PERPETUATING AGRICULTURAL HERITAGE:

SAVING SEEDS AND STORIES ON HAWAIʻI ISLAND

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I dedicate this thesis to the memory of Uncle Jerry Konanui,
and to all people who steward agricultural heritage for future generations.

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Abstract

The saving and exchange of seeds and other germplasm is an essential component of *in situ* conservation of agricultural biodiversity. This qualitative research project identified people who keep seed on Hawai‘i Island, collected their stories of prized varieties, interviewed them about their motivations for seed saving and exchange, and examined their challenges. Seed savers cited a wide range of motives for saving seed. These include both philosophical and practical reasons, such as: economic considerations, growing considerations, enjoyment, tradition, preservation of biodiversity, and a desire to build food security. Participants share seed to ensure continued access to specific varieties, to build social capital, and to help strengthen the local food system. Seed savers also identified specific challenges to effective seed saving here in Hawai‘i. These included both physical challenges, such as storage, disease and invasive species, and social challenges, such as needs for improved communication, information sharing and skill building within the community. The findings from this study suggest that individuals and organizations that seek to encourage seed saving and enhance seed exchange networks in the Hawaiian Islands should use messaging that addresses multiple motivations in order to reach a diverse audience of seed savers. Strategies for further identifying and collecting the stories and germplasm of rare heritage varieties through citizen science methods are discussed.

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Joseph's Story: Iaku's Persimmon

I got it from my neighbor, she's eighty-something years old. She's blind now, she lost her sight and so she doesn't garden a whole lot anymore. Her grandfather came over from Japan in 1917 to work over here. He had his favorite persimmons there; they were seeded persimmons, so he was able to carry a little pouch of his favorite persimmon seeds. He came over and he planted them and he had one that grew really well. It was on the very corner of their place down here, and I noticed it sitting there forlorn. I went, "God that looks like a persimmon! Could that be? Naww." And sure enough it was a persimmon tree! I asked Iaku if I could get a root cutting from it and she said, "Oh yeah, they come up once in a while, so when it comes up I'll save it for you." It grows here beautifully, every year like clockwork and it produces *hundreds* of persimmons. I eat as many as I can and I dry them also and use them in smoothies and I always leave some for all the birds: White Eyed Mejiro, the finches, *everybody* loves the persimmons. The seeds drop down from the ones that the birds eat and so little persimmons come up around the tree. I'll save the nicest looking ones, fastest growing and then I'll take a cutting from that persimmon tree and I'll graft it onto the seedling. I've given them away to different people just so I can get them out there, so it'll survive no matter what happens. Most of the persimmons you have now the Hachiya and the Tamopan, those are all seedless. But it's like grapes. The best tasting grapes are the ones that have seeds! It does grow a little bit different. Most persimmon trees, they have a little bit of a weeping quality to them, because persimmons get heavy on them, so it's kind of more like a Willow tree. This is much more upright than most of the persimmons I've seen… You know, I planted out a couple of other persimmon trees, the grafted kind. And the Chinese Beetles just massacred them. Every time a leaf would come out, they would just strip it down, so within two to three months the tree was dead. But not this one, this is a *survivor*.

The story of Iaku's persimmon was the seed from which this project grew, and it illustrates the value of preserving heritage varieties of plants and their stories. Throughout this thesis, I share similar stories of unique varieties that illustrate its essential themes or that are particularly moving.

Chapter 1: Introduction

> In plantation times, bringing seeds was like bringing the next generation to work in the plantation. When those guys would come, they would have the seeds with them in their luggage, and then they would just plant them. And those seeds and foods were shared with everyone else around the plantation. I don't think anybody thought about it, it's just what everybody did, was just the sharing thing of the plantation people. So everybody had that in their yard and when you wouldn't have one, there were tons of families who would have one and they would just give it to you free, you know? That has changed because there's no plantation now. I go back to Pa'auilo, I don't know who lives there. All the houses, all different people moved in. The whole community's changed. I don't think there's that sharing. I don't think you know your neighbors anymore.
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> My grandma folks, they used to grow everything. You grow for your house and then with the extra, you do whatever. You can give it to the neighbors or take it to the local store, to sell. So that's my grandparents, and then my mom folks grew some and then by the time it came to us already, we, the third-generation, we hardly grew stuff. (Tyson)

Throughout human history, migrating people have moved the seeds and cuttings of food plants across the earth. Human-facilitated seed dispersal plays a powerful role in the creation of diverse varieties of crops. The majority of crop varieties now found in the United States, including Hawai'i, descend from varieties introduced by immigrant populations, which subsequently adapted in response to both local environmental conditions and grower selection, resulting in a wide diversity of unique varieties (Ashworth 2004). In the Hawaiian Islands, immigration brought not only people, but also prized varieties of agricultural and medicinal plants, many of which home gardeners and small farmers have cultivated for generations. As a result, some of these varieties display unique characteristics and are particularly well adapted to specific locales in Hawai'i. These plants represent both distinctive cultural heritage and valuable genetic material. The networks of seed savers who perpetuate these plants represent a valuable mechanism for preserving agricultural biodiversity. Ellen & Plattern (2011) note that while many have studied the geographic patterns that crops have dispersed along and the selection processes involved in this dispersal, there is a need for greater understanding of the social patterns and sharing networks that are involved.

This qualitative research project had two principal goals. The first was to document some of the varieties of agricultural & medicinal plants that were brought to Hawai‘i during the late plantation era, approximately 1900-1959. Through a series of semi-structured interviews with seed savers, I sought to identify some of the old varieties that still exist on Hawai‘i Island, learn why people have saved them, and record the "seed stories" of these varieties, six of which I present in this thesis. The second goal of this project was to use interview data to begin to examine the dynamics of seed saving and sharing networks on Hawai‘i Island by identifying participants‘ reasons for saving and sharing seed as well as their challenges in doing so. An improved understanding of both the reasons why people save and share seed and what they see as obstacles to successful seed sharing can be used to help encourage these behaviors and to build stronger seed sharing networks.

1.1 Context

Seed savers often save "open-pollinated cultivars that have been grown and saved from generation to generation within a family or community" (Buttala & Siegel 2015). These maybe referred to as *folk varieties, traditional varieties, old varieties, local varieties*, *farmer varieties* and *heirloom varieties* (Cleveland et al. 1994; Veteto 2008; Elia & Santamaria 2013). Such varieties are distinct from *landraces*, which are locally adapted crops that are not subject to intentional selection (Berg 2009), and *modern varieties*, which emerged during the twentieth century. Traditional varieties are significant contributors to global agricultural biodiversity (or *agrobiodiversity*) (Thrupp 2000). Agrobiodiversity, which Pascual et al. (2011, 193) define as "the diversity of plant and animal genetic resources relevant to food and agriculture," is an essential component of creating resilient agroecosystems.

Growing genetically diverse crop species provides a variety of valuable ecosystem services. For example, substantial evidence suggests that increasing agrobiodiversity increases horizontal resistance to pests and disease (Thrupp 2000; Hajjar et al. 2008). Because of local selection processes, locally adapted varieties are often more resistant to drought, salinity or other environmental factors than are their modern counterparts (Hajjar et al. 2008). The fact that these varieties are resistant to biotic and abiotic factors makes them less susceptible to crop loss. Their inclusion in small-scale farming systems plays an important role in resilience (the ability to

recover following environmental changes) of such systems. As some varieties tolerate a given environmental stressor better than others, polyculture of multiple varieties can reduce the risk of crop failure because it increases the possibility that some plants will survive adverse conditions. Overtime, this increases overall yield stability (Kotschi 2006; Hajjar et al. 2008; Baumgartner & Quaas 2010; Pascual et al. 2011). Locally adapted varieties are particularly important in marginal/variable lands, where they often have higher yields than do their modern counterparts (Altieri 1999). Maintaining specific varieties is important not only because of their individual role, but because of their role in maintaining yield stability of the crop. Additionally, folk varieties can have significant socio-cultural value. Growers keep seed from these varieties for many reasons including storage, food preparation, taste, cultural significance, medcinal and nutritional qualities and reasons related to cultivation, e.g., intercropping and local adaptation (Cleveland et al. 1994; Bellon 1996).

In addition to their value as a living economic, ecological and cultural resource for farmers and gardeners, landraces and folk varieties can provide raw genetic material required by plant breeders when developing new varieties that are resistant to environmental changes (FAO 2010; Pascual et al. 2011). This role may increase in importance as global changes to temperature and water regimes alter the tolerable ranges for crop species, diseases and pests (Kotschi 2006). The Food and Agriculture Organization of the United Nations highlights this fact, stating that, "Increased environmental variability that is expected to result from climate change implies that in the future, farmers and plant breeders will need to be able to access an even wider range of PGRFA [plant genetic resources for food and agriculture] than today." (FAO 2010, pg. xix). Pascual et al. (2011) suggest that adaptability of agricultural systems to climate change will depend upon not only the preservation of genetic resources, but also upon building collective knowledge and social capital in order to strengthen the social components of these systems.

Over the last century, changing social conditions and land use patterns have led to the dissapearance of thousands of varieties, with an accompanying loss of both genetic diversity and cultural history (Fowler and Mooney 1990; Nazarea 2005). It is difficult to specify rates of loss of seed diversity because of a lack of documentation of folk varieties in different regions and because of limited genetic information (Cleveland et al. 1994). Due to phenotypic plasticity, it is

uncertain to what extent variety names actually reflect genetic diversity; some studies have shown a high correlation between diversity and variety names, while others have not (Jarvis et al. 2011). However, there is ample evidence for loss of named varieties worldwide, and researchers consider many to be threatened (Kell et al. 2009). In the United States, Fowler and Mooney (1990) found that of the seed varieties that were available in commercial catalogs in 1903, approximately 97 percent were not available in the National Seed Storage Laboratory 80 years later. There are limitations to this finding, both because of possible duplication among varieties and because focusing on commercially available seeds may exclude those found in communities (Veteto & Skarbo 2009). Plant breeding has developed many new varieties since 1903, and although varietal loss does not necessarily represent a decline in the overall number of varieties available, it is indicative of a significant loss of genetic diversity (Fowler and Mooney 1990). Similar declines have also occurred in other countries as modern agriculture has become highly dependent upon a small number of species and varieties (Thrupp 2000; Pascual et al. 2011). This has resulted in a simplification of agricultural systems, making them more susceptible to stochastic events and crop failure (Alteieri 1999). Modern molecular techniques confirm that the widespread use of improved varieties has led to an overall decrease in diversity (FAO 2010). The genetic erosion of local varieties is due both to smaller populations being grown and to conspecific cultivation with modern varieties (Cleveland et al. 1994; Elia & Santamaria 2013).

Increased uniformity of crop varieties is also, in part, due to globalization of the world food market, which in order to maximize profit, places an emphasis on maximizing yields, mechanical harvesting practices, increased shelf life of foods and ease of transport. These factors often require cultivation of modern varieties (Fowler and Mooney 1990; Cleveland et al. 1994). Consolidation of the seed industry and the widespread use of hybrids have led to a decline in seed saving, further reducing crop diversity (Thrupp 2000; Ashworth 2004; Elia & Santamaria 2013). Moreover, folk varieties may be lost through changes to the physical or social environment, including economic changes, urbanization, changing land use patterns, and loss of agricultural knowledge between generations (Cleveland et al. 1994; Elia & Santamaria 2013). Privatization and patenting of seed is also of concern, and as the private sector takes over, genetic resources become more vulnerable (FAO 2010b; Wincott 2015; Helicke 2015).

In Hawai‘i, seed security is tied closely to food security. Although genetically modified seed corn is a major agricultural crop in Hawai‘i, both in terms of acreage and value (Perroy et al. 2016), most of this corn seed is grown as field trials or for export; the vast majority of the seed that is planted for food in Hawai‘i is imported. This dependence creates concerns in light of fossil fuel limitations and climate change. Access to locally adapted varieties is essential for development of island seed systems that are resilient to climate change (Valenzuela et al. 2013).

The protection of crop diversity requires a combination of both *ex situ* and *in situ* strategies (Cleveland et al. 1994; Kotschi 2006; Berg 2009). A range of methods exists for the preservation of agricultural biodiversity; which method chosen to use depends on specific goals (Jarvis et al. 2011). For example, if the primary goal is preservation of genetic resources, or if varieties are immediately threatened, *ex situ* conservation practices, such as seed banks and gene banks are often favored (Cleveland et al. 1994; Berg 2009). However, if the goal is maintaining varietal diversity as a resource for growers, *in situ* conservation practices that occur on the farm or in the garden are more appropriate. This is because *in situ* conservation is a dynamic process and allows for the continued local adaptation of plants in response to their environments (Veteto & Skarbo 2009; Pascual et al. 2011; Thomas et al. 2011). This is further discussed in Chapter 3. *In situ* projects focus both on the identification of genetic resources, and on descriptions of growing characteristics and cultural histories. While a specific variety may hold valuable traits, it is the grower's narrative description or "story" that tell us what these traits are (Veteto & Skarbo 2009).

One major focus of *in situ* conservation is the inventory of germplasm found within a given region. Many groups have carried out inventories and surveys of varietal diversity, and tools and techniques to do so continue to advance (FAO 2010). Although we can never know the precise number of varieties of food plants on earth -- due to synonymy, continuing adaptation and the sheer scope of the task -- estimates of varietal diversity can serve as a proxy for genetic diversity (Kell et al. 2009). In such inventories, it is useful to focus on regions that exhibit particularly high crop diversity. Remote and isolated areas are likely to contain more diverse landraces and folk cultivars (Veteto 2008). Veteto (2008) identifies three key criteria associated with regions of high agricultural biodiversity. These are: 1) varied geography with a variety of microclimates and isolated conditions, which may lead to local adaptation; 2) geographic and

commercial isolation, sparse or rural populations and difficult growing conditions; and 3) some degree of cultural autonomy. The Hawaiian Islands exhibit all three of these qualities, and it is likely that a high degree of crop diversity exists in the farms and gardens of the diverse cultural groups found here.

Combining interview with varietal inventory allows researchers to collect information about the cultural history of the seed and demographics of growers. Various interview techniques, such as, "memory-banking," are used to collect information both on the varieties (e.g., microclimate, growing needs, food and cultural value, history) and on seed keepers (e.g., gender, age, socioeconomic status) (Ban & Coomes 2004; Nazarea 2005; Veteto 2008; Kell et al. 2009; Ellen & Platten 2011; Elia & Santamaria 2013). Data about the varieties can help identify appropriate seeds for other regions and aid in breeding projects, while data about the growers can reveal socio-cultural patterns that facilitate seed networks and direct further study by identifying groups most likely to save seed (Bellon 1996; Pautasso et al. 2013).

Despite progress in conservation of agrobiodiversity, further research is needed in a number of areas. The FAO (2010) recommends study of *in situ* agrobiodiversity management and notes that many areas of the world need better seed inventories. Several authors recommend that academia participate in attempts to capture existing diversity and in collaborative projects with farmer-breeders (Cleveland et al. 1994; Kell et al. 2009; Jarvis et al. 2011). These efforts may include establishing datasets to document folk varieties, testing variety performance in a range of environments, analyzing genetics, studying the role of demographic factors in planting material exchange/diversity, and examining ways to enhance *in situ* preservation through cooperation between farmers and formal breeders (Cleveland et al. 1994; Ban & Coomes 2004). Many have called for greater study of the sociocultural dynamics of seed exchange networks both in the developing and industrialized world (Ban & Coomes 2004; Badstue et al. 2006; Veteto & Skarbo 2009; Thomas et al. 2011; Calvet-Mir et al. 2012). Veteto and Skarbo (2009) have further identified a need for research into the effects of human migration upon agricultural diversity, specifically varietal diversity contained in the home gardens of recent immigrant communities.

Agriculture is fundamentally based upon the interaction of both human actors and plant material understanding the motives and behaviors of the humans who cultivate plants is as important as understanding the plants themselves. Developing a clear grasp of the social dynamics of seed networks can help to encourage their function and efficacy. In Hawai‘i, research priorities in this area include the inventory of folk varieties brought to the islands by immigrant communities and held in family lines, which are vulnerable to loss due to demographic change and lack of interest from younger generations (Russell Nagata, pers. comm.).

In the next chapter, I describe the qualitative research methodology used to collect interview data about seed varieties and seed savers. I discuss some of the advantages of using interviews, which allowed me to collect data about participants' thoughts, opinions and motivations that I would not have been able to obtain using other research methods. Chapter 3 examines the diverse motivations that people cite for saving seed and suggests some possible demographic trends within motivational patterns. Chapter 4 examines participants' practices of seed saving and seed exchange, looking at the structure of seed sharing networks and some of the difficulties that arise within these networks. Chapter 5 summarizes the findings of this study, suggests directions for future research, and outlines strategies both to preserve Hawai‘i agricultural history and to strengthen Hawai‘i seed networks.

