Seed sovereignty, rematriation, and Three Sisters Intercropping in Native American communities

by

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The student author, whose presentation of the scholarship herein was approved by the program of study committee, is solely responsible for the content of this thesis. The Graduate College will ensure this thesis is globally accessible and will not permit alterations after a degree is conferred.

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NOMENCLATURE

CBD	Convention on Biological Diversity
DoWH	Dream of Wild Health
GRIN	Germplasm Resources Information Network
ISKN	Indigenous Seed Keepers Network
ISU	Iowa State University
NAGPRA	Native American Graves Protection and Repatriation Act
NCRPIS	North Central Regional Plant Introduction Station
NICC	Nebraska Indian Community College
NPGS	National Plant Germplasm System
NS/S	Native Seeds/SEARCH
OSSI	Open-Source Seed Initiative
PAHMA	Phoebe Apperson Hearst Museum of Anthropology
SSE	Seed Savers Exchange
USDA, ARS	United States Department of Agriculture, Agricultural Research Service
WTCAC	Wisconsin Tribal Conservation Advisory Council

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ABSTRACT

Seed rematriation is a rising movement within greater efforts to improve seed and food sovereignty for Native American communities in the United States. As a feminized reframing of repatriation, rematriation seeks to heal Indigenous relationships with food, seeds, and landscapes. Seed rematriation is therefore the process and movement by which Native tribes may reclaim their cultural seed heritages. Since first contact, Native agricultural systems have been systematically destabilized by colonization and its reverberating impacts, resulting in diminished tribal sovereignty. As a result, the biodiversity of Native gardening systems has experienced great losses in the intervening years as varieties have gone extinct or been separated from their Native caretakers. Of this vast wealth, many varieties exist today solely under the stewardship of non-Native institutions. Seed reclamation work is therefore considered necessary by Indigenous communities for the reestablishment of healthy, diverse, and sustainable seed and foodways for generations to come.

This research explored the potential impacts and significances of seed rematriation for Native American communities. Throughout two seasons of ethnographic fieldwork while managing a Three Sisters Intercropping study, I have collaborated with Native seed keepers and growers to select varieties for rematriation efforts and investigations. By actively collaborating with the rematriation network in this capacity, I have explored the need for the increased participation of universities and researchers, and the potential role of these institutions in this largely Native-led movement. Such efforts also increase understanding of how and why Native nations are rejuvenating their traditional agricultural and seed systems, and what rematriation might signify for the future conservation of Indigenous varieties within their home communities.

CHAPTER 1. INTRODUCTION

Native American communities are rejuvenating their traditional food systems as a critical component within greater food sovereignty movements. These efforts, however, have shed light on a need for the restoration of traditional seeds and seed systems. At the heart of community well-being, nutrition, and food security is that of a diverse and healthy seed system. Native nations have historically stewarded hundreds of unique landrace varieties that were specifically adapted to their needs and growing systems (White 2019). The diversity of these crops lent to diets rich in plant foods, upholding community health and nutrition (Mihesuah and Hoover 2019; Hoover 2017). Today, few ancestral varieties[1] remain in the hands of Indigenous[2] North American farmers when compared to the wealth of biodiversity that once existed (White 2018b). While the realities of these situations are interwoven and complex, histories of colonial oppression, acculturation, and assimilation of Native communities can ultimately be linked to many of the issues of sovereignty faced today. The reverberating impacts of colonialism, felt at every level of Native lifeways, have created a complex paradigm in which communities have limited sovereignty and ability to reestablish culturally valued traditions and practices. While the current health of seed systems varies from nation to nation, there is a unanimous need for reclaiming greater diversity of culturally and historically significant varieties among Native communities[3] (Greendeer 2021a; Webster 2021a; White 2018b). This thesis considers the current

[1] I use the term, 'ancestral varieties' to refer to varieties of crops that have originated with Native peoples and are embedded in their cultures. 'Ancestral' speaks to not only the length of time that the relationships with these varieties existed, but more significantly to the deep sentiments of kinship that accompany Indigenous gardening and seed systems.

[2] I preference the term 'Indigenous' when referring to Native American people to demonstrate the shared experiences of these communities with Indigenous groups across the world. Indigenous is capitalized to acknowledge that this word represents an identity – not a descriptor.

[3] I use the term Native nations - as do other scholars - to recognize and assert the political autonomy of Indigenous peoples, distinct from European notions of the nation-state (Hill 2017b).

state of seed sovereignty within Native nations today. Through these challenges, rematriation will be introduced as a meaningful opportunity for reestablishing seed sovereignty, which in turn can has resounding impacts throughout Indigenous food ways. I will argue that that the reintroduction of ancestral seeds, and the subsequent rejuvenation of growing practices is vital to the conservation of Indigenous plants, and vice versa.

While a significant number of Native varieties have survived to present, they and the information associated with them are generally maintained by private seed companies, private and public research institutions, the USDA National Plant Germplasm System (NPGS), botanic gardens, and independent collectors (White 2018b). While these actors have played significant roles in the conservation of these varieties, Indigenous communities have had difficulties accessing these seeds thus far (Greendeer 2021; Webster 2021a; White 2018b). Recognizing this as an unfair exclusion of Native peoples and an affront to tribal seed sovereignty, Native nations are beginning to demand that their culturally significant[4] seeds be returned to them for stewardship and safekeeping (White 2018b; White 2019). These demands accompany cultural beliefs that Indigenous varieties should be grown and conserved by Native communities in traditionally tended fields, rather than solely reside in the collections and seed banks of non-Native people and organizations. The diversification of conservation methods, extended to recognize the value of grower contributions to plant conservation, would ultimately allow for the most effective preservation of valued plant resources. This is because small growers and seed keepers are important steward of landrace varieties, since when varieties are grown in their adapted, home environments, they continue to evolve, generate new genetic variability, and

[4] I also refer to these varieties as 'culturally significant' to more precisely indicate the value of varieties that might otherwise be deemed 'ancestral,' 'heirloom,' 'landrace' etc. I have chosen to highlight the cultural ties to seeds most predominantly in my discussion of rematriation to further support the justification for this process, given the significance of specific varieties to the cultural fabric of communities.

consequently adapt to changing conditions (Hernandez, Perales, and Jaffee 2020; Nazarea, Rhodes, and Andrews-Swann 2013; Kloppenburg 2014). This allows for plant populations to be resilient to increasing environmental volatility, a growing concern with climate change.

The rematriation movement, as the return of culturally significant seeds to seed keepers, growers, and Mother Earth, is therefore considered a vital first step in the restoration of Indigenous agricultural and food systems. Simply put, rematriation signifies a feminine[5] refocusing of the repatriation work defined by the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (Newcomb 1995; White 2018b). The evolving concept of rematriation, however, encompasses much more than human bones and belongings, broadening efforts to reclaim and return cultural traditions and knowledge to the communities of their origins (Newcomb 1995; Prechtel 2012). These aspects of Indigenous culture are a necessary component of increasing Native autonomy and sovereignty over traditional ways of life. The rematriation movement has specifically recognized seeds as culturally significant entities, linked to their own distinct spheres of knowledge and tradition. Seed rematriation is therefore the process and end goal of recovering and returning seeds and plant varieties to the Indigenous communities of their origin (White 2018b).

Seed rematriation is critically linked to seed sovereignty, food sovereignty, and food security. Ultimately, growers can only reclaim and restore their traditional foodways when culturally significant seeds are returned. This is because seeds are the fundamental unit of food production. When growers do not have control over their seeds, as in the ability to reproduce, save, and share them as they see fit, then their food system is unstable. Seed rematriation and

[5] In many, but not all, Native cultures, seeds are viewed as feminine entities. Women are assigned the role of seed keepers, because "it's the woman who carries the seed" both literally and figuratively (White 2018a). The shift from re*patriation* to re*matriation* is most appropriate for these gender dynamics.

gardening rejuvenation efforts therefore seek to stabilize Indigenous systems of subsistence while lessening communities' dependence on outside food and seed sources. These efforts are crucial because food deserts are a reality for many Native nations (Jernigan 2012; Mihesuah and Hoover 2019; Talahongva 2018). Regained access over culturally appropriate seeds is the first step if the reestablishment of cultural food systems is to be attainable – and sustainable – for Indigenous communities.

Three Sisters Intercropping

In light of recent cultural reclamation efforts surrounding traditional gardening practices, this research is focused on Three Sisters Intercropping. This system of polyculture, which consists of growing corn, beans, and squash[6] in the same space, has a long history with Indigenous communities in the Americas. It is believed that this type of intercropping originated and spread across Mexico nearly 3,500 years ago (Landon 2008). The system then diffused throughout North America, with Indigenous communities in the Northeast having adopted the Three Sisters by the middle of the fourteenth century (Mt. Pleasant 2006). The prevalence of Three Sisters Intercropping within the cultural fabric of Indigenous agricultural communities is evident by the oral histories surrounding the system. Despite minor differences among cultural versions, these narratives overwhelmingly describe how the sisters work and act together. The eldest sister, corn, stands tall and upright, holding baby bean within her arms. The rambunctious middle child, squash, freely wanders around the garden (Eames-Sheavly 2000). This narrative reflects the plant architecture of the intercropping and demonstrates the niche that each plant has. Corn provides structural support for the trellising pole bean, while squash covers the soil to

[6] Squash is used as the umbrella term for cucurbit species grown within this intercropping system.

provide shade and preserve soil moisture. Furthermore, the legends often reflect how the Three Sisters came to be tended by humans, relaying the principles of reciprocity central to Indigenous relationships with their gardening systems: humans need the sisters for sustenance just as much as the crops need humans to survive.

Today, Three Sisters Intercropping remains a vital component of Indigenous agricultural systems. This research has found that rejuvenation movements surrounding traditional gardening systems have targeted the Three Sisters as a starting point, given the relative simplicity of the system in terms of management. Intercropping is also extremely productive, allowing for multiple foodstuffs to be grown in the same, minimal piece of land – usually a mound. Jane Mt. Pleasant, a Tuscarora scholar of the Three Sisters, described how the system allows growers to increase yields, resource efficiency, pest management, agricultural stability, and human nutrition (2006). The system is also complementary in terms of providing for nutritional requirements: corn provides starch and calories, beans supply protein and amino acids, and squash provides nutrients and fats (Mt. Pleasant 2016). Therefore, intercropping can have significant implications for food security, dietary diversity, and human health.

Rationale

The reclamation of Indigenous seeds through rematriation is crucial if the reestablishment of cultural gardening systems is to be successful and sustainable. While rematriation networks are increasing in Native North America, universities and researchers have yet to situate themselves within these systems in meaningful ways. Such partnerships are essential for long-term success, especially regarding making rematriation, as a process, more easily accessible and advantageous to Native nations. My project explored the capacity of research universities to access seeds currently held by non-Native institutions in collaboration with communities for

rematriation purposes. Through this work, the research facilitated the growing inclusion of universities and researchers interested in supporting rematriation efforts, as well as contributed to the increased understanding of the role and capacity of these institutions to do so.

The gaining momentum of seed rematriation work provides an opportunity for this thesis to chart developing relationships between research universities, seed-holding institutions, and Native nations. Such relationships and collaborations foster meaningful opportunities for long-term progress towards making seed access and seed sovereignty attainable for Native American communities. The institutions in which this project takes place have colonial histories, necessitating that those involved in this rematriation research engage in what Linda Tuhiwai Smith defines as "decolonizing methodologies" (2012). Relationship-building and the development of collaborative networks have been the predominant means by which this project decolonized its university-based research practices. My project has actively engaged in Native-led discussions with seed keepers, growers, and elders on appropriate and respectful collaboration that privileged Native cultural values and traditional knowledge. This prioritization ensured that the research understood and addressed the challenges faced by communities in relation to Indigenous sovereignty. It is through these conversations that my research determined potential significances, shortcomings, and needs of seed rematriation and the conservation of Indigenous germplasm. The impacts of seed rematriation will likely be profound, yet little research has been done on the potential magnitude of these efforts. Increased research efforts are also necessary for understanding how progress can best be achieved.

Methodology

This research had two core components: ethnographic fieldwork amongst collaborating communities to identify the cultural significance and impact of rematriation, as well as an

agronomic field experiment located at the ISU Horticultural Research Station, in which selected culturally significant seeds were grown out specifically for rematriation. The research experiment existed within an overarching project entitled "Revitalizing the Three Sisters: Native American Intercropping and Soil Health." The objectives of this multidisciplinary, holistic study were to engage with Native growers in communities throughout the Midwest to develop an experiment to evaluate the impacts of the intercropping when compared to monocropping. While soil health was a major interest for this study, all associated research was conducted by another graduate student – and therefore will not be discussed in this thesis. Alongside the garden study, the project sought to assess the cultural, nutritional, and agricultural importance of Three Sisters Intercropping (Hill n.d.; Hill 2021). It is through the relationships upholding the Three Sisters Intercropping project that I was able to conduct ethnographic research within collaborating native communities. Collaborators included Dream of Wild Health[7], Nebraska Indian Community College[8] (NICC), Ukwakhwa Farm[9], and Tsyunhehkwa Farm[10]. My collaborators span many nations, including the Ho-Chunk, Omaha, Santee, and Oneida of Wisconsin.

My role as manager of the experimental garden provided opportunities to experience, first-hand, Indigenous systems of knowledge and practices. As an additional component of the project, it was decided that crop production (yield) from this experiment should directly benefit Native collaborators. With my own interests in seed saving and biodiversity conservation, it was deemed that rematriation would be the most appropriate end use of our crops. Through this, I had the capacity to put rematriation into action by managing the plants for the purpose of seed

[7] Dream of Wild Health, located in Minneapolis- Saint Paul, Minnesota, is an intertribal nonprofit that conducts educational programs related to traditional gardening and plant use at their 30-acre farm in Hugo, Minnesota (Dream of Wild Health, n.d.a).
[8] NICC is a tribal college with locations in Macy, Omaha, and Santee, Nebraska.
[9] Ukwakhwa is a farmstead managed by Dr. Rebecca Webster and Steve Webster (Oneida). Their farm focuses on traditional growing and seed saving.
[10] Tsyunhehkwa is the tribal farm for the Oneida Nation of Wisconsin, producing white corn and beef.

saving. Across two field seasons, I have been grower, seed keeper, and ethnographer, moving throughout the rematriation cycle to learn and understand all stages necessary for conserving valued varieties for the future.

The Research Garden

The experiment at the ISU Horticultural Research Station was a result of feedback obtained from project collaborators and Native community stakeholders wanting to better understand how use of Three Sisters Intercropping can impact crop growth, yield, and soil properties. My role within the broader experiment was to evaluate plant health and yield for crops grown in the two treatments. As manager of this experiment's garden plot, I was uniquely afforded the opportunity to conduct a portion of my ethnographic research *in*-the-ground, as I utilized traditional growing practices. Coinciding field visits and interviews allowed me to understand the cultural aspects of Indigenous gardening systems, while the growing of the Three Sisters became an additional component of my participant observation.

The Three Sisters Intercropping study was developed with and approved by the Native advisory council affiliated with the larger project, to ensure that all methods were culturally appropriate. The advisory council was comprised of members from collaborating organizations and nations mentioned above. The varieties that we selected for the experiment were well suited to Three Sisters intercropping, but also in need of rematriation to their home communities. Over the course of two growing seasons, I managed the sisters for seed production. At the end of the season, all crops were harvested (by weight, in kg) to enable yield comparisons between treatments (monoculture vs Three Sisters) for each crop. Experimental results demonstrated how valuable this growing system is to Indigenous communities. A cumulative result of this research

was also rematriation events each year, which aptly combined the seasonal seed harvests with my ethnographic work as I navigated the rematriation networks.

Ethnographic Work and Rematriation

Selection of participants

Prior to my ethnographic research being conducted, an institutional review board (IRB) exemption was obtained (Appendix A). Interview participants were drawn from the Three Sisters Intercropping project's advisory council: the group of Native elders, scholars, growers, and seed keepers interested in our work. Farmers, as the people who depend on seeds, were vital to my understanding of what crops are grown as well as their motivations for selection of varieties to be grown. Farmers also provided insight into what varieties are significant and valuable to communities and their cultures. Seed Keepers offered unique perspectives on the cultural and spiritual significance of seeds. These women were also knowledgeable in historic and current practices of seed saving, processing, and storage. Community elders, having invaluable knowledge of culture and tribal history, elaborated on the significance of seeds and agriculture for Native peoples and their culture. These peoples' involvement in my research, and their knowledge of traditional growing techniques and plants, was crucial to improving my understanding of Native gardening and food systems. Aside from our direct collaborators, I also made connections with various organizations, both Native and non-Native, involved in the process of seed rematriation. These included Sierra Seed Cooperative of Nevada City, California, and Seed Savers Exchange (SSE) of Decorah, Iowa. These actors, along with the North Central Regional Plant Introduction Station (NCRPIS), a genebank within the United States Department of Agriculture, Agricultural Research Service's (USDA-ARS) National Plant Germplasm System

(NPGS), contributed seeds to the ISU garden experiment, which was a critical first step in establishing relationships with these seed-holding institutions.

Interview process

My interviews assessed the cultural significance of seeds, seed saving, and seed sovereignty for Native people. Prior to beginning, I ensured that I had informed consent from my collaborators, as well as permission to record the conversation for transcription purposes. The goal of my interviews was to develop a better understanding of the Three Sisters, culturally significant germplasm, and the needs of communities regarding seed saving and seed storage[11]. I often asked people to first share about how they became interested and involved with seed saving work. Many of my interview questions also asked collaborators to provide definitions of relevant terms, such as seed sovereignty and rematriation. I encouraged people to reflect about the cultural significance of rejuvenation efforts for their communities, especially for food and seed sovereignty. Conversations often naturally led to divergent paths, as people began to describe histories, cultural teachings, and personal anecdotes. I viewed these tangents as valuable educational moments, rich with cultural and traditional knowledge. Conversations generally remained within the realm of gardening and agriculture, so all interviews provided needed context for my research.

Analytic framework

After transcribing all interviews, I coded the responses, by hand, to find commonly raised themes and threads of understanding. I was then able to put these remarks in conversation with

[11] For my full set of interview questions, please refer to Appendix B

one another, crafting a narrative that has interwoven the voices of my collaborators with scholarly sources and research. I have chosen to do so to demonstrate that my collaborators are theorists, and that their contributions should be recognized as such. This method of analysis was particularly useful for when I asked collaborators to provide cultural definitions of rematriation and various sovereignties. I have compiled these definitions to present as wide a conversation on the topic as possible, privileging the diversity of perspectives and experiences of my collaborators. Through this discussion analysis, I hope to establish the significances of seed rematriation as it affects seed sovereignty and greater aspects of Indigenous sovereignty. These responses have also been significant for considering the future trajectory of the seed rematriation and seed sovereignty movements.

Participant observation

Participant observation was a large component of my ethnographic work for this project, contributing directly to my understanding of Indigenous gardening systems. Participant observation included time both on campus as I managed the ISU research experiment, as well as off campus with collaborating Native communities. At the research experiment, this involved spending time actively using Native gardening methods in my day-to-day work. I was also fortunate to travel to Native communities in 2021 to conduct participant observation. This time was spent with collaborators in their communities, traveling together to visit community gardens and various food sovereignty projects. We participated in a variety of community events related to agriculture, from seeding to weeding and harvesting. This time was incredibly valuable, not only for increasing my awareness of cultural activities and practices, but for the deep conversations and opportunities for learning that coincided with these visits. I found that many of my collaborators are generous and gifted storytellers, and they often infused conversations with

cultural narratives and histories to increase my own understanding. It was through these interactions with gardeners and seed keepers, and access to their wealth of knowledge, that I was able to situate the research within the context of communities pioneering seed reclamation work.

Significance

Because this research occurred in collaboration with a growing movement for increasing seed access for Native communities, it ultimately contributes to increased understanding of seed, food, and broader tribal sovereignty. Scholarly research on seed rematriation is lacking, which is unsurprising given the evolving practice. Food sovereignty is often considered undertheorized, despite its significance within Indigenous food movements (Grey and Patel 2015). By extension, it can be assumed that seed sovereignty has been similarly neglected, perhaps even more so. Currently, there is very little research on the cultural significances of seeds. La Via Campesina[12] and the Zapatista movement[13] have considered seed sovereignty to be tied to cultural aspects of peasant agrarian systems within Central America, although literature has not focused deeply on cultural ties or relationships to seeds. More often, discussion of seed sovereignty is limited to farmers' rights and control over seeds, under threat by increases in seed patents, international trade, and use of genetically modified varieties (Hernandez, Perales, and Jaffee 2020; Shiva 2016; Martínez-Torres and Rosset 2014). This said, my thesis considers seed sovereignty as enacted through the social relationships between Native people and their ancestral seeds. This research, focusing on seed rematriation as it contributes to both seed and food sovereignty, adds significantly to the literature. Any outpouring of academic research and publications in the

[12] La Via Campesina is an international farmers organization with priorities of promoting food sovereignty, peasant seed systems, agroecology and demanding agrarian reform, among others (La Via Campesina 1996; Martínez-Torres and Rosset 2014)

[13] The Zapatista National Liberation Army (ELZN) is an Indigenous movement in southeastern Mexico that is in opposition of neoliberalism (Hernandez, Perales, and Jaffee 2020; Reyes and Kaufman 2011)

sphere of rematriation will critically add to the goals and efforts of rejuvenating Indigenous gardening and seeds.

This project also uniquely fostered collaboration and partnership between Native communities and research institutions where past relationships were colonial and harmful in nature. Most notably, this project occurred within a state's land grant university. Histories of colonialism and appropriation are indeed part of the complex origin of land grant universities, sometimes critically deemed "land grab" universities by scholars within decolonizing movements (Stewart-Ambo 2021). Therefore, this research was critically positioned within a new wave of decolonizing efforts. Relationships between Native nations and the institutions who hold ancestral seeds are on the rise, as use of seed rematriation works towards healing and development of future collaborative partnerships. This research has been privy to the inner workings of those relationships, and the tremendous strides being taken to sustainably conserve and share Indigenous seeds. The combined strengths of these relationships have powerfully allowed for increased opportunities and instances of rematriation success.

Significantly, this research increased knowledge on the benefits of Three Sisters Intercropping. While this system is perhaps a quintessential example of intercropping, very little agronomic research has been conducted using it. From the onset of this project, the ISU research team has prioritized decolonizing agendas. The establishment of a garden experiment, using solely Indigenous methodologies required what Tuhiwai Smith referred to as the constant, "negotiating and transforming [of] institutional practices and research frameworks" (2017 pg. 144). In the development of our experiment and collaboration, we remained determined to be aware and sensitive of the time, energy, resources, and knowledge of those involved. This project therefore focused on collaborative, community-driven research as a means of uncovering what

our collaborators wanted to gain, and what information was of the greatest priority. Through many conversations, an experiment was developed to explore the agroecological underpinnings of the Three Sisters. Collaborators were particularly interested in learning about how, and in what ways, that intercropping impacts plant health and yield. As an additional component of this collaborative project, we provided many deliverables such as workshops, soil testing, and general gardening advice when requested.

It is with this collaborative framework that this research aimed to reimagine Western science's approach to studying Indigenous traditional knowledge. We sought to work across cultural boundaries by privileging the knowledge of those contributing to project as scholars and scientists. Together, we have challenged the notion that Western and Indigenous methodologies must inherently be contradictory in their goals and values. Both, with acceptance and respect, can work towards the similar goal of exploring the natural world and bettering human understanding of natural processes.

Summary

This thesis considers the power of rejuvenation efforts for the restoration of traditional gardening systems. Sovereignty, particularly seed sovereignty, is crucial focus of my research. My collaborators have identified seeds are to be integral members within agricultural systems and their significance should not be overlooked in their significance. The seed rematriation movement is a response to the colonial histories that have contributed to the extinction, loss, and displacement of Indigenous seeds today. Seed sovereignty is notably presented as the relationships that Native people have with their seeds. Therefore, the absence of these seeds from the cultural fabric of communities has had lasting impacts on how Native nations are able to enact food sovereignty and broader aspects of tribal sovereignty. This research presents seed

rematriation as a powerful movement with the potential to restore seed sovereignty for Native nations. As many of my collaborators have noted, there food sovereignty is not possible without seed sovereignty. These realities have led me to envision Indigenous sovereignties as nested, a theory I will present in chapter 2.

The interwoven and nested layers of these sovereignties are essential for analyzing the status of Indigenous seed systems today. Through various historical and political policies, the United States government effectively deprived Native nations of their relationships with the land. This has had devastating impacts on seed and food systems, leading to issues of seed access and seed sovereignty today. The reverberating impacts of these policies, and the resulting diminishment of seed sovereignty will be discussed in the chapter 3. With the need for Indigenous seeds within communities understood, the evolving movement of rematriation can be presented as a means of reuniting growers with culturally significant varieties.

Rematriation as a term has a relatively recent history in its application to seed reclamation work. Prior uses of this term contribute to conversations on the evolution in interpretations, powerfully adding to the meaning of the movement. Chapter 3 also draws from ethnographic research to present the importance of this movement for Indigenous growers, as they navigate the seed rematriation network in tandem with the reclamation of traditional growing practices. Chapter 5 of this thesis details an example of rematriation in action, drawing from the research experiment conducted by the Three Sisters Intercropping project. This chapter uniquely departs from the social science aspects of the previous chapters to present an evaluation of the Three Sisters Intercropping experiment and its benefits to plant health and yield. Growing of the Three Sisters resulted in rematriation, as seeds grown and amplified in the research were reunited with their home communities.

Finally, this thesis will conclude with a discussion of the rising traction of the movement, including potential and future impacts of this work. Rematriation is notably a movement of reclamation, of both seeds and associated information, in response to the reverberating impacts of limited sovereignty. When seeds are brought back into the soils of their home communities, Native nations may be able to revive their cultural food and seed systems. These reestablished relationships are crucial to the conservation of Indigenous varieties. Once seeds are returned to the fabric of their cultures, it is hoped that communities can retain these seeds – and seed sovereignty – for generations to come.

CHAPTER 2. SEED SOVEREIGNTY IS THE WAY WE GO THROUGH LIFE: INDIGENOUS UNDERSTANDINGS OF SOVEREIGNTY

Many Native nations within North America are currently pioneering movements to reclaim cultural practices and knowledge. Most prominent among these are efforts to regain and restore traditional gardening systems, which have been destabilized by the compounding impacts of settler colonialism. As this chapter will explore, seeds are the fundamental unit of food production, meaning that they are intimately connected to the ways in which Indigenous communities enact traditional foodways. Therefore, seed and food sovereignty are interconnected, and should be considered as such in conversations surrounding broader Indigenous sovereignty. The concept of food sovereignty, however, is largely undertheorized (Grey and Patel 2015). By extension, so too must be seed sovereignty - if not even more so. Pertinent to this conversation is the fact that Indigenous sovereignty is a largely misunderstood concept in the way it has been colored by European and colonial origins of sovereignty.

As this chapter will discuss, colonization intentionally disrupted Indigenous relationships to their land, environment, and subsistence methods. Of specific interest to this thesis is the overlapping and interconnecting layers of Indigenous sovereignty; a concept I refer to as nested sovereignty. This theoretical approach to understanding Indigenous sovereignties will be presented through historical and ethnographic accounts, demonstrating the reverberating impacts that attacks against one sphere of sovereignty can have on all aspects of sovereignty. The nested layers of import to this research include seed and food sovereignty, which are intimately connected in the ways that they uphold and are upheld by broader tribal sovereignty.

Indigenous sovereignty will be presented as enacted through relationships with the land, meaning that when those relationships are targeted, so too are the relationships that people have with the seeds and food grown on the landscape. I argue that threats against Indigenous land

sovereignty ultimately threaten food sovereignty. When people are unable to govern their own land, they are largely unable to enact their cultural lifeways that depend on relationships with that land – such as subsistence methods of foraging and farming. The reverberating impacts of these attacks similarly threaten seed sovereignty, as people are unable to perpetuate their relationships with food plants, which require stewardship and careful management. In this sense, seed sovereignty simultaneously upholds food sovereignty and broader Indigenous sovereignty, creating a complex paradigm in which all spheres of Indigenous sovereignty can be viewed as overlapping and interconnected. Therefore, a threat against one nested layer of sovereignty can be perceived as a threat against all.

This discussion seeks to understand the challenges related to seed sovereignty within Native nations today. This chapter notably presents seed sovereignty as a form of Indigenous sovereignty, shaped by diverse values and perspectives when juxtaposed with Western, or even global, understandings of sovereignty. To fully explore how, and in what ways, Indigenous sovereignties are unique from Western understandings, this chapter will first contrast the two.

