our own dang label and we can still use our same certifying agencies but we're just going to say that that label [the USDA organic label] isn't worth anything anymore. You know, but that's me. I am not good at working within a system that is broken. I'm not that person, I don't have the patience for it. I'm like, let's just move on (Interview with Andrea Hazzard 2017).

To Hazzard the NOSB and the NOP failed to protect the primary tenet of organic agriculture, “feed the soil, not the plant” and therefor betrayed the organic farmers. In doing so they made the label meaningless which justifies leaving the label. Davidson did not bring up hydroponics specifically, but he did brings up the idea of creating a new label because the USDA organic label and the term “organic” are no longer useful to promote an idea of agriculture that incorporates diversity or agroecological systems:

> Davidson: Regenerate Illinois is another group that formed to try and get awareness about the notion of regenerative agriculture which is sort of moving past organic…because that is now a very difficult word to deal with…
>
> Halaska: Why?
>
> Davidson: Because it has been co-opted by the larger system because it has reached a point where they can get value out of it. So, we can't use it to advance the work that we are trying to do. Which is this notion of Regenerative which is a way of farming that improves the health of the land (Interview with Bill Davison 2017).

For Davidson, the work that he is trying to do is to popularize a system of agriculture that is based on diversified production that increases overall fertility of the land that it uses. As a producer, he does not see USDA certified organic agriculture as the best avenue to promote those ideas. Certified organic hydroponic agriculture brings to the forefront the division between producers that define organic based on inputs (synthetic and natural inputs) and those that define organic based on farming processes that promote sustainability through soil maintenance.

OFPA purposefully created the legal mechanism through the NSOB and The List of Prohibited and Allowed Substances to continually define and re-define what certified organic agriculture is by negotiating applicable inputs. The law also provides a structure, through record keeping, by which the inputs can be regulated. The law and regulations do not define any way that practices or procedures that promote soil health can be measured, which leaves these aspects of organic agriculture blurry and open to interpretation. Through these aspects of the law and subsequent regulation, regardless of what is on The List, certified organic regulation can be

defined as a system of agriculture that is based on specific inputs and not practices. This is how Hazzard and Davidson see certified organic regulation and why they do not consider it useful to their goals. Because they don't see a potential for it to be redefined in a way that will promote sustainability, soil health, and regenerative agriculture. Their observations fit in with Julie Guthman's analysis of organic regulation in the early 2000s; organic regulation supports input substitution instead of agroecological practices (Guthman 2014). [128]

Including or Excluding Organic

Hazzard and Davidson both assessed USDA certified organic agriculture as having lost its meaning or being meaningless to them because it is no longer about building soil. The meaningless-ness of the USDA organic label is a threat to the entire organic system of production which is based on customers purchasing organic products at a higher price because of the meaning that they attribute to it. Producers evaluate the meaning of organic certification as a way to determine how useful it could be to their projects; if the organic label becomes meaningless or its reputation declines in the eyes of the public, it is no longer a marketable product. In a letter to the NSOB Walter Goldstein expresses his concern about the future reputation of organics. He cites studies in his letter that have found that synthetic methionine increased a growth factor hormone in the chickens which causes them to grow larger more quickly (Goldstein 2014). He had the following warning to the NOSB:

> "As knowledge about methionine's role in IGF-1 production [growth factor hormone] becomes public, it seems difficult to believe that synthetic

[128] I would also argue that if processes can not be regulated then inputs can not actually be regulated either, ex. Synthetic methionine. Because the NOSB could not enforce animal welfare conditions or control aspects of production such as access to pasture or inclusion of appropriate diet, they were unable to get around the poultry industries claims about the necessity of synthetic methionine.

> methionine can continue to be used without backlash for the organic movement in general. Certainly conclusive research has not been done that links elevated levels of synthetic methionine and IGF-1 in poultry products with human health problems, as it has not been done for rBGH [bovine growth hormone], IGF-1 in milk, and human health problems, either. But, it is hard to imagine an acceptable level of use of synthetic methionine in the future in the face of angry consumers who will not want to be participants in an un-declared experiment. Some, if not many, will feel cheated and fooled for having trusted the organic label with their purchases and health. They will want a fully natural product, and will probably demand a super-organic standard that does not allow the use of synthetic methionine. The organic movement does not need another controversial, discrediting, and divisive rBGH-like issue for poultry, which this could grow into." (Goldstein, November 2014)

Goldstein is asking the NOSB to consider the future reputation of the organic label by trying to frame the argument from the organic consumer's point of view. Goldstein understands organic consumers to be buying organic food for their health and if the growth factor hormone in chickens is shown to be linked to health issues, then organic consumers will no longer trust the organic label. To Goldstein, a consideration of public opinion is important to maintaining the meaning of the organic label. If the consumers feel betrayed, they—like producers— will move onto the next label or producer that can better safeguard them from contamination. This is not to say that the meaning of organic is fixed or the same for all producers and consumers. Visions of organic agriculture are varied, from different perspectives organic agriculture is seen as an answer for health, environmental sustainability, and social justice concerns (Chrzan 2010). But some of the producers are making the

evaluation that USDA certified organic products might lose (or have already lost) its ability to address any of those concerns.