Tadashi & Emily's Stories: Rankko

We worked together and one day he asked me: "You want Rannko plants?" In those days, not too many people use to get that plant here. He was about to retire. I walked over with him to his home and he gave me about four or five plants. I took it home and planted it myself. Those days are when the old people were young, like my mother. She know a lot about Rannko and how to prepare this and that. Rannko is something like a green onion. But green onions, they use more of the leaf. I planted two or three each in about three inches deep. First you make it soft, the hole, because it makes a lot of roots. Before that you got to stir up some fertilizer, a little bit of chicken manure. I spread it in the hole. Put the plant in there but before you do you got to cut the root and bring back the dry the leaves. Before planting I cut the roots about one inch long. You always plant two or three, that's how you can increase your whole volume of Rannko, about three to four inches apart because that thing is going to increase.

The old people in Japan they figure it takes about a year. When the leaves get dry, that's the time to harvest. About a year, the leaves are dry because the bulb is increased already. They don't flower, when it's time for harvest the leaves will dry up and let you know. My mother say "You better try and dig it. Harvest that thing!" If it get mature that thing go 4 inches! But you cannot leave it too long you want a certain size of the bulb for the taste. You cut them and it's up to you how you pickle them. My parents used vinegar, sugar, salt.

The next crop I take about three, cut roots, and take the dry leaves off and plant. That's how I increase my Rannko. When it's time to harvest I take the big ones and leave the small ones and I replant, replant, replant. Slowly I can increase my Rannko volume I have. (Tadashi)

Michiko's husband had a garden out in Hakalau someplace – between Hakalau and Honomu. And he had little plot out there of these onions. He had all these onions and he told me they were a pickling onion. One day, he gave me some starts and I grew them at the Paʻauilo school with the students and, when we were ready to harvest, he and Michiko came up and in the homeroom we made the salt sugar syrup for pickling with the kids. They loved it! (Emily)

Chapter 2: Methodology

This study used qualitative analysis of interview data to identify both heritage varieties of plants and some of the sociocultural factors at play in seed saving networks on Hawai‘i Island. Interviews are a key method in qualitative research because they allow researchers to gather complex data that reveals thoughts, feelings, and opinions of participants that would be missed through the use of more quantitative methods, such as questionnaires (Valentine 2005). This is in part because questionnaires limit the range of feedback that people can give to specific pre-determined choices. In contrast, interviews allow people to "construct their own accounts of their experiences by describing and explaining their lives in their own words" (Valentine 2005). These wide-ranging accounts allow researchers to collect diverse opinions and investigate complex interactions from multiple perspectives; they can also reveal significant issues that the researcher did not identify ahead of time (Dunn 2010).

Interview analysis does not seek to be representative of an entire population, but rather to be illustrative of the thoughts and experiences of individuals within that population (Valentine 2005). Analysis of interview transcripts allows researchers to identify emergent themes and patterns across the data in order to create a more holistic understandings of the subject (Cope 2010). I chose to use interview analyses for this study to put forth a holistic interpretation of seed savers' motivations and strategies. As agrobiodiversity is based on the interactions between people and plants, it fundamentally encompasses both cultural and biological factors (Jackson et al. 2007). I wanted to learn about specific seed varieties, about seed savers' interactions with those varieties, and about seed savers' interactions with other growers. Interviews provided seed savers with opportunities to share nuanced information about these topics that I would not have been able to capture via other research methods (Cope 2010). Additionally, interview data was suited to scope and scale of the study. Because I thought to collect detailed information that was illustrative of patterns and trends within the group of participants, rather than a comprehensive examination of all seed savers within the study communities.

2.1 Study Communities

This project focused primarily on people who save seeds in the Puna, North Hilo and Hāmakua districts on the east side of Hawai‘i Island. I chose to focus on these districts in order to narrow the geographic scope of the project. I initially considered two factors in selecting focus communities. The first was the presence of an intermediate or high school with a garden or agriculture program. This was because I wanted to identify potential participants through students and outside of the network of seed savers who regularly attend public seed saving events. I worked with teachers to attempt to identify savers through student-based surveys of their families and communities. The second factor was the density of Japanese and Filipino people over the age of 75 as determined by data from the 2010 census. I considered this a key factor because the late-plantation era was characterized by waves of immigration from Japan and the Philippines (Takaki 1983). In many communities, elders hold the most knowledge about heirloom plants (Nazarea 2005; Calvet-Mir et al. 2012). I expected that locations with a higher density of these demographic groups might continue to keep more of the heritage varieties of seeds that were brought to the islands by these waves of immigration. Yet, this was not reflected in the data (see Section 5.1).

2.2 Botanical Focus

I sought to identify heritage varieties of food and medicinal plants, particularly those of Asian and Pacific Island origin. I did not focus on Polynesian “canoe plants” because others, including the U.H. Mānoa College of Tropical Agriculture and Human Resources, the National Tropical Botanical Garden, and Hawaiian cultural practitioner Jerry Konanui have studied the diversity of canoe plants (Whitney et al. 2007; Puhipau & Lander 2014; Kelling et al. 2017; McSwain 2017). I focused my interviews on plants that people propagate by seed, but I did record and analyze information that participants shared about plants that are propagated through other means (e.g., root and stem cuttings). My primary goal was to identify varieties that arrived in Hawai‘i before statehood in 1959. Because these varieties have been in Hawai‘i for a longer period of time, they have experienced greater selection pressure based on local climate conditions, and are more likely to exhibit local adaptations. Focusing on pre-statehood varieties avoided exposing interviewees to the legal and ethical issues surrounding importation of plant

material under current quarantine law, which prohibits bringing most seeds and vegetative propagation material into from a foreign nation into the state without a permit (Higa 1992). Again, while my focus was on pre-statehood varieties, I did collect and analyze all of the stories shared by participants some of which were about varieties brought to Hawai‘i after statehood.

A secondary and overlapping goal of this project was to examine the motivations of people who choose to keep seed and share heritage varieties of plants. Several organizations, including the Hawai'i Public Seed Initiative (HPSI), Seed Savers' Exchange (SSE) and Native Seed/SEARCH seek to encourage seed saving in order to increase sustainability and food system resilience in specific communities. Knowledge of the social and cultural mechanisms at work in seed exchange can be used to help strengthen seed systems (Pautasso et al. 2013). An improved understanding of the motivations of people who steward heritage varieties will help to better target educational and outreach efforts around preserving agrobiodiversity in Hawai‘i.

2.3 Identification of Seed Keepers

Although there are semi-regular seed-focused events, including exchanges, workshops and classes that occur on Hawai‘i Island, the majority of the people who attend these events do not belong to my target demographic. Because of this, I used two methods to attempt to identify seed savers within the local community: 1) family and community surveys done by secondary school students in the Hawai‘i School Garden Network (HISGN), and 2) purposive snowball sampling methods (Bradshaw & Stratford 2010). starting with known seed savers and community organizations. The first method of recruitment was ineffective at getting participants for my research and I outline the reasons why it was not successful in section 5.1. I include a description of this method here because other researchers have successfully used this method to identify seed savers and researchers may wish to use it in the future.

2.3.1 Community surveys by secondary school students

There are currently over 60 schools on Hawai‘i Island that have active school garden programs and are registered with HISGN (The Kohala Center 2017). These schools focus on integrating garden education into the regular curriculum in order to improve student health, engagement and learning outcomes (Klemmer et al. 2005; McAleese & Rankin 2007; Blair

2009). Because these programs already have an established focus on growing food, I chose to attempt to identify seed keepers in the school community through student surveys of their families and communities. In effect, students would provide outreach to specific island communities. This survey method is based on work by Dr. Robert Rhoades and Dr. Virginia Nazarea of the University of Georgia, who successfully worked with undergraduate students to identify seed keepers within the Vietnamese Community via such surveys (Rhoades 2013; Viginia Nazarea, pers. comm., 2015 International Seed Libraries Conference, Tuscon, AZ). People studying seed networks in Appalachia have also used student-based surveys as an effective method to identify seed keepers (Kent 2013).

In order to provide context for seed keeper surveys and incentivize student participation, I developed two 50-70 minute lesson plans on seed saving and the value of agrobiodiversity. The second lesson concludes with a survey that students were asked to use to identify seed keepers and their families and communities. This survey was available on Google Forms so that teachers could choose to distribute it digitally or via hard copy. I trialed the lessons in three classes in the Puna district during the fall of 2015 and adjusted them to incorporate teacher feedback. The director of HPSI, director of the HISGN, and Ecoliteracy Specialist at Pacific Resources for Education and Learning (PREL) also reviewed and provided feedback on the lessons. Both lessons align with the Next Generation Science Standards and contain a variety of educational strategies and activities, allowing teachers to tailor them to fit into curriculum while still addressing required standards. In the Spring of 2017, the completed lesson plans were distributed to over 60 teachers; they are also publicly available at http://kohalacenter.org/hpsi/resources/seed-webinars. Additionally, I trained approximately 16 teachers on use of the lessons at the Kohala Center's 2017 Kū ʻĀina Pā garden teacher training program. It is important to note that the school surveys were a technique to identify seed keepers and not to collect information about the students themselves; all student data remained anonymous, in compliance with ethical requirements and University of Hawai‘i Committee for Human Subjects best practices.

I received positive feedback from teachers, students were engaged during the trial classes and multiple students told me about family members who kept old varieties of seed and might want to participate in the project. However, the online survey yielded no seed keeper

connections. The only seed keeper who I connected with through my work in the schools was based on a recommendation by a teacher, not a student. The reasons that the method was not effective in identifying seed keepers and possible strategies for its improved use in the future are discussed in Chapter 5. Because the lessons were ineffective in the Puna district, I chose to use other methods to identify seed keepers and did not implement the lessons elsewhere.

2.3.2 Purposive snowball sampling

Snowball sampling, sometimes referred to as chain sampling, involves starting with known informants and using word of mouth to connect with other interviewees (Bradshaw & Stratford 2010). Several studies of seed networks have used snowball sampling techniques, both as a primary method of identifying informants from known seed keepers (Subedi et al. 2003; Veteto 2008), and as a secondary method of identifying informants following large-scale community surveys (Ban & Coomes 2004; Badstue et al. 2006). Nazarea (1998) also recommends visiting markets, festivals, and interviewing "gatekeepers" prominent individuals within the community when attempting to identify seed keepers.

For this project, snowball sampling included use of social media tools (e.g., Hawai‘i Island Seed Stewards Facebook group), outreach at public events, and posting flyers. I presented the project at three seed exchanges, three agriculture-themed festivals, two farmers markets, and a Filipino cultural festival, and I gave talks on the project for the Hawai‘i Public Library System, the Rotary Club, and three college classes. A segment on the television show "Seniors Living in Paradise" featured the project and encouraged viewers to refer seed savers. I asked the curators at the Lyman Museum, Hawai‘i Plantation Museum and North Hawai‘i Research and Education Center's Heritage Center to refer potential contacts. An undergraduate assistant posted flyers at fourteen local stores and churches. Because I have been gardening and attending seed exchanges on island for several years and have worked part time with HPSI, I also reached out to people I know within these in these networks.

I identified over forty potential participants through the methods listed above. However, I was not able to contact several people, others did not want to participate in the end, and still others could not participate due to health reasons. Of the potential participants, I interviewed a

total of twenty-three individuals in sixteen individual interviews and two focus groups (see Section 2.4.2).

2.3.3 Seed Saver Experience & Demographics

Participants in this study have different background experiences with gardening and there is a wide range of seed saving experience among them. Some have been saving seed since childhood. Hama, Frank, Robert, Tadashi, Saburo, Peggy, Joseph and Charne have all been growing food since they were young. As a teen during World War II, Michiko, along with all of the 8th & 9th graders at her school, spent two days each week working on plantations after the laborers were called up for military service. Hiroko reflected, "When you live in the country, you raise everything. You never suffer." Like Hiroko, many interviewees felt that their early gardening experiences instilled in them the idea that growing food is a way of life, but not all of them appreciated the experience at the time. Frank explains it this way:

> Pretty much some form of agriculture has paid my living all my life…the funny thing is [for] most of school-age years, the gardening thing was a chore…it is for most kids. And it wasn't until my 20s when I realized that I was kind of thankful that I had a lot of that forced on me. Because *at least I knew how* … peers my age never had that … and if they've got any interest in it down the years … they've got a huge learning curve. … so I am thankful for that. At the time, not so much.

Although he did not enjoy gardening as a child, as an adult Frank is grateful to have the skills needed to grow his own food.

Yet not all participants grew up with agricultural traditions. Nick, who did not start growing food until he was an adult, expressed gratitude for this:

> [It] sounds kind of weird, but I am glad I didn't learn from my father. He was born in 1929 … so the depression was mostly growing most of his food with his family. Their method was plant it out, weed it, and let the weeds go nuts after a certain amount of time. That's one of my pet peeves … So it worked out well that I didn't learn his method. As a kid I would have been out there pulling the weeds all the time and wouldn't have wanted to grow any food when I got older.

Nick started saving seeds as an adult when he was working at an organic farm and developing what he described as "a research homestead." He appreciated the fact that he came to agriculture

in his own way, not as an obligation or a chore. Charne also expressed that she was not introduced to gardening as family obligation, but as a form of experiential play:

> My parents were totally not interested in gardening. I actually started gardening really as a young child … I was probably in second grade, we had a … big yard and it was all flowers … to me it was like, fairies were everywhere. I would just spend all my time back there. Then, one day, this old man appeared. We had this nice little trellis area … he sat there, and he said, "You like the plants?" And I said, "Yeah, I love them. There's fairies in them" … he taught me a lot about the plants. My parents, they could care less, it just wasn't their focus…. he was really instrumental in promoting that love … It stayed with me, off and on depending on where we moved and where we lived. I would create little gardens either food or food and flowers, or do landscaping. I just stayed connected to it. It was in my DNA.

This childhood wonder with gardening as a way to connect to the natural world was also reflected in Joseph's early memory of the first time he realized the value of seeds: "I held those beans and ... I thought: 'One bean and I got all these back!'"

Joseph considered seed saving to be an essential element of gardening, but not all seed savers shared his views, and some only started saving seeds within the past 10 years. This interest may have been sparked by a desire to address some of the unique challenges presented by seed saving in Hawai'i, by concerns over agrobiodiversity or by opportunistic seed saving of garden vegetables. Max, for instance, said that he started seed saving because a lettuce that he liked bolted. All of these factors may build interest in seed saving, but this interest alone does not lead to high-quality seed. Jasper reflects, "Initially my seed saving was very ineffective. It would be just piles of seeds here in the pockets or on the counter." In order to develop his seed saving skills, Jasper attended a workshop on seed saving. Three other seed savers, including me, also cited attending educational events in order to improve seed saving skills.

The table that follows provides demographic information on all seed keepers interviewed including age, district of residence, and what their role in agriculture is: gardener, farmer, agriculture educator, or homesteader. It is important to recognize that this study included few interviews with market farmers who may, as a demographic group, have different views on seed saving and sharing.

Table 1: Participant Demographics.

This table lists all individuals who I interviewed for this project. Most pseudonyms were chosen by interviewees. When interviewees did not select a pseudonym, I attempted to choose one that preserved their ethnic identity.
Role in agriculture categories are defined as follows:
Educator: a person who works in agriculture education, or in school gardens.
Gardener: a hobbyist gardener, someone who does not grow the majority of what they eat.
Homesteader: a person who grows the majority of the food that they consume.
Farmer: a person who generates income by selling the food that they grow.
* indicates a person who is part of HPSI

Pseudonym	**Gender**	**Age Range**	**District**	**Interview Type**	**Role in Agriculture**
Ana	F	80-89	Hilo	Individual	Gardener
AnoAno	F	40-49	Puna	Focus group	Educator, Gardener
Arthur	M	80-89	Hilo	Individual	Other**
Charne*	F	70-79	Puna	Individual	Homesteader, Farmer
Emily	F	50-59	Hāmakua	Individual	Educator, Farmer
Frank	M	40-49	Hāmakua	Individual	Homesteader
Hiroko	F	80-89	Hilo	Individual	Gardener
Jasper	M	40-49	Puna	Focus group	Educator, Gardener
Joseph	M	70-79	South Kona	Individual	Homesteader
Linda	F	20-29	Hāmakua	Focus group	Farmer, Gardener
Max	M	40-49	Puna	Focus group	Gardener
Michiko	F	90-99	Hāmakua	Individual	Gardener
Nick	M	40-49	Hāmakua	Focus group	Educator, Gardener
Peggy	F	60-69	Hāmakua	Individual	Gardener & Farmer
Perlita	F	50-59	Hāmakua	Individual	Gardener
Robert*	M	60-69	Hilo	Individual	Gardener
Rowena	F	50-59	Hāmakua	Individual	Gardener
Rogelio	M	70-79	Hāmakua	Individual	Gardener
Ruth	F	20-29	Puna	Focus group	Educator, Gardener
Saburo	M	80-89 **	Hilo	Individual	Gardener
Sean	M	20-29	Hāmakua	Focus group	Gardener
Tyson	M	60-69	Hilo	Individual	Gardener
Tadashi	M	90-99	Hilo	Individual	Gardener

** Arthur is not a seed saver, but approached me because he wanted to share historical agricultural information (see Chapter 5)

2.4 Interviews

2.4.1 Individual interviews

Qualitative methods in the social sciences encompass a wide variety of strategies to collect data about participants; these include oral histories, surveys and questionnaires, and participant observation. Interviews themselves can be unstructured with no set questions, semi-structured with a general interview guide, or highly structured with an identical list of questions for each participant (Winchester & Rofe 2010). Each of these methods has different advantages, depending on what type of information the researcher is attempting to collect (Pautasso et al. 2013). For this project, I chose to conduct semi-structured interviews based on an interview guide (Appendix A) to collect information on crop varieties, qualities, propagation methods, as well as information on cultural history and motivations for saving seed. Using this method allowed me to focus on content and areas of interest, but I did not hold the questions to specific wording or order. I was able to choose to omit some questions altogether depending on the context and conversation. This is one benefit of semi-structured interviews, they allow for flexibility and can reveal contextual information that the interviewer may not anticipate beforehand (Dunn 2010; Pautasso et al. 2013). Data collected through open-ended questions can be more difficult to analyze than that collected through close-ended questions, but it is more likely to reveal new insights and unexpected information about the topic (Nazarea 1998; Hseih & Shannon 2005). Using an interview guide in semi-structured interviews is helpful because it helps to target topics of interest, and because it helps the researcher with time management during the interview, thereby reducing informant fatigue (Nazarea 1998). Studies of seed networks in areas as diverse as Appalachia, Mexico, Peru and Nepal have all used semi-structured interviews as a basis for data collection (Subedi et al. 2003; Ban & Coomes 2004; Badstue et al. 2006; Veteto 2008). This is, in part, because the method allows farmers and gardeners to reveal what they consider significant factors in the environment, rather than having the researcher pre-determine what is important in a questionnaire (Nazarea 1998). Qualitative researchers often use interviews rather than survey questionnaires because they provide a broader and more in-depth context for understanding human decision-making processes.