Western Concepts of Sovereignty

Often historical, Western concepts of sovereignty are a useful foundation for understanding Indigenous sovereignty because these Western definitions have impacted and shaped how Indigenous sovereignty is perceived. To preface conversations of sovereignty, it is necessary to consider how this concept is rooted in European histories and contexts. Michel Foucault, a notable philosopher from whom the field of cultural anthropology often draws, introduced a theoretical concept of sovereignty in his work, *The History of Sexuality*. Foucault defined the right of a sovereign power to decide life and death (1978). This distinction is embedded in European notions of monarchies and empires, with the sovereign being the absolute

ruler over land and its subjects (Foucault 1978). This framework is also influenced by European Christianity, which asserted that God granted divine right to the sovereign. The sovereign and his or her lineage was understood as having inherited authority from God, blessed with the absolute power to wage war in His name (Barker 2005). Foucault described how this concept shifted with the emergence of the nation state and European imperialism. He argued this change reframed the power of the sovereign as, "a right of seizure: of things, time, bodies, and ultimately life itself; it culminated in the privilege to seize hold of life in order to suppress it" (p. 136). This notion moved away from the stark ability of a ruler to decide who lived and died, and instead presented the subtler ways in which a sovereign ruler exerted power over his or her subjects - including rulers of democratic states. While unquestionably control over life remained, the right of the sovereign extended to how the subjects lived their lives and conducted themselves. This control ultimately shaped how sovereigns rule their subjects as political, economic, and social beings.

When the first European colonial powers made contact with Indigenous peoples, they vacillated between recognizing Native nations as their own autonomous entities, versus populations to be subjugated for the crown[14] (Hurt 1987). The political autonomy of Native nations was often not contested, because during initial encroachment on Indigenous land, to do so would have barred Europeans from essential trade. While settlers largely did not understand the structure or political functions of Native nations, they nonetheless treated them as equal powers in diplomatic and economic partnerships (Witgen 2012). Trade was the primary mode by which Europeans interacted with tribal nations, creating opportunities whereby both actors could leverage power to extend alliances and networks (Witgen 2012). These exchanges allowed

[14] After the Spanish had reached the New World, Pope Paul III legitimized Indigenous rights to their land and required restitution whenever those rights were violated. The French later refused to recognize the same rights, and forcibly claimed land and establishing treaties that brought Native people under the dominion of the French government. The English operated largely under the same pretext, at first claiming land for the crown (Hurt 1987).

Indigenous communities to maintain political autonomy by exerting control over certain areas of land, resources, and trade goods. Across these complex histories, treaty-making and the brokering of land purchases were the initial steps in recognizing tribal nations as sovereign entities (Hurt 1987; Kalt and Singer 2004). Even Native nations who did not engage in treaty making themselves were protected by the doctrine that inherent sovereignty was to be respected (Kalt and Singer 2004). This was the essence of Indigenous sovereignty, with communities governing themselves without influence of outside powers.

It was only when Western actors sought to disenfranchise Native nations from their resources did arguments about the validity of Indigenous autonomy arise (Witgen 2012). As colonial powers gave way to the nation-state, the concept of sovereignty was repurposed for democracy. In place of a single ruling power, the nation emerged as a collective of individuals with the right to rule themselves (Barker 2005). As a nation of individuals, however, emphasis was placed on the idea of the citizen: those whose social status and responsibilities resided with the nation-state. Alongside the creation and imposition of rigid territorial boundaries, strict cultural parameters were established so that those who fit the ideals of the nation-state were considered citizens, while those that resisted the mold fell into the category of those to be assimilated, often by force (Hill 2017b).

This concept of the "Other" is how the fledgling government of the United States viewed Native nations within their established political territory. To justify the colonization and exploitation of Native nations, the nation-state regarded them as existing as a part of nature, with the inability to assert sovereignty for themselves (Hill 2017b). Native nations were deemed unable to achieve social progress and in need of guidance. As Christina Gish Hill stated in her writings about this period of the emerging nation-state, humanity was, "divided into those who

have the right to exercise sovereignty and those who need others to do it for them" (2017b, pgs. 24-25). The same defining characteristics of Native kinship, which had allowed White settlers to engage in treaties and trade with these communities, were reimagined as evidence for their evolutionary inferiority (Witgen 2012). This is because the "state of nature" was viewed as below that of civilized society, on a lower rung of social evolution in which Indigenous people were constantly perpetuating violence against one another (Hill 2017b; Reyes and Kaufman 2011). Colonization and the forced conquest of Native communities was therefore heralded as an act of political protection, not only for the nation-state, but for the greater good of all.

The sovereignty of the nation-state depends upon the set of rights allocated to citizens; the rights to life, liberty, and the pursuit of happiness being among those most loudly championed (Witgen 2012). As Jeff Corntassel (Cherokee) and Cheryl Bryce (Songhees First Nation) have critiqued, these rights are conditional on the whims of the state, which can choose to withdraw or selectively enforce them at any time (2012). Giorgio Agamben, another philosopher of anthropological importance, built upon this reality in his theoretical contributions on sovereignty. He envisioned the sovereign's power – in this case, the state - as creating social "spheres" by which political populations are influenced. Sacred, or "bare" life, exists outside of the spheres of the juridical, profane, and religious, thus being a life that can be killed. This distinction is reinforced by the sphere of the sovereign decision, which, "suspends law in the state of exception and this implicates bare life within it" (Agamben 1998, p. 83). In a state of exception, populations are in no way protected from the violence of the sovereign. A sovereign may violate borders, commit genocide, and create an environment in which human life may be killed. This assertion of sovereign power explains many of ways that the United States government has exerted power over Native American nations. The irony should be noted,

however, in how assimilation was considered an end to violence, the federal government created states of exception in which Indigenous people experienced the theft of ancestral homelands, genocide, and the mass violence of settler colonialism.

With the penning of the U.S. Constitution, Native nations, as being determined as exempt from taxes and free to negotiate trading with the U.S., were legitimized as separate from the sovereignty of the federal government (Art. 1, sec. 2.3 and 8.3). Despite these assurances of Indigenous sovereignty, Western influences have sought to recreate Indigenous people as political, economic, and social beings much like Foucault describes in *The History of Sexuality*. This was accomplished by creating a state of exception in which tribal sovereignty was overthrown.

During the relocation and assimilation era of the mid 1800s to early 1900s, the federal government acted as absolute sovereign by creating a space of exception for Native people in which their own sovereignty was disregarded. As a result of the Indian Removal Act of 1830, Native nations experienced the theft of their ancestral homelands by the U.S. government as territories were redrawn and Native communities were required to relocate across the Mississippi onto designated reservations (Cave 2003). Despite the longstanding histories of Native nations on their homelands, and their deep social, cultural, and spiritual ties to the land, communities had very little power in this situation. As Agamben predicted, the state of exception allowed for the violation of borders, the violation of land sovereignty. Communities who resisted relocation were ultimately the targets of genocide, such as through forced death marches like the Trail of Tears (Cave 2003).

Reyes and Kaufman usefully explained Western concepts of sovereignty as being defined by internal and external attributes. Not only must the state structure its government so that it may

maintain territorial control, but that control must be legitimized through recognition from other nations (2011). Deloria et al., explained this same phenomenon for Native nations when they wrote, "paradoxically, the exercise of tribal sovereignty rests, in some measure, on the recognition of a tribe by the federal government" (2018). As the previous discussion has revealed, the political autonomy of Native nations was repetitively dismissed and contested. Even today, Native nations must fight for recognition and for the legitimization of their sovereignty.

Indigenous Sovereignty

Decolonizing Frameworks

In contrast to Western understandings of sovereignty, it is crucial to note that prior to first contact, Indigenous communities had none. The term sovereignty was simply not in their vocabulary. Sovereignty in it of itself is a wholly Western concept, fashioned from Christendom and placed upon Indigenous nations. Indigenous communities did not define their political autonomy as sovereignty (Barker 2005). This is not to say that Native nations did not have their own concepts surrounding governance and autonomy, but rather that Indigenous self-determination, "is something that is asserted and acted upon, not negotiated or offered freely by the state (Corntassel and Bryce 2012, pg. 152). This speaks to how Indigenous communities were historically autonomous, defining their own lifeways and actions independently of outside forces. No other power could dispute that – especially not the nation-state.

Given the colonial origin of the term sovereignty, some Indigenous actors and scholars have refuted the use of it to define their own autonomy, claiming that the colonial implications have left a stain too deep to be removed (Alfred 2005). Sovereignty, as a discourse, has been critiqued as unable to encompass Indigenous meanings, perspectives, and identities – thus

contributing to the mistranslation of how Native nations might wish to represent themselves as untethered from European influences (Barker 2005). As a response, some scholars have presented "political autonomy" as a phrase more appropriate for understanding how and in what ways Native nations exercise power (Hill 2017b; Lomawaima 2013). Jeff Corntassel, a Cherokee scholar, has employed the phrase "self-determining authority" to describe how Indigenous people assert and act out traditional lifeways (Corntassel 2008; Corntassel and Bryce 2012). In my own work, I have chosen to maintain use of the term sovereignty, while recognizing how it is imperfectly steeped in colonialism, to contribute to decolonizing practices and the production of theory. Many of my collaborators, including, elders, seed keepers, and growers, maintain this term when referring to relationships with traditional seed and food ways. Despite the imperfection of sovereignty, they intentionally use this word to explain – and reclaim - the significance of these aspects to their own nation's identity and culture.

Today, sovereignty is perhaps a misunderstood concept, due to how generally it is used to refer to the inherent rights of all people (Barker 2005). This said, sovereignty is a highly recognized term – and that lends to its power. In reality, Indigenous communities have been deprived of the ability to define their own sovereignty for generations. Recent theorizing from Indigenous scholars is therefore an intentional way by which communities have reclaimed and repurposed the term for their own benefits (Barker 2005). As Taiaiake Alfred, a Mohawk scholar, meaningfully explained, "Indigenous peoples have come to realize that the main obstacle to recovery from this near total dispossession – the restoration of peace and harmony in their communities and the creation of just relationships between people and the earth – is the dominance of the European-derived ideas such as sovereignty" (2005, pg. 48). While Alfred does not believe that the term sovereignty can ever be appropriately applied to Native autonomy, his

words speak volumes to the importance of disentangling Indigenous self-governance from colonial histories. If Native nations are to define their own sovereignty, they must do so removed from the definitions, influences, and constraints of Western ideals.

Indigenous Sovereignty Reimagined

As Alfred has simplified, sovereignty is a social creation (2005). For Indigenous communities, sovereignty is primarily enacted through kinship; the set of relationships that dictate respectful coexistence in the world (Barker 2005; Hill 2017b; Witgen 2012). The ethical and moral impetuses for these relationships are woven throughout Indigenous cosmologies. One facet that I have chosen to present, in an albeit condensed and generalized format, is the kinship shared with the land because, ultimately, Indigenous belief systems contribute to diverse understandings of broader sovereignty.

In many Native cultures, Earth is mother to all in the ways that she cares for those who dwell on her. She is all on this planet that gives life and causes things to grow (Forbes 2001). This understanding of Earth as mother is integral to the ways that this relationship influences and categorizes all other kinship between creatures on this planet. If Earth is mother, then all life who are cared for by her, be they humans, animals, or plants, are her descendants. Therefore, all living beings are kin through her, and should relate to each other as such. Kinship manifests in these relationships as respect and reciprocity; if nature provides unending support, guidance, and love, then in return, humans are expected to reciprocate with love, respect, and appreciation for nature's generosity (Deloria 1999, Forbes 2001; Tinker 2004). These kinship relations, while much simplified, are real and valid.

This generalized presentation of some Indigenous belief systems demonstrates the centrality of kinship to Indigenous lifeways. Similar threads of understanding are present across

many discussions of Native worldview, but most notable to my own research in conversations surrounding sovereignty. Throughout the literature on Indigenous sovereignty, the relationship of people and their land remained a focal point. This is because kinship is the foundation by which all social, political, and economic interactions are embedded (Barker 2005; Hill 2017b; Witgen 2012). In order for kinship to be genuine, however, these relationships must be grounded in respect and reciprocity. As Vine Deloria Jr. (Standing Rock Sioux) clarifies, Native kinship with non-human beings should not be misunderstood as a universal kinship with all elements of the natural world. While respect to all entities may be a crucial aspect of Native worldview, kinship can only be formed in particular and recurring relationships of reciprocity and respect (1999). Native peoples may not feel a deep sense of kinship with all elements of the landscape equally, but instead form attachments to places of significance. This is, I argue, is the crux of Indigenous sovereignty.

Indigenous sovereignty must not be simplified as absolute control over land, but rather framed as the unique relationship that Native people have with their land (Mihesuah and Hoover 2019). This is because Indigenous worldview, "honors the autonomy of individual conscience, noncoercive forms of authority, and a deep respect and interconnection between human beings and other elements of creation" (Alfred 2005, pg. 45). Humans are not viewed as acting separately and for their own benefit, but rather as embedded in a kinship network that requires careful consideration of all members.

Such is the case for all decisions and interactions made on the landscape. Joanne Barker (Lenape) further explained, "traditional frames of mind would seek a balanced perspective on using land in ways that respect that spiritual and cultural connections Indigenous peoples have with their territories, combined with a commitment to managing the process respectfully and

ensuring a benefit for the natural and Indigenous occupants of the land" (2005, pg. 46). Humans must balance their use of the land with the care that they give it, so that the cycles of reciprocity continue. It is only though these carefully maintained interactions that communities can be sustained on the land.

As the preceding conversations have revealed, and the following chapter will explore in more depth, Indigenous sovereignty was targeted by the United States government. When sovereignty is tied to the land through kin relations, then infringement upon those relationships can devastate all lifeways. Dana Powell, who researched Diné resistance to the controversial Desert Rock Power Plant, described this significance of land to Indigenous ways of life when she asserted that these, "multiple, overlapping interdependencies reveal how sovereignty itself – while appearing as a self-contained position – is enmeshed in networks of visible and invisible relationships" (pg. 126). This comment reflects the nested reality of Indigenous sovereignty, while also speaking to how relationships undergird all interactions. Sovereignty is not one state of being, rather it is composed of numerous layers that uphold one another. This, I argue, is necessary for understanding the challenges of Native nations today concerning their food systems and rejuvenation efforts.

Nested Sovereignty

When Indigenous sovereignty is understood as enacted through kinship relationships, especially with the land, then it can also be reframed as land sovereignty. I view the two spheres as connected; they might be referred to separately, yet they encompass the same ideas. I believe that they have been represented thus far as distinct sovereignties because the significances of Indigenous relationships with their landscapes have not received proper attention from Western theorists. To be fair, land sovereignty is closely tied to political sovereignty in Western

perspectives as well since it is envisioned as the way that sovereignty asserts territorial boundaries. The same understanding is not true for Indigenous/land sovereignty, which instead privilege social relationships as motivations for action.

Central to my research were the ways that Native communities related to their food and seed systems. These traditions are only possible through intimate relationships with the landscape, as seeds are planted, crops are maintained and then harvested, allowing the cycles of dependencies between humans and plants to continue. Growing is literally embedded in the land, in the soil. Therefore, without land, people cannot grow their crops and reproduce them, year after year, to survive. This interconnectedness demonstrates what I refer to as the nested nature of Indigenous sovereignty; sovereignty is not one state of being, rather, it exists and is enacted at many layers of Native life. Corntassel and Bryce allude to this understanding when argued that discourse on Indigenous sovereignty, "is often reduced to self-governance, when this is only one of several layers of Indigenous self-determining authority" (2012, pg. 153)

As the following conversations will demonstrate, food and seed sovereignty are immutable layers contributing to broader Indigenous sovereignty. Food and seed systems are enacted on and through the land, but more significantly, through *relationships* with the land. Sam Grey and Raj Patel added to this understanding of Native American food sovereignty when they highlighted the centrality of relationships with the land for food systems and Indigenous culture (2015). These sovereignties are not distinct. They overlap and are interconnected so that attacks against one sphere of sovereignty have the power to destabilize all other aspects of Indigenous sovereignty.

This nested nature of sovereignty is evident when colonial histories are considered. Land theft and forced assimilation were targeted efforts to diminish Indigenous sovereignty over the

land. While Native nations may not have conceived sociopolitical boundaries around their homelands, they were intimately connected to those landscapes by the network of relationships crucial to subsistence. To acquire food or produce it within the environment, a person must have a deep and personal knowledge of their surroundings. When such relationships are sustained over a long period of time, be it decades or generations, communities establish kinship systems with the land. When communities were relocated onto reservations, they were dispossessed of the relationships they had with their ancestral territories. Land access remained, but sovereignty – as kinship with the landscape – was stripped away. As a result, food sovereignty was weakened because communities were not able to enact these relationships in known ways, through food production and procurement. To take it one step further, when agricultural traditions were displaced, so too were the seeds of varieties crucial to those systems. As food and agricultural systems ultimately rely upon seeds, food sovereignty became vulnerable. Additionally, when considering that kinship relationships are central to food production and are based on respect and reciprocity with the land, agriculture can be understood as a means of acting out those relationships. Seeds are vital members within that kin network. When land relationships are impacted, so too are relationships with seeds and food. All of this is to demonstrate how seed and food sovereignty are ultimately nested within contexts of land sovereignty – as broader tribal sovereignty – and vice versa.

Food Sovereignty

Food sovereignty, as the heart of community health and well-being, is particularly vulnerable for many Native nations (Hoover and Mihesuah 2019). This concept of food sovereignty was originally defined by La Via Campesina as the movement, process, and goal of Indigenous communities to define their own food and agricultural systems through cultural and

community engagement (1996). Food sovereignty is perhaps one of the more widely discussed elements of Indigenous sovereignty, yet it is considered undertheorized (Grey and Patel 2015). This form of sovereignty should be distinguished from food security, which only considers access to adequate healthy and nutritious food (Mihesuah and Hoover 2019; Shiva 2016). Food security is often criticized as too narrowly focused. The concept of food sovereignty expands on food security to include the cultural traditions and significances of food production, distribution, and consumption within any community (Mihesuah and Hoover 2019).

Food sovereignty for Native American nations, however, also interacts with the kin relationships crucial to Indigenous lifeways. Food systems are how Native people interact with their landscapes, ancestors, and cultural identity (Greendeer 2021; Webster 2021a; White 2018b; Zeise 2021). As discussion of Indigenous sovereignty have revealed, it is these social relationships that directly uphold political and economic autonomy (Alfred 2005; Barker 2005; Hill 2017b; Witgen 2012). Therefore, food sovereignty is a crucial way by which communities enact their traditional and cultural kinship systems. Simultaneously, food sovereignty allows for the perpetuation of these relationships. This is because, "for Indigenous peoples, subsistence living involves everyday cultural, spiritual, and social grounded in reciprocal relationships that sustain communities for generations" (Corntassel and Bryce 2012, pg. 154). Food production is seen as a mutually beneficial relationship between Native people and Mother Earth. People enact spiritual and kinship bonds through the growing and nurturing of crops and the land and, in turn, crops provide communities with nutritious food. Lea Zeise (Oneida), program manager at the United South and Eastern Tribes Inc., explained this cultural significance of food sovereignty when she generously shared,

> There's this sort of far-reaching cultural fabric that we're weaving when we grow our own foods and participate in all of these activities related to growing our own foods. The farther you get into it, the farther you realize that there's a reason these foods are foundational to our culture, and foundational to our ceremony cycles. Because they really do feed your spirit, your body, and they help keep a balanced mental health. So food sovereignty is a way to make relationships with our foods, but also relationships with all of the plant, animal, wind, and waters that support that. It's like [when] stepping into your responsibility as a [Native] person, you are stepping into these relationships, and you're stepping into putting your roots really deep into the soil. [You're] then realizing how important it is to protect all of that from being disappeared - from the efforts to erase and destroy Indigenous teachings and knowledge. It's really powerful to know that you're playing a small role in reversing all of the efforts that have gone into erasing your own identity. (2021)

Food sovereignty encompasses not just producing enough food for oneself but producing enough food to sustain one's entire community in a culturally appropriate manner. Cultural foods, as Zeise referred to, are those that are deeply embedded in their communities, through not only ceremony, but day-to-day life. These foods reflect the spiritual, physical, and mental needs of the culture. Culturally appropriate food is critical to food sovereignty because food conditions, histories, and relationships matter (Hoover 2017). I focus so intently on these social relationships because this aspect of food sovereignty is largely underappreciated in scholarly work on Indigenous sovereignty. If broader tribal sovereignty is presented as relationships with the land, then by extension, so must food sovereignty. Farming and foraging are dependent on the landscape; food would not exist without it. To grow food or to be able to find it in nature requires

a depth of knowledge and familiarity with the environment. Subsistence also requires reciprocity, as people carefully tend plants in order to ensure food production. These interactions *are* social relationships and must not be overlooked.

Prior to assimilation, Native communities were incredibly self-sufficient, relying on gathering, hunting, fishing, and gardening for subsistence (Hurt 1987). Food was not viewed as a commodity, but rather a means of social interactions with the surrounding community of both human and non-human actors. Through colonial policies, the United States government intentionally destabilized Native ways of life by disrupting their subsistence methods (Cave 2003). These policies and subsequent consequences will be discussed in more details in the following chapter. Ultimately, settlers targeted sovereignty at the food system level as a means of toppling the broader sovereignty of Native people. To understand the implications of these colonial events, however, Indigenous food sovereignty necessitates a complete reworking of the beliefs of what food and sovereignty separately mean. Food must no longer be considered simply as a consumable commodity, but instead reframed under cultural meanings as something that bonds people, health, and land.

Seed Sovereignty

Seed sovereignty is a necessary and interconnected component of food sovereignty and must also not be neglected when discussing broader aspects of Indigenous sovereignty. If communities are to enact food sovereignty by producing culturally appropriate foods through culturally appropriate practices, they require culturally appropriate seeds. To be able to continuously produce food requires unimpeded access to seeds as well as the ability to regenerate them freely for future planting (Kloppenburg 1988; Shiva 2016). A vibrant and diverse collection of plant varieties upholds a healthy seed system (Nabhan 2002; Shiva 2016). A seed system is

composed of all actions regarding seeds used for future agricultural pursuits, from seed propagation to selection, seed saving, and storage (Kloppenburg 1988; Shiva 2016). Seed sovereignty has therefore been defined as access to traditional seeds and the ability to reproduce, save, and use these seeds as a grower sees fit (Shiva 2016).

If Indigenous sovereignty is to be understood as the acting out of social and kin relationships, and food sovereignty is understood as an extension of this, then seed sovereignty must be recognized as the ability to enact cultural kin relationships with seed. As Zeise added, "For me seed sovereignty is related to food sovereignty…You might think that people want to have control over their seeds. [But] seed sovereignty is just as much about having our own cultural relationship with our seeds as it is about protecting them from negative influences and threats" (2021). Those threats mentioned include the theft and appropriation of Indigenous seeds by corporations, seed patenting, and contamination of seeds by genetically modified and non-Native varieties (Greendeer 2021; Webster 2021a; Zeise 2021). Elena Hill also spoke to this theme when she said,

> True seed sovereignty would be easily accessible, free seeds, and they're all Indigenous - they're all helpful. They're going to work… they're going to last for generations, but they're also being planted year after year. So the seeds have that knowledge; they are resistant to drought, they are resistant to the cold winters, they are made for the land that they're being planted on. (2021)

This said, seeds are the fundamental unit of plant reproduction – and therefore uphold both food and agricultural systems. A relationship with seeds flows through the food chain, ensuring that people connect with their cultural food. As Jessika Greendeer (Ho-Chunk), a seed keeper and gardener added, "I definitely believe that we can't achieve food sovereignty unless we have seed

sovereignty. There are so many different aspects that go and get rolled into food sovereignty itself. [But] we can't grow or eat the cultivated crops our ancestors grew unless we're growing that same seed, or something else that has been adapted by that community" (2021). Her words demonstrate the significance of cultural varieties; they have longstanding ties to the communities. Relationships to these seeds, and therefore seed sovereignty itself, is stronger when those histories are present.

Native gardening and seed systems were historically incredibly diverse, with over dozens of distinct varieties of corn, beans, and squash (Hurt 1987; White 2018b; Will and Hyde 1964; Wilson 1987). For some Native nations, like the Haudenosaunee, the vast geographic distribution of communities across North America contributed to even greater genetic heterogeneity (White 2018b). To complement these thriving seed systems, many tribal nations participated in inter-tribal trading, increasing the spread of Native genetic material (Veteto and Welch 2013). As early accounts of contact have demonstrated, social relationships were the means by which people engaged in trade (Witgen 2012). At these social relationships were often ones of kinship, then these systems would also have facilitated the exchange of seeds between communities (Nazarea 2005; White 2018b). As many communities often intermarried as well, seeds would have travelled amongst communities quite freely (Witgen 2012).

Over generations, Indigenous seeds became incredibly well-adapted to their homelands and local environments. As traditional gardening systems also relied upon intercropping, Native crops were suited to their growing systems (Wilson 1987; White 2018b; Will and Hyde 1964). Due to these stewardship patterns, gardening systems increased tribal resiliency in times of unfavorable growing conditions, as intercropping are typically able to withstand environmental affects better than monocultures (Hart 2008). The diversity of seed and cropping systems also

contributed to healthy diets rich in plant and harvested foods. In terms of the Three Sisters, the nutritional complementarity of the intercropping is well defined. Corn is calorie-rich, but relatively low in protein and amino acids. Beans on the other hand, provide protein and are rich in the amino acids that corn is deficient in. Squash provides calories, vitamins, and minerals, while the seeds, when eaten, provide protein and healthy oils (Hart 2008; Mt. Pleasant 2016). Therefore, the diversity of crops cared for by Native nations directly upheld food security and community health. (Hoover 2017; Mihesuah and Hoover 2019; White, 2019).

Aside from food resources, Native plants were also significant for various cultural rituals and ceremonies, and populations of these sacred plants would have been tended for specific uses. While the gifting and trading of seed was quite common, some varieties were deemed so sacred by communities that they were not traded with outsiders (Hill 2017a). The protection of these sacred entities was paramount to the conservation of guarded ceremonial and religious rites. These instances, however, emphasize how crucial seeds are to the communities of their origin. They have essential historical, cultural, and spiritual significances and influences.

The significances outlined above are true for Native nations today. Seeds, as critical members of food and agricultural systems, are deeply embedded in the cultural fabric of communities. As Kyle Wisneski (Oneida), the farm manager of Tsyunhehkwa offered,

> To me, seed sovereignty is the way we follow our ceremonies to go through life. And to feed ourselves, we have a roadmap that we follow, and in there is saving seed. That all to me, falls under sovereignty - the ability and the right to save a seed that has been with us since time immemorial, that we have connection to, through the Creator's land and through Sky Woman. (2021)

Not only did Wisneski link seeds to ceremony, but he also spoke to the power of seeds in their connection to religion and spirituality in Native communities. About Sky Woman and the origin story of the Oneida people, he clarified, “There's no start without her. It all started with her falling through a hole in the Creator’s land. And when she fell through the hole, she was grabbing seed.” Many Native nation’s origin stories include seeds as an important part of their cultural history and heritage. Apical ancestors, like Sky Woman, have come with seeds to this world. Other cultures believe their people descended from seeds (Will and Hyde 1964; Erdoes and Ortiz 1984). In this conversation on cultural traditions and teachings, Kyle was adamant about honoring these relationships. These relationships are, as can now be understood, the very idea of Indigenous sovereignty.

Conclusion

European notions of sovereignty, when placed on Native nations, ultimately create situations where Indigenous sovereignty is misunderstood and misrepresented. Indigenous sovereignty has largely been misunderstood because European notions place too much emphasis on control over land as property. Indigenous ideas are in exact conflict with this mentality because the land is not viewed as something to exert authority over, but rather to be in cooperation with. In many Indigenous cultures, sovereignty is enacted through relationships with the land and all its inhabitants. Kinship and social relationships are the foundation of all these interactions, facilitating even how food may be produced on the landscape. Food sovereignty can then be imagined as not only embedded in relationships with the land, but dependent on these kin relationships. Seeds, as members of the community, also contribute to food production, necessitating those relationships be respectful and reciprocal. In this sense, all forms of sovereignty should be viewed as grounded in relationships; be it land, food, or seed sovereignty.

The relationships that Indigenous people have with those actors determines the health and success of living upon the land.

Therefore, threats against Indigenous relationships with seeds, food, and agricultural systems are devastating to Native nations. When these interactions are disrupted, sovereignty – as the acting out of these relationships – is made vulnerable. This is the case for Indigenous seed systems today, which have witnessed the loss and displacement of culturally significant seeds. The loss of these relationships is felt deeply. Today, only a small portion of historically and culturally significant seeds remain in the hands of Native people (White 2018b; White 2019). The colonial histories lending to this reality have been compounding in their impacts; as food production practices were displaced, so too were those related to seed saving. Consequently, some communities lost access to their traditional seed and have been unable to perpetuate their cultural food systems. Details of the colonial policies that have contributed to agricultural decline in Indigenous communities will be explored in the following chapter. These contexts will lend to a clear understanding of the state of Indigenous seed systems today. Ultimately, issues of seed security, as access to culturally appropriate seeds, and seed sovereignty, as the use of those seeds under the farmer's control, are of serious concern to many communities.