The farmers and breeders that I talked to were conscious of the large forces at play that make USDA certified organic agriculture useful to them. The USDA organic label is useful only because it meaningful to consumers. It is then in the interest of the producers to be aware of long-term viability of the label and also to be aware of alternative options, including the prospect of different labels. The farmers and breeders that I talked to considered the USDA's organic program in terms of their own projects. If they participate in the USDA's organic program, what avenues would open for them, what resources would be made available? What benefits could they reap through their participation?

After the official recorded interviews, I walked around with Marty Travis and we talked for a bit about seed saving, about his Dexter cattle and just about general topics. At some point I told him about my experience working on a certified organic farm and the demands of paperwork. Travis had a completely different view of the paperwork than I did. He saw the paperwork requirements as a beneficial way to help keep your farm in order. That it would be a positive aspect of organic certification beyond access to markets and other resources. That organic certification fostered good paperwork habits that would benefit the farm in the long run. This is one example of the many small ways that organic certification and the organic program can be evaluated as useful to a farm.

To Goldstein, Davidson and the other breeders working under the $2 million dollar OREI grant (federally funded grants connected to the organic program) incorporating the goals of organic production into their projects means that they have access to funding and are working in an organized way to present their varieties to farmers. Goldstein's work with the Methionine Task Force on producing high methionine corn also meant that he had access to funding and other resources that those organizations had to offer. In 2015 the Agricultural and Life Sciences Department at UW-Madison received a $1 million dollar endowment from Clif Bar and Organic Valley that is meant to

help fund programs focused on breeding varieties of crops for organic systems (College of Agriculture and Lifesciences 2015).

As many researches know, grants and funding represent a way to continue work on your project, but they also come with stipulations, constraints and reporting requirements. For example, Davidson does not see the organic grant project as pertinent to his larger project of Regenerative Agriculture, but the program is still a way to get farmers to look at his open-pollinated varieties. We saw in Goldstein's letter to the NOSB that he is cautious about what can be accomplished through the organic program in the future, but he is still dedicated to breeding corn for organic production systems.

During our interview Goldstein emphasized the importance of reducing the amount of nitrogen rich fertilizers being used and the need for regulation. Goldstein emphasizes the importance of eliminating nitrogen fertilizers from farming systems because of issues related to human and environmental health. He also mentions the amount of energy that is going into making fertilizers as a major factor to consider as an issue of sustainability. Goldstein's concentration on developing varieties of corn that are nitrogen efficient might be a steppingstone to the possibility of regulation. His project is multifaceted, but a portion of his project aligns with what the USDA's organic program is good at doing – input substitution. If Goldstein and other corn breeders can create varieties of corn that can internalize the work of high nitrogen fertilizers, then these varieties will become a reasonable substitute for that product. It is important to think about the impact that a commercially viable nitrogen fixing corn would have on the organic industry and United States corn production as a whole. Reliable varieties could allow more farmers to convert to organic agriculture which would reduce environmental degradation caused by nitrogen rich fertilizers. Additionally, a commercially viable nitrogen fixing substitute could potentially pave the way for regulation banning nitrogen rich

fertilizers all together. It seems more likely that a regulation could be entertained if there is already a commercially viable input that could be adopted by corn farmers and producers.[129]

Broadly, what does the USDA's organic program have to offer to projects that promote and conserve agrobiodiversity? The more recent marketing of heirloom varieties within the organic market is allowing new varieties of tomatoes and peppers to be developed by seed houses, grown by farmers, and explored by consumers. The heirloom varieties fit well into organic operations that require more attention or hand picking. However, I don't think that organic agriculture or any of the existing food labels have the necessary mechanisms to promote agrobiodiversity conservation within the mainstream market. Because farmers and breeders are the main growers of diverse varieties of corn (as opposed to backyard gardeners) the marketability of their products needs to be taken into consideration. The potential for producer groups and food labels to include agrobiodiversity within the scope of their mission could also assist in increasing marketability and consumer education.

As we have seen, the NOSBs changing definitions of organic and what inputs can be used can help stimulate the need to include or exclude certain heirlooms, genes and traits into breeding projects. It emphasizes the importance of agrobiodiversity to develop and adapt crops to changing conditions. The varieties of corn that Goldstein, Davidson, Hazzard, Tracy and Travis are developing all come from heirloom and landrace varieties. Because of its status as a commodity crop, corn has had the benefit of institutional breeding programs at Universities and dedicated seed banks such as the Seed Station in Ames, Iowa. However, this does not address the issue that more varieties of corn need to continue to be developed through annual growth and selection in a variety of environments to maintain long-term sustainability.

[129] However, this would also have to align with the federal government's desire to reduce nitrogen use and reduce pollution. With the current administration in 2019, this seems very unlikely that they will move forward any regulation to protect the environment or protect citizens from harmful pollutions if it will harm the short-term economic goals of even a single company.

Conclusion

In this thesis I examined the work and everyday care of heirloom varieties at Seed Savers Exchange in Decorah, Iowa and how a few people outside of Seed Savers Exchange in the Midwest are using heirloom corn in their projects as gardeners, farmers and breeders. By concentrating on the work procedures and the goals of their projects I got a better sense of the field they are working in and how they saw their projects in relation to mainstream industrial corn production and the margins of production occupied by heirloom and open-pollinated corn. Saving seeds, in the broadest sense of keeping seeds from year to year, is part of their craft and my informants are aware of how their selection influences the variety they are working with and how their projects fit into their vision of sustainability.