Interviews included questions about plantation-era varieties, favorite varieties seed saving methods and motivations for seed saving and exchange. I did not ask savers about the number of varieties that they kept. This was in part because my focus in this study was not a quantitative assessment of varietal diversity. Also, because interviews often were conducted outside of the home, seed savers usually did not have their seed collections on hand. Conversations with informants sometimes deviated from the topics of seed and variety. When the conversation turned to subjects such as cultivation practices, favorite crops, and agricultural history, I encouraged participants to continue, as these topics sometimes revealed much about their attitudes and motivations for saving seeds, providing context in which to better understand their decisions. Interviews also included questions designed to identify additional seed keepers and possible nodal individuals who interact with many others.

2.4.2 Focus groups

In addition to individual interviews, I facilitated two focus groups in the Puna and Hāmakua Districts in the summer of 2017. Focus groups involve a small number of people (usually 4-10) participating in a discussion that is guided and moderated by the researcher. One advantage of these groups is that the interactions between participants can reveal ideas that would not emerge in individual interviews (Cameron 2010). In this study, focus group participants saved seed, but most did not have seeds from the plantation era. I recruited participants via social media (primarily Facebook groups) and through known seed savers. The purpose of the focus groups was to create greater age diversity within my participant population. Most of my individual interviews were with people over the age of 50 and I wanted to compare their motivations for saving seed with those of people who have been saving seed for a shorter period of time. Focus group participants' methods and motivations for saving seed provided a basis for comparison with emergent themes in the individual interviews.

Seeds are valuable; they have cultural and family significance and high performing varieties can provide an advantage to market farmers. Because I expected that individuals may be reticent to share their unique varieties, this project focused on documenting story, location, diversity and motivations rather than on collecting seed itself. However, as some seed savers

were elderly and could no longer grow out their seeds, each interview concluded with an opportunity for participants to donate seed samples for conservation or seed increase.

I audio recorded all interviews and either I or my undergraduate intern transcribed them. We both completed CITI online training for researchers before contact with participants or transcripts and the project went through the University of Hawai‘i Committee on Human Subjects review protocols. I provided all interviewees with an overview of the project and consent form before participation. Following transcription, I analyzed all interview data and coded information related to the following emergent themes in the data: specific crops and varieties, motivations for seed saving, seed saving techniques and experience, seed sharing, and plantation era stories not related to seed. Within each of these broad thematic groups, there were between 4 and 17 specific codes that I identified through further analysis of the interview transcripts (see Appendix B). Analysis of interviews involved reading transcripts to determine broad themes, followed by rereading each transcript several times and coding the text. Because the themes and codes emerged from the text, some of the initial codes were split into more specific categories, while others were combined. This frequently occurs in analysis of interview transcripts and other textual sources (Cope 2010). Throughout this work, I use both direct quotes and summary of interviews to illustrate major concepts. Additionally, because stories of seed varieties are best told by the seed keeper themselves, I have chosen six illustrative seed stories that are included between the chapters of this work. I have edited these slightly from the original transcripts to improve readability and flow.

Frank's Story: Grandma's Lima Bean

After my dad's father, my granddad, passed away about 2000, my grandma gave me a box of seeds that he had stored in his refrigerator. Going through it I found some very unusual things that I hadn't seen since I was a little kid in there. Very old seeds, it took a lot of love to propagate them and get some to go. To renew that genetic base. One example was a huge climbing lima bean that I know was brought over from Portugal. It is a purple and white speckled. It's very, very large- the pods are about eight or nine inches. And when cooked, they'll swell up huge, about maybe 2 ½ inches long. Similar to the Christmas Lima Beans, it may be related. It may be the same variety but it spanned out over so many years. It just seems that *this* variety here does so well for our climate, maybe because it's been grown in our climate and our same soils for the last hundred years. Very productive. Bugs don't bother it. Once you plant it and put it in the ground, it starts crawling and climbing over anything. And it takes care of itself. Let alone, it'll kind of die back on you and in our year-round growing environment, if not taken out and replaced, it will come back to life a couple months later and give you a second crop. You can almost treat it as a perennial.

I use it mostly for soups or stews. I've tried just parboiling and sautéing it with butter and garlic and that's awesome also. But that there is not too much that's not awesome after sautéing in butter and garlic (laughing). It actually brings off this, like a vinegary fermenty type flavor to a soup or stew. It was funny, I would always try to do a Portuguese Bean Soup like my grandma did and it would never come out the same. Every time I do it, I complain to her, "It doesn't taste like yours, Grandma, it doesn't taste like yours." And that was the missing link! Because she hadn't grown it for years that was the missing flavor profile! So it's an important one, for my memory anyway, for my palate.

Chapter 3: Motivations for Seed Saving

The *in situ* conservation of local varieties is an important component of maintaining agrobiodiversity. But why do people save seed? Seed saving is a practice that requires time, energy, and attention. This is particularly true in the tropics, where heat, humidity, and unpredictable rainfall make it difficult to grow, harvest, and store high quality seed. The choice to save rather than buy seed presents an opportunity cost for growers: when they choose to save seed, they do so because they see monetary, social or other value in the process. A number of locally-based organizations, including the Hawai‘i Public Seed Initiative (HPSI), Kaua‘i Community Seed Bank, Maui Seed Savers, and Kailua-Kona Community Seed Library, seek to encourage seed saving and exchange in order to help to build resilient local food systems. To better target these efforts, it is important to investigate the perceived values held by seed savers and to try to understand why people who save seed think it is worth their time. In this chapter, I draw upon interview data to examine Hawai‘i Island seed savers' motivations for saving seed in order to identify strategies for effective messaging to encourage the practice.

There are many reasons that individuals engage in behaviors that increase environmental and community sustainability. Conservation psychology studies the factors that motivate people to act in ecologically responsible, sustainable ways (Borden 2017). These may include economic factors, environmental factors, and social factors, such as the preservation of self-identity and tradition (Clayton 2007; Barreto et al. 2014). Both individual choice and social context contribute to behavior; people may do the same thing for very different reasons. For example, a person may choose to conserve energy because of monetary savings, while their neighbor may choose to do the same thing because of environmental concerns or social pressures from their peer group. Because of this, different messages may be more effective at engaging different groups of people in sustainable behaviors such as saving seed.

Although the literature is limited, there are some studies about the different types of values and motivations associated with saving seed. These include DeMuth's (1998) overview of community-based stewardship programs in the United States; Phillips' (2005) study of the political aspects of seed saving as "green citizenship" in Canada; and Carolan's (2007) examination of the conceptions of nature expressed at Seed Saver's Exchange (SSE) seed bank

in Iowa. It is also instructive to look at Clayton's (2007) study of motivations for gardening in the United States and Wincott's (2015) discourse analysis of language used in British texts that discuss heritage and heirloom varieties of food plants, because they identify several distinct ways of thinking about seed saving.

Motivations for saving seed range from the practical to the philosophical. DeMuth (1999, pg. 5) describes these motivations as "diverse and difficult to characterize as the old varieties themselves." Gardeners and farmers often cite practical reasons to save seed, saying it confers tangible benefits like economic independence, food production and improved seed quality (DeMuth 1999; Carolan 2007; Clayton 2007). People also save seed for moral reasons, such as better protecting agricultural biodiversity, stewarding cultural heritage, or ensuring food system stability (Phillips 2005; Carolan 2007; Wincott 2015). Additional intangible reasons may also be at play, such as enjoyment, sensory pleasure, spiritual connection to nature, construction of identity, or community inclusion (Phillips 2005; Clayton 2007). Because seed has characteristics that benefit both the public and private good, the choice to save seed can involve a combination of social and individual motivations (Badstue et al. 2006).

In this study, participants chose to save seed for a wide variety of reasons, citing both tangible and intangible values, and most participants stated multiple reasons for saving seed. In chapter, I discuss motivations that people gave for saving seed and some of the broader patterns in motivation between people. Although I describe some demographic patterns, I do not provide detailed theoretical explanations of why these patterns were found, as that is beyond the scope of this work. It is difficult to isolate individual motivations because one reason for saving seed often relates to several others (Phillips 2005; Nazarea 2005; Clayton 2007). For instance, many participants stated a desire to grow locally adapted varieties. This desire may reflect a focus on variety performance, on future food security, on the preservation of local traditions or some combination of the three. The motivations discussed below do not fall into discrete categories, and it is important to note that there is some overlap between them. Additionally, due to the limited scope of this study, this list of motivations is by no means exhaustive, nor do I claim that it is representative of all people who keep seed on Hawai‘i Island.

3.1 Economic

A primary motivation for many participants in this study to save seeds was economic. Financial considerations are a primary driver of other sustainable behaviors as well (Clayton 2007; Black & Cherrier 2010; Barreto et al. 2014) and popular gardening magazines often cite personal finance as a reason to save seed (Bailey 2012; Scott 2014). Carolan (2007) also identifies economic reasons as an important motivation in his interviews with seed savers.

Participants in this study who save seed for economic reasons cited a range of different financial considerations. Eight people mentioned saving or earning money as a reason to save seed, yet their rationales were not all the same. Some discussed not having enough money to buy the quantity of seed needed for projects that they were working on. Ruth, a teacher in the Puna district, shared:

> I really didn't start to do it … more regularly until I was teaching. Gardening at schools. Mostly because that's where I stayed put long enough to have a garden and save seeds from it, but also to save money because I didn't have money for my garden programs … I'm saving seeds make do with what I have.

With hundreds of students to provide with gardening experiences every week, buying seed out-of-pocket is cost-prohibitive to Ruth; saving seed allows her to use her limited funds for garden infrastructure and other supplies. This cost-saving benefit is particularly relevant for people like Ruth who need large quantities of seed on a regular basis. While a packet of lettuce seed may contain 150 seeds, saving seed from just one lettuce plant can produce a thousand. Ruth's partner, Jasper, who works in permaculture design, echoed this sentiment, "From a work perspective, I like having access to lots of seeds because I never know when a project's gonna come up and ... I like having a lot of seed for broadcast." Saving seed allows Jasper access to large quantities of seed at low cost, so he can complete projects with fewer outside inputs while saving him money.

A focus on access to large quantities of seed sometimes takes priority over saving specific prized varieties. Ruth and Jasper are recent Hawai'i residents, and are relatively new to seed saving and are in the process building personal seed banks. When asked about valuable characteristics and specific varieties saved, they expressed interest in having a number of diverse

and hearty varieties, but did not focus on specifically named varieties. People who are saving seed for educational purposes or large-scale projects may be less concerned about specific varieties. For example, I sometimes teach seed saving classes and routinely grow a large quantity of basil because it is a good seed to use when teaching winnowing skills. The basils that I grow for this purpose are good types, but because my focus is on quantity and because I know some of the seed is going to be lost by beginning seed savers' mistakes, they are not my favorite types for culinary use. This emphasis on quantity and diversity contrasts with a narrower focus on specific varieties often expressed by older and more experienced seed savers, like Robert:

> I think it's gonna change too, the way people view the seed … keep trying different things and eventually people settle in on a small number of things that they're going to grow … They may collect a hundred, but they may only keep fifteen that they regularly grow … For me, I grow a lot of different things, but there's very few things that I save seeds [from].

Some participants save specific varieties that they already are familiar with because it allows them to invest their money in other things, such as new varieties with which to experiment. Peggy, who has been gardening in Hawai‘i for 39 years expressed this: "I usually save seed anyway because, [if] you're going to spend twenty to thirty bucks on seed for your garden … you can save the seeds [and] you use the twenty to thirty bucks to get a new variety." Experimenting with new varieties has additional benefits for Peggy. She was one of two participants who sell seed that she saves, both through a local store and to online customers.

> I put together little packets, then you can run them past the inspection people. Then they go 'Oh yeah, seeds. Okay, fine, get out of here'. They all get mailed off, people buy them, then they will swap them at the seed exchange. This variety [of marigolds] is called Orange Hawai‘i and it's good for chickens to make their eggs very yellow, very orange. I got this variety so I will be able to get the seeds and sell the seeds, because they say Hawai‘i on them. (Peggy)

In this instance, the financial benefit of saving seed provides Peggy with supplementary income. She sells her Bleak Hall Sea Island Cotton (see Seed Story 6) for as much as one dollar per seed to growers on the mainland, where it is no longer available. Because she makes money from selling seeds that she saves, she focuses on growing specific named varieties with known qualities, rather than saving from a wide diversity of varieties. When I offered her some seed

from a red-leaved variety of cotton, she was uninterested and replied, “It has white cotton, and doesn’t have as long of a staple [as the Bleak Hall Sea Island]. For me, I’m growing it for the fiber… I don’t care what the color of the leaf is. They make a blue-eyed white rabbit. I don’t care what color the eyes are! What quality is the *fiber*?” Peggy’s time, attention and garden space are limited. She is a seed and rabbit farmer, and her priority is not on maintaining as many varieties of seeds and rabbits as she can, but on those that have valuable qualities and are therefore the most profitable. Peggy’s attitude contrasts with that of seed savers who desire to preserve diversity, striving to collect as many varieties as possible (discussed in Section 3.10).

Other participants, particularly those who are of immigrant families but were born and raised on the island, describe seed saving as a subset of gardening activities that contribute to the family unit and help to save money. Saburo and Tadashi, both of whom are of the first American-born generation of families that emigrated from Japan, described food that they grew and seeds they saved as “for family use” and “to supplement our home.” Frank, also born on the island, told me how saving seed reflects the fiscal ethic that he learned from his family. “So you were able to, out of your garden, during your after work hours, do something to help yourself benefit your family. Which allowed you to maybe save more of your wages toward buying a piece of property.” Frank thought this practice of using the garden to save money was particularly poignant for his Portuguese ancestors because they immigrated to Hawai‘i . In Portugal commoners were not able to own land, and frugality, as evidenced in activities like seed saving, helped Hawai‘i’s first generation immigrants like Frank’s family make land ownership possible.

Thrift was not just evidenced in seed saving. Frank told me about a technique his grandmother used to feed her chickens, revealing a final economic theme that emerged during interviews: the idea that, although growing food does not necessarily create monetary value, it is a means to create energetic value.

> She always raised chickens and of course the more protein you have, the more eggs you get… she would take a bucket and hang it out in the coop, and drill holes in it like a showerhead and put an old knuckle bone or something in there. That would attract flies and … maggots would then fall through. Forty-some percent protein. Chickens love it, it’s actually their natural diet and free! Very

> little work, you're just enhancing the natural cycle of what all these systems would do on their own and working with nature. I thought that was ingenious, here's this lady that never really had an education but was working under natural law … It's the idea of the true piggy bank. Right here, I am taking something I cannot use and converting it into something I *can* use. Eggs… and then you're able to reuse the shells and put the calcium back. And that's the true idea of sustainability: taking out what you need along with putting in more than you're taking out.