CHAPTER 3. WE DON'T KNOW WHAT WE'RE MISSING: ISSUES OF SEED ACCESS TODAY

As the previous chapter has demonstrated, sovereignty is embedded in the ways that Native people act out their cultural relationships with their land, seeds, and food. When these relationships are threatened, sovereignty is directly jeopardized. This chapter builds upon the conversations of the interconnected, nested nature of sovereignty to demonstrate how and in what ways seed sovereignty is experienced by Indigenous communities today. Cultural reclamation efforts have been particularly impeded by the reverberating impacts of settler colonialism, which intentionally destabilized many aspects of Indigenous lifeways. The knowledge systems that uphold Indigenous lifeways have been purposefully dismantled by the combined forces of removal, relocation, and forced assimilation (Carlson 1992; Cave 2003; Talahongva 2018).

This chapter discusses the histories of settler colonialism to construct a narrative in which Indigenous sovereignties were intentionally targeted. Government policies during this time attacked crucial lifeways, most predominantly through food production and procurement. Removal and relocation onto reservations were the first actions to destabilize Native nations. This loss of land sovereignty, as the relationships that people shared with their ancestral homelands, had devastating consequences for food sovereignty. Due to the nested nature of Indigenous sovereignty, when land relationships were disrupted, so too were nations' abilities to perpetuate their traditional food systems. Native communities could no longer grow and forage in their new environment using known techniques. When communities witnessed the further upheaval of their traditional food systems through acculturation, their seed systems were displaced. As sovereignties were stripped away, so too were the deep cultural and spiritual relationships that communities had with their seeds. This period had nearly catastrophic impacts

on Indigenous seed systems, resulting in the extinction, loss, and displacement of many culturally significant varieties. The impacts of this loss are still felt today, with many communities struggling to locate and access their ancestral seeds. These situations ultimately impede the ability of Native nations to regain seed sovereignty for the future.

Historical Overview

Removal and Relocation onto Reservations

Removal was one way by which the United States Government intended to strip Indigenous people of their sovereignty – by stripping them of their kin relationships. While Native nations may not have conceived sociopolitical boundaries around their homelands, they were intimately connected to those landscapes by the network of relationships crucial to subsistence. To acquire food or produce it within the environment, a person must have a deep and personal knowledge of their surroundings. When such relationships are sustained over a long period of time, communities establish intimate bonds of kinship with the land. Despite the longstanding histories of Native communities on their homelands, and their deep social, cultural, economic, and spiritual ties to the land, nations were largely unable to retain rights to their traditional territories during this time (Cave 2003). Most notably, the Indian Removal Act of 1830 moved Native nations from their homelands and relocated them onto reservations west of the Mississippi. Some historians have viewed this policy as an attempt at cultural preservation, with removal being the only way to protect Indigenous people from land encroachment by those who might violently oust or exterminate entire communities (Black 2015). Ironically, some communities who resisted relocation were ultimately the targets of genocide regardless, such as through forced death marches like the Trail of Tears (Cave 2003).

Once communities were established on large swaths of land, it was then thought that through social evolution, they would become "a civilized group of yeoman farmers" (Black 2015, pg. 5). In reality, the removal and relocation of Native nations onto designated reservations had a counterproductive outcome. As nations were forced to leave their homelands, they experienced the severance of kinship ties with these landscapes. Some Nations approached removal as the only safe option for preserving these kin networks (Hill 2017b). Entire communities relocated West together, preserving what kinship relationships they could while being forced to abandon the relationships they had with the land. In being forced to do so, however, communities were stripped of their emotional, social, and spiritual relationships with the land - the foundations of cultural food systems. Designated reservations were also often marginal and not suitable for agriculture, impacting the ability of Native nations to participate in and perpetuate their culturally significant food systems (Cave 2003; Hill 2017a).

In the same ways that food systems were impacted, so too were traditional seed systems. For Native nations removed over long distances, ancestral crops may not have thrived outside of the environments that they had been specifically bred and adapted to. These connections to land are rooted in one name for these varieties: landraces. Casañas et al. have proposed a new definition for the term, as previous discourse on landraces have been critiqued for dismissing or minimizing the role of humans in their creation[15]. They instead proposed that landraces be recognized as, "cultivated varieties that have evolved and may continue evolving, using conventional or modern breeding techniques, in traditional or new agricultural environments within a defined ecogeographical area and under the influence of the local human culture"

[15] For example, As Nazarea, Rhodes, and Andres-Swann defined landraces as "traditional varieties of plants or animals that have developed without excessive modification, adapting more naturally to the local environment (2014). This definition, however, does not account for the careful stewardship of communities over these varieties.

(2017). In this sense, the environment in which a landrace is grown is just as significant as the culture. Traditional varieties are also notably lauded to, "contain large internal variation enabling them to adapt to various challenges and changes in the environment" (Gura 2016; pg. 127). Despite this, it is likely that some Indigenous plants may not have survived well in new climates and growing conditions, making the continuation of that variety challenging. In other situations, the forced removal of communities may have resulted in the loss of varieties before they could even reach their new territories (Webster 2021b). As a result, food sovereignty and food security became prominent issues for relocated nations.

In the following decades, as the growing nation of the United States pushed West, settlers again came into conflict with Native people over land and resources (Black 2015). The Homestead Act of 1862 allowed white settlers to purchase land in the West, land that had in theory, been intended for Native people. This act redistributed valued Native homelands, effectively barring many Native people from occupying this land in the future. The territories of Native nations were constantly redrawn in this time, shrinking, and shrinking until nations were located on much smaller reservations than originally promised (Black 2015; Hurt 1987; Porterfield 2004). Then the Dawes General Allotment Act of 1887 brought white settlers directly onto the reservations, as they purchased "surplus" land to live and farm on. Native people were also assigned to tracts of land during this time, where it was hoped that they would imitate their new neighbors, and finally become the yeoman farmers that the government hoped for (Black 2015; Hill 2017a; Hurt 1987).

Assimilation

Not only was the ability to physically produce food on the land disrupted by colonization, the knowledge of how to continue these practices was also targeted. Shortly after this period of

rapid geographic displacement, further policies implemented as a result of the Dawes Act broke up tribal reservations into parcels to each tribal member, under the condition that Native people assimilate to Western culture. This Act undermined tribal traditions of land being communally held (Carlson 1981). While Native nations may have occupied their own territories, they were granted usufruct rights by the relationship they formed with the land. Buffalo Bird Woman spoke to this when she explained, "It was our Indian rule to keep our fields very sacred. We did not like to quarrel about our garden lands. One's title to a field once set up, no one ever thought of disputing it; for if one were selfish and quarrelsome, and tried to seize land belonging to another, we thought some evil would come upon him" (Wilson 1987 pg. 10). Land could not be owned, but families may "own" the right to use it. Land is, as Anette Weiner would say, an inalienable possession; it is so intimately connected with the identity of Indigenous people that it cannot be disentangled from the collective. "The loss of such an inalienable possession diminishes the self and by extension, the group to which the person belongs" (Weiner 1992, pg. 6). Land being held communally was therefore an important part of the way communities were structured, allocating power and access to land more evenly over the entire nation (Carlson 1981).

Additionally, one of the key stipulations of the Dawes Act was that allotted land must be used to produce commodity crops[16] – a marked decision that rendered Indigenous gardening practices, and self-sufficiency at large, no longer an option for Native families. Indigenous seeds, and knowledge on the production of these crops, were therefore displaced by the influenced adoption of alternative foodstuff (Carlson 1981). Not only was the bundle of seeds needed for growing shifted to include foreign crops, but the forced adaptation of gender roles was a critical blow to the perpetuation of traditional agricultural systems. As many sources note, women were

[16] Such as wheat, barely, turnips, onions, parsnips, carrots and potatoes – although it should be noted that some Native nations had their own cultural varieties of potatoes (Cave 2003; Hill 2017b)

valued in most Native agricultural communities as gardeners, seed keepers, and keepers of knowledge (Hurt 1987; White 2019; Will and Hyde 1964; Wilson 1987). Policies during this time actively targeted men as the recipients of agricultural training and assistance (Child 1999). In order to indoctrinate Native communities into Western-style farming practices, white, male farmers were invited to reservations to teach men to grow food in new, albeit culturally foreign, ways (Carlson 1981). Women were purposefully dispossessed of their roles in food production, which had significant detriments to their economic power and autonomy, given their previous authority in trade networks (Hurt 1987). Indigenous economies, which had previously relied on self-sufficiency and inter-tribal trading, were reshaped into Western forms of agricultural commodity production (Carlson 1981). Similarly, the commodification of land required Native people to adopt Western notions of ownership and economics, further destabilizing tribal economic sovereignty. This introduction of capitalism to Native people was a further act of domination and cultural erasure and has had reverberating impacts on Tribal economies today.

Assimilation was therefore multipronged; not only were farming systems and economies shifted, so too were gender roles and dynamics. As men moved into the prescribed gender role of producer, women became relegated to the home and the role of domesticity (Child 1999). As keepers of traditional knowledge, women's displacement from gardening systems abruptly disrupted the transfer of cultural practices between generations. This shift in gender roles demonstrates how assimilation and the restriction of Indigenous agricultural systems had as much of an impact on food systems as relocation.

Boarding Schools

During the same era that Native men and women were experiencing culture shift, children were removed to boarding schools for further assimilation into Western society. A compulsory

attendance law was passed in 1891 to ensure that the youngest generation of Native Americans become molded to the expectations of Western culture (Child 1999). Trade skills were often emphasized over academic curricula, signaling the class expectations for Indigenous people, even after "successful" assimilation. For the most part, the schools functioned to indoctrinate boys into Western agricultural pursuits and girls into that of domesticity, training them to be housemaids, nannies, and nurses (Child 1999). The schooling directed at children reflected and supported the shift in gender narratives that were established by the Dawes and Homestead Acts discussed above. The nature of this system, and the ways in which Native families were forced to navigate it, are complex. For many communities, children were literally stolen away by the police from families that refused to cooperate voluntarily. For others, attendance was coerced when rations and resources were withheld from families that refused to surrender their children. Yet, as poverty conditions worsened on reservations, many Native communities began to turn to boarding schools as opportunities for refuge. Other parents and guardians sought boarding schools for their children with the hope that vocational training would offer greater opportunities in the future. They sought opportunities off the reservation because of the economic limitations there.

While the measures by which Native children entered these schools vary, the insidious nature of the boarding school system acted to deprive children of their traditional languages, style of dress, and any familiar sense of identity. Dr. Rebecca Webster (Oneida), a seed keeper and farmer spoke to me about this. She explained,

> I think one of the really disturbing parts about the boarding school, aside from clearly having children taken away from their families and punished for speaking their language, forced to wear different clothes, and eat different foods, is the pride the church had in

> teaching us how to farm. And it was just really strange and disturbing to see how they were ridiculing our practices. (2021)

The schools were harsh institutions of cultural erasure, effectively dismantling generations of cultural knowledge and traditions (Talahongva 2018). That loss is felt deeply today, perhaps most notably with food and agricultural systems (White 2018b; White 2019). Given the gendered restructuring of agricultural systems that happened within these institutions, girls were disposed of their roles in the fields. At the same time, boys who were learning farming practices, were doing so with a new suite of seeds under the pressures of a market economy. Seeds became a commodity and input to be purchased, moving farmers away from a need to save seeds for following seasons. The boarding schools essentially reshaped a culture's way of gardening on every level – both tangible and knowledge-based, displacing traditions central to what were Indigenous ways of life (White 2018b; White 2019).

While it can be noted that some Native people assimilated by choice into Western forms of agriculture and ways of life, the existing colonial paradigm should not be overlooked. In reality, Native communities during this time period experienced unprecedented cultural and social upheaval. Way of life as communities had known it were shifted as their relationships with the land were severed through removal. Once established onto reservations, the introduction of white settlers into their territories further impacted the ability of Native people to conduct their valued lifeways. Under such duress, many Native folks may have seen assimilation, and the various promises of protection, as the only reasonable option for sustaining their families and communities.

Status of Seed Systems Today

The systematic dismantling of Indigenous agricultural systems detailed above has resulted in the loss and displacement of culturally valued seeds from many Indigenous communities. While a significant number of Native varieties have survived to present, many are maintained by private seed companies, research institutions, the USDA's National Plant Germplasm System (NPGS), and non-Native independent collectors (White 2018b). International genebanks and botanic gardens of various capacities also maintain plant genetic resources and their information (Kloppenburg 1988; National Resource Council 1993; Nazarea, Rhodes, and Andrews-Swann 2013). This is because plant collection is embedded in the history of colonialism within the United States. Colonization is notably a process for the procurement of resources. Those who control the land, control associated resources, be they fuel, minerals and ore, water, or even agricultural production (LaDuke and Churchill 1980). When settlers arrived on the shores of North America, they saw the landscape as teeming with resources to be utilized and shared. Central to this was also the colonial notion that the land, and its occupants, needed to be tamed (Witgen 2012). Even though Indigenous people had stewarded the land for millennia, settlers viewed Native communities as not properly managed because resources were not being - as far as they could tell - sufficiently utilized. Due to this, settlers viewed the land as a wilderness to be brought under the plow and exploited for intensive food production (Witgen 2012). To do so, they needed seeds.

Plant Collection

Thomas Jefferson, founding father, and avid plant enthusiast once remarked, "the greatest service which can be rendered any country is to add a useful plant to its culture" (1800). Plant collection and introduction is a global occurrence, having been utilized by countries and

Indigenous peoples since ancient times to acquire plant samples for research and cultivation. This work has led to the extensive dispersion of plant resources globally. Early sentiments about the value of this process for the United States' budding agricultural sector spurred an era of plant collection and introduction in the early 1800s. Explorers ventured across the country and beyond in search of seeds and plant propagules that might be of use (Williams 2005).

Plant collectors consisted of trained professions, such as anthropologists and ethnobotanists, but also untrained settlers (Anderson et al. 2012; Williams 2005). As they travelled West, many came into close contact with Native communities with accomplished agricultural histories and practices (Williams 2005). This led to many opportunities for collection of Indigenous crops. In the records of this period, however, there are varying levels of details and information associated with some of these collection activities. Collectors from differing backgrounds with diverse levels of knowledge and skill used a variety of methods. Some early plant collectors often neglected to note where, geographically and culturally, seeds and propagules originated while others were meticulous (Anderson et al. 2012). They may have also neglected to note the ways in which Native communities depended on their seeds and related to them. These gaps in information, however, reveal the depths of interactions that occurred between early settlers and Indigenous populations. As Michael Witgen, an Anishinabe scholar, remarked, these cross-cultural communications have not been historicized because outsiders struggled to understand the social organization and adaptability of Native nations (2012). People could not write down what they did not comprehend. To be fair, Native relationships with their seeds, being embedded within the social networks of many nations, may not have been fathomable to white settlers.

The constraints of cultural data collection have been described for other early plant collection expeditions (Byrne et al. 2018). Even in California, where anthropologists collecting edible seeds

for the Phoebe Apperson Hearst Museum of Anthropology (PAHMA) in the early 1900s worked with Indigenous consultants during the process, record-keeping was neglected. Collectors often failed to note where, geographically and culturally, seeds and propagules originated. (Anderson et al. 2012). It was noted in the study of PAHMA's collections, however, that sometimes the Indigenous name for certain varieties was included on the museum accession card. However, no Western name was noted, which displaced scholarly research on the seeds for over a decade[17] (Anderson et al. 2012).

Within other plant collection expeditions, the opposite phenomenon was true, with Indigenous names being disregarded due to Western values and uses of biological taxonomy and scientific quantification (Sinclair 2018). Generally, it can be understood that when Indigenous plants were collected by non-Native actors, the cultural names and stories associated with these seeds, which are crucial aspects of identity, were unfortunately neglected in some capacity. Winona LaDuke considers this phenomenon, of collectors disregarding crucial information, in her work, *Recovering the Sacred* (2005). She specifically discusses settler historians' vagueness in describing events, statistics, and collection of data in relation to the murder of Indigenous people in California. This lack of attention was intentional; it was not that people did not know it was happening. They intentionally chose to ignore it so that it could continue. LaDuke cynically summarized, "such is the accounting for the destruction of a people" (2005, pg. 69). The destruction of Indigenous knowledge, practices, and tradition has historically proven to be no different. Today, seeds residing within seed banks may have little or no cultural information attached to them. While the exact histories contributing to these circumstances may never be

[17] One example is from a vial of edible seeds collected in 1904 from the Maidu nation. The original collector noted the Indigenous name, *o'kwám*, but it was not until 2012 that the seeds were identified as slender hairgrass (Anderson et al. 2012).

known due to the limited records from this time, the absence of this information speaks volumes. Whether people did not understand the use of Native plants, or did not care to, this silence is an act of erasure which must not be minimized.

Settlers arguably had the greatest impact on Indigenous varieties and information regarding them. Settler colonialism acted to dispossess Native people of their land. The intentional consequences of this land seizure were the erasure of Indigenous knowledge, relations, and control over the various elements of the landscape (Sinclair 2018). As settlers entered Native territories, they became early adopters of Indigenous crops, given their adaptation to the environments in which white settlers infringed upon (Williams 2005; Witgen 2012). Many seeds were collected and appropriated from these communities through trade, gifting, and more nefarious avenues (White 2019). The renaming process of Indigenous varieties during this time established what Rebekah Sinclair refers to as "settler temporalities," which placed Indigenous names and communities' connection to these plant resources in the past – effectively promising settlers the ability to claim those plants without threat of competition (2018). As settlers adopted more varieties from Indigenous communities, seeds began to trade hands more widely, finding their ways into the Western agricultural systems as fuel for a growing industry (Williams 2005).

Seed Companies

While plant collectors began building the nation's wealth of genetic resources, seed companies were also independently searching for novel varieties to be included in their catalogs. A notable example is Oscar Will, the founder of the Oscar Will Seed Company. He began selling seeds in 1884 and rose to prominence with his offerings of Native corn varieties (nd.gov n.d). As a breeder and seedsman, however, Will often collected seeds from the nearby Mandan, Arikara, and Hidatsa nations and then grew them for a few seasons, making his own improvements and

selections. He would then release these varieties to the public. One of his earliest and most successful cultivars was marketed as Indian Sweet Corn, and then renamed as Nuetta Sweet Corn in 1920[18]. Oscar Will's son described Nuetta to be, "the most prolific and hardiest Sweet Corn in the world, a North Dakota Native product. Our Original seed was obtained from a Mandan Indian and we have selected it for the past nine years…it is the most productive variety we have, and it bears several ears to a stalk" (nd.gov n.d). This narrative presents an example of the collection practices and mentalities for that time. As Christina Gish Hill critiqued, the company, "celebrated the agricultural contributions of the Native farmers in both their descriptions of seeds and their images. At the same time, true to colonial narratives of conquest, the catalogues construct the acquisition of seed corn from Indigenous people as either a gift or a discovery" (2017a, pg.102). Will's descriptions of his varieties often acknowledged their Native origin, therefore recognizing the nation's relationships and rights to that variety[19] and its subsequent use. The narrative of Nuetta Sweet Corn, for example, noted that while the seeds originate from the Mandan nation, the variety is not ascribed to a particular gardener or seed keeper. The inclusion of this person's name, as well as management practices, cultural uses, and population descriptors would have been relevant and significant details, allowing the seeds to be traced more directly to the community. About these situations, Hill also remarked, "[Oscar Will's] narrative emerges from the settler-colonial ideology, a system of dispossession that negates Indigenous autonomy in relation to their landscape and the resources it contains so settlers can claim it for themselves" (2017a, pg.103).

[18] It is unclear if this change in name reflects the true varietal name from the Mandan, given that Nuetta is a Mandan word. It is a possible that Will renamed the variety as a marketing ploy – which while effective, ultimately rewrote the narrative of the variety. Such albeit simple changes essentially obscure the identity of the variety, contributing to the cultural displacement of seeds today.

[19] However, in the same phrase, Oscar Will refers to the seed as a product – a concept wholly foreign to Native relationships with their seeds.

Where Seeds Are Housed Today

The seeds of plant collectors, as well as those of early seed companies have since found their way into the collections of various non-Native institutions. The most notable collections within the U.S. are those maintained by the United States Department of Agriculture's National Plant Germplasm System (USDA, NPGS). The NPGS uses *ex situ* germplasm conservation[20] methods for a large proportion of its holdings; this includes the propagation and protection of materials in designated genetic reserves, such as seed banks and vaults. It also uses *in situ* methods for plants that cannot be readily managed via *ex situ methods*, (i.e., clonally propagated plants and species that are best preserved in designated reserves in partnership with other actors) (USDA, ARS 2020). The purpose of institutions such as the NPGS is to ensure the long-term survival of valuable plant resources, safe from external pressures and threats of land loss, political disruption, and environmental catastrophes (Maxted et al. 2002; National Resource Council 1993; Nazarea, Rhoades, and Andrews-Swann 2013).[21] Seeds from these institutions are also stored within active collections; those that can be accessed by the public for educational or research purposes. These seed banks notably serve plant breeders as they search for genetic material to integrate into the breeding programs, and researchers and educators for use in a wide variety of specific projects. Requests for seeds are rigorously monitored to ensure that they are being used appropriately by customers (USDA, ARS 2020).

[20] Within the realm of biodiversity conservation, two methods of saving plants are commonly used: *in situ* and *ex situ* conservation. The 1992 Convention and Biological Diversity (CBD) proposes that these two techniques be used complementary to one another. Despite this, *ex situ* conservation continues to be the predominant method of safeguarding the world's genetic resources because of its effectiveness and reliability (Nazarea, Rhoades, and Andrews-Swann 2013).

[21] *Ex situ* methods of conservation generally rely on maintaining both dormant and active collections of plant resources. In the USDA NPGS system, for example, all seeds are backed up in the long-term storage facility, the Natl. Lab for Genetic Resources Preservation, in Fort Collins, Colorado (USDA ARS 2020). The NPGS and many other countries' national repositories also backup their collections at the Svalbard global seed bank for even further protection (Crop Trust 2021). These collections are deemed dormant, meaning that they are accessed only when their owner's sources are inviable. This can be contrasted with the active collections of regional repositories, as with the USDA.

Today, the USDA stewards over 600,000 accessions across 16,000 species (Germplasm Resources Information Network 2022). Early research and preparation for the garden research project included the creation of a seed index, comprised of all the Native varieties currently available via the NPGS through the Germplasm Resources Information Network (GRIN), the online database that houses all accession data both active and historic. We identified 372 accessions across the species of corn, bean, melon, squash, and sunflowers, based on identifying names or passport information[22]. Of these, more than half of the accessions identified were corn, which denotes the significance of the crop to both Native culture and history, but as well as to the Importance of its genetic conservation for global food security. It is possible however, that the actual number of Indigenous varieties within the NPGS is seriously underestimated, given limited accession information from early plant collection expeditions.

This lack of information, explained prior, is evident in the present-day accession data of Indigenous varieties housed within the NPGS. To clarify, each listed accession has its own passport data including the accession history (i.e., how, when, the seeds entered the repository, and their donor, whether an individual or an entity), as well as additional phenotypic and agronomic information. Each accession also has a section for a seed narrative; its ethnohistory. This is the portion of the accession data that would include connections to specific Indigenous people or communities. A pertinent example, is found attached to a historic (meaning no longer active) accession in the USDA named "Mandan Corn." While arguably a vague name, the accession has a wonderful narrative attached to it, as follows:

> Alfred Bowers received seed from the opening of Moves Slowly's bundle[23]. He was the last of the traditional corn priests, he died about 1907. His daughter, Scattered Corn,

[22] See Appendix C for information on the advanced search criteria used to identify Indigenous accessions
[23] It should be noted that the while opening of bundles was a very common practice for museums in the past, to do

> inherited the bundle who passed it on to her daughter, Otter Sage. Bowers conducted his fieldwork on the Ft. Berthold Reservation in the 1930's. (Germplasm Resources Information Network n.d.a)

In a perfect situation, every seed within the NPGS and other genebanks would have a known, descriptive history. Such information not only meaningfully ties seeds to an Indigenous community, but to a lineage as well. These connections are incredible for uncovering more information about the variety and its place within food systems, given the various cultural, ceremonial, and spiritual values of certain varieties. This, however, is not the case, as evident by the NPGS intake records that include the accession number and tribal affiliation[24]. These realities currently hinder rejuvenation movements, as growers struggle to reconnect with and welcome home ancestral varieties.

Names of accessions can provide some context for potential cultural affiliation and Indigenous ancestry. Many of the seeds in the Three Sisters Project's index were identified by accession name alone. As many scholars of landrace and heirloom varieties point out, these names often reflect phenotypic, geographic, or culinary characteristics (Nazarea 2005). Virginia Nazarea, an ethnobotanist, focuses largely on heirloom crops and their cultures. As a component of her research, she dissected the significance of naming systems, even in the diversity of ways that people refer to such crops as traditional, folk, vintage, and "old-timey" varieties. About this diversity of nomenclature, she wrote,

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so is incredibly offensive and damaging. Today, this practice is strictly prohibited under non-ceremonial conditions in Native communities. Museums must follow Indigenous protocol as well, thus ensuring that these oversights do not happen in the future.

[24] See Appendix D for examples of plant introductions intake forms. Note that the last entry, PI 472021 is the original inventory data for Turtle Mountain White corn.

> The very fact that these adjectives are used for traditional species… is an indication of the familiarity, affection, and dignity associated with what has been passed down from generation to generation. Signifying not only age but, more importantly, lineage and legacy, heirloom plants are highly prized… (2005, pg. 80)

Therefore, the names of the varieties, can in some capacity, lend to their narrative as richly as other segments of accession data. Names are shaped by time and use, reflecting the shared histories of those varieties from the contexts in which they were adapted and utilized. Oscar Will's seed catalogue similarly reflected these names, especially for the Indigenous varieties he sold. Some names have survived over 100 years and are apparent in GRIN. However, for countless other varieties, held by non-Native actors, the names of seeds and their connections to communities have been lost.

Barriers to Access

Lack of information, in the forms of varietal names, seed history, and accession narrative are therefore significant hinderances to the identification and reclamation of ancestral varieties. As Jessika Greendeer (Ho-Chunk), a seed keeper and gardener, explained about her own community's struggles,

> Our seeds have gone through a renaming. They've been living under names, and our culture hasn't always stayed with that story. And that's what makes it so difficult is that I can't look and see a Winnebago seed or a Ho-chunk seed in some places, because the name is no longer attached to them. (2021)

When the term "Winnebago" is searched for within the USDA NPGS, only a handful of accessions are returned. Three of these have names with direct affiliation to the nation: Winnebago Spotted, Winnebago Flint, and Winnebago Mixed. These accessions' passport data

includes a vague note stating, “American Indian corn and other miscellaneous varieties collected in the states indicated.” As Greendeer mentioned, neither the communities nor the USDA were able to maintain their stories, even while the names may have persisted. From an outside perspective, like that of an Indigenous gardener attempting to locate seeds though seed databases, the information or lack thereof presents challenges. While the tribal affiliation remains, the histories of the seeds are largely missing, a crucial piece of information that would allow a community to reconnect with those varieties more easily.

A lack of information surrounding Indigenous seeds is not only an issue among seed-holding institutions. Even when seeds leave repositories and make their ways back into the hands of growers, their identities are still obscured. This poses real barriers to growers reclaiming varieties, since the relationships and histories attached to seeds are in essence one of the most important deciding factors when Indigenous gardeners’ take up new varieties. Webster, an avid bean keeper and gardener, often receives seeds through various trading activities with other Native seed keepers and gardeners. In a conversation with Webster about some of these bean and squash seeds, she replied, “I didn't know their name because they didn't come with the name, they didn't come with enough information” (2021a). She is handed a vial of seeds devoid of any identifying information and grows them out in the hopes that she or a member of her community may recognize them. When those within her immediate circles cannot offer assistance, Webster resorts to sending descriptions or photos throughout her diverse network of Indigenous seed keepers in the hopes that they may be able to provide needed details. She shared a story about how she nearly removed a bean variety from her collection after mistakenly thinking it was not Haudenosaunee. When an elder seed keeper recognized the variety through a photograph, they

were able to rekindle their relationship with the variety and welcome the bean back into its place within the community.