At the Preservation Department, they are working within a professional, scientific discourse of conservation strategies and collection management. They practice non-selection as a way to freeze their heirlooms in time and keep the population as genetically still as possible. This way they have a greater chance of saving the genes that may be useful in those varieties. Through their practices they are maintaining a marginal space for the varieties to grow. Non-selection is practiced out of necessity. Because of their professional standards they are not able to, as they see it, responsibly grow out and maintain the varieties using selection, they just do not have the time or the labor force to do that work. So instead they are trying to connect their Collection to the Exchange and to gardeners and growers more broadly, where the varieties can be grown and selected.

The Preservation Department is utilizing stories and narratives as a way to provide information about the varieties to new gardeners and as a way to communicate the idea of a

shared heritage. Seed Savers Exchange does not discriminate about who they give their seeds to. They do not ask what people are going to do with them or how they are going to use them. If they have enough seeds to give out to other gardeners, they give out seeds to anyone who is requesting them. They are not asking members if they are maintaining them as they are, mixing them up, or using them in breeding projects. Their main goal is dispersal.

The American Corn Belt is a center of production for modern industrial hybrid and GE corn. This kind of corn was formed under modern productionist ideals, verified and intensified through scientific modern breeding and, more recently, genetic engineering. The ethics of production in this world revolve around a functional reductionism that looks for specific genes, that one tiny gem, that will improve their variety or give it the novel trait that the variety needs for a bump in yield. However, it is also because of the widespread use of hybrid seeds and GE seeds in this region, the massive consolidation of the industrial seed industry and the rise of modern industrial farming that critiques of this system of production became more prevalent.

We see this with the founding of Seed Savers Exchange. The founders were part of an early alternative movement that critiqued agricultural and economic systems as vulnerable and destructive to the environment and society. They found their alternative by turning away from mainstream modern production and consumerism and by remembering, reenacting and tapping into a heritage of food production guided by an ethic of self-sustainability. Kathleen Plunket-Black gave me a sense of the early back-to-the-land and organic food movements in the Midwest, existing in a kind of intentional marginality, being founded by these gardeners and home food producers. This was not a united group, but a number of producers loosely connected to each other through markets, organizations and literature. Through their practices and organizations, they promoted ideas that drifted from group to group, cross-pollinating in the

marginal spaces they were maintaining. However, many of them also understood universities and government apparatuses supporting agriculture as beholden to them as a kind of network of production that was also part of their heritage. They brought their ideas, practices and concerns to these places that were central to conventional industrial agriculture.

Seed Savers Exchange was unique because it became a focal point where ideas and practices that emphasized a heritage of production and an ethic of conservation could be exchanged. It was also attractive to many folks because, as Kathleen Plunket Black told me in her interview, they had many really interesting seeds. In the early days it was unique because it was a central place where these scattered, sometimes very isolated, people could gather to discuss their practices of sustainability. It became a fertile field where people could come together and let their ideas cross-pollinate, changing their practices and developing a different sense of what they were doing. As their movement and Seed Savers Exchange grew as an organization some of the heterogenous quirkiness had to be worked out of it in favor of a more well-defined and scientific conservation ethic.

As the market for the alternative food and organic produce grew it was subsumed by the larger mainstream farming industry into a kind of ethical consumerism. Environmental sustainability and growing the soil, were replaced with a vague notion of sustainability based mostly on health risks associated with certain substances. However, these ethics of production and different visions of sustainability are still being negotiated by producers who find themselves navigating USDA regulation, funding for grants and breeding projects, and the needs and demands of certain markets.

Professor Bill Tracy's sweet corn breeding program uses modern breeding to create hybrid corn varieties and open pollinated varieties that farmers, seed companies and researchers

can utilize. He selects his seed to create sweet corn varieties that other producers will use and this helps keep his department funded and relevant. As a university professor and the head of the agronomy department, it is not really going out on a limb to state that Tracy occupies a very central place within mainstream modern corn production. From this position he has a unique view of sustainability and a nuanced view of the differences between certain practices in seed production. In our interview he was very clear about what he thought were the strongest attributes of modern plant breeding— the ability to find something new that you did not even know you were looking for. There are surprises in plant breeding that do not happen if you are utilizing genetic engineering, which is based on absolute control. However, the new discoveries in breeding are contingent on a constant flow of seeds and a good base of material for breeding and experimenting. Tracy is an advocate for keeping seeds circulating and being traded between breeders and growers. This vision of sustainability has to do with the sweet corn breeding project specifically, but also a view of how modern plant breeding projects are sustained more generally. This vision of sustainability understands that modern breeding programs are dependent on the genetic diversity that is produced and saved in the margins.

Walter Goldstein was very purposefully working within the USDA Organic system to help create corn that would eliminate the need for high nitrogen fertilizers and synthetic methionine in organic poultry production. Goldstein sees the potential to change part of the industrial system, not by changing the system itself, but by changing the inputs of the system that are associated with environmental degradation and possible health risks. Goldstein has been working with organic farmers for a long time and has been working to develop corn to help producers. But he has also been working to create a more stable and viable alternative plant breeding program that allows alternative corn producers the ability to do the work they need to

do. The Mandaamin Institute creates corn for organic production, open-pollinated varieties and hybrid varieties. The issue of how to make these products profitable and sustainable is an issue that Goldstein and other producers are trying to figure out. This is an interesting area that needs more research. However, for my purposes, Goldstein's decision to participate in the mainstream USDA organic production and use his varieties to target one specific problem shows how he is purposefully navigating between mainstream industrial agriculture and more marginal agricultural practices.