By "working under natural law," his grandmother was able to take something that had no monetary value, that was in fact a waste product, and to create food. Even if she did not sell the eggs, she had converted energy into a form that was useful to her family. The value of the "true piggy bank" is that the pig eats slop, and creates meat. Frank's level of enthusiasm for the idea of converting waste into energy reflects the degree to which the ability to produce food motivates him to save seed: he uses seeds to convert sunlight into carbohydrate in the same way that his grandmother converted knucklebone into egg. Jasper expressed the same idea in a different way: "Actually, and I think this is a really important point, actually you can create calories. Which is the only real value on this planet, energy is the only real value on this planet… So seed is the starting point." Saving seed holds economic value because it allows one to circumvent the monetary system. If you grow it yourself, you do not have to buy it from someone else.

Many participants cited economic motivations for saving seed, but the nature of their motivations varies. Some people save seed because of insufficient funds to buy it, some save seed to make a profit, some save seed so they can put away money for their family, and some save seed because it helps them to convert light energy into food energy, or "the only real value on this planet." Although one might expect that people who sell seed would express economic reasons as a major motivation for saving seed, this is not always the case. A group of 10 farmers and gardeners from across Hawaiian Islands, known as the Hawai'i Seed Growers Network (HSGN), have formed a company that sells locally grown seeds. I have worked with this network, and interviewed two members for this project. Interestingly, neither of these people cited profit as a motivation for growing seed, focusing instead on issues of local adaptation and food security.

3.2 Local Adaptation

In order to ensure reliable crop vigor, yield and quality under local environmental conditions, many farmers and gardeners seek to obtain or develop "locally adapted" varieties of seed that people have grown in a specific region for several generations. Local adaptation results from a combination of farmer preferences and environmental conditions, and often develops in low intensity systems with less than optimal environmental conditions (Pascual et al. 2011). In these conditions, limiting factors (e.g., water and nutrient availability) place greater selection pressure on the plant population, resulting in genetic changes.

Although some evidence for local adaptation is anecdotal, observed by growers and not subject to rigorous genetic testing, studies of *in situ* management of genetic diversity have shown that varieties do "evolve in response to practices and environments where they are cultivated" (Thomas et al. 2011, pg. 332). A 26-year study in France found that growing wheat in sites with differing environmental conditions allowed for the development of seed populations with distinct locally adapted traits (Enjalbert et al. 2011). Tolerance of environmental stressors often involves multiple genes, and seed develops best via *in situ* exposure to those stressors (Kotschi 2006). Developing or improving varieties specific to a given bioregion or climate type is a common practice for seed savers (DeMuth 1999) and many gardening magazines cite this as a primary reason to save seed (Bailey 2012; Scott 2014; Tipping 2017; Lein 2017). Seven participants in this study cited access to locally adapted varieties as a reason for saving seed, in part because they are not widely available to buy in Hawai‘i.

The majority of seed available for purchase in Hawai‘i is grown in temperate conditions on the American continent. The University of Hawai‘i (U.H.) Seed Lab sells locally grown seed through their website, but, as of January of 2018, one-third of their offered varieties were out of stock and none were organically grown. Additionally, some seed savers are concerned that, due to lack of funds for maintenance of these lines, the U.H. varieties may have experienced genetic drift. Hoku Seeds, a biodynamic/organic seed company based on Moloka‘i, has sold locally grown seed in the past, but their online store is currently inoperable. Other local seed companies sell a combination of repacked seeds purchased from the U.H. Seed Lab and mainland growers.

Although HSGN began selling locally adapted varieties online in the fall of 2017, they did not yet have seeds available at the time that I was conducting interviews.

Most mainland commercial seed growers strive to create "widely adapted" varieties that perform in a range of conditions. Yet much of this seed is ill suited to Hawai'i's diverse microclimates and tropical soils. Several seed savers complained of lackluster performance from seed grown on the continent and noted that they would often have to trial several varieties to find one that worked. Ruth explained, "We could get free seeds for school gardens from places on the mainland…. I just got a big box of seeds from Seed Saver's Exchange… Which is awesome, but half of it doesn't stand a chance, down in Puna especially." Although U.S. mainland companies donate seeds to her school garden program, the varieties that Ruth receives do not perform well in the Puna district's climate and soils. Bulk seed donations are useful if the recipient has the time and space to experiment by doing variety trials. However, for school garden teachers like Ruth, who want to ensure that students have successful experiences, and for farmers whose profits depend on reliable production, it is imperative to have varieties that are going to do well. As Jasper said, "It's good to have ones that are locally adapted, that *you know* are gonna grow." Growing locally adapted varieties minimizes uncertainty over how the crop will respond to local environmental stressors.

Seed savers emphasized two distinct aspects of local adaptation. First, identifying varieties that perform well in a given locale, and second, grower selection to further improve those varieties. Some participants, like Frank, spoke of local adaptation in reference to heritage varieties, those that people had grown in the region for many generations: "Maybe it was a variety that was very bug resistant or tolerated tons of rain or whatever works for your climate and area. This is something that generationally was *proven* to work." Heritage varieties exhibit local adaptation due to a combination of natural selection by the environment and artificial selection by generations of growers. Frank and other participants spoke about working with varieties that are not from Hawai'i in order to encourage local adaptation. They said:

> Something will pique my interest and I'll order seeds from somewhere, try it out...there's some things that have never ever worked very well, because most of the seeds we're buying are based off of a temperate climate coming into tropical. But I found that if you give them about a five-year cycle and continue planting it yearly or bi-yearly you can get

> a lot of things adapted. And start pulling your traits that you want to select for … Maybe you select for the largest fruit or from the plant that gave you the most production … I've tried to do that and I've had some really good success through the years. (Frank)

> As the plant grows in your area it becomes acclimatized to that area, if each year you pick out the plants that look best, grows the best, and you save those seeds. So you're choosing the best, more vigorous, healthiest plants every year… you're improving [it], so over time you get this plant that just jumps out! (Joseph)

> I'm saving seeds because I like the strain that I have been culling for all these years. It's acclimated to this area and it's actually a plant that does well in this weather. And it handles the moisture well and it's hardy. (Max)

When people save their own seed, they perform artificial selection, both by saving seed from the better performing plants, as Joseph describes, and by rogueing to remove off-types, which Max refers to as "culling." Over time, this grower-mediated process produces seeds that are more likely to be successful in specific microclimate and soil conditions. Gardeners and farmers who plant seeds that are locally adapted to their environments and growing conditions are likely to have greater growing success.

Many seed savers seek to identify locally adapted varieties and to improve them through selection. Charne explains the process through which HSGN selects and improves varieties for sale. She states, "What we started doing was adapting seed and determining which microclimates they did best in… We grew the seed out for two years or more and looked at its performance-some [varieties] will do well, others will not... and then we select from ones that do well." Charne plants a variety that performs well in her region, and then selects from the offspring in order to improve that variety. The idea of not only choosing cultivars that do well in a given area, but also intentionally selecting to improve them, challenges the notion of varieties as static entities, as is implied by the terms *heritage* and *heirloom* varieties. This presents a major question for seed savers. When working with heritage varieties, do we seek to preserve their genetic makeup, or to "move them" via selection to emphasize certain desirable traits? (Carolan 2007). Robert, a former seed breeder and educator spoke about this:

> I always say, 'what are your goals with saving seeds?… To retain the variety as is or create one that does very well for you?' And, most times, it comes out to grow what grows very well for you… after so many generation, it's not gonna look like the original

> one- because you were doing your selection for what is really best in your microclimate. I think that's why we save seeds: because it does really well for you where you farm and under your conditions… It's a moving target, so we keep moving… It's not the same thing year after year after year.

Hawai‘i seed savers echo the findings of Carolan (2007), some of the individuals he interviewed at Seed Savers' Exchange did not think that preserving heritage varieties meant keeping seed genetics static, so long as it preserved the unique phenotypic traits that were characteristic of the variety, while others prioritize conserving original genetics.

Local adaptation is a concern for gardeners and farmers in Hawai‘i not only because tropical climates and soils differ significantly from the continental United States, but because of soil and climate variation on and between islands (University of Hawai‘i College of Tropical Agriculture and Human Resources 2014). Charne explained how this influences her seed saving and sharing:

> There are all these microclimates on this small island. And they vary, they vary hugely. So it's much more important in Hawai‘i where we're in an isolated small area, than it would be on the mainland… I can grow seed down here, grow a crop down here that does well for me, save seed and give it to my friend who's up 500 feet and it doesn't do well at all. But it does depend on the crop.

Charne lives at sea level in Puna and the plants that she grows are exposed to different limiting factors (e.g., rainfall, salinity, temperature, wind, and soil type) than those grown by friends who live at higher elevation. She clarifies that this is only true for some seed varieties. While there are some cultivars that perform best in a particular districts or regions, others are considered more widely adapted and perform well across the island. I interviewed Hawai‘i seed savers who seek both to "grow things that do well on the island", and to grow things that "like our area." This is evident in the use of location-specific varietal names (e.g., Wa‘awa‘a Wonder Bean, Pa‘auilo Pole Bean, or Waianae Okra), and the practice of recording the elevation (a proxy for temperature) where the seed was grown when sharing seed. Some advanced seed savers will work with the same initial variety in different microclimates to attempt to create multiple locally adapted strains.

> Two years ago… I started a cross of two peppers that I really loved … now a group of us are growing those out and selecting. Each of us are in different areas and each of us are selecting for different things… the idea is over a widespread area of different people growing them out, selecting for different things. (Charne)

The effect of diverse environmental conditions in a small geographic area on seed saving is not unique to Hawai‘i. Veteto's (2008) study of seed diversity in Appalachia found "considerable variation" among varieties that had the same name and even those that came from the same parent plants. He noted that, when sharing seed, recipients often assign an individual's name to an unnamed variety (see Seed Story 4). In my personal seed collection, there are several varieties labeled with names like "'Ano'ano's Lettuce" or "Okra from Julia." One function of naming a variety after an individual is that it serves as a reminder where that seed was grown. For example, I have some okra seed from a friend who lives near Kaunakakai on Moloka‘i. If I do not plant it, I am more likely to give this seed to somebody who lives in Kawaihae than to somebody who lives in Honoka‘a because of the similarity of climates.

Recently, concern over variation in growing success between microclimates prompted the development of the online Seed Variety Selection Tool (SVST) for the Hawaiian Islands. In 2012, attendees at the Hawai‘i Public Seed Initiative's (HPSI) Train the Trainers workshop identified a need for better tools for sharing information about varietal success in different areas of Hawai‘i. In 2014, as part of a geography class at U.H. Hilo, I developed a prototype map that divides the islands into 18 different microclimates. Subsequently, with support from The Kohala Center and U.H. Department of Geography, this map developed into an online tool that is currently available at http://kohalacenter.org/hpsi/svst. The SVST allows users to identify which of the 18 Hawai'i-specific zones they live in and to search a linked database that provides recommendations of seed varieties that perform well in that zone. As of the date of this writing, the database includes approximately seventy-five recommended varieties from twenty experienced growers across state. There is some interest among HSGN in further populating the database using either a mobile app or targeted interviews with experienced growers. Further developing this tool may help beginning seed savers and gardeners to identify varieties that are most likely to be successful for them, giving them positive initial experiences and increasing the likelihood that they will continue.

3.3 Maintain Access to Specific Varieties

Farmers and gardeners are interested not only in how a variety performs in their given locale but also its agricultural and culinary traits (DeMuth 1999; Wincott 2015). Heritage and heirloom varieties often have unique characteristics that are highly prized by small groups of individuals (Wincott 2015). Yet because the general public is usually more interested in maximizing yield, varieties with unusual flavors, appearances or growing habits do not hold wide appeal, making them less profitable to seed companies (DeMuth 1999). Because of this, seed scarcity and maintaining reliable access to unusual varieties are common concerns among seed savers. Charne explained:

> That's one reason that I'm interested in saving seed: I'm interested in maintaining varieties. When you have a good old variety that you've been buying from the seed company for years and years and years, and then one year, it falls out of favor and they no longer keep it, or they can't get enough seed, suddenly *you* can't get that seed… If you're growing it and you're sharing it, somebody within your circle can get it back to you.

For savers like Charne, saving seed allows guaranteed access to prized varieties, regardless of commercial availability. Thus, sharing saved seed serves as a further guarantee of continued access (see Chapter 4).

In the years since the Green Revolution, seed companies have stopped offering many traditional varieties (Rhoades 2013). Whealy (1995) found that in the period between 1984 and 1994, seed catalogs stopped listing two-thirds of the 5000 non-hybrid varieties initially available. Seed companies may choose to stop offering a variety for a number of reasons, including: low demand for niche varieties, limited resources for growing out multiple varieties, or attempts to promote specific types of seed (DeMuth 1999). As a result, many can only be obtained through seed exchange and saving (Ban & Coomes 2004; Badstue et al. 2006; Calvet-Mir et al. 2012; Rhoades 2013).

Maintaining access to older varieties may be a particularly significant motivation for people who have been saving seed for longer periods of time. Five participants in this study, four of whom were over the age of fifty, described varieties that they kept from year to year because they were no longer commercially available:

> I save seeds because… I know the quality is good. There are things that I can't get from, you know, commercial sources very easily and so that's why I save the seeds. It has nothing to do with you know sentimental value or anything… it's not a moral imperative. I do it because it serves my needs to have what I want. (Robert)

For Robert, saving seeds is a practical matter. It ensures access to a resource that is not available through other means. He knows which varieties suit his needs and if he is going to continue to grow them, he has to save them because he cannot easily get them elsewhere. Robert makes it very clear that his motivation to save seed is not abstract concepts about diversity or tradition, but the concrete need for continued access to the resources he needs to be a successful gardener.

Robert, a lettuce breeder, went on to describe what traits he looks for in a lettuce: "You look for the one that's the best for you. I really like the Red Oakleaf because it has good color and density and it forms a nice ball and it doesn't bolt easy..." Red Oakleaf lettuces fit the culinary traits that he is looking for, and have a growing habit that is well suited to his conditions. He finds it "easy enough to save the seed," and once he finds a variety that he likes, he sticks to it. In addition to color and culinary considerations, seed savers in this study prized other agricultural characteristics that included: yield, pest and disease resistance, salt tolerance, slow bolting, drought tolerance, and deep taproots for breaking up compacted soils.

Some people keep varieties because they are "tough" in comparison with commercially available types, which are grown in idealized, high input conditions (DeMuth 1999). If one were to grow these local varieties side-by-side with commercial ones under ideal conditions, they would provide a smaller yield. However, the fact that they are able to withstand specific limiting factors (i.e., rocky soils, irregular rainfall, or low fertilizer inputs) makes them essential for growers who are working in those conditions. For instance, ʻAnoʻano works with Pacific Island communities that are experiencing groundwater intrusion due to sea level rise and, as a result, seeks out plants that are salt tolerant.

> Right now, I'm extremely motivated by saline-adapted plants … sort of a narrow factor focus. So right now, the saving of seeds … or cuttings, has to do with that adaptation to the sea-level rise and sea water/saltwater intrusion. So again, that's a little bit of a game of it. What we do we have that's been adapted, that's gonna work in saline soils. So that's the more scientific, save the world sort of thing.

‘Ano‘ano used to think of seed saving as a game of collecting as many varieties as possible (see section 3.10), but now the game is focused on the specific characteristics of saline tolerant plants. Such varieties are hard to come by, and very few commercial seed houses market salt tolerant annual crops. Community seed savers who grow and save seed in coastal areas of Hawai‘i have become a valuable resource for the future of food in the Marshall Islands and other places experiencing sea level rise. What started out for ‘Ano‘ano as a game, has taken on a greater significance.

Seed savers also prize varieties with unique characteristics unrelated to growing considerations. Peggy, who works in the fiber arts, keeps a variety of cotton known as “Bleakhall Sea Island White” (see Seed Story 6). This is a tropical variety of cotton with a very long staple. It used to be popular throughout the South, but fell out of favor because the staple was unsuitable for use with the cotton gin. However, this long staple is exactly what interests Peggy as a fiber artist. Bleakhall Sea Island White Cotton is no longer widely available and if she wishes to continue to grow it, she needs to save seed.

Two participants said that they keep seed for plants that most people propagate vegetatively. Max, who grows medical cannabis, discussed how he keeps seed in order to prevent against deterioration of quality in clonally propagated plants.

> It’s a preventative measure … Because they [clones] actually maintain for five years just fine. …so I’m attempting to breed something back to as close to original as I can. Because it’s very desirable for me, because I don’t want to do cloning for another five years. I’d like to take a break and just have seed that I can plant.

Frank also keeps seed from his Portuguese Cabbage (see Seed Story 5), a plant that is usually grown from cuttings. He finds that his plants grown from seed tend to last longer, perhaps because of stronger root systems. For Max and Frank, seed saving is a form of insurance that they will have access to their vegetatively propagated variety in the future and helps to create plants that are more robust.

Seed savers also keep varieties that exhibit specific culinary characteristics such as flavor, texture and appearance. When I asked Saburo what types of varieties he likes to keep, he simply replied, “The ones that are good to eat!” An emphasis on the culinary quality by specific

varieties came up in many interviews with older seed keepers. Some, like Joseph, were concerned over the declining availability of high quality fruits and vegetables:

> At a lot of the old ranches, you'd get the [apples] they planted back in the 1890s and stuff … you can't even buy those kinds of varieties anymore, you know. Stuff like Cox Orange Pippin, which is an old, old English variety- kind of yellowish, small. Outstanding flavor, just bursts in your mouth! Which is so unusual these days, most apples taste like mush.