Without detailed information, even experienced seed keepers struggle to attach cultural identities and relationships to certain seeds. These realties have furthermore had an impact on how Indigenous communities view their cultural identities, both in the past and in the present. When identities, particularly those of agricultural and subsistence systems have been damaged, communities may feel that their lifeways are precarious. Suzi French (Omaha), a Community Food Specialist with the Center for Rural Affairs at the time in Macy, NE remarked about her own nation's struggles with identity,

> It's documented, like the books tell us we were great farmers, we were great garden producers, we were great things- our seeds [were] very important to us. Right now, we have none to claim. So I have no sovereignty to claim for myself, for my tribe, my people. We claim a lot of other people's seeds, but I have none that [are] ours. (2021)

Yet, today, the Omaha Tribe of Nebraska is one of the many communities struggling to revitalize their food and seed systems after generations of cultural upheaval. Greendeer described a similar loss for her own nation as, "a portion of our history [that] isn't intact" (2021). Webster echoed this in her own words as well; "So much has been taken from us" (2021b). Due to the turmoil of removal and relocation, as well as the trauma of forced assimilation and the boarding school era, many nations have lost a sense of what their agricultural systems looked like prior to contact (Carlson 1981; Cave 2003) Deeply impacted by these disruptions are Native seeds. Webster followed up with, "we don't even know what we're missing… there's nobody left that would know to recognize them" (2021).

While this loss may seem bleak, I present it as a means of highlighting how significant reclamation movements are for identity, tradition, and culture. Seed rematriation, as a process of recovering and returning displaced seeds, is therefore an opportunity for cultural rejuvenation and healing. Webster spoke to the importance of these actors when she considered her own nation's agricultural history. The Oneida Tribe of Wisconsin had a period of agricultural revival that precedes many of the efforts enacted by Indigenous communities today. Yet, for a time, they too had lost ties with many of their seeds and were able to regain seeds from non-Native institutions. Webster now considers *ex situ* of conservation with a more positive light, and explained their value in her own perspective as,

> We can't predict what the future is going to have. So if there's somebody else that's going to be safe keeping [our seeds], then that's great. And if they keep them, and we keep them even better, because I think the more places that you have caring for our relatives, then that's better. (2021b)

This pragmatism is useful for demonstrating how seed banks have a valuable role in the conservation of plant biodiversity. At the same time, however, Webster asserted that this form of stewardship is most effective when seeds are preserved more widely, in an array of environments and contexts. She also spoke to partnership and collaboration, with both Native nations and seed-holding institutions being viewed as equal actors in the preservation of cultural varieties.

If varieties are identified by their home communities from within the holdings of non-Native institutions, the act of acquiring ancestral seeds in large quantities, or even at all, may be difficult for nations. Indigenous growers may have concerns about the separation, both spatially, temporally, and genetically of certain seeds from their original contexts. Even seed companies and catalogs that may provide Indigenous seeds for sale are not without their own limitations to

access. Despite being what can be agreed upon as readily available, one understanding from a Native perspective is that there are cultural taboos around the commodification of seeds – which is perceived as an insult to the relationships and value that Native people associate with their plants – may prevent some growers from seeking to obtain seeds in this way (Pow Less 2021),

Conclusion

Issues of food and seed sovereignty are gaining traction as people begin to understand how these matters are interconnected with broader aspects of sovereignty. Seed sovereignty may be viewed as a crucial, foundational, aspect of Indigenous sovereignty in the way that it upholds community food systems – and therefore food sovereignty, community health and cultural identity. These nested layers reveal that sovereignty is interwoven in almost every facet of Indigenous existence. The compounding impacts of colonial histories on Indigenous seed and food systems have further demonstrated the interconnected nature of these lifeways. When agricultural traditions are displaced, so too are the seeds that uphold those practices. Seeds can therefore be understood as necessary actors within cultural reclamation movements. Their absence is felt most strongly by those working towards the reestablishment of traditional gardening systems. This chapter has demonstrated that the knowledge system that upholds Indigenous systems are incredibly rich, having been developed over many generations and landscapes. Indigenous landraces have been shaped by grower's selection and management practices, resulting in unique plants that are adapted to their environments, growing systems, and human needs. The relationships that Indigenous communities have formed with their seeds over these long histories is that of seed sovereignty.

Indigenous seeds have been displaced from communities over generations due to the compounding impacts of removal, relocation, and assimilation. While some varieties have been

lost to time, others have persisted within the seed banks and repositories of Non-Native institutions. Plant germplasm conservation was created to be a multifaceted, collaborative approach to protecting the world's plant biodiversity. Much has changed in the intervening years since the establishment of this science. Within the realm of biodiversity conservation, two methods of saving plants are commonly used: *in situ* and *ex situ* conservation. The 1992 Convention and Biological Diversity (CBD) proposes that these two techniques be used complementary to one another (1992). *Ex situ*, meaning, off-site or out of context, relies upon the protection of plant materials in designated genetic reserves, such as seed banks and vaults (Maxted, Myer, and Chiwona 2002). The purpose of these institutions is to ensure the long-term survival of valuable plant resources, safe from external pressures and threats of land loss, political disruption, and environmental catastrophes. In contrast, *in situ* conservation promotes the protection of genetic material within natural environments, be they created reserves or the original environment that the plant originated. The Convention on Biological Diversity defines this approach as:

> In situ conservation means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties. (CBD 1992)

In situ conservation, while privileging the role of natural environments in maintaining plant genetic resources has had limited use due to resource constraints. This method has generally been used for wild species, crop relatives, and perennials so that species diversity can be maintained within coadapted communities (National Resource Council 1993). While the CBD recognizes that domesticated crops may also be preserved *in situ*, this method has been debated

as an efficient use of time, labor, and additional inputs – at least for institutions conducting germplasm conservation on a large scale. Genetic reserves in this capacity are also vulnerable to environmental instability, making this method of conservation riskier than *ex situ* management. Perhaps this is why *ex situ* conservation continues to be the predominant method of safeguarding the world's genetic resources (Nazarea, Rhoades, and Andrews-Swann 2013).

While methods of these *ex situ* genebanks ultimately ensure that many of the world's resources will survive in the event of environmental catastrophe, this system of conservation has been criticized for its complete removal of these plants from the systems and cultures that created them (Nazarea, Rhoades, and Andrews-Swann 2013). In contrast, it has been suggested that, "maintaining landraces in traditional farming systems also constitutes a form of *in situ* conservation" (National Resource Council 1993, pg. 118). This acknowledges that not only is the physical environment of a crop's origin significant, but equally the agriculture system that it was developed in. Many of the Indigenous varieties currently housed within genebanks are heirlooms and landraces, meaning that they may have particular agronomic and consumption traits uniquely adapted to the cultures and agricultural systems of their origins (Ocampo-Giraldo et al., 2020). For these crops, then, the establishment of conservation methods within the traditional systems that shaped cultural varieties could have a valuable role in the preservation of these plants if used in tandem with *ex situ* conservation (National Resource Council 1993; Nazarea, Rhoades, and Andrews-Swann 2013). Indigenous *in situ* conservation practices might therefore allow for the maintenance of seeds not only within the soil of communities, but within the cultural fabric and network of kinship that makes seeds so valuable.

Despite how seed-holding institutions have been vital to the conservation of these varieties up until this point, the colonial nature of this system of conservation has at times

contributed to displacement of culturally significant seeds from their affiliated communities. The mishandling of Native seeds through the collection process by misnaming, renaming, and omitting (either intentionally or otherwise) the narratives of these varieties has only exacerbated these issues by hindering reclamation work. Webster, alongside her relative acceptance of actors like the USDA NPGS, also strongly asserted, "I think to continue to do [conservation in this way], it's really important to get [a seed's] history straight" (2021b). Her emphasis on this transparency speaks to the past treatment of Indigenous varieties by non-Native institutions, and how the loss of seed histories and narratives have created painful situations whereby Native nations cannot easily find or reclaim their seed heritages. She went on to say that if a variety is believed to have been altered by time or the hands that have stewarded it, that repositories should be, "very clear that this [seed] has a new story" (2021b). Such histories have made the identification of Indigenous varieties difficult, especially when it concerns their tribal affiliations and cultural ties.

The loss and displacement of ancestral seeds has had reverberating impacts on many facets of Indigenous sovereignty. Today, Native nations are seeking to identify and reclaim cultural varieties, to bring them back into original contexts, to their home communities for Indigenous conservation *in situ.* The return of these seeds has the potential to restore and revitalize traditional seed systems, lending to the long-term perpetuation of these varieties by those who value them.

CHAPTER 4. THE SEEDS ARE COMING HOME: SIGNIFICANCES OF SEED REMATRIATION

When Cora Baker, a Potawatomie elder and seed keeper, donated her collection of Indigenous seeds to Dream of Wild Health in 2000, she likely had no idea of the legacy she would leave behind. Baker, who passed away shortly after entrusting her seeds to the organization, was a skilled seed keeper, so renowned in her abilities that people within her community and elsewhere entrusted her with their seeds (Dream of Wild Health n.d.b). Thus, she acquired a wealth of biodiversity, and even traded seeds with ethnobotanist and seed collector, Gary Nabhan, when he travelled through Fort Berthold Reservation (Nabhan 2002). After Baker donated her collection to Dream of Wild Health (DoWH), the organization experienced an outpouring of interest, with some people mailing their cherished seeds or delivering them folded in handkerchiefs (Dream of Wild Health n.d.b). Jessika Greendeer (Ho-Chunk), seed keeper and farm manager at DoWH, recounted of this time, "other Native communities sent some of their seeds to the organization as well, for not only safe keeping, but also to give the youth an opportunity to work with those seeds" (2021). As an organization with the goal of providing youth education through gardening, this influx of seeds presented opportunities for cultural teachings and reconnecting the next generation with Native plants (Dream of Wild Health n.d.a). From this wealth of opportunity also sprang rematriation. Greendeer shared,

> There was one squash that we had grown, two seasons ago, and I had asked someone from that home community if there were any special ways to plant that particular seed, or how to care for it during its growing season. And the seed keeper I talked to said they had never grown that particular squash [before]. So that seed was then able to go back to the community again through different hands, over just a short amount of time – essentially about 20 years. (2021)

This story offers a glimpse of not only what rematriation is, but why this process matters. Currently, many Indigenous communities struggle with regaining seed sovereignty, necessitating the reclamation of ancestral seeds (Greendeer 2021; Hill 2017a; Hill 2021; Shiva 2016; Webster 2021a; White 2018b). The seed rematriation movement is a growing response to the state of Indigenous seed systems. Rematriation, as the process of identifying and returning culturally significant seeds, therefore contributes to the (re)establishment of seed sovereignty for Native nations. This is because when seeds are returned to the communities or their origins, they can be conserved in their original environments and agricultural systems that developed them - a valuable measure within *in situ* conservation methodologies.

Virginia Nazarea proposed a more anthropological and cultural reimagining of *in situ* conservation approaches through her concept of *in vivo* conservation. She described this method as, “conservation as a way of life” (2005, pg. x). While subtle, this shift in terminology offers a critique of conservation as simply considering the physical environment in which a plant is grown. Emphasis is instead placed upon the lives of those who have relationships with certain varieties, recognizing the mutual dependency that humans and cultivated crops have on one another for survival. Not only is *in vivo* a type of land ethic that upholds conservation, it upholds sustainability and continued reciprocity between humans and plants. Nazarea’s ethnographic career highlighted the crucial role of seedsavers as the main actors within this conservation ethic, who have been quietly conserving the seeds of valued varieties for generations within their fields. This rephrasing also usefully mirrors decolonization work, with Nazarea urging academia and Western science to,

> wean ourselves from the historically colonial appropriation of plant genetic resources in botanical gardens and gene banks to a more enlightened position of facilitating conservation in situ and in partnerships with small-scale farmers. (2005, pg. x)

A critical component of *in vivo* conservation is therefore increased attention towards the cultural and historic narratives of plant varieties. Nazarea referred to this work as "memory banking." According to her 1998 book on the subject, entitled *Cultural Memory and Biodiversity,* this form of conservation addresses the cultural dimensions of biodiversity, essentially "capturing" human memories in parallel to efforts for the preservation and documentation of germplasm. Such materials could include oral histories, associated technologies, evaluation criteria, growing histories, preferences, and uses of traditional plant varieties (Nazarea 1998). This increased breadth of data would complement the passport data currently available for many plant accessions, like those within the Germplasm Resources Information Network (GRIN). While current passport information may contain limited phenotypic and agronomic data, actors within the germplasm conservation and utilization sphere have cited historic and cultural data as an area for increased priority (Byrne et al. 2018) Nazarea, in her focus on cultural memory, hoped that increased attention to these narratives will highlight the unique, yet significant, role that cultures have on the development and preservation of plant resources while simultaneously identifying and uplifting their continued use (1993). Rematriation is the critical first step to returning seeds to the communities that value them, so they may be preserved through continuous cycles of day-to-day use. In turn, and with seeds in hand, communities can begin to produce their traditional foods more widely. The end result of these reclamation movements is that Native nations and communities may potentially regain food sovereignty for generations to come.

Rematriation as a movement and goal, is new and still evolving. New efforts have arisen in the past few years, however. This outpouring of seed reclamation lends to a constantly progressing understanding of the significances and meanings of rematriation. At the same time, very few researchers have considered these evolving concepts in a scholarly light. Little has been written about the process and results of rematriation. This chapter therefore provides a history of the term rematriation, including its origins and evolving interpretations. With a foundation of this term's appearance in Indigenous scholarship, we better understand how this term relates to seed reclamation and seed sovereignty movements. This chapter also draws from ethnographic research within one seed rematriation network, in order to shed light on cultural understandings and significances of this work across many aspects of Indigenous lifeways. The gaining momentum of the movement will be discussed, considering both who is doing this work as well as the need for increased participation and collaboration.

Origins of Rematriation as a Term

Most scholars and activists credit Rowen White, a Mohawk seed keeper, with spearheading the rematriation movement and generating awareness about returning seeds to Indigenous communities (Ocampo-Giraldo et al. 2020; Huambachano 2019). While this acknowledgement is valid, White herself avidly cites Martin Prechtel as the source and inspiration of the term (2018). Prechtel introduced his coinage of the term in his 2012 book entitled, *The Unlikely Peace at Cuchamaquic.* While the history of the term lends to evolving interpretations, I would like to recognize what I believe is the first use of the term.

In my own review of the literature on the topic, an earlier use of the word rematriation may be credited to Steven Newcomb, in 1995. His interpretation stems from a critique of the colonial nature of the term repatriation, as defined by the Native American Graves Protection

and Repatriation Act (NAGPRA) of 1990. The Act declares that, “Native American remains, funerary objects, sacred objects, and objects of cultural patrimony, referred to collectively in the statute as cultural items” must be returned to the patrilineal descendants or tribal nation to which the remains and objects are related (McManamon 2000). In an analysis of these specifications, Newcomb recalls the textbook definition of repatriation as the return of prisoners of war to their home countries. The return of Native American remains (and, by the extension of NAGPRA’s jurisdiction, cultural objects) to their “home country” therefore earns some tension given the colonization of Native North America. The theft of Indigenous homelands has, in reality, deprived Native people of their home country. Newcomb questions how and where then, should Native people and objects be appropriately and sensitively returned. As a response, he presents the adoption of *rematriation* as a more apt term. He claims,

> By "rematriation" I mean "to restore a living culture to its rightful place on Mother Earth," or "to restore a people to a spiritual way of life, in sacred relationship with their ancestral lands, without external interference." As a concept, rematriation acknowledges that our ancestors lived in spiritual relationship with our lands for thousands of years, and that we have a sacred duty to maintain that relationship for the benefit of our future generations. (Newcomb 1995, pg. 3)

This perspective realigns Native people and their ancestors’ remains with cultural homelands in a way that repatriation is unable to, by shedding light on the intensity of the relationship that Indigenous people have with their land. Newcomb’s reframing additionally demands recognition of Native sovereignty over their land, culture, and way of life, despite the reverberating impacts of colonization. Most significant to this recentering is the focus on Mother Earth as the home to which Native remains and cultural objects should be returned. As Newcomb argues, however,

Native people and their belongings ultimately belong to and with Mother Earth. Culturally, Mother Earth cares for all beings (1995). Therefore, the term repatriation, while a worthy attempt at righting the appropriation of Native remains and cultural objects, offers an imperfect understanding of Native relationships with their deceased relatives, culturally significant objects, and land. In light of this, rematriation offers a healing reframing of previously inappropriate and misguided attempts to rectify the abuse of Native graves and sacred places.

Martin Prechtel seemingly reiterates Newcomb's sentiments in his book, *The Unlikely Peace at Cuchamaquic.* Prechtel defines rematriation as, "an instance where land, air, water, animals, plants, ideas, and ways of doing things and living are purposefully returned to their original natural context – their mother, the great Female Holy Wild" (2012 pg. 439). Like Newcomb, Prechtel acknowledges a feminine spirit of the land as the rightful entity for beings to be returned to. His interpretation is most useful, however, in its extension to elements of nature as well as systems of knowledge and practices.

Rowen White found inspiration in this term. Her first publication on rematriation dates to 2018, as a blog post through the Sierra Seeds website. She reframes the term through her own identity and life's work as an Indigenous seed keeper. Adding to Prechtel's emphasis on the wide applicability of the term, White describes,

> The Indigenous concept of Rematriation refers to reclaiming of ancestral remains, spirituality, culture, knowledge, and resources. It simply means back to Mother Earth, a return to our origins, to life and co-creation, rather than Patriarchal destruction and colonization, a reclamation of germination, of the life-giving force of the Divine Female. (2018b)

It is clear to the see the parallels between her definition and those who shaped this interpretation. White reiterates rematriation as a return to a natural context: life before colonization, particularly for relationships between Indigenous people and the land as Mother Earth. However, given her sphere of work, White narrows in on the use of the term in relation to seed reclamation efforts. She reiterates that a feminized reframing is necessary because the patriarchal notion of repatriation does not appropriately highlight relationships central to Indigenous seed keeping.

White notes that in her own culture, and in Native communities more generally, the stewardship of seeds is a right and responsibility of women (2018). She also clarifies that culturally, seeds are feminine entities themselves: she states, ""rematriation" reflects the restoration of the feminine seeds back into the communities of origin" (2018). In doing so, she adds a cultural context for the reclamation of plants and seeds that, while reflecting Prechtel and Newcomb's distinction of Mother Earth and the great Holy Female Wild, extends this idea of the Divine Female. Through this concept, White recognizes not only the environment, but the community of women who safeguard seeds and the seeds themselves as a collective feminine force. Many historians have noted that agriculture falls within the women's domain in Indigenous communities.

Ray Douglas Hurt, the author of a comprehensive history of Native agriculture, noted that the first people to cultivate plants in the Americas were probably women. In his emphasis on the term "farmer" in these discussions, he purposely refers to the responsibility and role of women in Indigenous communities, as well as the fact that they possessed a greater knowledge and interest in plants than men (1987). This delegation of roles persisted culturally through time and was noted in the early 1900s by George Will and George Hyde. They travelled among the Mandan, Hidatsa, and Crow to study their diverse and well-established agricultural activities. The

researchers were astonished by the seemingly singular involvement of women in agriculture, particularly surrounding corn production, ceremony, and trade (1964). It should be noted that this is not always the case, because in some communities – like the Hopi – it is men who are tasked with the responsibilities of seeds, even when women are the farmers (Nabhan 2002). In other communities, responsibilities for certain seeds or seed tasks also fall to men (Will and Hyde 1964; Wilson 1987). In practice, however, the seed rematriation movement in the Midwest is notably a feminine force. I experienced this for myself as I engaged with the network of growers, gardeners and seed keepers pioneering this work; the vast majority of whom were female. The sentiments of Newcomb, Prechtel, and White were felt throughout this network, put into action by the those pioneering this work in their own communities.

The Rematriation Movement

While Newcomb and Prechtel's definitions of rematriation may be less recognized in broader discussions of this movement, their sentiments are undoubtedly present in the popularized meaning of the term by Indigenous seed actors like White. My ethnographic interviews, which often centered around rematriation work in collaborating Indigenous communities, reveal these common threads of understanding. As Dr. Rebecca Webster (Oneida) a seed keeper, gardener, and participant in Seed Savers Exchange's rematriation project, succinctly described, rematriation means, "that the seeds are coming home" (2021). When asked about the importance of the gendered aspect of rematriation, Elena Hill (Oneida) a food sovereignty apprentice with the Wisconsin Tribal Conservation Advisory Council (WTCAC), replied, "I always assumed that we use rematriation instead of repatriation because Indigenous communities are usually matriarchies, and usually females are the ones who are head of the agricultural activities" (2021). Her comments ring true.

This gendered dynamic persists today, visible within the networks of seed keepers and seed activists. Even in other Indigenous and peasant cultures, women are predominantly those that work with seeds. Vandana Shiva, in her book *Seed Sovereignty, Food Security: Women in the Vanguard,* spoke to this. She uplifted the centuries of knowledge and dedication that have created our world's biodiversity, noting agrarian women's multifaceted identities as activists, scientists, seed keepers, food producers, and mothers (2016). In my own conversations with USDA scientists, I have many times explained the gendered nature of Native agriculture and seed stewardship. I remember the moment well when a white, male plant geneticist remarked in wonder about the truth of the feminized rematriation. He thought aloud, about even in his own profession within the ARS, and through his collaboration with the NPGS, how women were often at the forefront of plant conservation work. I can attest to this, having collaborated with many actors in both Native and non-Native seed circles. In cultures across the world, women are equated with the creation and nurturing of life. Therefore, it is culturally consistent that the careful stewardship of plants and their seeds falls under the domain of women. In fact, that men are associated with farming in European cultures seems to be the exception.

The cultural significance of women in seed systems is similarly extended to that of seeds. Webster similarly attested to the suitability of the term rematriation when she asserted, "we think our seeds are women and they're female, they carry life. They're going to be bringing life into this world" (2021). In White's writing on rematriation, she singularly refers to seeds as female, and recognizes the unique role that human women have in sustaining the relationships crucial to seedkeeping (2018). They have the task of safeguarding cultural varieties and handing them down through the generations, contributing directly to the preservation and conservation of Indigenous seed and food ways. These women belong to a "lineage of people cultivating

relationships with their food and to Mother Earth" (White 2018a). Jessika Greendeer (Ho-Chunk), a seed keeper and participant in rematriation efforts included,

> Rematriation does revolve around the feminine energy. There are so many different cultural teachings about the seeds being feminine, or being women. Women have a different way of looking at things than our male counterparts do. And it's about, you know, not only are you being a good mother to your seeds, but it's [that] women have the gift of giving life. And that's exactly what seeds do. That's their whole purpose; they sacrifice themselves for the future, or for their future generations… It's all about the feminine energy surrounding it. (2021)

Lea Zeise (Oneida), a program manager at the United South and Eastern Tribes Inc. also expanded on this with her own culture's understanding,

> We use the word rematriation because corn is a feminine spirit for us. And I think most Indigenous cultures view corn as a feminine being, a life-giving being and, and the people that we are returning her home to usually are the women. The women's roles traditionally are to grow the food and to distribute the food to make sure everybody has enough to eat. And so, I think that using repatriation erases that identity of the corn and then the role of the women in that process. But rematriation, it gives you the idea of a woman or a mother being involved in that. And that's exactly the kind of impression that we want to get… we can choose our words really carefully to reflect exactly what we mean, and the cultural importance of what we mean. (2021)

These comments do much to frame rematriation as a term that purposefully acknowledges the gendered aspect of women as seed keepers, and seeds as feminine entities themselves, in Indigenous agricultural communities. As Newcomb and Prechtel highlight, however,

rematriation also uplifts the connection to Mother Earth as a grounding force in human life. White, in her use of the term rematriation, refers to the feminine spirit of the land as Mother Earth, and recognizes the importance of this relationship within Native agriculture and seed keeping. This reverence is maintained across many aspects of the environment and how humans should appropriately interact with the Earth (Forbes 2001). Rematriation, as a more culturally relevant term, appropriately aligns with the belief systems already intact within Native American cultures.

Kinship

Often, I found that my interviews revealed layers of cultural complexity and significance. As the evolution of the term rematriation explains, Mother Earth is a central figure in Indigenous life. When the land is mother, then all life who are cared for by her, be they humans, animals, or plants, are her descendants. All living beings are kin through her and should relate to each other as such. This understanding is quite prevalent in Native religious traditions, as seen with the phrase "All My Relatives." This saying, which is invoked in the opening and closing prayers of ceremonies, is a reminder of the covenant of respect and responsibility between humans and the natural world (Deloria et al. 1999).

Enrique Salmón, an ethnobotanist, explained the significance of this mentality when he wrote, "Indigenous cultures of North America include human communities in their cultural equations of nature…humans are at an equal standing with the rest of the natural world; they are kindred relations" (2000, pg. 1331). The same ethos is echoed throughout Winona LaDuke's *All our Relations*, which draws from Indigenous teachings on kin relations with the environment to demonstrate how these connections, "bind our cultures together" (1999, pg. 2). As LaDuke explores throughout her work, threats against the environment, and more specifically,

biodiversity, translates directly to a loss of cultural wealth for Indigenous peoples. Reclamation efforts, of both physical relationships and spiritual are acts of resistance and reassertions of cultural identity (LaDuke 1999). In this vein, rematriation offers a meaningful opportunity to reestablish these valued kinship ties with seeds and plant relatives.

This system of respect and reciprocity is also demonstrated in the way the rematriation more aptly brings the kinship relationships central to gardening to the forefront of reclamation movements. Zeise explained this significance as,

> Rematriation is the return of seeds to their people that they have a relationship with. And it's a really powerful act to do that. It's like returning children that have been missing back to their families. Because those seeds have a place within the cultural fabric of ceremony and song and food and culture and everything. (2021)

Her recognition of seeds as children, and their role as valuable keepers of generational knowledge, is reminiscent of conversation surrounding the boarding school era's impact on cultural identity and the perpetuation of valued traditions. As precursors to traditional foods, seeds are valuable actors in the continuation of culture. Like children, seeds are vital links between generations -of both plant and human populations, - gaining and passing on knowledge to ensure that traditions remain alive. The removal of seeds from their communities, much like how children were removed to boarding schools, has had a devastating impact on knowledge systems (Child 1999). Their return allows for healing and for the cycles of cultural education to be reestablished. On a literal note, however, seeds are considered children by those who safeguard them. As Buffalo Bird Woman, a Hidatsa gardener who became the subject of one of the most seminal books on Indigenous agriculture, once expressed,

> We cared for our corn in those days as we would care for a child; for we Indian people loved our gardens, just as a mother loves her children; and we thought that our growing corn liked to hear us sing, just as children like to hear their mother sing to them. (Wilson 1987 pg. 27)

This direct acknowledgement of kinship was a common thread throughout my conversations with seed keepers. Greendeer explained about how she relates to seeds in this way: "I consider them babies, but they're also my ancestors. They have so much wisdom, and they live such a good life" (2021). She echoes the mentality of Buffalo Bird Woman: seeds are children in the ways that they require care to germinate and grow. With careful tending and nurturing, they grow strong and healthy. Yet, Greendeer draws attention to an interesting dichotomy in Indigenous ontology in the way that she simultaneously refers to seeds as children and ancestors.

Seeds are valued as keepers of knowledge and memories. As Webster simplified, "Now the seeds are our memory. They're keeping our identity generation after generation" (2021a). On a genetic level, seeds hold the memories of interactions with people and their environments, expressing them through their phenotypes – their outward appearance. They reflect the needs of the communities by which they have been shaped. In this sense, seeds hold the knowledge and legacy of the human ancestors who have long interacted with these cultural varieties. Through these relationships, seeds reflect ancestors and are ancestors to those who steward them. Seeds are also ancestors themselves due to the wisdom and knowledge they contain, as well as their ability to pass on that information from one generation to the next. This wisdom contains many aspects; from nutritional information to the ability to adapt to environments, to even their participation in cultural ceremonies. Their depth of wisdom and generosity elevates seeds to the position of cherished ancestor (White 2018b; Hill 2017a).

This worldview is also explained by the cosmologies of many Native cultures who view humans as the least conscience members of the universe, because humans came into being much later than other members of the environment such as rocks, animals, and plant life (Tinker 2004). This belief system becomes incredibly important to Native agriculture, where this relationship created between seeds and humans, one of nurturing, guidance, and protection, is akin to that between ancestors and their descendants. Human beings, as the youngest creatures, look to these non-human kin for guidance in how to live and fulfill their responsibilities to one another and to Mother Earth (Deloria 1999).

Greendeer spoke to this kinship when she said,

> For Native people, and even some non-Native people, we don't look at the seeds as an object or a thing. They're a living being, they give life and they get adopted into communities, and they become relatives of those particular people that carry them and care for them. (2021)

Webster also reiterated this point when she offered,

> I think it is that re-establishing that relationship with [seeds] - because we consider seeds our relatives so we want to bring them home so that we can care for them and they can care for us. So, we can nurture that reciprocal relationship that we had in the past because so often we have lost contact with those relatives. (2021a)

Seeds, when taken care of, give continually as food, but sometimes share more important gifts such as cultural knowledge and wisdom. As Jack Forbes, a scholar of Native American studies, explained broadly, many Nations' creation stories dictate that humans should be respectful to the natural world, and to look to it for guidance (2001). Through these relationships and respect and reciprocity, plants teach humans to be generous. The exponential return of seeds is reminiscent

of the full circle of generosity inherent to agriculture systems. Reciprocity in these relationships bring forth tangible results. If someone saves seeds and replants, and through this process established a kinship relationship with the seed and cares for it as it grows, the plant will reciprocally produce bountiful amounts to continue the relationship. Seed keepers in Native communities steward their culturally significant seeds and honor the kinship ties that humans have had with plants for generations.