Bill Davidson, on the other hand, is working within the Extension program attached to the University of Illinois and he works as a breeder but also as an educator and food system critic. He is very purposefully utilizing heirloom corn to create open-pollinated mixtures and composites that can be utilized in alternative systems. Davidson is very explicit about his work to help change the overall system of food production as a way to create a more sustainable food system overall. For Davidson, he sees the biological barriers to alternative corn adoption as secondary to the common understanding of what makes a good corn, which is primarily the highest yield possible. Davidson sees the incredibly high rates of corn yield as unsustainable in and of themselves. Basically, super high yields will deplete the soil to the point of creating an unsustainable system. He advocates for systems of agriculture that are sustainable in a sense that they are environmentally sound and focus on regenerating the fertility of the soil. Davidson also discussed the need to break away from the dominant food system all together if a viable alternative system is going to be create. He sees the cross-pollination that happens between the two systems and the tendency for the alternative system to use the language of the dominant system as inherently problematic.

The Grain Guild that Davidson runs is trying to remedy structural issues related to grain production, mainly access to equipment and facilities that grain producers need to support their farming endeavors. By sharing equipment and facilities it takes some of the financial burden away from single producers and the cost can be shared within the community. In this way, Davidson and Goldstein are working in a similar problem of creating a network of production that can sustain marginal producers who are not working within mainstream production.

The farmers that I talked to, Andy Hazzard and Marty Travis, were both working on family land. Land that they had inherited from their family and that had a close historical and contemporary connection to mainstream modern corn production. Having familial land to grow their corn on is incredibly important for these two farmers. It allows them to experiment and takes some of the immediate pressure off needing corn varieties that produce right away. They are able to utilize varieties from organizations like Seed Savers Exchange or other small seed houses because they have the space and time available to work the varieties. They have land that they can use as experimental nurseries. Both of these farmers are also tuned into the markets of alternative food consumers and are able to market their products very well. They focus on creating varieties that will grow well on their land but also varieties that will sell well in the consumer markets that they work with.

Travis's vision of sustainability is very clearly stated as community sustainability of producers that is able to adapt and communicate with their consumers and respond to their needs. He emphasizes the importance of finding ways that rural families can continue to produce and make their farms and their projects more economically viable. Here the ethics of production revolve around environmental stability but also maintaining a community by locating and utilizing the markets that are available. Here Travis is working to connect rural farmers with the

central hub of the Chicago food scene. Travis is working with other groups of farmers in other cities to work on these "pods" of economic sustainability for farmers. It will be interesting to see what emerges from these newly formed connections and relationships; what ideas will flow and intermingle with each other as the relationships develop.

Hazzard works in many of the specialty markets that Travis works with in Chicago. However, I would say that she is much more critical of the entire system of production than Travis is. She acknowledges that she benefits from the commercial corn industry that her family works in but is also highly skeptical of USDA organic regulation and mainstream production to produce anything that focuses on long term environmental or societal sustainability. Hazzard is focused more on the tenets of the early organic movement that sees self-sustainability and environmental sustainability as starting primarily with the soil and a closer relationship with the land that the farmer is working. These tenants may have come from her education in horticulture but also in her training in land management and ecology.

Heirloom Corn in the Margins

Virginia Nazarea emphasized the importance of examining seed savers as actors in the field to understand what makes seed saving practices so resilient (2005: 19-20). My informants were dedicated to their work as producers and purposefully navigated themselves and their corn seed saving projects in areas that were sometimes in-line with mainstream production and other times, purposefully, more marginal. By looking at these producers as actors in the field we see how they created and sustained the marginal spaces where they could work with their heirloom corn varieties.

In the American Corn Belt, where industrial commodity corn dominates the landscape, heirloom corn and open-pollinated corn can only be grown and kept in the margins. While many of my informants work closely with central, mainstream locations in terms of classic core-periphery theory – the margins here exist in relation to the dominant system of corn production in the Corn Belt. Heirloom and open-pollinated corn need marginal spaces to pollinate and reproduce away from the clouds of pollen produced by hybrid and GE corn. If heirloom corn was left to open-pollinate along with the commodity corn it would be crossed with hybrid and GE corn, something most seed savers, farmers and breeders see as detrimental to their heirloom crops. This uncontrolled crossing carries the risk of losing genetic resources that could possibly exist in the heirloom corn populations. Marginal spaces, which come in many different forms, are key to keeping these heirloom populations uncrossed.

Throughout this research, I have seen the margins take many different forms. When breeders move their open-pollinated projects to Montana or the Dakotas, they are moving their projects to geographically marginal areas for corn production. Heirloom and open-pollinated varieties that are planted around the schedules of conventional neighbors are being grown in the temporal margins of the season. If geographic and temporal isolation can not be achieved, hand pollination techniques and gametophytic isolation work to maintain a marginal space for the corn to reproduce. In the shadow of industrial corn production marginal systems of production are being worked through where heirloom and open-pollinated corn can be marketed in a way that supports the breeders and farmers that create it.