Although Joseph does not keep apples on his farm in Hawai‘i, his focus on food quality and flavor is a key reason that he saves seed from other plants.

Specific heritage varieties often have flavors and textures that are essential for traditional culinary uses. Sometimes the variety itself is what makes the dish. In Seed Story 3, Frank described his joy after finding an old store of his grandmother's lima bean seed, growing them, and making a dish from his childhood. He would have lost this variety if had not found some old seeds. Had the variety been lost, he would have also lost that unique character which makes his grandmother's Portuguese Bean soup. In preserving the seed, Frank is simultaneously preserving the unique physical character of the variety and a family tradition.

Ana, who keeps a unique variety of achiote (annatto) from Puerto Rico, also spoke about the value of heritage types in traditional dishes. She noted that there are other types of achiote, often used in Filipino cuisine, that are more widely available than hers. However, these do not have color and flavor that Ana wants when preparing her holiday pateles. Likewise, Ana spoke about using a particular banana to produce the right type of masa for her pateles:

> If you cannot find the Chinese banana, if you go with the Williams bananas, the masa … is harder … they grate potato in there … it ferments, and the masa becomes soft … but again, when you eat it, can taste, you no more that banana texture. Because the potato fermented and made it rise … Other people do that for commercial selling today ... and it's not the way that *we* were taught, it's not the way we want it. So, for myself … I like my own, because it tastes different.

Even when commercial seed companies do have special varieties available, they usually do not discuss specific culinary uses in marketing, tending to emphasize agricultural aspects such as yield and disease resistance. Peggy discussed how frustrating this lack of information can be:

> A lot of times you get a seed package and it says, 'space them at 24 inches on center.' They don't tell you how they taste! These people [a new seed company] will tell you 'This bean is really good for refried beans, it will turn into mush when you cook it.' Then they say, 'these other beans are better for soup' or they give you recipes to go with the beans. Which I think should be why we save seeds…the recipes. Why are we growing these things? To eat, I think, aren't we?

In this case, the new seed company that Peggy discovered is the exception that proves the rule: most commercially available seeds do not come with information about flavor and cooking. For Peggy, the whole point of growing food is to eat it, so when she finds a variety that is well suited to a particular culinary use, it makes sense to save seed from it.

3.4 Experimentation

Gardeners and farmers frequently work to modify and improve planting material, both through seed saving and through plant breeding (Ban & Coomes 2004; Badstue et al. 2006; Deppe 2015). As Frank put it: "I think anybody who gardens tries to experiment." Badstue et al. (2006) consider this experimentation to be a method of managing risk, as it allows seed savers to diversify their varieties and stay ahead of environmental fluctuations. For experienced gardeners, part of the appeal of seed saving is being able to breed new varieties to fit their purposes. Robert shared, "Most people just want to grow things. For me, it is more growing something, looking what it is, selecting what I want out of it, or moving it in a direction that I want. Not necessarily just to keep the variety intact … modifying, making selections." Robert is attracted not only to the agricultural aspects of seed saving, but to the intellectual aspects of breeding new varieties.

Four of the seed savers who I interviewed said they enjoy breeding new varieties, including a practice known as "breaking hybrids." Some of the most animated conversations I had with experienced seed savers were when they told me about new varieties that they were able to develop through on farming breeding and experimentation. Charne's enthusiasm is evident in her description of successfully isolating seed from a parthenocarpic variety:

> The Diva Cucumber does really well for me. [It's] parthenocarpic, so I always bought it from one seed company ... I never save seed from it. And then I got it from another seed company and some of them became ripe enough to save seed and I thought, 'I'll try it and see what happens' And it was fine! Germinated, I grew it out ... I have a Diva that's not

> parthenocarpic! I don't know how stable it is (laughing), I'll have to grow it a lot more. But it has all the same traits! So that was cool!

Parthenocarpic plants are bred to develop a fruit without seed development: a classic example is the seedless watermelon. A mutation in a parthenocarpic plant that allows for seed saving is very exciting for the garden experimenter. What excites Charne is not only finding an off type, but the prospect of working with it to develop a stable and reliable open-pollinated variety. Joseph also emphasized the importance of looking for and working with off types and mutations in purchased seed.

> With broccoli we have found a few varieties that will go to seed! And some carrots will develop seed, Red Chantenay. Every once in a while we'll run into a mutant, you know ninety-nine of them won't produce seed but one of them will and so we save that one and we plant that one out. Next year, maybe three or four of them will seed and so we save We're looking for those kinds of mutants all the time. Anything that is unusual, that looks like it has possibility, then we'll plant it the next year. We [humans] have been doing that for thousands of years (laughing). [Short day onions are] another thing we are working on trying to get one that will mutate and will actually put seeds out here. I know you can do it, because Central America grows a lot of onions. We have some growing right now from Guatemala and got onions about that big (indicates 2"- 3".)

Here, Joseph tells us how he looks for off types in several different contexts. Most Brassicas and onions will not set seed in Hawai'i because our day lengths are not long enough. Brassicas usually require a change in photoperiod to trigger flowering. In contrast, biennials like onions,carrots and beets require vernalization – a change in temperature – to trigger flowering. In both cases, Joseph and his wife save seed to encourage the trait and try to isolate varieties for the tropics. They consider where varieties were originally developed and try to manipulate conditions in order to produce seed. Joseph reminds us that humans have developed the majority of our food diversity this way, by on-farm breeding experiments over thousands of years.

Charne explains why finding an off type, like her Diva cucumber, is so exciting: "I was excited about that because it was a little bit of a bummer to have to buy seed constantly. It's the same thing having to do with hybrids, and that's why it's so fun to break a hybrid (laughing)." "Breaking hybrids" refers to the practice of planting seeds saved from commercial F1-hybrid plants and then selecting from the F2-offspring to develop new open-pollinated varieties. Frank

Morton, lettuce breeder and owner of Wild Garden Seed, used this process to create seven new open-pollinated varieties from one hybrid (Zschunke & Morton 2014). Essentially, planting the offspring of hybrid plants allows the garden breeder access to a wide diversity of genes from which to select desired qualities. Although he did not use the same terminology to describe it, Frank also talked about breaking hybrids. When I asked how many generations it takes him to get a stable open-pollinated variety through this process, he said:

> About twelve and you can lock it in. There was an old Japanese gardener in our area. He grew greenhouse tomatoes for many years and gave me some huge large Romas, big old Romas. Really meaty, very few seeds. I knew it was a hybrid, but they had such great flavor to them I said, "Man, I'm gonna try and see." And sure enough, after the first planting everything under the sun comes up. I mean, there were cherry, there were what looks like some beefsteak. Then you have to start your selection process. It took me about twelve generations until I got it where it was back to the consistent Roma. The flavor profile was there, very prolific, very high pest resistance, it's got to that point. It's just fun to experiment!

Frank could buy hybrid Roma tomato seed, or could try to find an open-pollinated variety of Roma that he likes; considering the time and effort that goes the planting and selecting for twelve generations, these options would probably be cheaper. However, he enjoys the process of breaking a hybrid and developing his own variety. It allows him to create one specifically suited to his needs and gives him a sense of ownership.

Another way to create a diverse population to select from is to create a hybrid by intentionally crossing two or more open-pollinated varieties. The grower then selects from resulting offspring based on how they perform (Deppe 2015; Tipping 2017). This method first introduces greater genetic diversity and then limits it specifically according to local environmental conditions. Deppe (2015) refers to this as a shortcut to create landraces Charne described the process of doing this with two pepper varieties:

> I love this one, Corno di Toro Galleo, which grows about 5 feet high, you have to really stake it, but it has a continuous production and I always know I'm going to have peppers. It's a long, sweet… yellow, and it's a good grilling pepper. And then I like to grow Kaala, which is a university-bred pepper for the tropics. And that's on a shorter plant. It has one or two big flushes. Nice, red pimento shape, thick skin, really sweet. Both of these tend to be pretty disease-resistant as long as I grow them undercover if there's a lot

> of moisture. I am selecting for more of the traits of Corno di Toro, because I want that sequential [production]… I think for the home gardener that makes more sense, than suddenly you have 50 peppers and that's it. It's hard to process so much. So I'm looking for that, and then I'm also looking for shorter stature so I don't have to do as much staking. I'm … defining what my selection criteria are and then selecting for that. I'm on second-generation, I think [a friend who Charne shared some of the seed with] is on her third. I went and saw some of her plants and it was really interesting. Because she's just kind of observing … the Corno Di Toro Galleo is yellow. But there's a Corno Di Toro that's red. Some of hers are going back to the red! …Red is a dominant gene… Kaala is red ... So some of hers haven't colored yet but they're shaped like the Corno di Toro, but there's others *on the same plant* that are shaped like the Kaala. So it's kind of strange, but it's so fun! It's like Christmas!

Again, Charne is not just excited by the prospect of developing a new variety, but the by the whole process of experimenting and interacting with these plants. For people like Charne, Robert, Joseph, and Frank, the intellectual engagement of the breeding process is valuable in itself. It is worth noting that all of the seed savers who directly spoke about experimentation had been saving seed for decades. These seed savers were more likely to be extremely selective about adding new varieties to their farms, gardens and collections.

3.5 Seed & Food Quality

Seed savers' concern over the vigor of commercially grown seeds are an additional reason to save seed. Five participants in this study said that they save seed because it lets them control how they grow, save and store it. The notion that "growing your own" produces higher-quality products is reflected in Joseph's reasons for farming: "In this day and age, if you want really high quality food, it's best if it's in the front yard. You're going to take care of it, you know where it's going, and you want the best for it. And it does the best for you." People who grow their own food have greater faith in its quality, and people who save their own seed do likewise.

Some seed savers expressed concern over seed that they had purchased that did not germinate well, either due to local conditions or due to poor storage. Commercial seed houses are required to meet certain germination requirements and to renew stock yearly. However, seed that is shipped to Hawai'i is likely to go through multiple changes in temperature and humidity. Michiko, for instance, complained that when she recently bought a packet of peas, "the seed

wasn't even alive." Additionally, seed sold by retail stores is often stored in ambient conditions. Both of these factors can result in reduced germination rate and vigor.

Seed savers also cited concerns over varietal consistency in purchased seed. The principal focus of commercial seed houses -- conventional and organic -- is seed production and sales, not breeding or maintaining genetic lines. Consequently, these growers may not routinely "rogue" off-types or perform selection in the field (Bailey 2012). Off-type seeds produce disappointing results for the gardener. Charne told me that she had purchased carrot seed from a major seed company to find that most of it was Queen Anne's lace! Even when there is not such contamination of seed stock, failure of company to perform selection can result in genetic drift over time.

Concern over varietal quality goes hand-in-hand with concern over the globalization of the food market. Global pressures emphasize shelf life, shipping considerations and maximum yield. Some seed savers feel this has resulted in a deterioration of the overall quality of the varieties available:

> They're selecting for different traits [in beef cattle]. In addition, the same thing is happening in the plant world… shipability, late ripening, or early ripening. Or they're selecting traits for mass production-type industrial agriculture. When that happens, you start losing the flavor profile … you start losing traits that made the plant so hardy… drought resistant or able to deal with wet soils … You lose those traits. (Frank)

Some seed savers expressed further concerns about the synthetic inputs that conventional seed growers use. For instance, Peggy is concerned that the USDA's 2011 approval of RoundupReady Alfalfa would affect her garden:

> This is all fertilized with bunny manure. That's the only fertilizer I use, but I'm worried about the herbicide on the alfalfa. Because when you're using bunny manure as the fertilizer… it goes through your bunny into your fertilizer. So you're fertilizing with herbicide. Not exactly optimal. It's like they don't realize everything is connected…

In addition to being concerned that glyphosate residue was affecting the quality of her rabbits manure, Peggy was also worried that it was affecting her rabbits' fertility. At the time I interviewed her, they had gone from producing over 100 kits per year to producing none: the only kit born did not survive.

> They eat all the residue off the leaves. Looking through my database, I have a database of who was born, these guys all have pedigrees, back in 2010, 2011 there were like 124 babies born … 24 or 25 matings, you get an average of … six or so per litter. Then the litter sizes were decreasing. There were a lot less litters [even though] you had 24 breedings… That's why I [am] growing all the stuff for them, because there have been no bunnies.

Peggy suspected that, although RoundupReady Alfalfa was approved in 2011, it had taken some years for its application to be widely adopted and for the chemical to make its way through stored stock and into her bunnies. She believed that this was directly affecting her livestock production. Shortly before I interviewed her, Peggy switched to organic alfalfa in order to test her hypothesis. She had also planted a "bunnyfeed garden" where she grew food for the rabbits that she had complete control over. Although Peggy was referring to growing food crops for her rabbits rather than seed crops here, she expressly told me this story to illustrate her desire to know where her seeds and food come from.

Several other participants also expressed distrust over conventionally produced food, citing this as a reason to farm or garden. Three seed savers felt that conventionally produced food inherently has lower nutritional values because of the varieties used to grow it:

> Most commercial varieties have been inbred for the looks and lack nutrition. (Sean)

> Most of the hybrids if you look at the nutritional profile they have the least amount of nutrients because you sell by volume ... how many tons you produce … how many bushels per acre ... whether it had the nutrition or not…So you get a lot of virtual food…empty food. (Joseph)

> And animal feeds, I'll tell you straight up: I've got to feed three times what I did 10, 15, 20 years ago in order to get the same gains and results … the animals are not picking up the nutrition. And that goes the same for us … not getting the nutrient density. We're eating, twice as much [and] you're still hungry, you're not getting those trace nutrients that your body is craving. So it's malnourishment. And even obesity is malnourishment … and were seeing these things now, more and more and more because of the commercial, industrial [food system] (Frank)

Some studies have indeed indicated a connection between the decline in agricultural diversity and nutrient density (Thrupp 2000). Analyses that compare modern high-yield varieties with

older varieties of the same crops show an "inverse relation between plant yield and mineral concentration." (Davis 2009, pg. 1). This may be due to a dilution effect: increases in the carbohydrate mass of modern varieties have not seen accompanying increases in minerals (Marles 2017). For Sean, Joseph and Frank, saving the seed of traditional, open-pollinated varieties is a way to produce healthier, nutrient-dense food.

In addition to concerns over pesticide use and nutritional profiles, many seed savers expressed distrust over the industrial food system; saving seeds gives them a measure of personal sovereignty over their food and garden.

3.6 Saved Seeds: Alternatives to Commercial Agriculture

Saving seeds can build a sense of community independence when facing an increasingly global food system and give individuals a sense of personal agency and power (DeMuth 1999; Phillips 2005). Monoculture-based agricultural systems rely heavily on F1 hybrid varieties, which produce uniformly and maximize yield. Because the offspring of hybrid seed does not grow "true-to-type," growers must buy new seed each season (DeMuth 1999; Wincott 2015). In this paradigm, seed saving, which used to be a common practice, is now "an exception, even an anachronism, to the endorsed norms of modern, industrial agriculture" (Phillips 2005, pg. 39). Not all seed savers see it as such, but some have described the act of saving seed as political act that directly challenges the dominant food system (Phillips 2005; Nazarea 2005).

Although much of the seed related conversation in the media centers around genetically modified foods (GMOs), genetic engineering is only one aspect of the corporate seed system that concerns politically motivated seed savers. Reduced public access to seed varieties, the consolidation of seed companies (and germplasm ownership), and decreased varietal diversity are also concerns. In the past 20 years, controversial legislation in both Canada and the European Union has reduced the rights of farmers to save and share seeds (Phillips 2005; Enjalbert et al. 2011) while in the United States, several state departments of agriculture temporarily shut down seed sharing libraries (discussed in Chapter 4) (Kinkaid 2015).

The increased reliance of agriculture on GMOs is a major source of concern over the industrial food system. Six participants in this study expressed concern, both over the

philosophical aspects of genetic engineering and the possible contamination of non-GMO seed stock through cross-pollination. It is worth noting that of these six people, five lived in the Hāmakua district. This heightened awareness may be due to recent controversies over the use of genetically modified corn to grow silage at the Big Island Dairy in nearby ʻŌʻōkala (Burnett 2012). Frank, a homesteader from the Hāmakua area, who has made his living in agriculture for all of his life, expressed his concern over contamination:

> It just depends on how you look at it. For me, if it's an outside source of genetics … it's against nature, it's against natural law… like trying to put an animal gene into a plant … something that could never happen on its own in nature through evolution. That's a bad deal in my book. The argument can be made for genetic modification that it's been done for thousands of years in agriculture, but we've always had to work under nature's terms … propagation through selection …you're still working under nature's terms... It's not a matter where we are speeding up the process by going through a laboratory…Basically it's on money terms for a bigger, faster profit…and usually nature's gonna win that game sooner or later. The idea is to be able to find the way to work with nature and under her rules and still prosper. I see the understanding behind trying to find different ways … the few having to feed the masses, I understand why different things get tried. So like I said, I'm on the fence on the deal... But that's a really, really big reason for saving: trying to keep genetics pure.