However, since the advent of settler colonialism, Native nations have witnessed a decline in the diversity of their Indigenous crops. Through theft and appropriation, communities have been separated from their seed relatives and ancestors. Seed rematriation therefore represents a valuable opportunity for Native people to be reunited with their kin. Hill aptly summarized these understandings of rematriation's significance when she remarked, "I think rematriation efforts are important, not only from a cultural standpoint because they are part of someone's traditions, [but also] they are part of someone's stories. Those are the elders and the ancestors of that community" (2021).

Seeds are revered as relatives for how they are the "cultural legacy and sacred entities" of Native nations (Hill 2017a). As living remnants of the past generations of Native growers and seed keepers, seeds contain a cultural memory that cannot be found elsewhere. This knowledge is encoded in their genetics, outwardly reflecting the past relationships that these plants had with their human growers. They are direct links between people today and a community's long lineage of seed keepers (White 2015). In this way, the wisdom and knowledge of seeds that is shared when they are grown is akin to that of a beloved ancestor. Within the Native seed movement there prevails the saying, "If you take care of the seeds, the seeds take care of you" (Caduto and Bruchac 1996; White 2015, Zeise 2021). The reverence and dedication of seed

keepers to their crops displays a deep, intimate relationship. This love and care that they display towards the land and their plants can only be described as kinship. Jeff Corntassel (Cherokee) would describe this work as a resistance to colonial authority because in relation to seed reclamation work, This work, "these everyday acts of resurgence have promoted the regeneration of sustainable food systems in community and are transmitting these teachings and values to future generations" (Corntassel 2008, pg. 98) Through understandings of sovereignty as being defined by kin relationships that must be perpetuated for food systems to be successful, it becomes clear that seed sovereignty is not possible without the restoration of these relationships. Seed rematriation, as the movement and goal of doing so, is therefore a powerful means by which Native nations can reclaim seed sovereignty.

Significances

Cultural Reclamation

Seed rematriation is most notably a movement of reclamation: of Indigenous seeds and their associated systems of knowledge and practices. It should be noted that rematriation is just one aspect of a broader movement within Native North America for the reclamation of traditional knowledge and practices. I argue, however – and I believe that many of my collaborators agree, that rematriation is a critical first step if other rejuvenation efforts surrounding food and gardening systems are to be successful. Many of my ethnographic interviews spoke to this importance of these movements for current and future generations. My collaborators ranged in age from young adults to elders, who were all able to offer their own age group's perspectives and hopes for community efforts. In light of the histories and reverberating impacts of colonization, many of the younger generations of Native people feel separated from their cultural heritages. As Elena Hill (Oneida) a food sovereignty apprentice with the Wisconsin

Tribal Conservation Advisory Council, described about the generational disparity of cultural knowledge,

> Me and my cousins are all scrambling to get back this culture that now we have to find for ourselves as young adults. And that's [the same for] a lot of the community too, and a lot of tribal communities in general are trying to bring a lot of these teachings and our old ways from taboos back to something that's relevant and significant. (2021)

As discussed in prior chapters, traditions regarding food, gardening, and seed saving are among those that have been most impacted by forced assimilation policies. The results of the boarding school era are proof enough for how the generational exchange of knowledge directly upholds systems of knowing and doing (Child 1999). As Hill described, many Indigenous traditions were labelled by the dominant settler culture as taboo, especially regarding the religious and spiritual significance of gardening systems. Settlers, when they first encountered Native growing practices, were also abhorred by the seeming disorganization of Three Sisters gardening (Hurt 1987; Will and Hyde 1964). The restructuring of fields into straight lines is one example of how Indigenous traditions were actively displaced.

In Native communities, seed saving knowledge has been especially destabilized. For many nations, seed saving knowledge is traditionally passed generationally, from one seed keeper to the next, creating a direct lineage by which this knowledge can be traced (White 2015). This loss of traditional seeds and their associated knowledge has had severe consequences for communities' connections to their history, landscapes, and food. In the literature, Gurney et. al., referred to these instances of disconnection from their knowledge as "invisible losses" (2015). For Native peoples, it can be surmised that one significant connection within agricultural communities is the one that growers have with their seeds and plants. Constructed as kin

relationships, these connections are fundamental to the beliefs of respect and reciprocity that uphold gardening systems. When these kin relations become estranged due to assimilationist pressures to purchase and grow Western seeds, the cultural significances of seed systems are lost. The related teachings about human-plant dynamics are also painfully displaced. Additional invisible losses include the cultural memory stored within seeds. When seeds are displaced from communities, the role or purpose that they were created for remains unfulfilled – leaving gaps within the cultural tapestry of food systems.

These intangible, though incredibly meaningful, aspects of culture are on the forefront of cultural reclamation movements. It is through this understanding that the emphasis on reawakening knowledge in youth is prioritized in many Native communities. This too was a major theme in many of my interviews, as those I spoke to often shared their hopes and aspirations for the next generations of Native children. Jordon Pow Less (Oneida and Navajo) mused that rejuvenation efforts are about,

> Trying to get back to your old ways. To teach our children and, you know, we're kind of slowly dwindling down of what we knew in the past…we're trying to get back to that, with food or language or anything. I think it's very important to get that for the Three Sisters, for white corn - to pass that knowledge on, and hopefully keep it going. (2021)

Lani Moran (Omaha), a faculty member at Nebraska Indian Community College (NICC) interested in expanding community engagement with gardening, also shared values of preserving and passing on traditional knowledge. Children were often the targets of cultural education, because "sustainability is upheld by transmitting knowledge and everyday cultural practices to future generations" (Corntassel and Bryce 2012, pg. 156). In our conversations, Moran cited her eight-year-old son as her hope and legacy for a better future. She has been teaching him cultural

understandings of gardening, plant identification and uses, and the relationships crucial to upholding respectful and reciprocal Indigenous foodways.

> She felt strongly about the importance of teaching her son these things because, [Now,] he has the stuff that can help him; help his community. I'm also working on him with the language and the traditional stuff that we have here. You know, and I tell him, 'I'm sorry, son, that I'm putting such a weight on you.' I said, 'but you know, when you're a grown man, I see you'll probably be giving Indian names to your relatives, and you'll be showing them how to grow food, and how to save food and do all this kind of stuff. And so that way, you can look to this.' And so it's like what my grandparents share with me and my mother that I'm trying to do with him. (2021)

It is interesting how through these two conversations, occurring across two different nations with very different experiences of food sovereignty within their community, the same values of traditional foods and languages persist. Both Pow Less and Moran consider these two elements of culture to be the best targets for education The reclamation of cultural traditions, like language and food, go hand-in-hand (Corntassel and Bryce 2012; Sinclair 2018). As both Pow Less and Moran allude to, there is power in the restoration of language, especially for kinship relationships with both human relatives and food stuffs. There are also cultural teachings that arise through Indigenous languages that may not be as translatable in English, as evident by Moran's emphasis on the progression of naming to teaching traditional practices. Language opens the door for traditional teachings to be effective (Sinclair 2018). The use of Indian names, as she described, is one example of how reclamation reawakens senses of cultural identity and pride.

As my interviews have demonstrated thus far, food is another crucial vehicle for cultural rejuvenation efforts. Food itself is an incredibly significant component of culture. Food can

affirm cultural identity and bring people together for social and ceremonial purposes (Mihesuah and Hoover 2019). Food production is one common way that I have witnessed communities reinstate cultural traditions and reinforce cultural identities. Aside from education within the home, as Moran does with her son, many schools in Indigenous communities are beginning to target their youth through after school programs. About the scope and impact of Macy Public School's youth gardening program, Delberta Frazier, a teacher, remarked,

> I think this is the first time that anybody's grown here [in Macy] by hand, a large garden, you know. Other people just grow in their yards, and it's just a small amount, probably just a few ears of corn. But to try to feed a community, this is the first time this has been done. A lot of that wisdom has been lost. But we have stories, and we can reclaim them. And we can make our own stories now. (2021)

Macy's gardening program brings middle and high school students directly into the field to learn traditional gardening methods. They tend an impressive amount of land, split into multiple gardens. One field was planted in blue corn, which is highly valued by Omaha people. They also seeded a Three Sisters Garden, to allow the group to experience this aspect of cultural gardening systems. The rest of the land was planted in various vegetable crops, all of which would be used in the school's cafeteria program. I was struck by how teachings within the garden focused on with the land and the plants within the garden. In this context too, kinship was presented as the fundamental root of sovereignty.

The program intended to foster increased cultural understandings and values that have been displaced by attacks against food sovereignty and security. Not only were students provided with the opportunity to experience traditional practices, but their lessons were rich in cultural stories, teachings, and language. Gardening was presented as an all-encompassing cultural

experience. From the way that the kids were actively engaging with their teachers, both human and plant, it was evident that gardening itself was an effective avenue for reconnecting with traditions.

The Healing Power of Reclaiming Seeds

Greendeer, a recipient of seed rematriation, crafted an analogy to aid in a Westerner's understanding of the emotional magnitude of rematriation. About welcoming seeds home and back into the fabric of her life, she mused,

> The feeling that you get from [experiencing rematriation], - the only way I can explain that feeling is you grew up hearing about Uncle Bill. Maybe you saw a picture of him, but you really didn't know anything about Uncle Bill. And then one day he shows up at your door. And you grew up with stories about him, so you know that he's an amazing person, and that he's done great things, but you've both lived lives apart from one another. And it's kind of like, just a feeling of wholeness. It's such an intense emotion. I'll cry or I'll just have all these different emotions just come over me. Because it's bringing someone home who hasn't been home in a very long time. (2021)

Other collaborators have expressed deep emotions when speaking about seeds and their homecoming. Webster, another of the recipients of seeds from Seed Savers Exchange, became overwhelmed with emotion when speaking to her own experiences with reclaiming Oneida seeds. She remarks that rematriation has been, "a beautiful, healing journey" that has allowed herself, her family, and her community to reconnect with aspects of their cultural heritage previously thought to be lost (2021a). Now, both women are involved in seed work within their own communities, acting as a bridge between seed-holding institutions so that seeds may return

into the hands and soils of Indigenous gardeners. Greendeer spoke about her own rematriation work,

> I wanted to make sure that if I could help anybody else have that same feeling that I was going to do everything I could to do that and continue to do that. Because there's so many people who are not only not only trying to find their seeds, but some people don't even know what they're looking for. And any way that we can help one another reestablish that connection with seeds, you know, it's not just the seed coming home - there are aspects of our culture that reawaken when those seeds come home too. And so it's something that the secondary and tertiary effects, we don't even know what those are when they come home. (2021)

It has been apparent through my ethnographic fieldwork how powerful rejuvenation efforts like rematriation can be. This work affirms cultural identity, strengthens social and spiritual relationships, and helps to heal lasting wounds from colonization.

Delberta Frazier (Santee Sioux) also had much to say on this topic. She reflected,

> Gardening is helping us to reconnect back to the land, to heal in my mind, to heal all the past trauma that we deal with. We can forget about all of that. And we can just sit down and create something, we put that seed in the ground, how easy it is to put something into the ground and watch it grow. It becomes so beautiful. And it gives back to us (2021).

The reclamation of cultural practices has also been healing to the social relationships disrupted by colonization. As well established, these relationships are how Indigenous people enact sovereignty. To reconnect back to the land is the process of reaffirming sovereignty. About gardening and growing, Lavonne Snake (Omaha) remarked, "that's what's what brings us together; we celebrate that food, we respect that food." She did not see these relationships for

quite some time, within her own community she conceded. Recently, however, “it's coming back now” (2021).

Seed rematriation restores relationships and identity. It restores sovereignty. While seed rematriation directly aids in the reclamation of seed sovereignty by bringing ancestral seeds back into their home communities, the impacts of this reclamation work are reverberating. When seeds are returned to the hands and soils of Indigenous communities, the nested layers of Indigenous sovereignty become apparent. Through conversations with various food and seed actors, it became apparent that the restoration of seed systems has resounding impact. This work to reestablish relationships with seeds ultimately reestablishes relationships with many aspects of Indigenous lifeways, most significantly with the land. This creates a ripple effect across various spheres of Indigenous sovereignty. When seeds return home, they open the doors for similar reclamation work; through food, language, education, economics, and religion to name a few.

Rematriation Work

Early Efforts

Prior to the rematriation movement gaining broader notice around 2018 or so, similar work and efforts often utilized the term repatriation. This is because seeds were seen as the cultural patrimony of countries (Nazarea, Rhodes, and Andrews-Swann 2013; Williams 2005) Nazarea, Rhodes, and Andrews-Swann considered the process of repatriation in their book entitled, *Seeds of Resistance, Seeds of Hope.* They defined plant repatriation as, “to return what has been lost, displaced, or contaminated, from collections in genebanks that hold these irreplaceable materials in trust and for posterity, back to their original inhabitants and custodians” (2013, pg. 7). While these authors envisioned a myriad of situations in which seeds would need to be repatriated, a focus remained on returning seeds after catastrophe, as a means

of bolstering the agricultural systems of impacted areas. These events have been earthquakes or floods, and even less direct impacts like through international trade and the introduction of genetically modified corn varieties (Nazarea, Rhodes, and Andrews-Swann 2013).

These instances of plant repatriation are incredibly meaningful and powerful for the communities involved. It is not my intention to discredit these early efforts. Rather, I believe that the seed rematriation movement has progressed past the point of plant repatriation, especially for Indigenous communities in North America. While repatriation may acknowledge the significance of traditional seeds for cultural identity, sovereignty, and lifeways, conversations do not carefully consider who these seeds should be repatriated to. In discussion of a potato repatriation that occurred in Peru, the gendered term is maintained even while women were identified to be the cultivators of genetic diversity (Graddy 2014; Nazarea, Rhodes, and Andrews-Swann 2013). Perhaps, in their use of the term, these authors consider the nation more broadly. Yet, these generalities may be imperfect or even offensive for other communities because they convey Western notions of patriarchy and the father land, as critiqued by White, Prechtel, or Newcomb. For Native American communities, then, repatriation is not the culturally appropriate way to refer to this work.

What is most notable about these early instances of the reclamation of plants, however, is how they aptly recognize seeds as the cultural legacy of Indigenous communities. Whether the term repatriation is applied or not, these efforts convey that the return of culturally appropriate seeds, “validates local sovereignty and triggers the revival of culinary traditions” (Nazarea, Rhodes, and Andrews-Swann 2013, pg. 6)

Heritage Seeds for Sustainable Lifeways

The Heritage Seeds for Sustainable Lifeways is a joint project with Anishinaabe communities and the University of Michigan. The project, concluded in 2017, sought to reunite local Native nations with seeds that had become housed within the University's Museum of Anthropology and Archeology (UMMAA). Together with regional tribal representatives, the Heritage Seeds for Sustainable Lifeways Project developed a framework for the process of returning seeds (Hill 2017a; Michener et al. 2017). Interestingly, this project does not refer to their work as either repatriation or rematriation. This could be because, as a collaborative project with a museum, the term repatriation may have improperly conveyed that seeds legally fall under the jurisdiction of NAPGRA[25]. The project members did, however, note that seeds are considered objects by Indigenous cultures, but valued community members (Michener et al., 2017). This work therefore falls within the understanding of rematriation, given the emphasis on returning seeds in the most culturally appropriate and sensitive way.

The Movement Today

Rematriation, as such a new and evolving process has not yet become a widespread movement. Some of the participants interviewed had not yet heard of the term although they

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[25] Currently, seeds are not under the jurisdiction of NAPGRA unless they have been uncovered from burial sites or bundles. This being said, some Indigenous seed actors have begun to discuss the legal protection of seeds. A bill entitled the "Native American Seeds Protection Act" was introduced in 2019 but did not pass. This Act sought to study, "the availability and long-term viability of Native American seeds, including an analysis of the storage, cultivation, harvesting, and commercialization of such seeds." The bill also stated that, "nothing in this Act shall be construed as interfering with, limiting, or otherwise affecting the exclusive ownership and control of Native American seeds by an Indian Tribe unless the Indian Tribe consents to the ownership or control of such seeds by another entity"- which may have impacted the institutionalized conservation of these varieties had the bill been enacted (GovTrack.us 2022; Wozniacka 2019).

were attempting to become part of the work (Frazier 2021; French 2021; Moran 2021; Snake 2021) Rowen White, as the pioneer of the rematriation movement, has been connected, either directly or in acknowledgements, to most instances of seed returns and reclamation.

Native Seeds/SEARCH

Native Seeds/SEARCH (NS/S) is one of the most prominent actors within Indigenous seed conservation. Founded by Gary Nabhan, an agricultural ecologist and ethnobotanist, NS/S defines their mission as to, "find, protect and preserve the seeds of the people of the Greater Southwest[26] so that these arid adapted crops may benefit all peoples and nourish a changing world" (2022b). They steward the seeds of nearly 2,000 crops in their own repository, many of which are denoted as rare and endangered. With seeds from over 50 different Indigenous communities, NS/S pioneered a means to increase Native access to their ancestral seeds. NS/S created the Native American Seed Request Program, which enables Indigenous peoples of the American Southwest and Northwest Mexico to request 15 packets of ancestral seeds per household, per year, free of charge (2022a). In addition to this program, NS/S is one of the first seed-holding organization to formalize a rematriation program to support Indigenous seed sovereignty. Announced in 2021, the organization devised a formal seed rematriation process by which Indigenous communities can define their own sovereignty over their ancestral seeds. This formal process allows communities to access more significant quantities of seed and potentially place restrictions on the distribution of their ancestral varieties (Native Seeds/SEARCH 2021). This last inclusion is interesting; not only can Native nations access their seeds, but they are able

[26] Greater Southwest region includes Arizona, New Mexico, Utah, Colorado, Nevada, western Oklahoma, western Texas, southern California, and northwest Mexico (Native Seeds/SEARCH 2022b).

to protect them against future access by non-tribal members. For a seed-holding institution to do so demonstrates that they have centered the needs of Indigenous communities while being allies for the continued conservation of those varieties.

NS/S usefully defined rematriation for their organization as, “the return of seed to a person or tribe with a direct relationship to those seeds based on seed collection information, and without the expectation to share or return seed to NS/S in the future” (2021). This emphasis on seed collection information is interesting and might suggest that the record-keeping process for the organization’s accessions is well-defined. Many of their available catalog varieties note clear connections to Indigenous communities, which lends support to their dedication to seed histories. As the previous chapter demonstrated, seed data and information are often the limiting factor in reclamation work. While Native Seed/Search is outside of the collaborative scope of my research, they are important to this conversation. Having just recently stepped up the call for seed rematriation, the establishment of their policy could influence additional seed-holding institutions in the future.

Seed Savers Exchange

Seed Savers Exchange (SSE), od Decorah, Iowa, on the other hand, has been involved in seed rematriation since its conception. With a collection of over 20,0000 heirloom seeds, SSE has pioneered some of the earliest rematriation efforts between a non-Native institution and Indigenous communities. Since 2017, the organization has been working with Rowen White and the Indigenous Seed Keepers Network to appropriately rematriate seeds of Indigenous ancestry from their collection. The non-Native organization was approached by White, who had recently secured funding for a project through the Indigenous Seed Keepers Network (ISKN) – and they had carved out a spot specifically for Seed Savers Exchange. Recounting those initial

conversations, Philip Kauth, the former Director of Preservation for the organization remarked humorously, “Oh, I didn't even have a chance to decline – not that I would have. I was like, ‘great, what do we need to do?” (2021). The project began slowly, with the first few years as SSE growing out seeds on their own to hand off to White for rematriation. In the third year, 2019, Kauth recalled,

> Rowan's ultimate vision was to get the seeds out of Seed Savers Exchange, to the communities who want the seeds so they can grow them themselves. And ultimately, that's what I wanted too, as part of our partnership. Because [the seeds are] no good sitting here and just having us grow them. That's not the point, right? (2021)

This became the turning point for Seed Saver’s Exchange rematriation project. In that year, three gardeners and seed keepers were identified to be recipients of seeds; two of whom were Greendeer and Webster. Since then, the number of recipients has grown to include eight seed stewards from the Meskwaki, Ho-Chunk, Oneida nations. Kauth explained that these partnerships are incredibly collaborative, with cooperation between the Seed Savers Farm and participating growers to determine which varieties to grow, and where (Kauth 2021). Webster explained the process to us by saying that she received an excel spreadsheet that contained a tab of “possible Haudenosaunee varieties,” given the limited information about some seeds within the collection. Seeing the number of seeds however, Webster said she was thrilled (2021a). While many seeds went home to collaborating communities to be grow out and shared, the SSE farm also offered to simultaneously grow out additional seeds to add to rematriation efforts. With their staff, large amount of space for isolation, and the ability and training to hand pollinate varieties, sometimes SSE can take on more responsibility for varieties than the home gardeners they work with (Kauth 2021).

While SSE and their partnership with the Indigenous Seed Keepers Network may make rematriation work appear simple, Kauth recognized that there are some major challenges to overcome. He stated that many gardeners have misconceptions about the technical information and skills necessary to save seed, which discourage more people from becoming involved. About his own experiences with rematriation, as well as what he's learned from working in these wider circles, he remarked,

> It's a challenge to find people to actually take those seeds. And [rematriation collaborators have] specifically said that a lot of people say, 'I don't want to mess it up and so I don't feel comfortable taking those on and being seed keepers of those particular varieties.' So they just need more information on how to do seed saving for the public and for their communities. (2021)

These concerns powerfully speak to the significance of cultural varieties for Native communities. In today's technological agronomic environment, the average white, Western, farmer likely never has to worry the state of their seedstocks; if seed health or quality declines, they can simply purchase new seed. In fact, most choose or are required to do so (Kloppenburg 2014). The same conveniences are not afforded to Indigenous seed keepers and their endangered seedstocks. For some varieties, seeds are so rare or in such poor health that amplification of the seed can either lead to success or extinction. At Seed Savers Exchange, we drove past a greenhouse with a singular, lonely, corn plant visible through the glass. When asked about the situation, Kauth explained that SSE received seeds of the variety, Choctaw Blue, from the collection of one of Seed Savers Exchanges founding members, Dr. John Wyche (Cherokee). Of the less than ten seeds of corn they had received, only one seed germinated. The production of even one ear of corn from that plant was critical for ensuring the survival of the variety. After

pollinating the plant, they got only 12 seeds from the ear. Kauth remarked that they would grow the variety again and keep trying until they saved the variety (2021). The amount of pressure on the organization for the continuation of this corn was strong, despite their best efforts and intentions. It is no wonder, then, that so many Indigenous gardeners feel overwhelmed by the task of reviving their cultural seeds, ensuring their trueness to type, seed quality, and seed health.

Additionally, grower fears of stewarding seeds should also consider the cultural significance of these seeds. While rarity of seeds is certainly an issue, Indigenous seeds more generally are deeply connected to cultural lifeways. To take on responsibility for a seed and its survival is, by extension, taking on the responsibility of the perpetuation of one's culture. This too, is a burden that some people might not feel comfortable bearing. With cultural rejuvenation being such a priority within communities today, and with seeds being understood as such a vital part of this process, people may fear failure.

As a seed-holding institution, however, Seed Savers Exchange is poised for increasing grower confidence with seed saving work. Kauth commented that the organization has been working to develop educational materials on the importance of seed saving, including detailed information on how to do it. This has included online materials, such as guidebooks, but also virtual workshops with Native seed keepers (2021). While the institution has ambitious goals for increasing the scope of their work, it is without question that their involvement in the rematriation movement has had lasting impacts on the gardeners and communities they are collaborating with.

The Future of the Rematriation Movement – Opportunities and Challenges

Rematriation events are on the rise as this movement gains more traction. Ultimately, however, actors have cited they need increased participation by non-Native allies and seed-holding institutions. Greendeer explained that if more seeds are to be returned home,

> We just need more people to help in any way that they can. We can't do this alone. But you know, there's certain aspects that I think good allies also know when they need to take a step back and let people do what we were meant to do. It's not just for Native people, speaking for the seeds that aren't Indigenous to the Americas. There's so many seeds out there that need to be adopted and brought back in. No matter where our ancestors came from, there were seeds that nourished us, and being able to pick them up and give them the same love that I hope all of us are giving our seeds -giving them essentially a seat at the table (2021).

Greendeer presents a powerful truth through her words; if non-Native people hope to contribute to seed rematriation, they must recognize the leadership of Indigenous seed keepers and growers. Collaboration is an effective means of making change, but only when relationships are sensitive and respectful to the needs of all participants. Her words present a challenge to all seed-holding institutions involved in rematriation. Greendeer pushes them to understand the sovereignty of Indigenous people over their seeds. Not only should Indigenous communities be able to do what they were meant to do, but they should do so through reforming the relationships critical to seed stewardship. By reestablishing those relationships of love, respect, and reciprocity, Greendeer emphasizes the impact that rematriation can have on Indigenous seed sovereignty when she explained that seeds are living beings who need to be adopted and brought home.

It appears that organizations like Seed Savers Exchanges are especially well situated to meet such demands. The organization is not shying away from the ethical concerns of stewarding so

many varieties, many of which have connections to minoritized communities. In recent years, concerns have arisen over the prioritization of seeds within the collection. In any given year, SSE is only able to grow out 10% of this collection – meaning that most seeds remain within the seedbank without being utilized for long periods of time (Carolan 2007). About this, Kauth explained,

> There's been a real big mindset change with the preservation staff here. Just recently, in the last couple of years, where it's not so much about the quantity. I tell people, I don't care that we have 25,000 plus varieties in the collection. I don't care that we have 6,000 tomatoes. What are we doing with that collection to connect people with those seeds? *That* is what I care about and that's what we need to be doing (2021).

Kauth directly challenged the notion that conservation is considered more effective when it is far-reaching. Greendeer, a recipient of seeds from SSE's rematriation project, seemingly echoed Kauth's sentiments. She explained, "I understand that there's lots of red tape to cut through - there's different processes that each institution has in place - but the seeds aren't doing any good by sitting in their respective collections" (2021). Both seed actors spoke to the moral and ethical quandaries of seed saving and sharing networks. If seeds are to be collected for the purpose of sharing, as was Seed Savers Exchange's original purpose, then the creation of a long-term seed bank may seem counterproductive to those goals (Carolan 2007).

Kauth hoped that, in the future, Seed Savers Exchange may aspire towards making their seed holdings more widely available to the public. This could significantly increase seed access for Indigenous communities in North America. If the organization wishes to connect more people with seed within their collection, however, then they must devise a way to share them in the most sensitive, culturally respectful way. Rematriation is the only appropriate way to do so.

While the movement is well defined, the process of actually returning seeds in a safe and respectful manner has yet to be explored in depth.

The Rematriation Process

While the definition of rematriation provides a cultural context for where and to whom seeds should be returned, the process of rematriation remains largely undefined. Ocampo-Giraldo et al., who were responsible for the successful rematriation of the Jala maize landrace in Mexico, notably phrased rematriation efforts as,

> A co-creative process of engaging with a community of farmers, including Indigenous and local people, to transfer germplasm conserved in an *ex situ* collection back to its place of origin, where it can continue to evolve in situ in a nurturing environment as part of a cultural heritage and livelihood improvement. (2020, pg. 2)

A co-creative process implies synergy and collaboration yet leaves much to the imagination about how seeds were ultimately transferred back into the hands of Indigenous farmers. The work of the Open-Source Seed Initiative[27] (OSSI) is relevant to this conversation. The OSSI has developed and implemented framework regarding the sharing of Indigenous seeds. This organization advocates for the *conditional* sharing of plant germplasm (Kloppenburg, 2014). Any seeds available within the network can have their uses and distribution be restricted (Hill 2017a). This conditional sharing is a valuable guideline for the conservation and sharing of Indigenous varieties. Speaking to this, one of OSSI's basic principles is, "respect for the rights and sovereignty of indigenous communities over their seeds and genetic resources" (Kloppenburg 2014, pg. 1239). If the OSSI were to engage in the sharing of Indigenous

[27] The OSSI was formed in opposition of inflexible restrictions on seeds, like those of agribusiness giants who claim patents on plant germplasm (Kloppenburg, 2014).

germplasm, it would have to be done so under the permission and guidance of the Native nations from which those plants belong to. The Indigenous Seed Keepers Network (ISKN) has adopted a similar stance to OSSI on the conditional sharing of seeds. They offer seeds freely to Indigenous people within the network who pledge and commit to growing them in specific ways (Native American Food Sovereignty Alliance n.d.). Seed trading networks, as being led by communities and focused on the exchange and stewardship of Native plants, therefore offer culturally appropriate avenues to share and conserve Indigenous plants.