Cross-Pollinations in the Field

Examining the informants as actors in the field yields descriptions of the "fields" they are working in. The American Corn Belt is a core of production where modern hybrid breeding

programs and seed companies have transformed corn farming and the landscape over the span of a few generations. We can think of this literally and metaphorically as a time when the farmer's fields changed; became more suitable for certain kinds of crops, ideas and practices than others. As we saw in the first chapter, Creation of Modern Corn, small farmers across the Corn Belt and the populations of corn that they maintained were active in these changes. They transformed the land into farming land, they participated in corn shows, gave their corn to breeding projects, worked with university programs and seed companies to improve their crops. The corn varieties kept and maintained by farmers across the Corn Belt were foundational to the modern breeding projects that produced hybrids. Through this history as well we see a heritage of production and a farmers familiarity with university and agricultural institutions. Because of these public new technology and varieties were distributed quickly to farmers but farmers also had access to research facilities and central locations of resources and power. This history of production and collaboration has led to frequent cross-pollinations that become most apparent when looking at the organic movement.

In reaction to the massive environmental and social changes that came with industrialized farming the organic farming movement formed with a foundational belief in the importance of soil fertility. The popularity of the organic movement inspired the USDA Organic program. Over the years USDA Organic regulation has been a field where cross-pollinations have occurred between industrial farming communities, organic farmers with differing ideologies, regulators, and consumers. The ideas that have prevailed during these cross-pollinations have led some organic farmers to believe that the field of USDA Organics is no longer a place where their visions of sustainability can exist. These farmers will move their projects and develop other

avenues of production more conducive to their visions of sustainability where they can maintain their heirloom corn projects.

There has been a continual cross-pollination of ideas and practices from the dominant and alternative corn production systems in the American Corn Belt. Heirloom and open-pollinated corn make up the base of the modern breeding projects. They are foundational resource to the sustainability of modern breeding projects and the economy in the Corn Belt. The current disconnect, the deep divide between how the sustainability of these resources are considered and where and how they should be maintained is an issue for further consideration.

A Few Last Notes

To many of my informants producing corn fits in with their vision of sustainability and it is important to them to figure out ways to keep producing and maintaining their varieties. The visions of sustainability help to create places – nooks, niches, and margins – that heirloom and open pollinated corn can fit in and be grown and multiplied. My informants described for me their habits of searching seed catalogs, or finding new varieties, uncovering new traits, and pushing their plants a little each season. Seed saving offers a sense of discovery that mixes exploration, research and craft. There is an addictive joy that many of them described to me. Because of the time and land required to grow heirloom corn many producers are limited to how much they can grow or if they can incorporate these crops in their seed saving projects. However, for the farmers, breeders and seed savers who work with heirloom corn they have found a bounty of surprises to keep them interested in this versatile crop. It is a bastion of diversity and curiosities that inspires many growers to dedicate themselves to maintaining the marginal spaces these crops need to grow.

Glossary

Agrobiodiversity: agricultural biodiversity, includes cultivated varieties and the local knowledge systems that create them.(that is a quick and dirty definition, I will make a better one soon).

Agroecology: the study or understanding of agricultural systems as an ecological system. Considering a field not as a sterile place where people grow plants but places where multiple species and processes are going through their life cycles. Reframes the importance of diverse systems to help stabilize the system overall. Monoculture, or simple ecosystems, tend to be delicate while diverse ecosystems have a greater capacity for resiliency.

Aquaponics: system of farming that cycles water from fish tanks to fertilize plants. The plants usually have their roots in a growth media (coconut husks) to hold water. The water is drained and cleaned as it passes through the growth media and the majority of it is returned to the fish tanks.

Back to the Landers: A movement of people who in the United States in the 1960s and 1970s that, for a variety of ideological reason, decided to leave towns and cities and disconnect themselves from the mainstream society and economy.

Biodynamics: Similar to organic agriculture, a system of farming that emphasizes incorporating diverse crops and livestock onto farms with rebuilding soils. They have their own label and certification, from the Demeter Association. Some people have critiqued it as incorporating too much mysticism or have claimed it was a religion. I think an archival review of the Biodynamics Journal would be an interesting summer read.

Bioponics: system of farming that uses the biological processes of microorganisms living in water to fertilize plants plants.

GMO (GEO, BE): genetically modified or genetically engineered organisms. These are varieties that are created using gene editing technologies to insert a specific gene into the genome. This technology has allowed for transgenetic species to be created where a gene from one species is transferred to the genome of another. Round Up Ready corn and BT corn are the most common types of GE corn.

Hand Pollinated: a strict isolation policy that completely limits the flow of pollen. In the case of corn this means protecting the female part of the flower with a bag until it is ready to be pollinated, collecting all of the pollen from the male flower and only using the pollen you have collected to pollinate the female flower. This is used when you really don't want a variety to crosspollinate and you think that it will be likely.

Heirloom: a more contemporary term for any varieties that has been passed down at least one generation. MarkeiPopular understanding of heirloom is usually limited to "weird" looking tomatoes

Hybrid varieties: these are created by crossing two inbred lines. The offspring of the inbred lines (F1 generation) contains favorable traits from each parent across the population. These are popular because it can produce hybrid vigor, where there is a massive jump in yield in this first generation. If seeds are saved from hybrids you will get a mixture of traits from the grandparent lines and you lose hybrid vigor.

Hydroponics: a soil-less or soil lite system of farming that usually takes place indoors. The plants are grown either in trays, buckets or directly in water. The plants are fertilized primarily through nutrients in the water supply. Aquaponics and bioponics are similar processes.