Frank is not taking a moral stance against genetic engineering, but he has practical concerns over the impacts of the technology upon seed and food production. He is concerned that bypassing natural processes for profit motives will lead to unintended consequences. For Frank, saving seed is not a political practice in opposition to commercial agriculture, but rather a form of insurance in case commercial agriculture fails. Frank continued, describing how many farmers have to adopt genetically engineered varieties to stay competitive:

> Alfalfa is a big example of the problem of genetically modified stuff…seven years now since RoundupReady varieties have been on the market. Well, the hay farmers … they're jumping on the bandwagon. They spend less worktime and effort and make more money… but at the same [time], every new farmer that plows his old crop under and reseeds with genetically modified … They lose that ability to get non-modified seed … There's gonna come a point in time when it's a rare commodity to find non-modified [alfalfa] seed … We're going to see more and more and more of it and it is actually going to be the small-scale producer … the backyard farmer that's going to be the only place that you can find ... the original stuff. To me, it's really sad.

For Frank, seed saving is an act that allows him to resist the inexorable movement towards industrial/GMO agriculture and to ensure access to non-modified seed for his homestead and for the farming community that he has grown up in.

Concerns over seed variety patents and a desire to maintain the public right to save seed can also be a motivation for seed saving (DeMuth 1999; Phillips 2005). For some, maintaining public access to diverse, robust varieties is an issue of social justice. Indeed, some seed savers resist the very idea of commodification and ownership of seeds. Carolan (2007, pg. 748) suggests that this is because these savers see seeds as not only discrete objects, but also as elements of a dynamic connection to nature and history: "The seeds being saved and sold at SSE are not *their* seed, nor are they Monsanto's or Pioneer's. They are part of our genetic and cultural heritage. As such, they cannot be said to be anyone's proprietary technology." Some seed savers see patents that are held by seed companies as a threat to access to this genetic and cultural heritage.

Charne explains seed companies' role in the decline of the USDA free seed program in the early 1900s and the subsequent consolidation of the industry:

> The focus of the political will used to be giving seed free to farmers … they gave out thousands of containers of seeds that had five different varieties and really encouraged people to grow seed. And then the first seed companies came along, and they lobbied really hard against that. And it's just kind of gone downhill since that time.

She describes concerns over industrial agriculture motivated her and others to become more actively involved in seed saving and seed saving education as a form of political advocacy:

> I did some seed saving, but it didn't become a focus and it didn't become a concern until about the mid-90s when genetic engineering happened and people were concerned about varietal loss. And also, the current concern about so much germplasm available to big corporations to do whatever they want to do with it. So people did start to get interested in seed saving. So by the time I came here [to Hawai'i] there was a big interest in "How do we keep our seed in the public domain?"

One interviewee, Sean, explicitly described his seed saving as an act of resistance to commercial agriculture: "I started doing research on the whole G.M.O. thing… saying that they wanted to feed the world, but they're really trying to control the people. To me it was a

revolutionary thing to save seeds, to take the power back." This statement reflects that Sean is thinking not only of preserving genetics or knowing how foundation seed is grown, but also considers the very act of seed saving to be something that counters conventional agriculture: "a revolutionary thing." For people like Sean, Charne and Frank, seed saving represents an alternative agricultural model that allows them to bypass the commercial seed system and oppose the industrial food system in their own yards and gardens (DeMuth 1999; Phillips 2005; Nazarea 2005; Ellen & Platten 2011; Wincott 2015). As alternative economic systems, seed saving and exchange creates "spaces of hope" by giving participants a way to act in accordance with their values while fulfilling their need for goods and services in their daily lives (Harvey 2000; Hughes 2005). As Charne says, "I think this movement has been really good. Not only has it created awareness, but it's created action. And positive action."

3.7 Food Security/Food Sovereignty

There is growing concern among Hawai‘i residents over reliable access to food and the inputs required to grow food in the event of the disruption of global shipping. Hawai‘i currently imports 85-90% of its food; the state recognizes the need for increased food security and has made this a priority (State of Hawai'i Office of Planning & Department of Agriculture 2012). It is helpful here to distinguish between the concepts of food security and food sovereignty. Food security generally refers to the availability, access, use and stability of sufficient food supplies for a population; in contrast, food sovereignty encompasses ideas of local control and production of food (Loke & Leung 2013). One aspect of food sovereignty is seed sovereignty, the ability of a community, state or nation to grow its own food seeds (Helicke 2015).

Food sovereignty is inherently more concerned with social structure and food justice issues than is food security; we see this clearly in authors' definitions of the concept. Altieri and Funes-Monzote (2012, pg. 32) define it as "the right of everyone to have access to safe nutritious and culturally appropriate food in sufficient quantity and quality to sustain a healthy life with full human dignity." Wincott (2015, pg.7) also makes clear the political aspects of food sovereignty, which she defines as "a conscious challenge to the globalized capitalist system of food production." In Hawai‘i, food sovereignty has come to be associated with "a renaissance

movement by various cultural groups to restore many of the self-sufficiency and sustainability practices of traditional Hawaiian agriculture" (Loke & Leung 2013, pg. 178).

Ten of the seed keepers I interviewed spoke about food security or food sovereignty as motivations for saving seed, but none of them distinguished between the two concepts. This theme was particularly common in the focus groups and seed savers under the age of 50 mentioned it often. Frank, for example, highlighted the fact that simply not enough people are growing food in Hawai'i to provide for its residents:

> They [Portuguese immigrants to Hawai'i] raised large families doing that, so why is it not possible today? It should be, it's just that there's not enough farmers…more people opt out and say, "I'll take the convenience factor over the sweat factor". Until that gets reversed, until the farmer is looked upon with the same status as the white-collar attorney or the doctor … until society honors him … I don't think it will change.

Frank also shared his concern that although many people are interested in growing food, the learning curve is such that they would not be able to do so if faced with a real food crisis: "There's just not enough knowledge base there to do for your own. … I always tease tons of my family friends … I say 'when that day comes, the hillbillies are going to rule the world, and I'm going to be king." Seed keeping is one aspect of building food system resiliency in the event of reduced inputs due to crisis or increased oil prices. Hawai'i residents' concerns over loss of access to adequate food "if the ships stop coming" to Hawai'i associate reflect the "apocalyptic" theme that Wincott (2015) identified in her study of discourse on heritage and heirloom seeds.

Saving seed can help communities to move towards more locally based, sustainable food systems and help fulfill an individuals' desire for control over their access to food (DeMuth 1999; Clayton 2007). Like owning land, having a seed collection can provide self-sufficiency and an ability to support future generations (Belk 1988). The idea of food self-sufficiency provided a sense of security to many participants, including Frank:

> As long as we're able to cover [grow] and get things we want for ourselves, we're good…In the current world of technology that we live in there is so many changes … genetically modified foods, climate change, so many different issues that goes on. [We need to] keep up with tried and true varieties that we know work or, taking that even

> further, helping those tried and true varieties to survive through the changes, so that you have a guaranteed food source.

Being able to grow the food that his family needs is important to Frank, as is maintaining "tried and true varieties," which will help ensure continued community-scale food production. Many of the seed savers who discussed food security issues also talked about the importance of growing 'hardy' varieties. Joseph, for instance, described his Portuguese Collards (see Seed Story 5) as "a great survival plant," which he and his wife have shared with many others.

While some participants focused on the practical issues of food security, some participants discussed it as a moral/ethical ideal, more closely aligned with the concept of sovereignty. Jasper said simply "I love the *idea* of food security," while other seed savers, such as Sean, teased apart the political-economic implications of having control over food and energy production in his own backyard:

> You need those high producing stuff that grow in the backyard ... One Ulu tree, one Laupele, one Chaya, one Moringa. That would be a pretty solid diet in your back yard. … What is it the community needs? What is there lacking? What can I do to benefit or solve a certain problem? I do want to get into biofuel crops; I'm tired of buying gas. I'm also getting into fiber crops… Now that I have space, my big dream is to never have to go to a store again...I think it would be so rad to totally break free from the system and try to liberate other people.

Jasper's love of the "idea" of food security and Sean's desire to "liberate other people" reflect an idealism and interest in a resilient food system as not just a practical matter, but philosophical concept (see also Section 3.5). Like Sean, other seed keepers strive to increase self-sufficiency around non-food items. Peggy, for instance, produces angora and cotton fiber and grows fodder for her livestock. Six other seed keepers spoke about medicinal plants that they keep. One essential element of resilient food systems is agricultural biodiversity and several seed savers in this study explicitly stated a desire to preserve agricultural biodiversity as an incentive to save seed.

3.8 Preserve Agricultural Biodiversity

There is growing concern, within both the scientific community and agricultural sector, over a global decline in the genetic diversity of food plants and the genetic erosion of heritage

varieties and landraces (Fowler & Mooney 1990; FAO 2010; Thomas et al. 2011). Addressing genetic vulnerability in agriculture and preventing further genetic erosion is a major goal of the Food and Agriculture Organization of the United Nations (FAO 2010). Fowler & Mooney (1990, pg. xiv) go so far as to say, "What is at stake is the integrity, future and control of the first link in the food chain." For many participants in this study, preserving varietal diversity is an important reason to save seed.

> We've lost so many varieties since the early 1900s... if you look at what was offered in the early 1900s, versus what we have available and seed catalogs today, the variety numbers are way low. But since people have been seed saving, I'm seeing more way more varieties coming up. (Charne)

Ban and Coomes (2004, pg. 348) observe that "the global decline of cultivated plant diversity in tropical agriculture systems" has led to increased interest in gardening. Some gardeners see their role as one of preserving genetic diversity in garden fruits and vegetables (DeMuth 1999). Nick and Jasper expressed this sentiment:

> The reason I got into [it was] because I heard about the sixth extinction, also called the Anthropocene extinction. It seems to be caused a lot from agriculture, modern agriculture. I got into finding ways of growing food that didn't contribute to that and seed saving seemed a pretty big part of that. (Nick)

> A big thing to me is just knowing the amount of loss of genetic diversity in our food systems around the world. (Jasper)

Not all participants expressed concern over the loss of varietal diversity, and several older seed savers were entirely unaware of the issue. Robert, a lettuce breeder, discussed how duplication makes it difficult to document the extent of varietal loss:

> [Local selections] … that's the basis of a lot of seed catalogs early on. That's why a lot of times I dispute when people say 'we've lost so many varieties'... it is a tricky one, because every seed company -- and we had hundreds of seed companies -- would collect seeds. And they're not gonna sell something under the name that their competitors did, so they would rename it in their catalog ... so, you know, germplasm-wise we haven't lost all that much … not 90%. I'd say the number's a lot smaller because there was a lot of duplication.

Regardless of the precise extent of varietal loss, there is ample evidence that varietal diversity is beneficial to consistent, sustained production. Agrobiodiversity helps farmers manage risk in uncertain conditions by providing a measure of "natural insurance" against fluctuations in environmental factors such as climate and diseases (Thrupp 2000; Ban & Coomes 2004; Baumgartner & Quaas 2010; Pascual et al. 2011). Eight participants in this study, six of whom were under the age of fifty, said that they save seed as an attempt to preserve genetic and varietal diversity. This type of grass roots attempt to preserve varietal diversity can be seen as a type of "citizen science," with seed savers contributing to *in situ* conservation (Thomas et al. 2011).

Effective diversity management requires on-farm, *in situ* conservation activities as a well as *ex situ* conservation in gene and seed banks (Enjalbert et al. 2011). *Ex situ* methods are a static approach to seed preservation, which preserve the genetic makeup of a species or variety at one given point in time. Some criticize this phenomenon of "evolutionary freezing" because it prevents adaptation in concert with environmental changes (Carolan 2007). In contrast, *in situ* conservation is a dynamic process and allows genetics to shift in response to environmental conditions (Altieri & Merrick 1987; DeMuth 1999; Pascual et al. 2011). Robert discussed some of the benefits of seed saving as a form of *in situ* preservation:

> I think that … it can help to alleviate some of the problems of global warming and these kind of things. Because we're making that transition slowly over time. It's not like you kept [seeds] in storage 50 years and bring them out. It's just a different way to keep seeds … grow it out and then save it for another 10-20 years and then grow it out and save it. As opposed to … doing it year to year…Everything comes down to what your goal is. Because, you know, most of those big major seed banks long-term goal is for germplasm preservation. They're basically keeping the lines intact.

Crop varieties that exhibit traits like drought resistance, early maturation and light sensitivity are more likely to thrive under novel climactic conditions; continued access to these types of varieties increases resilience to change, including climate change (Kotschi 2006; Veteto 2008; Jarvis et al. 2008; Pascual et al. 2011). In fact, Pascual et al (2011) suggest that agrobiodiverse systems may show more rapid response to climactic shifts not only due to the resilience of individual varieties, but due to gene flow between varieties of the same species.

Maintaining crop diversity provides not only "current use value", that is, practical immediate benefits to the seed saver, but also "options value" or the possibility for future use by the seed saver. It also holds, "altruistic value" in its possible future use by others (Jarvis 2011). Frank talked about the altruistic value of biodiversity:

> Here are varieties of things that you can't find … taste profile or preservation profile… it lasts longer or it ripens during a longer period so you can use it longer … it worked and it was something important to save. And it kind of clicked on for me: nobody else is doing this… Be the guardian, at least pass it on to someone.

In Section 3.3, I discuss seed savers' desire to maintain access to specific varieties because of their current use value, but what Frank is talking about here is different. He is not keeping varieties around only because they are useful to him; he is keeping them so that *others* have access to them in the future. Linda echoed this feeling of responsibility to keep things around saying: "If you don't, who will?"

Interest in preserving varietal diversity leads some seed savers to keep varieties that are less than ideal for their conditions, because for some seed savers, preserving diversity is a moral imperative rather than a practical consideration (DeMuth 1999). Seed savers in the Puna focus group spoke about the importance of maintaining the full suite of banana diversity in Hawai'i, "Just in case one [variety] fails." One Hāmakua seed saver compared keeping diverse varieties of pigeon peas to "not putting all your eggs in one basket." As Jabs (1984, pg. 4) suggested: "in a world … changing so rapidly, one of the most meaningful things we can preserve … is a full range of possibilities."

In addition to preserving genetic diversity, i*n situ* conservation of plant genetic resources preserves growing, harvesting and preparation methods, which may increase productivity and yield (Pascual et al. 2011; Jarvis et al. 2011; Calvet-Mir et al. 2012; Rhoades 2013). Saving and sharing seed increases the likelihood of successful outcomes not only because of variety and seed quality, but also because of the specialized information that growers exchange with the seed. This knowledge, which is unavailable with commercially sourced seed, is carried in the stories that seed savers share.

3.9 Preserve Traditional Knowledge and Practices

People save seeds not only to preserve genetic diversity but also for socio-cultural reasons such as preserving story or family practices (Carolan 2007; Calvet-Mir et al. 2012; Wincott 2015). Seeds are living things, and their genetic material gives them a biological value, but some varieties also possess a social value held in the stories and traditions that are associated with them (Carolan 2007). People may save seed in order to carry on a family legacy, to define their cultural identity, to increase social prestige, or to reconnect to agricultural practices of the past (DeMuth 1999; Jarvis et al. 2008; Wincott 2015). Jasper highlights the ways in which seed saving helps to connect to our common agricultural heritage:

> If you think about the whole history of agriculture around the world, all these thousands of different agricultures, with their own varieties …that they created. Their stories and hard work and love in every single one of those. And those seeds are designed for those places. So they actually allow people to connect directly to that place, so then you don't have that loss of sense of place or meaning.

For Jasper, and many others who save seed, this work is a way to honor the "hard work and love" of our collective human ancestry. It provides a way to connect not just to our sociocultural past, but also to the physical places where varieties are from (see Section 3.12).

Seed saving is a way to carry on what it means to be human: to connect to the earth and its cycles, to provide food for ourselves, and to steward varieties passed down to us by the past for the future. Carolan (2007, pg. 743) found that, for many, seed saving represents "a way of life." Many of this study's participants, particularly those who have been growing food since a young age, referred to seed saving as a fundamental part of their nature, saying things like: "it is part of being human," "that's what we do," and even just "it's in me." Jasper elaborated on this theme:

> On a really deep level, it is how human beings are connected to the world, the earth. For thousands of years in a lot of cases. And I think it's really important to continue ... Think about human beings migrating … imagine if you're migrating, if you have any clue about agriculture, you probably have some seeds with you. You're taking those varieties with you because you recognize their value.

Growing food is a profound aspect of being human, and saving seeds is a fundamental part of this process, allowing farmers to preserve germplasm until planting conditions are ideal. When contemporary gardeners save seed, it allows them to connect to traditions of the past.