Seed Savers Exchange could adopt these policies if any Indigenous varieties were to remain within the collection for sharing. Such avenues might include more direct collaboration with the multitude of tribal nations whose ancestral seeds reside within the collection, with each nation deciding their own limitations for the seeds. The navigating of these relationships, and how to negotiate barriers to access, would be taxing on an organization like SSE. Perhaps that is why the organization is moving towards the deaccessioning of Indigenous heirlooms.

In recent conversations with Seed Savers Exchange, deaccessioning has been a major goal and process for the organization. They define deaccessioning as, "the process of ending management of an accession in the Collection" (Johnson et al. 2015). This shift in management is quite a departure from the original origins of SSE, which sought to conserve and heirloom varieties as widely as possible. The deaccessioning of varieties, however, can only be accomplished after the organization ensures that the seeds are safely stewarded elsewhere, and therefore not under threat of being lost. In events of deaccessioning prior to SSE's collaboration with Rowen White, the organization had policies for plant repatriation. When accessions were removed from the collection, a critical first step was to ensure that the seeds could be repatriated to the home country (if the seeds originated from abroad) or even the original donor or his/her

descendants. SSE defined repatriation as, “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” (Johnson et al. 2015).

More recently, however, the organization has adopted the term rematriation. Aside from the cultural significance of this term, rematriation in this context is important because it acknowledges that seeds are living beings, capable of reproducing themselves once allowed to do so in their home communities. Regardless, Seed Savers Exchange has acknowledged that Indigenous seeds must be returned to their home communities, into the hands of Native seed keepers who are able to care for the seeds in culturally appropriate ways. For Indigenous seeds, however, this identification of where, and to whom, the seeds should be returned is often difficult due to the general lack of information associated with the varieties, as previously discussed. In response to this lack of information, SSE has pioneered an area of research within the organization through the efforts of seed historians. These members of the staff are tasked with the uncovering of seed histories, through rigorous online research, conversations with original seed donors, or, more often, the descendants of those donors (Straate, Cabrera-Mariz, and Fernandez 2021). The hope is that these efforts will uncover connections between seeds within the collection and communities in search of their ancestral seeds, allowing seeds to be sent home. Kauth affirmed, “it's not about abundance for me. Yeah, which is like steeped in colonialism too…the [emphasis on] quantity and the abundance” (2021). He wants to see as many seeds as possible leave the collection. Kauth’s aspirations for the future of Seed Savers Exchange is to, “Just to get more out. I think that's it, that’s the big one” (2021). He explained how their seed collection is sometimes perceived by the public:

> A lot of people think like, “Seed Savers Exchange is the epitome of it all, [we’ve] got this big collection, [the seeds are] here long term. It’s Great - the seeds are safe.” And I don't like that mentality. Because seeds aren't meant to be kept in a vault, in the freezer, you’ve got to grow those seeds. They need to be shared and be grown and be back with the people who want them and cherish them and love them. Whether it's an Indigenous variety, whether it's another variety that we have in the collection here. (2021)

With their continuing efforts through seed historians and the rematriation project, it is likely that Philip Kauth’s plans for SSE will be actualized. Perhaps, in future years, their efforts will continue to grow in scale and ambition, to include additional growers and nations in their rematriation efforts. It is without doubt that their dedication to sending seeds home will have a lasting impact on their collaborating communities.

Webster is also looking towards brighter futures. Through her own work on her farmstead to grow ancestral varieties, to her pioneering of a 20-member bean co-op on the Oneida reservation, she is steeped in cultural rejuvenation work. About her aspiration for the future of gardening and seed keeping for her nation, and Indigenous people elsewhere, she said, “I'm hoping that it just becomes a normal thing, and it's not anything to be like, “oh look at that, what are they doing?” - but it's like, “yeah I'm doing this and it's normal and it's a part of our everyday lives” (2021a). Her comment spoke to the hopes for a more stabilized seed and food system for Indigenous communities. The need for rematriation has shed light on the somewhat dire state of seed systems for many Native nations. In returning seeds, however, it offers growers the chance to seize control of their seed systems, extricating themselves from Western, commercial seed markets in the process. If seed saving once again becomes a normal part of their gardening systems, then many communities will no longer have to worry so intensely about threats to their

biodiversity. Furthermore, as Webster's own work within seed trading and sharing networks demonstrates, the reinstatement of seed production at the community level offers opportunities to rekindle these exchanges of seeds and knowledge. These resurgences significantly contribute to the preservation of cultural varieties, as the more people that that thoughtfully, skillfully, and with reverence steward cultural biodiversity, the safer communities will be against future attacks against seed and food sovereignty.

Conclusion

The evolution of the rematriation movement, and the impacts that it has had on Indigenous communities thus far, is remarkable. These efforts have successfully reunited communities with their culturally significant seeds. In doing so, Native nations have been able to rekindle relationships with these communities' members, effectively making progress in the reestablishment of seed sovereignty. The lasting benefits of seed reclamation work have been considered, such as the ability of communities to revitalize traditional foodways and ceremonies (Nazarea, Rhodes, and Andrews-Swann 2013). Yet, the process of rematriation remains largely undefined, which has left some seed-holding institutions who have thus far contributed to this work, to consider new ways by which they can increase the scope of their support.

In my own research, Seed Savers Exchange has presented itself as a powerful ally in the seed rematriation movement. Having been involved in the process since its origins, SSE has used its seed-holding capacity to identify seed keepers form various nations in the Midwest and has opened the doors of their seed vault so that seed keepers may reconnect with their ancestral seeds. The organization is currently at a critical turning point as they explore what an ethical future of seed stewardship looks like, for both their own collection and for Indigenous communities.

The rematriation movement, while having had significant success so far, will need to leverage the increased participation of non-Native actors if more seeds are to be sent home. There are areas for improved collaboration for seed-holding institutions, which hold the ancestral seeds for rematriation, and research entities, which can lend to the process by exploring the mechanisms and frameworks of the movement. Notably, research institutions may offer their services as go-betweens in the process, using their capabilities to access seeds directly for rematriation purposes. They may even be well poised to access, increase, and share accession data, working sensitively with Native communities to learn the histories of cultural varieties. In doing so, this increase in information will simultaneously reunite seed keepers with ancestral varieties that were previously obscured within the collections of institutions. Regardless of how seeds are identified for rematriation, future collaboration must privilege the knowledge and direction of Indigenous seed keepers. Only they can determine the proper protocols for reuniting seeds with their home communities. The rematriation process must also strive to respect the decisions of Native actors regarding how seeds and information are shared, and ultimately, how they are protected. After so many generations of being separated from their original caretakers, it is time for Indigenous seeds to return into the hands and soils of the communities who cherish them. Raising awareness around this movement forces institutions to become aware of their histories of disenfranchisement, hopefully leading to a sense of moral responsibility to participate in the rematriation process moving forward.

The following chapter of this thesis explores these themes. My ethnographic research has been conducted within and alongside an overarching project evaluating the impact of the Three Sisters Intercropping on soil and plant health. With our capacity as a research institution, we accessed seeds of corn, beans, squash, and sunflower specifically for rematriation. The growing

of these plants for seed production, and the resulting ethnographic work alongside rematriation actors contributed to the research being an example of rematriation in action. It is through these experiences that the significance of the Three Sisters will be explored for Native communities, as well as how seed rematriation contributes to the reclamation of these gardening practices.

CHAPTER 5. REMATRIATION IN ACTION: REUNITING THE THREE SISTERS

Seed rematriation, as the process of identifying Indigenous seeds from within the holdings of non-Native institutions and reuniting them with Native stewards, holds profound value for communities involved (Greendeer 2021; Webster 2021 a; White 2018b). For rematriation to be increasingly successful, however, more collaborative efforts are needed. While some seed-holding institutions have begun to conduct seed rematriation work in tandem with Native actors, research universities have been slow to collaborate. The Three Sisters Intercropping project at Iowa State University is therefore a unique example of collaborative research with the goal of rematriation between a land-grant university, seed-holding institutions, and Native communities. It is perhaps one of the first, if not the first, project of this scale and reach. The rematriation component of the came to being as a result of ethnographic footwork accomplished prior to the planning of the agronomic experiment. Overall, the Three Sisters Intercropping project sought to explore the historical, cultural, nutritional, and agronomic significance of traditional gardening for Indigenous communities in the Midwest. The collaborative, decolonizing focus of the research privileged the needs and interests of the Native communities involved.

The experiment at the ISU Horticultural Research Station was a result of feedback obtained from project collaborators and Native community stakeholders wanting to better understand how use of Three Sisters Intercropping can impact crop growth, yield, and soil properties. Through these early conversations, we developed a scientific experiment using Indigenous methodologies to compare intercropping and growing each of the sisters in monoculture. This planning revealed a need for Indigenous seeds. Not only did the research require the seeds of Native crops to appropriately evaluate the benefits of the intercropping

system, but we learned of a need for rematriation of ancestral seeds within Indigenous communities. Through my own interest in seed saving and the conservation of ancestral varieties, and through communication with Jessika Greendeer, a seed keeper and farm manager at Dream of Wild Health (as well as a collaborator on the Three Sisters project) it became clear that Iowa State University could positively contribute to rematriation efforts through the Three Sisters Intercropping experiment. Thus, this overarching, multidisciplinary research study became an example of rematriation in action.

The intercropping study therefore became a necessary component of my thesis work, as it bolstered the depth and breadth of my ethnographic focus on rematriation. This study forged relationships with seed rematriation advocates and actors, increasing my access to diverse perspectives on the movement in tandem with my ethnographic interviews. This element of the research also added to my participant observation, as I spent time learning and applying the Indigenous knowledge lent to me by our collaborating gardeners and seed keepers. Production and careful stewardship of varieties used in the study was essential to success and to the building of respect and reciprocity with Native communities. In this sense, contributing the products of the growing seasons, as seeds for rematriation, was one way that the Three Sisters Intercropping Project sought to provide tangible benefits to our vested collaborators.

Seed rematriation, as one deliverable of this project, utilized Iowa State University's abilities to access USDA germplasm and seeds held by other non-Native institutions in need of rematriation. Through this collaborative rematriation work, I acted as grower, seed steward, and ethnographer. This chapter discusses the findings of the intercropping experiment and its relevance for the rematriation work as part of the Three Sisters project. I have intentionally shaped this narrative to reflect and highlight horticultural research while simultaneously infusing

it with ethnographic data when appropriate to demonstrate the significances of rematriation for this work. This decision ultimately reflects the collaborative, holistic nature of this project.

Objectives

My ethnographic experiences revealed Three Sisters Intercropping to be a commonly adopted system within broader gardening rejuvenation efforts. This intercropping includes the growing of corn (*Zea mays* spp. *mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita pepo*) in the same piece of land, generally, a mound. In some instances, a fourth sister is planted along the perimeters of gardens and can take the form of sunflower (*Helianthus annuus*), bee balm (*Monarda fistulosa*), and amaranth (*Amaranthus* spp.) (Kruse-Peeples 2016; West 2013). This intercropping is well-known, even outside of Indigenous circles, for the complementary effects of growing the crops together (Morales-Rosales and Franco-Mora 2009). In the Three Sisters, the plant architecture contributes to symbiotic relationships between each of the crops. Corn, as the upright, tallest sister, can access the most direct sunlight. Simultaneously, her[28] height provides structural support for sister bean, who trellises to reach as much sunlight as possible. Bean reciprocates by fixing atmospheric nitrogen in the soil for the other plants, but primarily for corn, a heavy nitrogen feeder. Lastly, sister squash provides ground cover, increasing soil moisture and suppressing weeds (Hurt 1987; Mt. Pleasant 2006; Mt. Pleasant 2016; Kimmerer 2013). The complementary nature of intercropping implies that the most limiting resource in the system, be it sunlight or soil moisture in this case, is captured more effectively by the companion plants, when compared to monoculture systems (Morales-Rosales and Franco-Mora 2009). Each sister

[28] I intentionally refer to the Sisters, and plants in general, with feminine pronouns to privilege the language used by the Indigenous collaborators I worked with. This language properly acknowledges and reflects the kinship systems discussed in the previous chapter.

has her own unique role, contributing to the overall health and productivity of the system. For Indigenous farmers, intercropping has also been recognized as having the benefit of producing maximum yields within smaller fields (Hurt 1987).

Despite these benefits, there is limited agronomic research on Three Sisters Intercropping. The origins, histories, and socio-cultural underpinnings of the system are well explored, but research focusing on agronomic productivity and yield estimations is lacking and relies primarily on historical data (Mt. Pleasant 2006, Mt. Pleasant and Burt 2010). Other research has utilized a literature review approach, using historical and cultural documents to draw conclusions about the benefits of the intercropping (Terry, Pearson, and Holder 2020). Very few scholars have researched the Three Sisters with the goal of understanding cultural, nutritional, and agroecological benefits. My research, and the Three Sisters Intercropping project at large, sought to consider these aspects, weaving the historic and cultural significance of the intercropping gained from ethnographic fieldwork with a replicated agronomic experiment to understanding the ecological and biological complexities of this system.

The research experiment was carefully crafted using Indigenous knowledge and varieties to compare the benefits of the intercropping on plant health and yield, when compared to each of the sisters in monoculture. By plant health, I refer to plant productivity in the face of environmental, pest, and disease pressure, and the ability of these plants to withstand such stressors (Döring et al. 2012). Through collaboration with the emerging network of seed reclamation actors, our research study became an example of rematriation in action as well as an experimental foray into how cooperative, decolonizing research may support Indigenous sovereignty movements.

The main objectives of this research study were to (1) develop a collaborative research experiment that utilizes Indigenous growing methods, (2) grow a Three Sisters garden to consider the impact of intercropping on plant health and yield, and (3) rematriate seeds grown at this research plot. This research therefore considers both Indigenous growing and seed saving practices. The experiment and rematriation activities go hand in hand, as yield from the research provided both the agronomic analysis and rematriation capacity of intercropping systems. Ethnographic and agronomic data from two growing seasons contribute to discussion on the agroecological impacts of the Three Sisters Intercropping. The results of this study, in terms of increased understanding about the impact of intercropping on plant health, are of great importance to our Native collaborators. Hopefully, increased information on intercropping benefits will lead more communities to rejuvenate this practice and increase food security and sovereignty in the process.

Materials and Methods

As briefly mentioned, all materials and methods for this research were decided on and approved in collaboration with a Native advisory board comprised of seed keepers, gardeners, and elders from throughout the Midwest. The advisory board assisted with the development of protocols for the fields experiment, rematriation process, and facilitating the exchange of knowledge. The advisory board was also vital for determining which seeds and inputs were appropriate for use in the field study. These collaborative efforts essentially formed the foundation of all methods utilized in this study.

Experimental Design

As a project with the goal of exploring the agronomic underpinnings of the Three Sisters, a replicated randomized complete block experiment was created to compare intercropping with each of the sisters in monoculture. The hypothesis was that the Three Sisters, when grown together, would have increased productivity benefits when compared to each of the sisters alone. While it has been shown that monocrops will generally yield higher than intercropping systems, there are still benefits to be found in regard to land use efficiency (Mead and Wiley 1980; Morales-Rosales and Franco-Mora 2009; Xu et al. 2020). Therefore, this experiment sought to better understand in what ways the Three Sisters Intercropping is more productive or efficient. My involvement in the study allowed me to specifically consider the benefits of the Three Sisters on plant health and yield. Yield is primarily discussed as seed, by weight, when appropriate, considering the project's aim to grow and amplify our chosen varieties for rematriation. For squash, yield is instead discussed as weight of fruit, with the assumption that each fruit will produce plentiful seeds for rematriation efforts.

Research plot

This research was conducted on certified organic land at the ISU Horticultural Research Station, in Ames, Iowa during the 2020 and 2021 growing seasons. The land had most recently been planted in a cover crop of sorghum sudangrass, cowpea, and sunn hemp. Before the first season of planting began, compost was applied the week of May 25th, 2020, at the rate of 10 tons per acre and incorporated to create a baseline soil nutrient profile on which the experiment could build.

Experimental design consisted of two treatments per crop: one treatment of the complete Three Sisters Intercropping versus the monoculture growth treatment of each of the corn, bean, and squash. Therefore, each experimental block consisted of four plots. This block was then replicated four times. Each treatment plot measured 20ft x 20ft in size (Figure 1, Appendix E).

Planting

The planting design of the garden plot relied heavily on the guidance of the advisory board as well as Indigenous literature on the matter (Eames-Sheavly 2000; Kruse-Peeples 2016; Will and Hyde 1964; Wilson 1987). Traditionally, Three Sisters Intercropping is grown in raised mounds, which has the benefits of enhancing soil physical and biochemical environments, minimizing soil erosion, and providing weed control (Hurt 1987; Mt. Pleasant 2006). Given these management benefits and the direction of the advisory board, we too decided to grow in mounds. Mounds were approximately three feet in diameter and one foot high and were constructed by hand. Mounds were spaced five feet center to center on all directions and each treatment plot consisted of 16 mounds. Over the course of the first growing season, the mounds decreased in height and size, due to natural erosion and soil compaction. They were overwintered to be reused during the second growing season to preserve the effect of treatments on soil quality and health. In the second year, at the beginning of the growing season, mounds were reformed.

Mound layout consisted of four corn seeds per mound, approximately 6 inches from the center in all directions (Eames-Sheavly 2000; Kruse-Peeples 2016). This allowed for one foot of distance between opposite corn plants. Four beans were also seeded per mound, approximately 3-4 inches behind each corn plant. Squash were then placed on opposite side of the mounds, diagonally, approximately 18 inches from the center of the mound (Figure 2, Appendix E) (Kruse-Peeples 2016).

A perimeter of sunflowers at the margins of the plot was also included, which had the agronomic benefits of attracting pollinators, providing some natural protection against large pests, and contributing to integrated pest management practices as a trap crop for insects (Kruse-Peeples 2016; West 2013). The perimeter began 5ft from the centers of all perimeter mounds and was three ft wide. Width was determined by available seed quantity and recommended seeding rate (Myers 2002). Seeds were broadcasted evenly by hand. These plants were not included in the agronomic experiment, so no core data was collected from them.

Variety Selection

Varieties of corn, beans, and squash, known colloquially as the Three Sisters, were obtained from the USDA's National Plant Germplasm System and two seed conservation organizations for use in a research experiment (summarized in Table 1, Appendix G). Native varieties were selected for use in this study to emphasize Indigenous methodologies. Crops from Native American origins, specifically suited to the Three Sisters, and in need of rematriation, were obtained. The study originally intended to use Dakota varieties in honor of the ancestral land on which the Iowa State Horticultural Research Station is located. However, due to limited availability of some varieties, parameters were expanded to identify rare seed in need of amplification and rematriation, regardless of geographic or National origin. The corn, Turtle Mountain White (Turtle Mountain Ojibwe), was obtained from the USDA Plant Introduction Station in Ames, Iowa. This corn is a short season variety, with 49 days to silking noted within GRIN characterization data (Germplasm Resources Information Network n.d.d). The bean variety, Hidatsa Red (Hidatsa – Three Affiliated Tribes), was donated by Seed Savers Exchange, of Decorah, Iowa. This variety was introduced commercially by Oscar Will in 1915. It matures in 80-100 days and is a half-runner type that can trellis up to 3 ft high when given support

(Germplasm Resources Information Network n.d.b; Seed Savers Exchange n.d.c). The squash, Algonquin Long Pie Pumpkin (Abenaki), was donated by Sierra Seeds, of Nevada City, California. This variety is quite rare, with contradicting, or altogether lacking, information about the variety's cultural ties available. The variety may have originated with the Algonquin people and was traded broadly throughout communities in the Northeast until it was adopted by White Euro-American settlers and popularized (Fedco Seeds n.d; Great Lakes Staple Seeds n.d). Seed of the sunflower variety, Arikara (Arikara – Three Affiliated Tribes), was donated in part by both the USDA and SSE. This variety is common today and may be the same variety that was mentioned in *Buffalo Bird Woman's Garden* (Seed Savers Exchange n.d.a). The sunflower was originally collected by Melvin Gilmore, the author of the book, and then later sold in the catalogue of Oscar H. Will. It is a 70-day annual and the seed packet from the USDA included a statement about the potential weediness of the variety. The Arikara sunflower is incredibly diverse and productive, towering over 10 ft tall, with both single and branching morphologies. Heads vary greatly, with some branching heads as small as a few inches across, and other, single heads, larger than a foot in diameter (Germplasm Resources Information Network n.d.c; Seed Savers Exchange n.d.a).

Growing Seasons

Traditionally, all crops are direct seeded, however, due to the delay in the 2020 season, all seeds except for corn were started in the greenhouse. Corn, the first sister to be planted, was direct seeded on June 4, 2020, nearly a month late due to delays caused by COVID-19. According to traditional protocol, bean is seeded approximately wo weeks after corn emerges– or when the corn reaches 4 inches in height. Squash is then seeded one week after the beans (Kruse-Peeples 2016). During the 2020 growing season, beans and squash were seeded in a

soilless mix (BLP Organic Growing Mix # 13) (Beautiful Land Products, West Branch, IA) on June 23. Beans were transplanted in the field on July 8, 2020, more than four weeks after the corn had been planted, creating a delay from traditional planting schedules. For the bean monocrop treatments, an A-frame using bamboo stakes was crafted to mimic the structural support that corn offers in the Three Sisters Intercropping treatment. Squash seedlings were fertigated in the greenhouse with Phytamin® Fish Plus (4.5-2-1) (California Organic Fertilizers, Hanford, CA) and, then transplanted on July 12, reuniting all the sisters in the field.

In the 2021 season, a more typical planting schedule was able to be maintained. To align with organic certification requirements, crop rotation was implemented in the monoculture treatments. The rotation plan was adapted from Elliot Coleman's eight-year rotation; maize → cucurbits → legumes (Porter 2009). With this rotation established, corn was direct seeded first on May 13, 2021. Emergence occurred on May 21st, 2021. Beans were direct seeded on June 1, 2021, when corn was at the V3 stage, approximately 5 inches tall. Beans emerged approximately a week later (Image 1, Appendix G). In the original design implemented during the 2020 season, two squash plants were seeded per mound, on opposite sides and diagonal from the corn and beans. This configuration was revised during the second year of this experiment, however, because of competition between the sisters in the intercropping treatment. The number of squash plants was decreased to one per mound in all the perimeter mounds, maintaining two plants in the four center mounds. These four center mounds from each treatment were designated as data mounds, and consistency was maintained between years to allow for comparison across years[29]. In the 2021 season, squash was seeded two weeks after beans, on June 15 and emergence occurred within a week (Image 2, Appendix G). We experienced some emergence issues due to

[29] This was particularly important for the soil aspect of the broader Three Sisters research experiment, which was not the focus of my research.

an early season drought, therefore some mounds needed to be reseeded in the following two weeks.

During the first growing season, overhead irrigation was installed once the corn had emerged and reached a few inches in height. However, when common smut (*Ustilago maydis*) emerged as an issue in July 2020, it became apparent that overhead irrigation contributed to the severity of the infection. In the following season, drip irrigation was utilized to mitigate this issue.

Pests

Pest pressure at the research plot was an issue, albeit a minor one, across both seasons. During the early season both years, when corn plants were young and tender, bird and racoon predation was a problem. Apparently, this is a common occurrence for Indigenous gardeners, as project collaborator Becky Webster spoke to similar nuisances on her own farmstead (2021a). During the second year of the project, after corn had been damaged by raccoons, an electric fence was installed around the perimeter.

Insect pressure during the season proved challenging, but not overall damaging to the health of the plants. A wide variety of pests were experienced, such as white flies, cucumber beetles, corn rootworm, corn earworm, European corn borers, and fall armyworm. With frequent scouting and pesticide applications, all pest populations were able to be controlled. Tank mixes were often utilized, such as M-Pede® (Gowan Company, Yuma, AZ) and PyGanic® (MGK®, Libertyville, IL) as well as Safer® (Safer® Brand, Lititiz, PA) and PyGanic®, to control white flies, corn rootworm and cucumber beetles. A tank mix of M-Pede® + PyGanic® + DiPel® Pro (MGK, Libertyville, IL) was also utilized for the same suite of insects. To treat powdery Mildew

in the squash near the end of the seasons, Cueva® (Certis Biologicals, Columbia, MD)– a copper octanoate product, was sprayed.

Pollination

As rematriation was a fundamental component of this research, appropriate isolation and seed saving methods were essential. Controlled isolation, using pollination bags, and spatial isolation were used to effect control of the parentage of seed progeny.

Isolation distances for corn, a highly outcrossing species, varies depending on a wide variety of environmental factors. A commonly approved isolation distance is 1,600 ft (Ashworth 2002; Organic Seed Alliance 2010). During the first growing season, neighboring conventional corn was further than 1,800 feet from the plot, so plants were allowed to open pollinate. Corn tasseling occurred in the second week of July in 2020, approximately a week earlier than expected. During the second growing season, seed saving become more complex due to presence of other corn varieties nearby the research plot. Since Turtle Mountain White was a short season corn, pollen contamination from later flowering conventional corn, which was slightly closer than the recommended isolation distance, was not considered to be a major threat. During the 2021 season, Turtle Mountain White corn again silked a week earlier than expected, in the final week of June.

Beans, as a self-pollinating crop, posed minor concern for seed saving purposes both seasons, especially as it was the only variety grown (Ashworth 2002; Greendeer 2021; Organic Seed Alliance 2010; Webster 2021a).

Squash, on the other hand, is a monoecious, outcrossing crop. In the absence of another cucurbit crop of the same species with which to cross with, however, cucurbits may self-pollinate. Had another *C. pepo* variety been within 300 feet of the research garden, then cross

pollination would have posed an issue (Ashworth 2002; Greendeer 2021; Organic Seed Alliance 2010; Webster 2021a). Therefore, spatial isolation was possible for squash in both seasons.

The remaining outcrossing sister, sunflower, did require controlled isolation. During the 2020 season, a nearby plot at the research farm was planted as a sunflower cover crop. Sunflowers were also identified in a nearby compost heap and wild sunflowers grew alongside the roads. An additional concern for outcrossing is the fact that the Horticultural Research Station also conducts pollinator research. As bees can transfer pollen from miles around and this could cause crosspollination of sunflowers, perimeter plants were bagged using the Delnet™ Apertured Film pollination bags (Image 1, Appendix G) (Myers 2002; Parker 1981). The unique polyethylene weave of the bags protects against unwanted pollinator insects while still allowing adequate water, air flow, and sunlight to pass (SWM Intl. n.d.). Pollination methods were adopted from protocol utilized by the North Central Regional Plant Introduction Station[30].

Harvest

At harvest, both marketable and unmarketable count and weight (in kg) was collected for each of the treatments, by crop. In the 2020 (first) season, the 10 August derecho significantly damaged the crops. While the beans and squash recovered from the damage, the corn crop was decimated. Therefore, corn harvest data for this season was lost. An additional component of the research, added during the second season, was the collection of corn smut (*Ustilago maydis*) galls as marketable yield, given the culinary value of the fungus for some cultures (Patel 2016) (Image 1, Appendix I). This collection also helped mitigate the spread of infection, since the removal of galls before they sporulated reduced the risk of infection to other plants (Christensen

[30] See Appendix H for sunflower pollination methods

1963). This developmental stage is also when the fungus is used for culinary purposes, allowing the harvest to be considered as fresh yield (in kg) (Patel 2016). To harvest smut, immature galls were collected each day and weighed for each plot (Image 2, Appendix I). Data collection began on 6 July 2021 and ended on 13 August 2021.

Corn

The process of harvesting corn followed Indigenous practices for seed saving. According to these methods, the primary ear of each corn plant is set aside for seed (Greendeer 2021, Webster 2021a; Will and Hyde 1964; Wilson 1987). Given this information, the primary ear, when available – as sometimes this ear had been removed prior due to smut infection, was separated and identified as seed yield (for rematriation). All other harvested ears collected as food yield, for human consumption. This distinction was crucial so that the best seed was rematriated. Both seed and food ears were weighed (in kg), and then yield was totaled and treated statistically as marketable yield. All unmarketable ears were those diseased or too undeveloped to be eaten. These too were collected for data and weighed. Corn harvest during the second season concluded on 21 September 2021.

Bean

Beans were harvested, as pods, when fully dried. Due to the length of the season and the varying maturity rate of the pods, a staggered harvest was implemented, collecting pods as they dried down. All pods were considered marketable unless they were diseased or not fully dried by the date of the final harvest. During the 2020 growing season, we began harvest on 15 October and concluded harvest on 20 October.

During the 2021 season, harvest began on 9 September and concluded on 22 October 2021. Pod weight was recorded at the time of harvest, and beans were later shelled. Weight of shelled beans were then collected, in kg, to record seed yield more accurately.