Inbred lines: these are created when breeder selects corn with very specific traits and breeds it to itself for many generation to bring out specific traits more consistently. This is like purebred domesticated animals, a population with a specific set of traits was bred to itself over many generations to bring out those traits consistently.

Industrial Agriculture: A term used to describe modern agricultural practices by comparing them to factory production. Industrial farms are also called "factories in the fields." Industrial Agriculture is commonly defined by the following features: large scale monoculture, dependence on chemical inputs (fertilizers, pesticides and herbicides), use of large machinery and dependence on fossil fuels, standardized outputs that feed into processing systems or to long chain markets. Critiques of Industrial Agriculture were developed with the organic movement. Organic, biodynamic, and other alternative farming systems are seen as the developing in reaction Industrial Agriculture.

Isolation Practices: Think of these practices like safe sex for plants. These are a mixture of techniques and barriers used by farmers, breeders and seed savers to stop pollination or only allow pollination from certain sources. This can be isolation by timing—you make sure that varieties that you don't want to cross are maturing at different times. Isolation by distance—keep them far enough apart that their pollen can't reach.

Landrace: A landrace is a an old open pollinated varieties that has been cultivated by one group for many generations. These varieties tend to have a high amount of genetic diversity within the population, some are tall, some are short, differences in color etc….

Methionine: An essential amino acid. Important in poultry production because it has been linked to growth and development as well as animal wellbeing. Corn varieties are being developed that have higher amounts of this amino acid to replace synthetic methionine which is currently used in organic production.

Modern Varieties: Usually referring to a hybrid variety or a variety developed within the last 20 years by a university or a seed company. Contrasts to an heirloom or a landrace variety.

Monoculture: A farming or production system that grows one crop at a time. Contrasted by a multicropping system where many crops are grown together on a farm. Growing only one crop in a field per season allows the farmer to specialize in that crop and either purchase equipment or hire employees that also specialize in that crop.

National Organic Program (NOP): Federal program within the USDA's Agricultural Marketing Service. They develop organic standards and accredit third party certifiers. The third party certifiers are independent organizations that certify farmers as organic.

National Organic Standards Board (NOSB): Federal advisory board that reviews organic standards and regulations and makes recommendations to the Secretary of Agriculture and the National Organic Program (NOP). The main focus of the Board is reviewing and modifying The List of Allowed and Prohibited Substances to determine which inputs are considered organic. Board members are appointed for five years by the Secretary of Agriculture.

Open Pollinated: There are two main definitions of open pollinated.

1)Any plant that spreads its pollen far and wide as a reproductive strategy. Corn is an excellent example of an open pollinated plant that depends on the ability of its flowers to disperse pollen and receive pollen. Because the flower is split into two different parts, the tassels on top and the ears below, and these two parts develop at different times, self-pollination is less likely to take place. This is contrasted with plants that are prone to self-pollination such as peppers. In peppers the male and female parts of the flowers are located very close together and usually mature and pollinate before the flower opens.

2) An Open Pollinated variety, or an open pollinated population. Sometimes just called an "OP corn" distinguishes the population from hybrid varieties where one generation is utilized for producing crops. Open pollinated corn varieties are multigeneration. Each generation is grown out, goes through its reproductive cycle, some corn is used and some corn is saved for the next year. Farmers and gardeners may use different types of isolation practices to keep their open pollinated population from crossing with other nearby corn varieties. Open pollinated varieties can be developed from hybrid varieties by growing and saving seed for many generations. Heirloom and landrace varieties are all open pollinated varieties (although they may not be open pollinated plants).

Organic Food Production Act of 1990: Legislation passed by congress to begin a federally regulated organic program. The law created the structures to define organic and enforce regulation. The law was passed in 1990 but the organic program did not actually start for another 10 years. This law created a centralized definition of organic that law makers hoped would increase interstate commerce and boost consumer confidence.

Organic Movement: A large movement that started in the United States and Europe as early as the 1940s (possibly earlier), gained momentum from Food Purity scandals, ecological crises and growing awareness of issues of pollution. Organic farming was seen by many people as the solution to modern woes that were caused by industrialization of the food system. The main focus was on feeding the soil instead of the plant and to reduce dependency on chemical inputs. Back to the Landers would be considered as part of this movement.

Seed Saving: The act of growing plants, keeping the seeds and maintaining the plant population through many plant generations. Contrasts with consumer seed acquisition, where seeds are purchased yearly from seed companies. Seed Saving and ordering from seed companies or other sources are usually combined techniques to integrate new varieties into a garden.

The List of Allowed and Banned Substances: In federally regulated organic agriculture synthetic substances are banned unless they are approved of by the National Organic Standards Board. Conversely, natural substances are allowed unless they are banned. The List informs producers which inputs are allowed in certified organic agriculture. Strict record keeping practices are required to track all inputs producers use.

Third Party Certifiers: In USDA organic certification, certification is outsourced to independent organizations. These organizations are accredited by the National Organic Program. The certifiers check the organic plans of farmers, review their records and their farming systems and determine if farmers are maintaining organic standards. The certifying organizations interpet and enforce the rules and regulations adopted by the National Organic Program. These organization collect dues from farmers to support themselves financially. In the Midwest largest organic certifier is the Midwest Organic Services Association (MOSA).