Other seed savers spoke about the practice as a way to honor their family elders, by "preserving history" and "carrying on traditions … handed down." Frank, who grew up with his grandparents, spoke about a sense of moral obligation to carry on these agricultural traditions, returning to this theme several times throughout our interview:

> I always tell people my grandparents farmed organically, even though they didn't know what the term meant by today's standards…And you always get the guilt hounded in to you… "Make sure you keep this up!" So you get the responsibility of continuing [traditions], we try to…The elders did pass away … we've got tons and tons of family, unfortunately most of the cousins and my peer group don't want anything to do with it …

Frank feels privileged to know traditional methods of saddle making, preparing food and saving seed. He feels that it is his duty to preserve and pass on this knowledge not only out of respect to his elders but also because he sees that his peers are not doing so. Frank has a role in his community and family to keep traditions and traditional varieties alive. He does this both to honor his elders and to give opportunity to his children, so that they may have the option to continue the traditions: "I'd love to be able to pass the stuff onto them, knowing that it may not interest them at all, but if it does, it's there. And to be able to pass on traditions that are hundreds of years old is important."

Preserving old varieties makes some seed savers feel connection to those who gave them seed as well as to gardeners of the past (DeMuth 1999; Calvet-Mir et al. 2012; Rhoades 2013). Seed exchange allows people to practice their beliefs about what is worth sustaining and creates a sense of active participation in the community (DeMuth 1999). In this way, seed saving and exchange not only maintain traditional knowledge, but also build community. Charne and ʻAnoʻano to expressed this love of personal connection through seed and story:

> My taxman, who has done my taxes since 1980… [said] 'Oh, we have a bean that our family's been saving that came from Italy for as long anybody in our family can remember.' And I said, 'Oh, what variety?' And he goes, 'We don't know. It just came from Italy with the family.' So I said, 'Well, send me some seed. And then I'll grow it out

> and save it and if for some reason you lose yours, I'll have it …' It's a nice bean; we call the 'Taxman Bean'. And it's worked out really well … What I like most about it … It's not one of my favorite cooking beans…but every time I grow it I really think of him, so it becomes a personal experience besides just a practical and food experience. (Charne)

> What was interesting to me was the story. "This seed came from [Joseph's] farm and ended up to my garden and now I'm giving it to [another friend] … to me, the collection is not just only the collection of the actual seed or the plant but … that line, that story is really what I love. It's not just the seed, or the history of the seed, but the reminder of the person who gave you the seed. ('Ano'ano)

For Charne and 'Ano'ano, having plant varieties from friends and loved ones makes them feel more connected to those people. The emotional connection to these seeds and plants is a powerful motivator to save seed and even if, like Charne's Taxman Bean, the variety is less than ideal, they want to add it to their collection.

3.10 The Collector Impulse

For many seed savers, there is an appeal in adding a novel variety to your collection, and DeMuth (1999) notes that excitement over unusual shapes, colors, flavors and even unusual varietal names can be powerful motivation for saving seed. Although it was not a common theme throughout my interviews, four seed savers discussed a desire to build their collection, particularly when they were new to seed saving, as a reason to save seed. 'Ano'ano spoke about this "collector impulse":

> The more personal /cultural /selfish [reason to save seed] is that I think human beings are naturally hoarders … It's the whole collection thing … So instead of collecting, you know, matchstick boxes … to me, it's like, "Okay, if you are going to collect something, let's collect something that is useful. … Instead of collecting Beanie Babies, collect beans!" … It's the whole idea of hoarding and saying: "This is *my* little collection." The thought that I have some reason to choose the seeds. Even if I made up the reason … it's something intrinsically human about saving and hoarding and collecting…

She went on to describe how this had influenced her as a beginning seed saver:

> It was sort of a game … I was a collector. That's when I had my Pa'auilo farm and the game was: How many plants can I get from school gardens around the whole island in my farm? That's the game…I'd go visit a school garden and be like, "Oh, I really like

> this!" And then collect the seed and grow it out in Pa'auilo and then save that seed and spread it to another school garden ... So it wasn't like, "this is serious seed saving for biosecurity or biodiversity." It was a game! … You could walk around my garden in Pa'auilo and I could say 'That came from Konawaena School. That came from Waimea School.' It was more of a game.

Seed collections express identity. Human beings consider possessions as extensions of the self; the type of possessions that we choose to collect reflects the concept of self that we wish to create, forming an "extended self" (Belk 1988). This notion of the extended self can apply to the act of gardening. In her study of motivations for gardening, Clayton (2007) found that, though individuals considered their gardens to be both part of their homes (an extension of their selves) and part of the natural environment, they associated it more with their homes than with nature.

Seed collection, in particular, may appeal to multiple aspects of this desire to define the self. Belk (1988) contrasts the views of Jean-Paul Sartre, Karl Marx and Erich Fromm on what is the essential element of existence: the possessions that we have, the work that we perform, or the way that we experience being alive through sharing, giving, and sacrifice. Saving seeds is a behavior that addresses all three of these elements. When I save seed, I am simultaneously fulfilling my need to define myself through possessions -- my seed collection -- through my work -- my gardening and seed saving skills -- and through my actions -- stewarding the seed and sharing with others.

3.11 Fun

Fun and enjoyment are powerful motivations for saving seed (Phillips 2005). Seven seed keepers mentioned this aspect of seed saving, saying things like "it's a hobby" or "it's interesting." When I asked Joseph why he gardens and saves seed, enjoyment was the first thing he mentioned: "One: It's really interesting to me. I really love fruits, vegetables, nuts, berries. [My wife] really loves vegetables, medicinals. So we're both doing what we love and that works out." Frank expressed a similar sentiment: "You know, I just enjoy growing everything … I just love seeds and seeing things grow, whether it's a steer or tomato plant … You get a reward out of it." In addition to the material rewards of saving money and producing high quality food, saving seed provides an emotional reward to Frank and Joseph, it is something they love to do.

Some seed savers who work in education found that the fun aspect of seeds made them a useful teaching tool. ʻAnoʻano, who grew up in Malaysia, spoke about the games she and other children played with seeds:

> These red seeds that are really hard and you would collect them and … sew them into little pouches. You would have to make at least five and you play this game called ʻFive Stones'… like Jacks but with the seeds in these little pillows … It became like an addiction. Like: "Where is all the seeds?!?"

Her father, a teacher, reflected on how educators could build on children's interest in these seed games to teach basic science concepts: "I can at least think of five, six different games the boys would play with seeds. And it just occurred to me had I been wiser I [would have] used that when I was teaching … for pollination, dispersal." Teachers who save seed can use it as a starting point to teach about many natural science topics. Ruth also spoke about this "I like it as a teaching tool ... teaching kids to be resourceful and to value what they have in their own backyard. And it's very sensory exposure." The fact that seeds are fun makes them a practical tool for keeping students engaged in garden-based learning. I have personally incorporated seed-based lessons into environmental science classes at both the high school and community college level, and I keep a collection of 'experiment seeds' for just this purpose. ʻAnoʻano described a seed activity that she does with both children and teachers:

> The other thing magical about seed … something I do a lot with the teachers and the children is … show them the seed, and the question is "Is it alive?" You go through "what makes something alive?" It breeds, it reproduces, it poops … there's this whole discussion of: is *this* alive? … It goes off on these really amazing tangents with the children and the teachers … It's not really alive, and yet it's alive! And that's to me the magic. It's powerful really, pretty powerful.

This magical quality of seed – that it is a living thing, full of potential and yet so similar to an inanimate pebble or piece of shell, fascinates both children and adults. Many of the people interviewed for this study discussed such an intangible, spiritual aspect to their seed saving.

3.12 Connection to Nature & Beauty

For many growers, seeds and plants are more than just genetic material: they represent the connection between humans and wild nature. Gardeners in multiple studies have cited

'experiencing nature' as their most important motivation; the importance of this connection to nature and natural processes often outweighs tangible benefits (Clayton 2007). Saving seed allows an opportunity to create deeply meaningful connection with food and medicine plants and can be a means of expressing spiritual values (Carolan 2007; Jarvis et al. 2008). Six seed savers interviewed explicitly mentioned connection to nature as an aspect of their seed saving, and several regarded this connection as spiritual. Frank spoke about the dangers of losing connection to nature:

> It's living outside of that cycle of nature that, for the majority of people … causes most of the problems. You can trace that all the way down to the wars in the world and famine … it's that connectivity to the earth. We're all biological creatures; therefore, we are all a part of and accountable to natural law. It's that simple. We are not going against it. We do! On a daily basis. But we're paying the price for that, you know.

Frank believes that our societal problems fundamentally stem from disconnection from our animal nature and from our symbiotic relationships with other organisms. Growing food, and saving seed, helps us to stay conscious of those relationships and of our role in the greater scheme of things. Sean also spoke about the value of growing food as a means to connect with other living things, saying that it allows us "to create a harmonious balance, to learn how to take care of ourselves and take care of everything else." Agricultural plants are fundamentally dependent upon human beings to reproduce, and we are dependent upon food and medicine plants for our very survival. This relationship leads some of us to hold certain plants with a type of spiritual reverence. Tadashi called his Shiso "a God plant" because "you take that and he gives you … relief." The plant's ability to relieve illness gives it sacred qualities, making the act of sharing that plant or its seeds with another person a spiritual practice.

It is also important to consider the aesthetic appeal of seeds; for many, the beauty of nature is a part of spirituality. When I asked Charne about her favorite seeds to save, she said, "Some of the flowers…I like to have something for the pollinators. And also, I think you have to feed your spirit, so beauty is really important." Two other seed savers also mentioned beauty as an aspect of saving seed. This aesthetic appeal is not insignificant, and in addition to practical agricultural and culinary considerations, selection for physical beauty may be one of the reasons for the great varietal diversity found among beans (Walter 1992).

3.13 Chapter Conclusion

In this study, seed savers state multiple interrelated reasons to save seeds. Practical aspects of seed saving, such as, economic considerations and access to locally adapted varieties were important for some seed savers, whereas philosophical and moral aspects, such as preserving tradition and spiritual connections were important for others. Most seed savers cite a combination of factors. If nonprofit and academic organizations, for example, the University of Hawai‘i, Hawai‘i Public Seed Initiative, Maui Seed Savers, Kaua‘i Community Seed Bank and others wish to encourage people to save seed in the Hawaiian Islands, they should consider the motivations expressed by seed savers.

Generally speaking, young adults and those in middle-age tend to place greater value on items that they believe will help them build a brighter and sustainable future, while older people tend to value items that remind them of cherished times past (Belk 1988). If we apply this model to philosophical motivations to save and share seed, an emphasis on food security and preserving agricultural diversity are more likely to appeal to younger generations, while focusing on preserving tradition or connecting with place may hold greater appeal to those who are older. Although the sample size in this study was limited, responses from participants support this motivational pattern. In general, seed keepers over 50 (who constituted the majority of participants in this study) were more likely to emphasize a desire to maintain access to known varieties and more selective about the varieties that they saved, focusing on ones that they knew performed well and had desirable qualities. Seed savers under 50, were more likely to emphasize the desire to preserve varietal diversity and enhance food sovereignty. There was also a difference between newer seed savers, who were often interested in building a collection, while more experienced seed savers were more likely to focus on experimentation and breeding.

An additional consideration in framing seed saving education and seed exchange is the tone of the message. Wincott’s (2015) discourse analysis found that different types of text used distinctly different language and messaging when discussing heritage varieties. She identified narrative themes around the reasons to preserve heritage varieties. These included: apocalyptic, caretaking, guardianship, patriotism, reality (which one can also describe as legitimacy) and uniformity/character (Wincott 2015). Scientific institutions and activist groups tend to use a

model that emphasizes threats to diversity and public access, while popular lifestyle texts emphasize nostalgia, heritage and culinary choice. Different themes appear because they appeal to different consumers of these narratives, and when attempting to encourage sustainable behaviors like seed saving it is important to consider audience and message.

Considerable research exists on how to best motivate people to act in sustainable ways. One classic examination of motivation around sustainable behaviors and environmental issues is the "sick baby"/ "well baby" appeal (Fine 1995). This idea differentiates communications that emphasize the seriousness of a given environmental problem, demonstrating the need for immediate action, that is, the sick baby, versus those solutions that appeal to the power of individual action for helping with a given problem, that is, the well baby. In two separate studies of sick baby/well baby appeals, Obermiller (1995) found that each has advantages in specific circumstances. In cases where people are unaware of an issue or do not consider it important, the sick baby appeal is more effective. However, when people are already aware of or concerned about an issue, the sick baby appeal can cause a boomerang effect: people feel that the problem is unsolvable and not worth the effort. In these cases, well baby appeals, those that emphasize the potential positive impact of acting, rather than emphasize the problem itself, are more powerful.

In the context of seed saving, it needs to be recognized that leaning towards sick baby approaches or Wincott's 'apocalyptic' theme, that is, declining diversity, food security, GMO "Frankenseeds", etc. is not going to appeal to all gardeners and may in fact 'turn off' some people. This is because the choice to participate in sustainable behaviors, like seed saving, is not only based on rational practical concerns or environmental conservation minded motivations, it also includes subjective value based needs (Carolan 2007). Black & Cherrier (2010) caution that appealing solely to a desire to preserve diversity or act in a sustainable manner may be irrelevant or even alienating to individuals who do not prioritize conservation values.

A multifaceted approach that appeals not only to environmental / conservation concerns but also to individual economic self-interest, to social and moral/philosophical values, to tradition, to fun and to spirituality is more likely to attract multiple diverse seed savers and therefore more likely to preserve a greater diversity of seed. Such a strategy could incorporate multiple types of messages in advertising, educational workshops and seed sharing events.

Including messages that appeal to a desire to save diversity, save traditional knowledge, honor ancestors, save money or celebrate food are likely to reach to a wider audience, then simply a message to "save our seeds." If we wish to invite more people to the seed saving table, it is also useful to refrain from politicaly charged messaging and topics. For instance, there are many people who are involved in conventional agriculture and also keep heritage varieties of seeds from their families. Conflating seed saving with organic agriculture or criticizing conventional methods is likely to alienate these people from attending seed saving and sharing events. Likewise, on Hawai'i Island there are many papaya farmers of Filipino ancestry, who may hold heritage varieties that their families brought from the Philippines while simultaneously growing genetically modified papaya varieties that are resistant to the ring spot virus. If seed saving and sharing events are critical of genetic modification, these farmers are unlikely to feel welcome at attending the event. For environmental activists or food activists who are sincerely interested in growing the seed sharing community, this may be a matter of picking their battles.

Final considerations in encouraging individuals to share and save seed are building skills and network connections. Werner (1999) suggests that attempts to motivate sustainable behavior should examine not only the problem and potential behavioral solutions but also provide opportunities to practice and master necessary skills. In order for people to be effective seed savers, they need to know proper techniques for saving and storing seed. It is also important to build seed exchange networks. (Calvet-Mir et al. 2012) suggest that in order to do this, we should identify the most active seed savers--those central to the network-- and connect them with the people who keep local varieties and local knowledge. Additionally, events could not only offer lecture-style education, but also provide a format for community elders and experienced growers to share their knowledge. This knowledge sharing model has been used with some success at the Eastside Seed Exchange, but could be scaled up and formalized. Jarvis et al. (2011) also suggest a number of strategies for strengthening social seed networks by increasing connections between seed savers and access to diversity. The following chapter discusses seed saving education and seed sharing networks on Hawai'i Island.

Charne's Story: Joey's Bean

On Maui, we went up to this lavender farm. A manager up there that was growing a bean that he brought from Italy. His name is Joey, so we just call it Joey's bean. And that's kind of the interesting thing about these old heirloom seeds that people keep in families for years and years. A lot of times either there never was a variety name, that wasn't important in those countries, or they just got lost in the shuffle. And so they tend to get these generic names. So you can never "trace them back". You can never really trace their heritage back. But that's interesting too, we're so focused on variety and making sure that we keep that and then all of a sudden you have all these beans they you are naming after the person they gave it to you. And in a way, it's kind of more personal because you think of that person when you plant it, when you harvest it, when you eat it. Versus this abstract contact concept of a variety, you have this personal concept. I think we've got pretty rigid in the scientific sense and it's really important to have that. But I'm not so sure in *all* the seeds it's important because if the variety name is lost and you try to track it down and you can't, then I don't think it's all that important, because then it's a personal endeavor and it's a personal collaboration. Even though they don't remember you or know that you're growing their seed, you remember them and where you got it. Then, when sharing or selling those seeds the question is: is that pono? And I actually think it is. Because they couldn't tell me the variety and probably their family couldn't tell me the variety. So, I'd much rather have it named after them and then put on the seed packet a little bit of the history, where I got it from hat I named it after the person that shared the seed with me. It's a way to keep varieties going.