Squash

For squash, marketable and unmarketable weight was collected. During the 2020 season, harvest was conducted on 12 October. During the second season (2021), bacterial spot of cucurbit (*Xanthomonas cucurbitae*) caused fruit rot in the field; infected fruit were collected as unmarketable along with those that were also immature. Due to the longer season, and a general shortage of labor, harvest during this season occurred in a staggered manner, collecting fruit as they matured. Harvest began on 10 September and concluded on 5 October 2021.

Seed Processing and Storage

Once crops were harvested, seeds were processed by hand following Indigenous and home gardener seed saving practices. For corn, the Indigenous practice of braiding was used to allow the ears to dry down properly and for storage (Will and Hyde 1964; Wilson 1987). This practice was recommended by seed keeper Jessika Greendeer (Ho Chunk). Ears denoted for seeds were the primary ears of each plant (Greendeer 2021). Seed keeper Dr. Rebecca Webster (Oneida) also noted that seed ears are typically large and with straight rows of kernels (2021a). These criteria were also identified by Buffalo Bird Woman (Wilson 1987) and Will and Hyde (1964[31]). The process of corn braiding was learned through an online educational video (DiMaio

[31] Seed selection is mentioned in their book, *Corn Among the Indians of the Upper Missouri*: "Whenever an exceptionally good ear, ripe, and hard, long, straight-rowed, and of good color, came to hand it was stuck into a bag reserved for the seed corn, which was later plaited into separate braids" (1964; pg. 127).

2011) (Image 1, Appendix J). Braids consisted of approximately 55 ears, per the literature, and were then hung in a cool, dry place until they were rematriated (Wilson 1987).

Beans were similarly processed by hand when the pods were sufficiently dry. Dry pods were threshed by placing them within a paper bag or large container, and then crushed under foot or by hand to loosen seeds from the pods (Ashworth 2002). Seeds were then screened to remove any remaining dust and plant material. Beans were then bulked to create the most genetic diversity. Seeds were stored in a paper bag, in a cool dry place until they were rematriated.

Seeds of the pumpkins were removed by hand, and then thoroughly rinsed in a colander under running tap water to remove pulp (Image 2, Appendix J). Once the seeds were cleaned, they were spread to dry on a mesh screen, turning them once or twice to ensure that they did not stick together (Ashworth 2002) (Image 3, Appendix J). After a week of drying, pumpkin seeds were bulked in paper bags and again stored in a cool, dry place until they were rematriated.

Statistical Analysis

Yield comparisons were conducted using single-factor analysis of variance (ANOVA), with comparisons made between treatment groups for each of the crops. Therefore, corn yield in monoculture was compared to corn yield in the Three Sisters Intercropping, and similarly for corn smut, bean, and squash. This analysis revealed any significant differences between the treatments. Statistical analysis was conducted on JMP. Significance level was set to 0.05.

Other publications considering the impact of intercropping utilize the land equivalent ratio (LER) to better understand yield data (Mead and Willey 1980; Morales-Rosales and Franco-Mora 2009; Xu et al. 2020). This calculation uses the proportion of yield for each crop in

the intercropping system to yield for each crop in monoculture (Mead and Willey 1980). The calculation for LER is as follows:

$$\text{LER} = \frac{Y_1}{M_1} + \frac{Y_2}{M_2} + \frac{Y_3}{M_3}$$

In the context of this experiment, Y_1, Y_2, and Y_3 are yields (per area of the total treatment block – 20ft x 20ft) of species 1 (maize), species 2 (bean) and species 3 (squash). M_1, M_2, and M_3 are yields for the corresponding monocrop yields (per area of the total treatment block). To obtain a LER for the entire cropping system, the ratio of intercropped yield to monocrop was collected for each crop and replication. The LER for each rep was then averaged to create an LER for the entire season. For this calculation, any number greater than 1 denotes an increase in land use efficiency.

Results

Corn

Our first season suffered due to the loss of corn yield from smut and damage by the 2020 derecho. Smut was first noticed during the last week of July 2020, after the early summer rains had ended. Corn smut typically appears during this time because it thrives in humid conditions (Christensen 1963). By early August, smut galls had completely infected entire ears (Image 1, Appendix I). Then, on 10 August, a Derecho struck central Iowa and surrounding states. Akin to a Category 2 inland hurricane, the storm ripped through the research plot, leveling the plants. The impact of the Derecho was catastrophic, with 43% of Iowa's cropland affected (Halverson 2021).

Despite notes in the literature that monoculture systems generally yield high than intercropping due to incased plant-plant competition (Morales-Rosales and Franco-Mora 2009) yield for corn was higher in the Three Sisters treatment, on average, during the 2021 season.

Marketable weight for corn in the intercropping was 5.81 kg, compared to 5.57 kg for the monocrop. When a one-way ANOVA was conducted, however, there was no statistically significant difference between treatments (Table 1). Associated ANOVA tables are available in Appendix M.

Corn Smut Biomass

The second season, and increased familiarity with corn smut, spurred the collection of smut as marketable yield. For many cultures, corn smut is a delicacy that fetches high prices at market (Patel 2016). Despite smut infection being slightly higher in the monoculture treatment (average of 2.08 kg fresh weight harvested vs. 1.10 kg in the Three Sisters Intercropping), there was no statistically significant difference between treatments (Table 1). Associated ANOVA tables are available in Appendix M.

Bean

The delayed transplanting of the beans during the 2020 season caused notably stunting. Yield, as marketable weight, was significantly higher in the monocrop treatments, with an average yield of 0.71 kg, versus 0.06 kg in the Three Sisters. (p-value of 0.001) (Table 1). Associated ANOVA tables are available in Appendix L.

Improved growing conditions during the 2021 season markedly improved yields for the bean crops. Despite this, the monocrop treatment produced significantly more than the intercropping, with average marketable yields of 3.12 kg and 0.74 kg, respectively (p -value of 0.002) (Table 1). Associated ANOVA tables are available in Appendix N.

Squash

Yield was also significantly higher in the monocrop treatments for squash during the first year of the project. Average marketable yield was 192.6 kg in the monoculture, versus 133.33 kg in the Three Sisters (*p*-value of 0.006) (Table 1). Associated ANOVA tables are available in Appendix L.

Given the severity of disease in the 2021 season, much of the yield was lost, and considered unmarketable. Differences in marketable yield were slight, and statistically insignificant, with 59.26 kg produced in the monocrop treatment compared to 56.09 kg in the intercropping (Table 1). For unmarketable yield, however, the monocrop treatments lost an average of 46.15 kg to disease and the Three Sisters Intercropping lost an average of 29.52 kg. While the monocrop may have produced more fruit in total, the intercropping lost marginally[32] less fruit to the disease (*p*-value of 0.065) (Table 1, Appendix F). Associated ANOVA tables are available in Appendix O.

Table 1: Marketable yield across two growing seasons, with statistical comparison between Monoculture vs Three Sisters treatments for each of the crops

Yield (kg)	**CORN GRAIN**		**CORN SMUT**		**BEANS**		**SQUASH**	
	2020	**2021**	**2020**	**2021**	**2020**	**2021**	**2020**	**2021**
Mono	nd	5.57	nd	2.08	0.71	3.11	192.38	59.21
3 Sisters	nd	5.81	nd	1.43	0.06	0.74	133.33	56.04
P - Values	nd	0.78	nd	0.44	**0.001**	**0.002**	**0.006**	0.06

[32] A *p*-value of 0.065 is considered marginal in this thesis, considering that this result may be of practical interest to our collaborating gardeners

Land Equivalent Ratio (LER)

LER for the first season was calculated using marketable yield for bean and squash, since there was no harvestable corn yield due to the Derecho and smut infestation. Using what yield we had, a LER for the 2020 season was calculated to be 0.78 ± 0.03 (Table 1, Appendix K).

LER for the second season was calculated using two different sets of parameters. The first parameter considered total food produced, as marketable yield. Marketable yield for corn included both grain yield, but also fresh corn smut, given it being an edible and valuable delicacy. Using this approach, an LER of 2.20 ± 0.30 was calculated (Table 2).

For the second approach, total productivity was considered. This calculation considered both marketable and unmarketable yield. Due to the loss of squash yield from the bacterial disease, this approach allowed us to better consider the productivity of the cropping systems, regardless of fruit quality. This approach yielded a LER of 2.12 ± 0.17 (Table 2).

Table 2. Two approaches to calculating LER in the 2021 season

Land Equivalent Ratio (LER)	Rep 1	Rep 2	Rep 3	Rep 4	AVE
Total Food Produced: marketable yield + smut (in kg)	1.72	2.24	2.55	2.29	**2.20 ± 0.30**
Total Productivity: unmarketable yield + marketable yield + smut (in kg)	1.7	2.24	2.26	1.99	**2.05 ± 0.23**

Comparison of Yield Between Seasons

Due to the very different growing conditions of our two field seasons, it is not meaningful to the goals of the study to make comparisons between them. Despite this, such analysis provides insight into not how well the intercropping performed, necessarily, but rather the significance of growing conditions and management decisions to cropping success. I have chosen to conduct statistical analysis between growing seasons in order to quantify the difference in growing seasons and management decisions. I therefore conducted a single factor ANOVA for the crops for which there was yield data for in both seasons.

Bean

Average yield of beans in the monocrop treatment in 2020 was 0.71 kg, compared to an average of 3.1 kg in 2021. This amounts to nearly a four-fold increase in yield. This marked increase in yield during the second season resulted in a *p*-value (from a single factor ANOVA) of 0.002. For the Three Sisters Intercropping treatment in 2020, average bean yield was 0.06 kg, versus a yield of 0.79 in 2021. The resulting *p*-value was < 0.0001 (Table 3). This amounts to a 12-fold increase in the Three Sisters treatment between years.

Squash

I also wish to bring attention to a management decision made during the second growing season to reduce the number of squash plants by 62.5% per treatment. The decision was made due to the overly competitive nature of the plants in the intercropping, which may have contributed to reduced yield for corn and beans in the 2020 season. When the number of squash plants was decreased, yield diminished as well. However, due to bacterial leaf spot of cucurbits (*Xanthomonas cucurbitae*) dramatically reducing yield in the 2021 season, as well as drought and other insect damage, the most accurate comparison to deduce the impact of population reduction necessitates that yield from 2020 be compared with total productivity of the squash in 2021 (marketable and unmarketable yield combined). For the monocrop treatment in 2020, average yield was 192.38 kg compared to 105.32 kg in 2021, with a *p*-value of 0.0005. This amounts to a 45% decrease in yield. For the Three Sisters treatment, average yield in 2020 amounted to 133.33 kg compared to 85.53 kg in 2021. The resulting *p*-value with single factor ANOVA was 0.034 (Table 3). This amounts to a 36% yield decrease between growing seasons.

Table 3. Statistical comparisons between growing seasons for bean and squash

Yield (kg)	BEANS		SQUASH	
	Mono	3 Sisters	Mono	3 Sisters
2020 Season	0.71	0.06	192.38	133.33
2021 Season	3.12	0.75	105.33	85.53
P - Values	**0.002**	**<0.0001**	**0.0005**	**0.034**

Discussion

Drought and Late Planting

Yield for the bean crop, in both monoculture and intercrop treatments, is notably lower in the first season of this experiment. This could be attributed to a delayed start in 2020, nearly a month later than recommended in Iowa (Elmore 2012). Because of this timeline, the decision was made to transplant the beans, which may have resulted in the stunting of the plants. Daylength signals that trigger flower initiation would have occurred when plants were shorter than if they had been planted at an earlier, normal time. Throughout the season and well into July, the plants remained elongated and weak. Even by August, plants remained diminutive, neither climbing nor becoming bushy. The low yield in the first season, across the entire experiment, demonstrated how vital growing conditions are to the health and productivity of the plants.

In the 2021 season, drought was an issue early on. Water levels at ISU's Research farm's irrigation reservoir remained low throughout the season, causing issues of low water pressure across the farm. This became exacerbated in the plot's drip irrigation system, where irrigation pressure became low at the back end of the field, in the last replication. Conversely, pressure was highest at the front of the plot, in the first replication, meaning that this treatment received the most water. This irregularity may explain the great variation in yields across the four

replications. Yields are relatively high in the first replication, are very similar in replications 2 and 3, and then are visibly reduced in the fourth replication (Table 2, Appendix K).

Pest and Disease Pressure

Plant health responses to disease were perhaps the most interesting takeaway from this experiment. Both corn smut (Ustilago maydis) and bacterial spot of cucurbit (*Xanthomonas cucurbitae*) had marked impact on the health and productivity of the crops. Since Turtle Mountain White corn is an heirloom landrace variety, it lacks the resistance of more modern cultivars. The life cycle of common smut is such that spores can overwinter in the soil, infecting growing plants in the following season (Christensen 1963). One of the only management tactics in organic systems, and especially in those that utilize heirloom varieties, is to rotate away from the plot for a minimum of five years. Given the nature of this experiment, smut was a pervasive disease in need of management.

The decision to move away from overhead irrigation, and rely solely upon drop irrigation, was useful for minimizing humidity within the research plot. This, coupled with the 2021 season's drought, could have impacted smut development. The removal of immature smut galls by hand, before they broke open and spread infectious spores, could also have helped reduce disease pressure.

Xanthomonas cucurbitae, the causal agent of bacterial leaf spot of cucurbits, was also devastating at the research plot (Appendix P). The emergence of this disease was quite unexpected, given the nature of infection. Bacterial leaf spot has been reported as a seedborne pathogen, being carried both within and on the seedcoat. Pumpkins with symptoms during the growing season can therefore pass on the disease to the next generation through its seeds. The use of disease-free seeds is therefore the most proactive and effective management tactic

(Babadoost and Ravanlou 2012). The seeds received during the first year were untreated, as is common in Indigenous philosophies of how seeds should be cared for (Greendeer 2021a). While it is possible that these seeds could have carried the bacteria, to my knowledge, none of the plants grown in the 2020 season had signs or symptoms of the disease. Therefore, seeds saved in the 2020 season were not treated for the bacteria. Even if the seeds were clean, growing plants may still have become infected in the field due to surviving inoculum within the soil from infested crop residue (Babadoost and Ravanlou 2012). While the soil could have been the source of the inoculum, it would also be assumed then that we would have experienced the disease, in some capacity, during the first season. Therefore, the appearance of this issue, and the severity of it, is somewhat puzzling.

Bacterial leaf spot also proved to be challenging because very few cultivars have any level of resistance. The North Central Region of the United States, which is responsible for over 90% of processing pumpkin production in the country, has been particularly limited by disease loss due to varietal constraints (Babadoost and Ravanlou 2012). The Algonquin Long Pie pumpkin, like many heirloom varieties, was incredibly susceptible. With this disease, fruit become more vulnerable to colonization by secondary fungi and bacteria, increasing the decomposition rate of the fruit in the field (Liu, Ravanlou and Babadoost, 2016). Once infection occurs, bacterial leaf spot can cause up to 100% yield loss (Babadoost and Ravanlou 2012). While this level of loss was not experienced at harvest time, significant yield loss in the field did occur. We lost an average of 44% of pumpkin yield (in kg) at harvest in the monoculture treatments, versus 34% in the Three Sisters intercropping. Secondary colonization also poses significant threat of rot in storage (Liu, Ravanlou and Babadoost 2016). During post-harvest storage, nearly all fruit began to rot. At the end of the season, only one pallet of squash remained,

perhaps less than a quarter of the season's harvest. The rate at which fruit was lost, and the percentage that turned unmarketable in storage would have been interesting data to collect, had the project not been in its advanced stages and labor not been a limiting factor.

Despite these challenges, the impact of bacterial leaf spot of Cucurbits provides interesting insight into the significance of intercropping for plant health protection. Intercropping systems[33] are considered to be more resilient to pest and disease pressures when compared to monocultures. This method of growing plants together can be a component of disease management since intercropping may promote natural regulation mechanisms (Fininsa and Yuen 2002). Such mechanisms include barrier effects, the creation of microclimates, and increased microbial diversity both below and above ground (Finckh 2020). It is thought that intercropping mimics natural plant communities, where plant pathogen populations numbers often stay below an economic damage threshold (Fininsa and Yuen 2002)[34]. As noted in my own results, yields from the 2021 season demonstrate that plants in monoculture were impacted more severely than those in the intercropping. We experienced a yield reduction of 44% in monoculture plots, compared to only 34% in the Three Sisters plots. This difference, while perhaps not statistically significant, would be well understood by the stakeholders of our project – the gardeners utilizing varieties which may be susceptible to *Xanthomonas cucurbitae.* There are certainly opportunities for future studies to be designed to evaluate the impact of intercropping of squash on disease

[33] According to relevant literature on the subject, intercropping in an epidemiological context is defined as a change in disease intensity, progression, or transmission when a host species is grown in association with one or more plant species (Fininsa and Yuen 2002).

[34] While research endeavors have yet to consider the impact of intercropping on bacterial leaf spot in cucurbits, various studies have analyzed *Xanthomonas* in other crops. Fininsa and Yuen (2002), explored the impact of intercropping on the progression and severity of bean common bacterial blight (CBB), caused by *X. campestris* pv. p*haseoli*. Bean intercropped with maize or sorghum resulted in delayed progress of CBB, lower disease incidence, and lower severity. This study cites the mechanisms of disease reduction as including a change in microclimate, reduction in host density, and induced resistance and competition within the field. These findings verify the benefits of intercropping defined by Finckh (2020), above.

severity of *Xanthomonas cucurbitae.* Additional studies might also strive to better understand disease control mechanisms within Three Sisters Intercropping and intercropping more broadly.

Productivity of Three Sisters Intercropping

Despite these pest and disease pressures, the field seasons demonstrated the resiliency of Three Sisters Intercropping. Hart (2008) has noted that intercropping can be more stable than monocultures, even having the ability to withstand stochastic weather events better. While our yield data was greatly impacted by the 2020 season, a key takeaway was the ability of the Three Sisters to withstand the derecho. Aside from the corn, which was too badly damaged by the high wind speeds, the plants were able to recover and produce. This being said, the health of the plants greatly impacted by the late season start – so that yields were much decreased overall. It is difficult to draw conclusions about if, under better growing conditions, the intercropping would have withstood damage better, and therefore yielded higher, than in the monoculture.

Yields in intercropping systems are often slightly lower, due to the realities of plant-plant competition (Morales-Rosales and Franco-Mora 2009). Therefore, we were not disheartened when some of our results followed this same trend. The yields of the bean in the Three Sisters were decreased when compared to the monoculture, perhaps more dramatically than expected. Other studies have considered the impact on intercropping corn with a legume, given the significance of corn worldwide. In many situations, it was found that while corn yields increased in intercropping systems, bean yield was often reduced due to shading (Xu et al. 2020). It is very exciting that our corn yields during the second season align with these findings. Xu et al. studied corn/soybean intercropping, so the difference in architecture between the plants might explain the shading of the beans. In a Three Sisters system, the pole bean climbs the corn, thus accessing as much sunlight as possible and reducing competition for light (Hurt 1987; Mt. Pleasant 2006;

Mt. Pleasant 2016). From field observations during both seasons of this experiment, however, it was noted that the intercropping often did not act as symbiotically as anticipated. The diminutive stature of the Turtle Mountain White corn, paired with half-runner Hidatsa Red bean, made for an uncooperative pairing. Additionally, I observed that the Algonquin Long Pie Pumpkin may have been too vigorous for growing with shorter corn and bean. As the pumpkin originated from the Northeast, its regional adaptation is different from the Midwestern sisters. The pumpkin had much wider leaves and vigorous growth habit that what may have been typically grown with the corn and bean. It is possible that this mismatch in growth habits and plant architecture contributed to the shading out of beans, leading to a significantly diminished yield in the intercropping. A collaborator once remarked that in Three Sisters Intercropping, the plants may act more like roommates than true sisters. This metaphor is useful for explaining how, when varieties are not well-suited to be intercropped together, they may not act harmoniously. In the case of our intercropping, it was evident that the Algonquin Long Pie Pumpkin behaved more like a selfish roommate towards the corn and the bean, refusing to share equally in the system.

Given the dramatically different yields between crops in monoculture and the intercropping, the land equivalent ratio (LER) was the only appropriate tool to compare the yield results of the experiment. According to Xu et al.'s metanalysis, their findings indicate that an average LER for intercropping systems falls between 1.22-1.3 (2020). In the same metanalysis, Xu et al. also calculated the average LER for corn/soybean intercropping within North America. Using yield data from 63 studies, the average LER was 1.06 ± 0.066 (Xu et al 2020).

When compared to Xu et al.'s results, the LER calculated for the Three Sisters is groundbreaking. When an LER was calculated in the 2021 season, a result of 2.05 ± 0.23 was achieved for total productivity. When total food produced was considered, the LER increased to

2.20 ± 0.30. Both of these results are remarkably higher than most studies. As mentioned, a LER greater than 1 denotes an increase in land-use efficiency (Mead and Willey 1980). Our results can therefore be understood as the Three Sisters are 105-120% more efficient in regard to land use.

These calculations, however, are extremely limited by the constraints of the study. To start, in LER calculations require that same number of plants be present per area of land in order to ensure that the yield comparisons are fair (Mead and Willey 1980). In this experiment, the combined issues of pest and disease pressures in the 2021 season made it so the number of plants per treatment plot is unknown. Raccoon damage and squash vine borers eliminated some plants in the early season, whereas bacterial spot and corn smut also dramatically impacted yield results. Therefore, these constraints demonstrate that the LER results may not be an accurate representation of the intercropping's efficiency and may be skewed by a difference in plant numbers between treatments. Therefore, the results should not be misconstrued as definitive proof for the productivity of Three Sisters Intercropping. Despite the limitations of this study, the current LER calculations may indicate that a more accurate comparison between treatments could yield a meaningful result of greater than 1, thus demonstrating land use efficiency and productivity benefits. Additional research would further illuminate the nature of these benefits.

Despite the constraints of this study, these results would be of genuine interest to our collaborators. Land access has been a commonly cited limitation by collaborating Indigenous growers (Greendeer 2021; Zeise 2021). The efficiency of Three Sisters Intercropping could therefore be a crucial piece of evidence for convincing more growers to adopt the practice. This information might contribute to the increased participation of Indigenous people within rejuvenation efforts. As an effective system, intercropping may also lend to the increased

production of food on reduced tracts of land, such as in urban environments. The reality is that the Three Sisters could significantly increase food security and nutrition for these populations. Similarly, the restoration of these systems would contribute to efforts for increasing food sovereignty within Native nations.

Conclusion

Growing a Three Sisters garden has been a valuable aspect of my ethnographic fieldwork[35]. I have been afforded the opportunity to use Indigenous growing methods within a larger, wholistic research experiment, which has built upon my understanding of traditional ecological knowledge. I have, through interviews, participant observation, and collaboration with the project's advisory council, been privy to some of the greatest challenges faced by communities today. Seed and food sovereignty are among the most significant concerns for communities, and the interconnected nature of the two has been a dominant theme of my research. The commitment of Native nations to restore their cultural foodways is evidence of how meaningful these traditions are to identity and sovereignty.

Three Sisters Intercropping is a highly sophisticated system, with each plant having its own distinct role that contributes to its success. The efficiency and productivity of intercropping was demonstrated by my two field seasons of managing a Three Sisters study. Despite two very different growing seasons, each with its own unique challenges, intercropping proved to be a beneficial practice. While yields were lower for each of the crops in intercropping when compared to monoculture, the power of intercropping lies in the land equivalent ration (LER). This measurement quantifies how efficient intercropping is, in terms of land use. Our growing

[35] For additional photos of the Three Sisters Intercropping study, see Appendix Q.

systems yielded a LER of 2.20 ± 0.30, meaning that Three Sisters Intercropping can be 120% more effective than growing each of the crops separately. These findings, which build upon generations of traditional ecological knowledge by the communities who have developed these systems, increase scholarly understandings of how these crops work well together. Native growers know that intercropping has benefits, yet this study explored in what ways specifically do the Three Sisters support one another to maintain system health and productivity. By sharing our results through the project's collaborative network of Native growers, it is hoped that more communities will revitalize their traditional growing systems. Such resurgences can have lasting impacts on food security and sovereignty for generations to come.

CHAPTER 6. CONCLUSION

Seed rematriation as a movement, process, and end goal is new and has yet to receive the academic attention it deserves. Few research projects have attempted to work within the rematriation framework, and even then, recent publications often cite the same limited body of literature (Ocampo-Giraldo et al 2020). Therefore, increased scholarly work on this subject could significantly lend to future reach and impact of this process. In the sphere of academia and research, such developments may be necessary for this work to gain sufficient traction and respect. As the movement challenges many of the colonial institutions currently at the forefront of germplasm conservation work, a great deal of research and support will be necessary if rematriation is to be successful for Indigenous communities.

My research has explored the evolution of the rematriation movement, from the origins of the term to its evolving meaning and uses for seed reclamation work. It has become evident, through ethnographic interviews and collaboration within the seed rematriation network, that this process offers profound benefits for Indigenous communities. This form of reclamation work centers sovereignty; for both seed, food, and broader tribal sovereignty. My thesis has presented a nested theory for Indigenous sovereignty, discussing how various spheres of sovereignty are overlapping and interconnected to uphold community autonomy. The status of seed systems today within Native communities, and the histories of dispossession and loss of valued ancestral varieties, has demonstrated that seed sovereignty is perhaps the most precarious layer. Seed sovereignty, as seeds within the hands of growers with the rights to reproduce and save seeds as they see fit, directly impacts food sovereignty if people are unable to enact their cultural foodways. As farming is also dependent on land, I envision these three sovereignties as nested, each vitally contributing to the ability of a community to sustain itself.

The precarious nature of seed sovereignty within many Native American communities today has spurred an era of reclamation – of both cultural seeds and their associated systems of knowledge. Seed rematriation has been proposed as one means of restoring traditional seed systems. The process of rematriation identifies culturally significant seeds from within the holdings of non-Native institutions, such as museums, universities, botanic gardens, and germplasm repositories. There are various paths by which Indigenous varieties have entered these institutions, but the fact remains that today, these actors control seeds that Indigenous communities have need for. The longstanding, deep cultural and kinship relationships that many Native nations have with their seeds constitutes a right, for both control, preservation, and conservation for those varieties. In that sense, rematriation seeks to access these seeds and return them to the hands and soils of their home communities.

The rematriation movement has contributed to the reclamation of cultural knowledge, traditions, and practices. When seeds are reunited with their home communities, growers and seed keepers are able to rekindle the kinship relationships that are fundamental to Indigenous gardening systems. Seeds are considered valued members of the community and are seen as the crucial link between generations in the ways they hold and share cultural knowledge (White 2018b). Seeds are also embedded within kinship systems, viewed as valued ancestors for their guidance and generosity (Greendeer 2021; Hill 2017a; Webster 2021a; White 2018b). Seeds also reawaken and make possible the perpetuation of cultural traditions, for both seed keeping and food production. In this way too, the return of seeds contributes directly to seed and food security while upholding seed and food sovereignty.

While my ethnographic interviews were crucial for my understanding of the rematriation movement and its implications for Indigenous seed sovereignty, this research would not have

been as successful without my ability to grow Indigenous seeds for the purpose of rematriation. As a member of a collaborative research project with the aims of exploring the cultural, agronomic, and nutritional underpinnings of Three Sisters Intercropping, I was afforded the opportunity to manage a garden plot at Iowa State University's Horticultural Research Station. In collaboration with a Native advisory board made up of seed keepers, growers, and elders, we selected Indigenous varieties of corn, bean, squash, and sunflower for seed amplification and rematriation. Working in collaboration with this network helped the project build rapport with communities while gaining an increased understanding of the complexities of seed saving and the rematriation process. While seeds for rematriation were a critical deliverable of this research, I also compiled agroecological data to provide to our collaborators. Through the Three Sisters Intercropping experiment, we found that growing the sisters together is more efficient, in terms of land use and productivity, than growing them in monoculture. Using the land equivalent ratio (LER), we calculated a value of 2.05 ± 0.23 for the 2021 season, using total productivity (both marketable and unmarketable weight combined). A calculation for total food produced (marketable yield), resulted in an LER of 2.20 ± 0.30. While these calculations are flawed by the constraints of the growing seasons, they demonstrate that intercropping allows for an increase in land use efficiency while maintain yields. This data is valuable for increasing acceptance of the practice in reclamation efforts. Considering the productivity of the system, Three Sisters Intercropping can contribute to food security even on small parcels of land – as is common for many Indigenous growers. This research therefore adds to current rejuvenation efforts by supporting the benefits of the intercropping for community health and food security.

Significances of this Research

Seeds are an integral part of reviving traditional agricultural practices, and the conservation of seeds and knowledge are linked. Without access to their traditional seeds, Native people have been unable to revitalize their traditional food systems (White 2019). By returning seeds to the hands and fields of their home communities, rematriation seeks to reestablish community-based conservation efforts. This method of conservation, as being enacted through day-to-day life, in rhythm with the cultural practices of Native people and their food systems, has been depicted as more culturally appropriate than the current sole reliance on genebanks and seed libraries (Nazarea, Rhoades, and Andrews-Swann 2013). *In situ* conservation, sometimes rephrased a *in vivo* might allow Indigenous varieties to be preserved through traditional means, thus contributing to the lasting and effective preservation of unique cultural varieties. When seeds are returned to their communities and become reestablished within cultural seed saving networks, conservation becomes a way of life (Nazarea 1998).