Variety: For any agricultural crop there will be multiple varieties of one species. Varieties have been selected and modified by growers through selected breeding and specific environments to have specific traits. One way to think about varieties is like thinking about dog breeds; all dogs are the same species but they have different morphology that comes from specific breeding projects and practices.

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Appendix

Accessions Policy to Guide the Acquisition and Management of Plant Material in Seed Savers Exchange's Preservation Collection (Seed Bank and Vegetative/Clonal Plant Repository) (Seed Savers Exchange 2015): Source: SSE website, https://www.seedsavers.org/site/pdf/AccessionsPolicy_Public.pdf , consulted 12/8/2019

Accessions Policy to Guide the Acquisition and Management of Plant Material in Seed Savers Exchange's Preservation Collection

(Seed Bank and Vegetative/Clonal Plant Repository)

Adopted December 12, 2013

Updated July 28, 2015

Report prepared by the SSE Collection Committee, which is comprised of: Tim Johnson, Seed Bank Manager; Jenna Sicuranza, Collection Curator; Shanyn Siegel, former Collection Curator; John Torgrimson, President and Executive Director; Laura Merrick, Advisor; and David Cavagnaro, Board Member.

I. Seed Savers Exchange Mission Statement

Our mission is to conserve and promote America's culturally diverse but endangered garden and food crop heritage for future generations by collecting, growing, and sharing heirloom seeds and plants.

II. Definitions of key terms

Definitions of key terms can be found in the Appendix at the end of this document.

III. Scope of the Collection

The primary goal of the *Accessions Policy* is to set accessioning criteria and priorities that are congruent with SSE's mission. Types of plant material prioritized for inclusion and active management within the Collection are described in the following subsections.

A. Geographic range

The Collection will be limited to varieties with a history of use in the United States, as per the mission and intentions of the SSE Board of Directors.

B. Plant materials

Accessions of seed-propagated crops must be open-pollinated for inclusion in the Collection. Vegetative material (tubers, bulbs, scion wood, rhizomes, corms) of crops that are typically vegetatively propagated is also eligible for inclusion in the Collection.

All crop types or species are eligible for inclusion in the Collection, granted the accession can be effectively maintained by Seed Savers Exchange. High priority accessions that cannot be effectively maintained at Heritage Farm may be archived in anticipation of future off-site regenerations.

Accessions that are being held by other genebanks or are currently available commercially are eligible for inclusion in the Collection, granted there are resources available to maintain such accessions.

C. Accession classes

The Collection will be limited to the following classes of accessions, listed in order of priority:

1. ***U.S. Heirlooms*** are the highest priority for the Collection. This class includes *Exchange Heirlooms*, *Historic Heirlooms*, *Likely Heirlooms*, and *Modern Heirlooms*.

2. ***Historic Commercial Varieties*** are a secondary collection priority.

3. ***Exchange Heirlooms*** – U.S. Heirlooms of special importance to the organization because of their extensive history of being listed and shared in the *Seed Savers Exchange Yearbook* and/or Online Seed Exchange – are a third collection priority. These will be maintained as resources allow, taking into consideration whether or not they are also *Historic Heirlooms*, *Likely Heirlooms*, and/or *Historic Commercial Varieties*.

4. ***Modern Commercial Varieties*** are the lowest priority within the Collection. These will be maintained as resources allow and based on additional criteria of perceived usefulness to members and need for conservation (e.g. availability to members from other sources).

IV. Donation Criteria

- **SSE will not curate plant material if donors restrict distribution** to members or restrict other uses including, but not limited to, commercial sales, educational activities, preservation promotions, or seed swaps.
- **Donations should be stable, exhibit a uniform phenotype, and grow true-to-type**. If there is variability in a prospective acquisition, this variability should be well documented and accounted for during the accessioning process.[1]

[1] Crops that are normally cross-pollinated are expected to show higher degrees of variability than crops that are normally self-pollinated. Landraces and Native American varieties generally have greater variability than other types of crop varieties. These characteristics will be taken into consideration when assessing accessions.

- **Original donations and acquisitions should be of sufficient quantity and quality to ensure the genetic integrity of the accession can be maintained** in future regenerations. Smaller donations or acquisitions will be considered under some circumstances.

- **Original donations and acquisitions should be sufficiently free of seed-borne disease** that a disease-free increase can be obtained for distribution to Members. When possible, SSE will attempt to reduce disease loads in the plant material after accepting it for accessioning. When not possible, the accession may be archived in hopes that an efficient system for effective regeneration will be identified and applied in the near future. Accessions with known seed-borne diseases will not be distributed to Members.

- **Donors should share information and documentation about the history of the variety when known**. This includes information about the chain of stewardship, original source, description of the variety, traditional uses, and photographs, letters, or articles that help document the variety's history. Such information may be used by SSE for educational, conservational, or commercial purposes.

- **SSE will accept donations that meet the *Accessions Policy*, regardless of crop type or species**, granted the variety can be effectively maintained by Seed Savers Exchange. At present, there are crops and varieties that cannot be regenerated or maintained at Heritage Farm due to lack of adaptation, difficulties inherent in their propagation, or other circumstances. In most cases, such varieties will not be accessioned. However, some high priority varieties may be accessioned and archived in anticipation of future off-site regenerations while donors are simultaneously encouraged to find additional means to protect their varieties.