In order for the preservation of cultural varieties to be the most effective, elements of *ex situ* conservation must be incorporated into long-term plans. Any created systems of conservation that arise from the rematriation movement must prioritizes effective, long-term and sustainable methods that uphold culturally beliefs around the appropriate safeguarding of Indigenous plant resources. While my own research did not delve deeply into seed storage work within Indigenous communities, many of my collaborators shared their current practices. Remarkably, many of the seed keepers I spoke with to decide to *not* save seeds for longer periods of time, but rather to cycle through the differing varieties in two to three years. The mechanisms of these fast-paced conservation system, however, was a reliance on community seed networks. Rebecca Webster started her own bean co-op for this very purpose, spreading the responsibilities for Haudenosaunee ancestral beans across 20 different families. Each year, the members of the

group select different seeds to grow out, ensuring that the most diversity is conserved over both time and space (Webster 2021). These efforts contribute directly to the conservation of a healthy, regionally, and culturally adapted variety, but are notably different in their values and priorities. Elena Hill, a younger member of the Oneida Nation of Wisconsin, with a passion for food and seed sovereignty, voiced her own hopes that the community might one day establish its own seed bank (2021). Research on community seed banks and small-scale seed saving at the community level is limited (Shiva 2016). I believe that this form of seed conservation presents a braided effort for both *in situ* and *ex situ* methods, with seeds being grown within their environments but also stored there too, by the members of the community most invested in these seed resources. For the moment, however, seed saving and sharing networks may be the most powerful actors in conserving and distributing Indigenous seeds for the future, expanding the diversity available to them.

This research, as collaborating with seed saving and sharing networks, supported the preservation of traditional knowledge and practices surrounding Native gardening and seed keeping. The reclamation of cultural growing practices, alongside the reintroduction of culturally significant seeds, will ensure that these plant varieties will not be separated from their communities again. The reestablishment of cultural seed systems, in their most healthy and diverse forms, could allow communities to grow these crops and maintain them for years to come. This future, with access to and control of ancestral seeds securely in the hands of Native growers and communities at large, is that of seed sovereignty for Native nations in the United States.

The safeguarding of cultural seeds, and more acutely, the relationships that communities have with their seeds, is a rising concern for Indigenous communities. Within conversations of

seed sovereignty and culturally appropriate methods of sharing seeds, actors within Indigenous seed networks are currently developing their own seed information databases. These databases may be password protected, so that only Native growers can access information and seeds (Webster 2021a; Zeise 2021). Such online applications have the goal of rejuvenating traditional seed systems by connecting Native growers with cultural seed keepers. Collaboration and reciprocity are prioritized so that seeds pass hands in culturally appropriate ways, reminiscent of the seed trading networks that upheld Indigenous gardening systems prior to contact. However, for these networks to be successful, they may require access to the seed collections of institutions like those of USDA or Seed Savers Exchange, at least early on. Seeds from these institutions could be listed as initial seed sources, until varieties are rematriated into their home communities under the stewardship of Native seed keepers. Once cultural varieties are reintroduced into these local seed systems, Indigenous growers may eventually replace non-Native institutions as the source of these varieties for other growers within the database and network. The successful outcome of such collaboration would be that those varieties, while still being maintained by germplasm conservation institutions, would simultaneously be preserved by Native nations in a position to share those seeds through culturally defined avenues.

Relationships between Indigenous seed networks and seed-holding institutions for this purpose have not yet been developed. The possibilities of collaboration and rematriation to re-establish cultural seed systems are of interest to the Indigenous growers and seed keepers involved (Webster 2021a; Zeise 2021). With the large collections that reside within these seed banks, however, there are many opportunities for making seeds and their associated information more accessible to Indigenous communities. The culturally sensitive participation by these institutions could allow numerous varieties to be identified and claimed by their nations.

Moving Forward

If the rematriation movement is to grow beyond the networks of actors and institutions currently involved, more information about the motivations, goals, and significances of this work must be prioritized. Scholarly research on this subject is currently limited, which provides many opportunities for investigations and insight. This research can attest to that. Any exploration of this movement by academia may increase understandings of Indigenous sovereignties and the nested nature of seed, food, and land sovereignty. Such attention could powerfully shift the trajectory of cultural reclamation efforts surrounding Indigenous agriculture by shedding light on the need for ancestral seeds.

Throughout conversation with Indigenous growers and seed keepers, various other opportunities for seed reclamation work have been noted. A prominent example has been through the leveraging of policy, although many people have acknowledged that the associated red tape with this magnitude of policy action is incomprehensible. This is especially true for conversations surrounding how the rematriation process might draw inspiration from the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990. As mentioned, rematriation signifies a feminine refocusing of repatriation work, which has attempted to rectify past abuse and mishandling of human remains and sacred cultural objects of excavated and plundered grave sites (McManamon 2000). Seeds recovered from burial sites or religious bundles do fall under the jurisdiction of NAGPRA (Hill 2017a). For seeds not under this protection, some scholars have argued that Indigenous seeds should more broadly be understood as cultural objects or living entities in need of returning home (Hill 2017a; White 2018b; White 2019). Like pipes or war bonnets, seeds have cultural, religious, spiritual, and ancestral value.

Seed reclamation actors have therefore looked to this legislation as a framework for how the rematriation process might be leveraged within seed-holding institutions. At this point in

time, the movement could develop collaborative projects for the voluntary return of seeds from public institutions. A logical example is that of USDA seed banks. As Christina Gish Hill surmised about concerns over seeds in these types of institutions, "Although Native people can also access them, including their Indigenous varieties, with no say in how the seeds in the bank are treated, they are unable to safeguard Native varieties of great social, economic, and religious value from culturally inappropriate uses" (2017a, pg. 106). Rematriation, in a more developed and implemented set of procedures like that of repatriation, would help define what responsible, culturally appropriate stewardship of these resources entail. Hill also established that the adoption of a more formalized process based on repatriation practices would require institutions to trace the histories and lineages of the seeds in their collections, thus developing clearer affiliations between seeds and Native nations. While the limitations of current accession data have been well developed in this thesis, and funding for researching seed histories would be an additional hurdle, increased efforts in any capacity might build collaborative partnerships between Indigenous seed keepers and seed-holding institutions for the production and dissemination of information. While such efforts and collaboration have yet to be established in force, the integration of rematriation guidelines might lead to respectful, effective, and sustainable partnerships for the conservation of Indigenous varieties.

Seed rematriation, as such a recent and evolving practice, holds many opportunities for relationships and cooperation between research universities, seed-holding institutions, and Native tribes. My research, having occurred within a land grant university, has explored potential roles and responsibilities of non-Native seed holding institutions to contribute to seed rematriation efforts. Collaboration fosters a meaningful opportunity for making seed access, and as an extension, seed sovereignty, attainable for Native American nations. By drawing attention

to the significance of collaboration and partnership for the rematriation movement, this project has been uniquely positioned at the forefront of a new wave of decolonizing work. My research critically relied on the combined efforts of a variety of stakeholders: Native communities, public Universities, non-Profits, and the USDA. Through navigating the differing agendas and cultures of the participants in these relationships, this research sought to define how, and in what ways, collaboration can meaningfully occur. The efforts and results of this thesis have the power to influence how future stakeholders respond to the increasing momentum of the rematriation movement.

Such is the need to move forward now. There are many opportunities for non-Native institutions and actors to meet the needs of the rematriation movement. A primary issue, as discussed in this thesis, is that of information. Many more seeds would be able to be identified and returned home if seed accession information (of many types) increased. Lack of information for seed collections is not just an issue among museums and seed-holding organizations. This is a serious concern within the USDA National Plant Germplasm System, which curators strive to address in a proactive manner. Since the NPGS's role is to provide seeds to the public, the prioritization of accession information has been identified as a strategy for increasing access by GRIN users (Byrne et al 2018). Data sharing and collaboration could fill these gaps in knowledge. If seed conserving organizations were to partner with Native seed keepers, and all shared information resources with a focus on fully documenting the histories of the varieties they steward, more Indigenous varieties could be identified and the range of and success of the rematriation movement could dramatically increase.

The USDA NPGS could also target the Germplasm Resources Information Network (GRIN) as an area that could better support rematriation success. As my own experiences with the

database has revealed, GRIN-Global can be cumbersome to navigate for those with limited information or knowledge about the seeds they are searching for. I was able to amble and formulate my own methods (with some experienced guidance) for finding Indigenous seeds within GRIN, by narrowing down search criteria by improvement level (landrace), country of origin (United States – and then by state) and finally by the genus of the crop I searched for. Even narrowed search parameters locate a wealth of accessions that are not Indigenous, due to the prevalence of Western heirlooms within the collection.

During the Three Sisters Intercropping project's 2022 advisory board meeting, we toured the North Central Regional Plant Introduction Station (NCRPIS), in Ames IA. We were given a demonstration of a search feature available through GRIN-Global that allows searching accession data using a descriptor designation of "ethnic group," from which 67 nations are recognized. The 'ethnic group' search feature currently works only for the maize group because innovative genebank personnel made it a priority to identify and annotate those accessions (246 currently) meeting the parameters. Given the obscurity of some accessions, it can be wondered how many varieties are unaccounted for. This search feature, however, heralds a brighter future, with actors like the USDA acknowledging the significance of cultural affiliation and relationships. I would like to think that our research project, and the needs of our collaborators, played a small role in the development of this search feature. Throughout this research, we have become well acquainted with the NCRPIS, having shared in three years of visits and conversations; first as a seed donor, but later as an active member in the collaborative network of our project. The increasing need to identify and access Indigenous varieties has been at the forefront of our minds since the inception of this work. The NCRPIS has been a valuable ally to the project, and increased attention to locating Indigenous varieties for NPGS customers is a

progressive step towards making these seeds more easily accessible for those who need them. The application of this program to additional crops, with bolstered accession data and historical narratives gathered in collaboration with Native nations and seed historians, could shift the trajectory of the rematriation movement. It is my hopes that increasing partnerships contribute to many more Indigenous communities being reunited with their culturally cherished seeds.

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APPENDIX A. IRB EXEMPTION

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office of Research Ethics
Vice President for Research
2420 Lincoln Way, Suite 202
Ames, Iowa 50014
515 294-4566

Date: 09/22/2020

To: Emma Herrighty Christina G Hill

From: Office of Research Ethics

Title: **Seed Rematriation, Seed Sovereignty, and the Three Sisters Gardening in Native American Communities**

IRB ID: **20-290**

Submission Type: Initial Submission **Exemption Date:** 09/22/2020

The project referenced above has been declared exempt from most requirements of the human subject protections regulations as described in 45 CFR 46.104 or 21 CFR 56.104 because it meets the following federal requirements for exemption:

2018 - 2 (ii): Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) when any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for continuing review. Instead, you will receive a request for a brief status update every three years. The status update is intended to verify that the study is still ongoing.**
- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any *modifications to the research procedures* (e.g., method of data collection, nature or scope of information to be collected, nature or duration of behavioral interventions, use of deception, etc.), any change in *privacy or confidentiality protections*, modifications that result in the *inclusion of participants from vulnerable populations*, removing plans for informing participants about the study, any *change that may increase the risk or discomfort to participants, and/or* any change such that the revised procedures do not fall into one or more of the regulatory exemption categories. The purpose of review is to determine if the project still meets the federal criteria for exemption.
- All ***changes to key personnel*** must receive prior approval.
- **Promptly inform the IRB of any addition of or change in federal funding for this study.** Approval of the protocol referenced above applies only to funding sources that are specifically identified in the corresponding IRB application.

APPENDIX B. INTERVIEW QUESTIONS

1. How did you get into seed saving?
    a. Who or where did you learn from?
    b. Why do you feel this work is important?
    c. What methods of seed saving and storage do you use?
2. Are there any stories in your nation that highlight the cultural or historic importance of seeds, if you feel comfortable sharing?
    a. Are there any specific varieties associated with those stories?
3. Can you say a little about seed sovereignty? What does it mean to you?
    a. How does this relate to other aspects of Native sovereignty?
4. What does the term “rematriation” mean to you?
    a. How do you use this word?
    b. Why do you think it’s important that we use this word, as opposed to others?
    c. Why are you involved in this process? What does it entail?
    d. Why do you think this movement is important for Native communities?
5. What criteria do you look for in seeds for potential rematriation?
    a. If a seed has spent a long time away from her community, is there anything that would make her too different
6. What do you envision as the future of seed saving and rematriation?
7. What are the challenges that you or seed keepers face?
    a. Technical, social, and economic factors?
    b. Both currently and in the future?
8. how do you feel Indigenous seeds should be cared for by Non-Native institutions?
    a. Do you think there should be restrictions on who can access Indigenous seeds? How could or should seed-holding institutions better protect these seeds?

APPENDIX C. GRIN GLOBAL SEARCH CRITERIA

Finding these varieties through the Germplasm Resources Information Database (GRIN-Global) requires the use of multiple search features and choice key words. The most successful search methods that I utilized included narrowing down the selection for each crop species by genus name, and the narrowing further to the criteria of country and state of origin, as well as using the identifier of "landrace" to locate heirloom, possibly ancestral varieties. When search results did yield potential varieties, another point of reference for locating Indigenous varieties is through the names of the varieties. Heirloom varieties typically have descriptive names, denoting color, shape, and other unique characteristics as well as sometime incorporating the name of the person or community connected to those seeds (Nazarea 2005). When searching for landrace corn (genus *Zea*) from Nebraska, for example, results yielded varieties such as "Winnebago Spotted" and "Wa-haa-ha-kow (Yankee cheat)" on the first page alone.

Thus, it was through this methodology that we complied a seed index of 203 varieties of corn, 90 of bean, 60 of squash, and 19 varieties of sunflower. It is very possible, however, than many varieties and seeds evaded our search.

APPENDIX D. PLANT INTRODUCTION INTAKE FORMS

213775 to 213811. ZEA MAYS L. Poaceae. **Corn.**

From North Dakota. Seeds obtained through the Oscar H. Will Seed Co., Bismarck. Numbered Mar. 3, 1954.

213775 and 213776. Mandan, N. Dak.

213775. *Rainbow Flint.*

213776. *Northwestern Dent.*

213777 to 213789. Experiment Station, Brookings, S. Dak.

213777. *Golden Jewel.*
213778. *Gehu.*
213779. *Blue Flour.*
213780. *Fulton Yellow Dent.*
213781. *Flaconer.*
213782. *Brookings #86.*
213783. *Brown County Yellow.*
213784. *Dakota White.*
213785. *Black Hill Special.*
213786. *Early Murdock.*
213787. *Rainbow Flint.*
213788. *Northwestern Dent.*
213789. *Wimples Yellow Dent.*

472016 TO 472021-continued

472016. Ivory King. United States. Kernels white, some with pink tint, flour type. Cobs white. Primitive Cultivar. Seed.

472017. Karpation Russian. United States. Kernels yellow, flint type. Cobs white. Primitive Cultivar. Seed.

472018. Mercer Flint. United States. Kernels yellow, flint type. Cobs white. Primitive Cultivar. Seed.

472019. Pima White. United States. Kernels white, some with pink tint, flour type. Cobs white. Primitive Cultivar. Seed.

472020. Prides of the Plains. United States. Kernels white, flour type. Cobs white. Primitive Cultivar. Seed.

472021. Turtle Mountain White. United States. Kernels white, some with pink tint, flint type. Cobs white. Primitive Cultivar. Seed.

APPENDIX E. RESEARCH PLOT DESIGN

Figure 1. Treatment map for the 2020 and 2021 growing season. The rotation is separated as 1st year/2nd year. For example, Rep 1, plot 1 (farthest left) was planted in corn the first year of the rotation and squash in the second year.

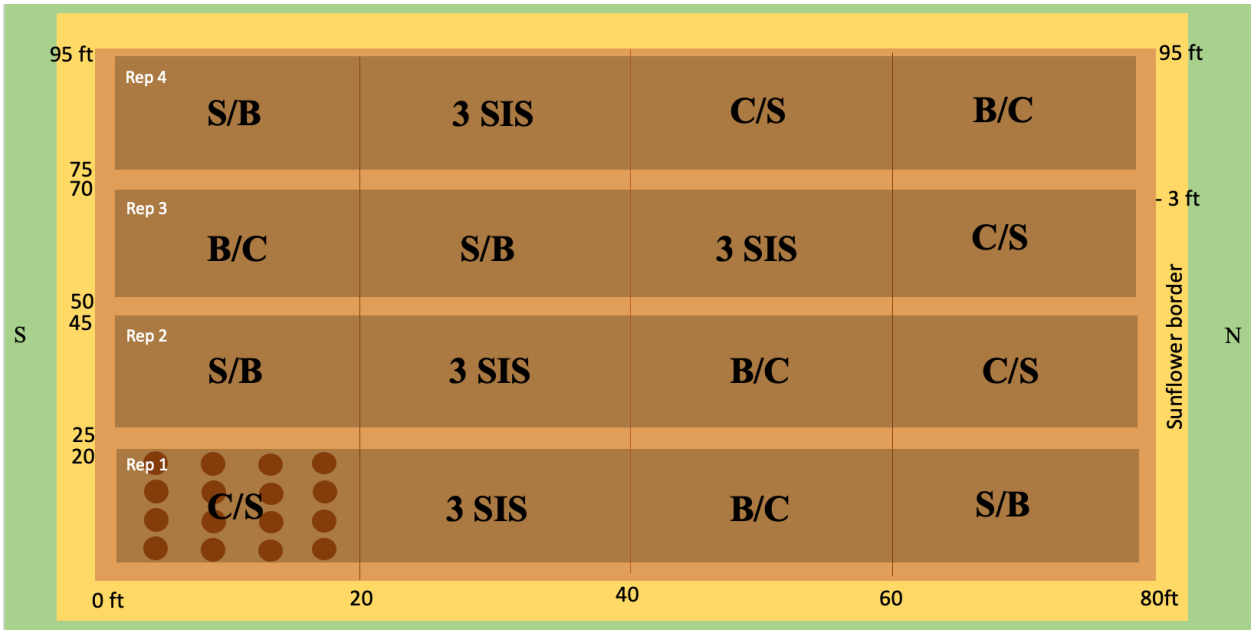
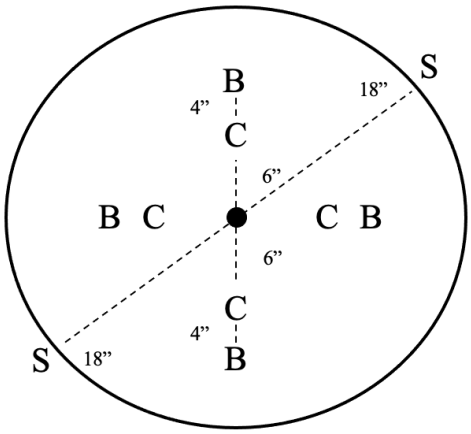


Figure 2. Mound layout, where C is corn, B is bean, and S is squash. For perimeter mounds during the 2021 season, which only had one squash plant, the plant on the North side of the mound was left out.



APPENDIX F. SUMMARY TABLE FOR THREE SISTERS EXPERIMENT

GERMPLASM USED		
Variety	**ID**	**Source**
Turtle Mountain White Corn	PI 472021	USDA NPGS
Hidatsa Red Bean	---	Seed Savers Exchange
Algonquin Long Pie Pumpkin	---	Sierra Seeds Cooperative
Arikara Sunflower	PI 369357	USDA NPGS and Seed Savers Exchange

PLANTING DATES		
Crop	**2020 Season**	**2021 Season**
Corn	June 4	May 13
Bean	June 23 (seeded in greenhouse) July 8 (transplanted in field)	June 1
Squash	June 23 (seeded in greenhouse) July 12 (transplanted in field)	June 15
Sunflower	June 15	May 13

HARVEST DATES		
Crop	**2020 Season**	**2021 Season**
Corn Smut	---	July 6 – August 13
Corn Grain	---	September 21
Bean	October 15 – October 20	September 9 – October 22
Squash	October 12	September 10 – October 5
Sunflower	September 22 - September 28	September 29

MARKETABLE YIELD (KG)						
Crop	**2020 Mono**	**2020 3 Sisters**	**Significance**	**2021 Mono**	**2021 3 Sisters**	**Significance**
Corn Smut	nd	nd	nd	2.08	1.43	0.44
Corn Grain	nd	nd	nd	5.57	5.81	0.78
Bean	0.71	0.06	0.001***	3.12	0.74	0.002**
Squash	192.38	133.33	0.006**	59.26	56.09	0.81

UNMARKETABLE YIELD (KG)			
Crop	**2021 Mono**	**2021 3 Sisters**	**Significance**
Corn Smut	nd	nd	nd
Corn Grain	0.10	0.13	0.55
Bean	0.08	0.05	0.14
Squash	46.15	29.52	**0.065***

The term “nd” refers to no data

APPENDIX G. GROWING SEASON IMAGES

Image 1. Bean emergence on 7 June 2021

Image 2. Squash emergence on 21 June 2021

APPENDIX H. SUNFLOWER POLLINATION

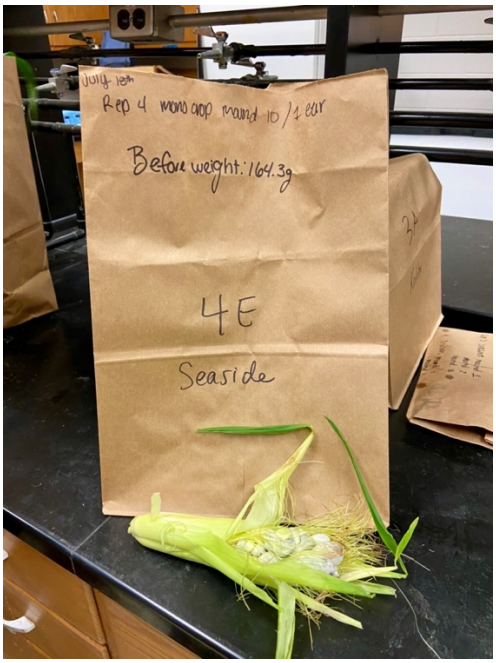
Methods include the bagging of heads when they are at the button stage: the petals of the head remain closed while a peak of yellow indicate that the flower is close to opening. Generally a day after this stage, the flower opens and anthers begins to shed pollen and the stigmas become receptive. Each morning, when stigmas are most receptive, pollen is collected from the flowers by opening of the bags and swabbing of the flower faces with a square of paper towels. The bags over the head are then swiftly closed to prevent any pollinators from entering. I would then go on to the next sunflower, open the head, and deposit pollen onto the flower while collecting pollen from that flower at the same time. This process is then repeated around the entire perimeter to ensure that all the pollen is being mixed, therefore allowing outcrossing for the flowers. After a few weeks, flowers began to dry out, with anthers no longer shedding pollen and stigmas no longer active. At this point, bags remained on the heads as protection against bird or insect predation. When the backs of the heads became droopy, bright yellow to brown in color, and brittle, I knew that the seeds were mature.

Image 1. Controlled Isolation with Delnet™ Apertured Film pollination bags

APPENDIX I. SMUT HARVEST

Image 1. Fresh smut gall

Image 2. Data collection of fresh smut yield



APPENDIX J. SEED PROCESSING

Image 1. Corn braiding

Images 2 and 3. Processing pumpkin seeds

APPENDIX K. YIELD RESULTS

Table 1. Yield (in kg) for bean and squash in monoculture and intercropping treatments, as well as LER for the 2020 growing season

	CORN		BEAN		SQUASH		
	3 Sisters	**Mono**	**3 Sisters**	**Mono**	**3 Sisters**	**Mono**	**LER**
REP 1	nd	nd	0.07	0.69	138.7	212.90	0.75
REP 2	nd	nd	0.06	0.64	128.5	185.29	0.78
REP 3	nd	nd	0.04	0.86	150.5	209.80	0.77
REP 4	nd	nd	0.06	0.64	115.5	161.60	0.81
AVE	**nd**	**nd**	**0.06**	**0.71**	**133.33**	**192.38**	**0.78 ± 0.03**

*Due to the 2020 derecho, yield for corn was lost. This is denoted as nd, for no data.

Table 2. Total productivity (marketable and unmarketable yield, in kg) for corn (including fresh corn smut), bean, and squash in monoculture and intercropping treatments, as well as LER for the 2021 growing season

	CORN		BEAN		SQUASH		
	3 Sisters	**Mono**	**3 Sisters**	**Mono**	**3 Sisters**	**Mono**	**LER**
REP 1	8.13	10.05	0.85	2.28	57.79	111.20	1.70
REP 2	8.83	9.38	0.75	3.38	121.47	112.63	2.24
REP 3	7.19	6.52	0.78	4.42	102.74	104.42	2.26
REP 4	5.32	5.04	0.78	2.70	60.10	93.05	1.99
AVE	**7.37 ± 1.53**	**7.75 ± 2.37**	**0.79 ± 0.42**	**3.20 ± 0.93**	**85.53 ± 31.65**	**105.33 ± 8.93**	**2.05 ± 0.23**

APPENDIX L. 2020 ANOVA TABLES

Table 1. Anova: Single Factor for Marketable Beans During the 2020 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	2.828	0.707	0.010983
Three Sisters	4	0.234	0.059	0.000131

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.841105	1	0.8411045	151.364	1.75751E-05	5.9873776
Within Groups	0.033341	6	0.0055568			
Total	0.874446	7				

Table 2. Anova: Single Factor for Marketable Squash During the 2020 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	769.5	192.375	574.4958
Three Sisters	4	533.3	133.325	220.4425

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6973.81	1	6973.805	17.545524	0.0057573	5.9873776
Within Groups	2384.82	6	397.469			
Total	9358.62	7				

APPENDIX M. 2021 CORN ANOVA TABLES

Table 1. Anova: Single Factor for Marketable Corn Grain During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	22.2909033	5.57272583	1.74504559
Three Sisters	4	23.2337	5.80843271	0.81842519

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.11111546	1	0.11111546	0.08669142	0.77834728	5.98737761
Within Groups	7.69041234	6	1.28173539			
Total	7.80152781	7				

Table 2. Anova: Single Factor for Unmarketable Corn Grain During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	0.393353	0.098338	0.00403
Three Sisters	4	0.528775	0.132194	0.007535

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.002292	1	0.002292	0.396418	0.55215	5.987378
Within Groups	0.034697	6	0.005783			
Total	0.036989	7				

Table 3. Anova: Single Factor for Marketable Corn Smut During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	8.32919	2.08223	1.40858903
Three Sisters	4	5.73068	1.43267	1.10251461

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.84403178	1	0.84403178	0.6722397	0.44361527	5.98737761
Within Groups	7.53331092	6	1.25555182			
Total	8.37734269	7				

APPENDIX N. 2021 BEAN ANOVA TABLES

Table 1. Anova: Single Factor for Marketable Beans During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	12.46927	3.1173175	0.83268261
Three Sisters	4	2.96701	0.7417525	0.00230102

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	11.286618	1	11.2866181	27.0343459	0.0020159	5.98737761
Within Groups	2.504951	6	0.41749181			
Total	13.791569	7				

Table 2. Anova: Single Factor for Unmarketable Beans During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	0.3086	0.0772	0.00042432
Three Sisters	4	0.2008	0.0502	0.00058078

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.00145261	1	0.00145261	2.89045902	0.14001356	5.98737761
Within Groups	0.00301531	6	0.00050255			
Total	0.00446792	7				

APPENDIX O. 2021 SQUASH ANOVA TABLES

Table 1. Anova: Single Factor for Marketable Squash During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monoculture	4	237.0561	59.264025	280.01696
Three Sisters	4	224.3441	56.086025	393.18323

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	20.1994	1	20.1994	0.06001	0.8146433	5.9873776
Within Groups	2019.6006	6	336.6001			
Total	2039.7999	7				

Table 2. Anova: Single Factor for Unmarketable Squash During the 2021 Season

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Mono	4	184.6191	46.154775	66.7119
3sis	4	118.0627	29.515675	151.6541

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	553.7193	1	553.7193	5.0714773	0.0652621	5.9873776
Within Groups	655.0982	6	109.1831			
Total	1208.8175	7				

APPENDIX P. BACTERIAL LEAF SPOT OF CUCURBIT

Images 1 and 2. Signs and symptoms of Xanthomonas cucurbitae on the leaves of plants during the 2021 season

Image 3 and 4. Subsequent fruit rot due to the disease

APPENDIX Q. ADDITIONAL PHOTOS

Image 1. The research garden during the 2020 growing season, August 10

Image 2. The research garden during the 2021 growing season, August 13