- **SSE will accept donations that meet the *Accessions Policy* regardless of whether they are being held by other genebanks** or are currently available commercially, granted there are resources available to maintain such varieties.

V. DEACCESSIONING

From time to time, and with guidance from collection management staff and/or advisors, it may be necessary to remove an accession or accessions from the collection because 1) they do not conform to accessioning criteria, 2) they are not viable, 3) they are severely diseased, crossed, or phenotypically unstable, 4) they are known duplicates of other accessions in the Collection, 5) their distribution is limited by a PVP or other legal protection, 6) they cannot be effectively maintained by Seed Savers Exchange, or 7) resource limitations require the prioritization of management of higher priority accessions over lower priority accessions as outlined in Section IV.

When non-commercially-sourced accessions are scheduled for deaccessioning, Heritage Farm will attempt to repatriate or return the plant material to the donor, provided the material is phenotypically stable and relatively free of seed-borne diseases. Accessions originally obtained from foreign genebanks or from foreign collecting trips will be offered to the donor genebank or other appropriate genebank. Accessions donated by individuals will be offered to the original

donor or, when possible, a living relative of the donor. Plant material scheduled for deaccessioning that cannot be repatriated or distributed to a donor will be made available to members for one year in the Yearbook on a first-come-first-served base, provided that the material is phenotypically stable, relatively free of seed-borne disease, and not restricted by a PVP or other legal protection. Standard Yearbook distribution rules will apply.

Accessions for which there is not enough information to determine whether they should be included in the Collection will be archived – provided that the plant material is phenotypically stable and relatively free from seed-borne disease – to account for the possibility that information may surface that will allow for a definitive decision about the continued management or deaccessioning of the accession.

Accessions that are deaccessioned because plant material is dead, severely diseased, or phenotypically unstable may be re-acquired if they otherwise meet accessioning criteria and are deemed to be high priority accessions.

APPENDIX. DEFINITIONS OF KEY TERMS

1950: This date approximates the rapid increase of available hybrid varieties and their utilization in American agricultural systems as farmers transitioned towards increasingly mechanized methods.

Accession (verb): the act of recording information about and accepting a new addition to a collection, thereby committing to its management

An **Accession (noun)** is the basic unit of a collection. In regards to the SSE Collection, an accession is a lineage of plant material (seeds, scion wood, tubers, bulbs, or other plant parts that can be used for propagation) with a common genetic background, material source, and cultural history that is held in the Collection.

Active management: the collective term representing the process of performing all preservation activities needed to sustain an accession including storing, regenerating, evaluating, documenting, promoting, and distributing plant material.

Archive: the formal process of removing an accession in the Collection from active management while continuing to hold a sample of the plant material. When an accession is archived, the most original, viable plant material will be held in ideal storage conditions (or in as ideal conditions as possible) for up to 20 years. At that time, the material will either be deaccessioned or moved back into active management.

The Collection is the term used to describe the entirety of SSE's Preservation Collection consisting of a seed bank, orchards, in vitro tissue cultures, and a vegetative plant repository located at Heritage Farm in Decorah, IA.

Deaccession: the process of ending management of an accession in the Collection.

Exchange Heirlooms: a class of *U.S. Heirlooms* with at least a 20 year history of being listed and shared by members in the *Seed Savers Exchange Yearbook* and/or Online Seed Exchange.

Historic Heirlooms: a class of *U.S. Heirlooms* with well-documented histories that predate 1950. "Well-documented" means that there is documentation of who grew a variety, when it was grown, and where it was grown. This information may be obtained from primary (donation letters and personal communications) or secondary (catalogues, books or other sources) references. This accession class accommodates varieties with heirloom histories that predate 1950, even if they were not brought to the U.S. until after 1950.

Historic Apple Varieties: a class of *Historic Commercial Varieties* of apples bred or commercially released before 1950 and with a history of being maintained on U.S. soil. The SSE apple collection also prioritizes varieties with a history of use in the Midwest over varieties from other regions of the United States.

Historic Commercial Varieties: commercial varieties with a history of use in the U.S. beginning before 1950.

Likely Heirlooms: a class of *U.S. Heirlooms* without well-documented histories, but for which it can be deduced or for which there is anecdotal evidence that they were in cultivation prior to 1950.

Midwest: the region of the U.S. occupied by the states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

Modern Heirlooms: a class of *U.S. Heirlooms* that are not known to have originated before 1950, but that have a history of being grown and shared in the U.S. for at least 20 years.

Modern Commercial Varieties: commercial varieties not known to have been available in the U.S. before 1950 with at least a 35 year history of continuous (or nearly continuous) commerce in the U.S., regardless of their country of origin or history outside of the U.S.

Repatriate: the process of contacting original donor institutions in foreign countries to determine if they would like to receive a sample of plant material that is scheduled for deaccessioning.

U.S. Heirlooms: varieties that have a history of being grown and shared within a family or community in the U.S. U.S. Heirlooms may have either a foreign or domestic origin and may have originated as commercial varieties, emerged non-commercially, been bred or selected on farms or in home gardens, or been maintained as landraces. This includes varieties that were originally brought to the U.S. by immigrants who then maintained them on U.S. soil, and those that were obtained from foreign sources and subsequently maintained in U.S. farms and gardens. It does not include foreign heirlooms for which there is not an heirloom history in the U.S. This general definition applies to Historic Heirlooms, Likely Heirlooms, and Modern Heirlooms.