Chapter 4: Seed Saving & Exchange

The sharing of planting material is a fundamental aspect of maintaining agricultural biodiversity, particularly in small farming communities where planting material is often obtained through exchange with neighbors and friends (Ban & Coomes 2004; Badstue et al. 2006; Jarvis et al. 2011; Thomas et al. 2011; Pautasso et al. 2013). Because this sharing involves both interactions between people and between people and plants, understanding it inherently involves a cross-disciplinary perspective that examines both biological and social factors (Pautasso et al. 2013). Studies of seed exchange networks help to enhance variety conservation, promote an understanding of the social organization of seed savers, maintain mechanisms that allow preservation of cultural knowledge, and build knowledge about the transmission of plant diseases (Pautasso et al. 2013). While significant research has been done into understanding the movement of germplasm (both in the form of seed and vegetative propagules) in developing nations, there is a need for study in industrialized nations in order to understand and strengthen seed networks.

In this chapter, I discuss participants' reflections on the processes of saving and exchanging seed, examining the methods that they use to save and exchange seed, the reasons that they choose not just to save but also to *share* cherished seeds, and the factors that they see as barriers to both seed saving and exchange.

4.1 Seed Saving

4.1.1 Education

A key aspect of organized systems of seed exchange is education on best practices of seed saving (Carolan 2007). This education is a central focus of organizations like Seed Savers' Exchange, Native Seed/SEARCH, the Organic Seed Alliance, the Hawai‘i Public Seed Initiative (HPSI), and public seed libraries. Seed saving is not difficult, but there are factors to take into account in order to maintain varieties and produce high quality seed. Charne, current director of HPSI, discussed the program's early attempts at educating seed savers on best practices:

> We realized that a lot of education needed to happen. People were anxious to do it - they were excited, they wanted to grow their own food! But they didn't really have a lot of

> understanding of how to [save seed] properly. So we did educational workshops at the seed exchanges. Tried to share how to store them properly.

In addition to presentations at seed exchange events, in 2012, HPSI sponsored a series of two-day workshops on five of the Hawaiian Islands titled: Beginning Seed Savers for Farmers and Gardeners (The Kohala Center 2018). In 2013-2014, these were followed up by a series of three-day "Train the Trainers" workshops on Hawai'i Island that were designed to provide individuals with the skills needed to run seed exchanges and workshops themselves. HPSI educational events have helped many people in the Hawai'i learn how to save seed properly. Linda, Jasper, Ruth and I have all participated in such events in order to improve our seed saving skills. Linda, who went on to start the Honoka'a Seed Exchange, describes the trainings this way:

> Train the Trainers, that was really cool. Before then, I think I was just saving seeds because you could … without really realizing any method or theory behind it. Just being: 'There's a seed, I will put it in the ground now and it will be a plant.' I was having seed exchanges and telling people that's what they should do: Collect all the seeds you can and just plant them. And that's totally beautiful too. It is definitely interesting over the years learning … I still don't have it all down, but at least there's some thought behind it now … It is interesting learning how to do it properly.

Here, Linda distinguishes between the initial stage of seed saving, where the wonder of the process captivates the seed saver, and a more experienced stage, where the seed saver is focused on producing high-quality seed that produces high quality fruits and vegetables. This second stage of seed saving involves rogueing for off-types, selecting for desired traits, and considering isolation distance, population size, and proper storage.

4.1.2 Best Practices

Proper seed saving technique is essential for producing high quality, reliable seed, and many participants emphasized this. In general, seed savers keep open-pollinated varieties of seeds – these are non-hybrid and their offspring tend to grow true-to-type (DeMuth 1999). Seed savers also consider whether the species that they are working with are typically self-pollinating or out-crossing, as out-crossing crops are more likely to hybridize naturally. Ellen and Plattern's (2011) discussion of the differences between Runner Beans and French Beans illustrates the importance of this. Due to flower morphology, French Beans tend to self-pollinate, while Runner

Beans cross-pollinate. As a result, among the seed saving network that they were working with, varieties of French Beans tended to remain true-to-type over generations, while named varieties of Runner Beans morphed over time as they naturally hybridized. In order to prevent such hybridization, experienced seed savers consider isolation distance, the distance between a variety and sources of contaminating pollen that is required to avoid cross pollination, or use other mechanisms of isolation (e.g., bags, cages, or sequential planting for staggered flower timing) when working with out-crossing plants (Buttala & Siegel 2015).

Another consideration is from which individual plants growers choose to save seed. An important element of maintaining varieties is rogueing for off-types (Buttala & Siegel 2015). In addition to removing off-type plants, seed saving also requires ensuring healthy, high quality parent plants. Robert and Peggy, for instance, talked about the importance of saving seed from the highest quality plants. This can be a challenge for beginners, who may be tempted to eat the best plants and leave others to go to seed.

As I discussed in Chapter 3, some seed savers seek to keep varieties true-to-type while others try to move them towards specific qualities and characteristics. Peggy, for instance, was only growing one variety of cotton (Bleak Hall Sea Island White) at the time that I interviewed her, because it is a rare variety and she wanted to "keep it pure" by isolating it from other cotton pollen. Nick also spoke about working with a few high-performing varieties:

> [I] focus on what does well, try to improve it in breeding, but still aiming to collect from multiple… plants [to] get the best genetic diversity from that … one variety. One variety, not one plant, that's genetic bottleneck … can create problems that are hard to get out of.

Here, Nick not only addresses means to prevent out-crossing, but also considers minimum population size: the concept of growing enough plants to ensure that you are saving the full genetic diversity of the variety (Buttala & Siegel 2015).

This focus on varietal purity is not a sentiment held by all seed savers interviewed. Some, like Sean, value diversity over consistency:

> I have a bunch of pigeon peas on my land. I have one that is the most strongest and produces the most. That's the one I will plant most for food. But the other varieties

> probably [resist] certain diseases. So I will have one to grow my food, but keep the other varieties for the genetics

Carolan (2007) suggests that what is perhaps most important is not whether seed savers strive to keep varieties pure or allow them to cross to create new genetic combinations, but that they are conscious of what they are doing and have the skills and knowledge to understand the implications for their seeds. It is important to note that most, but not all, of the seed savers interviewed for this study had a thorough knowledge of these skills, illustrating a need for continued community education.

Even when growers save seed properly from a large enough population of healthy plants, important storage considerations remain which affect germination rate and vigor. I discuss challenges with seed storage in section 4.3.1. Regardless of how they are stored, it is important not to keep seed too long, as Frank highlighted, saying he often thinks: "Oh! That's getting old, I haven't planted that for a few years. I better plant that." Another strategy to preserve seed vigor is planting regularly and exchanging seed. Charne explains:

> What you can do is just, try not to store seed very long. Just grow it out. *The best place to have your seed is in the ground*… keep collecting and growing it out and the more you do that, the more adapted it's gonna get to your locale. As long as you select properly … keep big enough populations and… have good isolation distance for out breeding crops… the best thing to do is just grow it ... share with your neighbors … then if you lose your seed you can always get back from them … It's a community resource!

Many participants in this study echoed the idea that sharing seed helps to maintain access to it.

4.2 Seed Exchange

4.2.1"The Social Seed Bank"

Seed exchange networks are social networks that can function to conserve locally adapted varieties and knowledge about these varieties (Calvet-Mir et al. 2012). These informal exchange systems can be as important a mechanism for preservation of diversity as are *ex situ* seed banks (Calvet-Mir et al. 2012). Carolan (2007, pg. 746) expresses this sentiment by saying, "[T]he nature that Seed Savers' Exchange is seeking to conserve cannot be housed and anyone seed bank or farm alone, but must include gardens, flowerpots and seed bins around the world."

Redundancy within the network creates a form of insurance by putting "vital plant germplasm into as many hands as possible" (DeMuth 1999, pg. 2). Thomas et al.'s (2011) review of multiple studies identified that a key aspect of seed exchange was replacement when seeds are lost due to natural disaster or other stochastic events such as failed storage. Badstue et al. (2006, pg. 255) suggested that participation in seed networks to maintain access to genetic diversity constitutes a form of collective action. They proposed that "a group of farmers could maintain more diversity than any individual, and at a lower cost and reduced probability of loss." This maintenance of diversity, cost savings and insurance against loss should create of motivation for seed savers to form organized networks. Although Badstue et al.'s (2006) study found that experimentation with new varieties was a stronger motivator for seed sharing than loss of varieties, in this study, sharing seed as protection against loss or merged as a major theme.

Seed exchange allows seed keepers to back up their seed collection in case of crop loss or storage failure: varieties that grow in more than one place on the island are less likely to be lost. Peggy, for instance, spoke about creating such redundancy for her Bleak Hall Sea Island White cotton seed (see Seed Story 6). When she was first gifted it, she made a point of sharing two of the six plants that she received with a friend in case she had a crop failure. Since the time she received it, the man who gave it to her lost his plants to whiteflies and did not have any seed stock, so she has since returned that seed to him. As Peggy puts it: "I like spreading things around… in case something happens." Frank also reflected on the value of "spreading things around:"

> Whenever I've got extra seed, I'm gonna pass it on and share with those who are interested. So that someday if we ever lose it… lose your bank… your seed source…and in memory say "Hey, I passed it on to so-and-so I wonder if he's got some." Even just a couple seeds to get me back in the game. And I thought that was very important so I really try to spread it out as much as I can.

A discussion of favorite varieties during the Honoka'a focus group further illustrated the value of this redundancy:

> Nick: Here's what I had on top of the list: Linda's purple bean … Do you know what the real name of it is?
>
> Linda: No, but I'm still glad that you have some of it because I don't!

Nick: I didn't say I [still] have it… (group laughter)

Linda: Charne said she had some of it!

Nick referred to this function of the seed network as a "social seed bank," in that it allows seed savers, particularly those with poor storage conditions, continued access to prized varieties. In this way, the seed network itself becomes a community resource. Linda explains:

> Which is another reason why sharing them is so awesome … say you grow something "x" amount of generations and you feel like it's finally getting acclimated to your zone and then something happens, and you lose it. But if you have given it to other people, then hopefully you can call them and be like 'Hey do you still have any of that?' Hopefully they say, yes! You can get it back and it has changed more from being with them. Hopefully they have been saving it properly.

Here, Linda is not only telling us the value of the "social seed bank," but some of its limitations. Because seed quality and variety consistency is dependent upon the skill of the seed saver, it is essential that an effective seed *sharing* network is made up of people who are familiar with best practices for seed *saving*. 'Ano'ano shared a story of how a network of experienced seed savers helped reestablish a friend's garden:

> What hit me more seriously was ... A few years ago there was a horrible flood. And [a friend's] garden got wiped out… totally wiped out! And what was so cool was that she could re-create her garden with the seeds from around the island that we had saved from her garden. That's when it suddenly got to me that… Whoa, this is food security! This is biosecurity! It was no longer just a game … It was stored in the network! … And so that's when I started taking it seriously.

Preserving varietal diversity is not an individual effort, but a community one. Individual gardens may flood and personal seed storage may fail, but if multiple people keep the same varieties, they will not be lost to the community.

Joseph expands this sharing philosophy from annual plants to fruit trees (see Seed Story 1). He has a particular interest in grafted varieties of trees and currently has a variety of Rollinia that produces 5-pound fruits. He told me that he wants to share with the community not for sale but just to "get them out there." This redundancy serves not only as a form of insurance against

possible loss of this variety, but also helps to build a resilient local food system, providing another reason to share germplasm.

4.2.2 Seed Sharing and Social Capital

Seed saving is a practice that is rooted in both public and private life. While the actual saving of seed happens in a private arena, gathering at seed swaps and sharing among friend networks brings a public element to this practice (Phillips 2005). Participating in seed sharing networks is a concrete way for individuals to help build more sustainable communities and can produce feelings of self-efficacy (Phillips 2005). These interactions build social capital, the "social bonds and norms [that] are important for sustainability" (Pretty & Smith 2004, pg. 633). In this way, seed exchange not only enhances agricultural systems but also strengthens social systems (DeMuth 1999; Thomas et al. 2011). Social responsibility and social obligation are powerful motivators for seed sharing, exchanging valued varieties with neighbors and friends helps to strengthen social relationships (Badstue et al. 2006; Ellen & Platten 2011).

Differing social roles may result in different priorities and sections. Ban & Coomes' (2004) study of two traditional farming societies in Amazonian Peru found that there was an inverse relationship between the agricultural diversity of a given garden and their participation in exchange to obtain planting material. That is to say, gardeners holding higher plant diversity tend towards purchasing planting material while households with low home garden diversity acquire more of their planting material as gifts. This may be because established gardeners have already acquired the high quality varieties that they can access from the community. In this study, more experienced participants also tended to be more selective about new varieties that they acquired through seed exchange. However, other factors exist that motivate experienced growers to participate in seed exchange. Nick, for instance, said that he often gives seed away because of the difficulty in storing it for long periods.

Experienced gardeners frequently have a surplus of germplasm that they share with less experienced gardeners (Ellen & Platten 2011). Peggy shares, "The thing with cotton is you get so many seeds you're trying to get the things off the seeds, you end up with too much seed…I'm trying to get this cotton spread all over the place. The more the merrier!" This sharing helps to reinforce and grow the network (Ellen & Platten 2011), can be an indicator of social standing

within the network, and is a way for experienced seed savers to carry forward the generosity shown to them by others when they themselves were first learning. In this way, exchange can help to develop a long-term sense of "diffuse reciprocity" among the group that becomes self-perpetuating over time (Pretty & Smith 2004).

Ellen and Plattern (2011) found that a majority of experienced gardeners intentionally plant with the intent of harvesting more seed than they need for personal use; explicitly so that they can participate in seed sharing. In this way, a few skilled individuals provide seed for many others in the community. Several participants expressed the idea that when sharing with family and friends, one does not expect anything in return:

> There is a lot of people that I pass on seed to who will never end up saving it. They will plant it out, utilize it and just not want to go through the extra steps … because they're not [seed] savers. I've had people come back and say "Oh, that was great! You got more seed?" (laughing) "Sure, here you go." (Frank)

> I used to give my friend [shiso] … Because his wife is from Japan, she knows how to prepare the thing… So I give him two, three bags full of the shiso. And I thought they were going to give me some sample food (laughing)… But never did come. I don't care, you know… When I give, I *give*. (Tadashi)

The generosity reflected in both of these quotes illustrates a desire to share nature's abundance with friends and family without the expectation of reciprocity from the individual. I further discuss this type of sharing with familiar groups in section 4.2.3.

Another reason to share seed is to encourage others to grow food. For some, building a more resilient local food system is a goal in and of itself (see Chapter 3). Gerry, Nick and Jasper all spoke about a desire to share easy to grow, productive plants so that even beginning gardeners would be successful with them. As Nick said, "Whatever does well I like to share. I would rather give out winners than the weak ones." This desire to share successful varieties with the community at large can serve as an incentive to share seed at centralized events, rather than just with friends.

4.2.3 Seed Exchange with Friends, Seed Exchange with Strangers

Seed sharing transactions can take a number of forms. Badstue et al.'s classification of these transactions includes *exchange*, when one variety is exchanged for another; *gifting* ,when one individual gives another seed without remuneration; *barter*, when seed is exchanged for other goods or services; and *borrowing*, when seed is given to another person with the understanding that it the recipient will save seed and return it to the giver at a later date (Badstue et al. 2006). Ellen & Plattern (2011) characterize three major types of noncommercial seed sharing. These are: 1) between individual gardeners in informal networks, 2) in networks facilitated by gardening associations, and 3) in networks facilitated by community spaces, including both discrete in person events and ongoing groups online.Thomas et al. (2011) identified two main patterns of seed exchange. The first was among small social networks of trusted friends, relatives and neighbors to replace seeds that have been lost due to natural disaster or other events. In these interactions with familiar people, gifts of seed are an important way to strengthen existing social ties. The second pattern that they identified is exchange with less familiar people, these exchanges function to give growers access to new varieties with which to experiment. Recipients are more likely to have faith in quality of seed that they get from a known provider (Badstue et al. 2006; Pautasso et al. 2013). Familiarity builds both trust in the donor's seed saving experience and knowledge of their growing conditions.

Both Badstue et al. (2006) and Ellen & Plattern (2001) found that, while growers rely on existing networks to share seed, these networks were not developed with seed in mind. That is to say, people in these studies may share seed with neighbors and friends or in a gardening club, but they do not explicitly belong to a seed saving group. This was also reflected in interviews with some participants in this study. Peggy, for example, told me that "everybody" saves seeds and quickly listed several names. When I said "I don't know any of those people," she told me that I should join her quilting group if I want to meet seed savers. As Frank said, "When you do find your little clique of friends that does [save seed] you're always trading stuff between all of you."

Participants in this study talked about exchanging seed both with close familiar networks and with networks of strangers at seed saving events. It is important to note that, while all participants who spoke about seed exchange referred to familiar networks, they did not all

participate in seed sharing events. This may be in part because these types of exchange serve different functions.

Several formal seed exchange events occur regularly on Hawai‘i Island. From 2003 to 2014 the Hawai‘i Island Seed Exchange occurred at the Amy Greenwell Botanical Garden. This was a large public event for the first seven years and later became a smaller gathering that focused on exchange among students in local schools. The Eastside Seed Exchange occurred annually at La‘akea Permaculture Community from 2004 to 2016 and the Honoka‘a Seed Exchange, which started in 2008, still occurs on an annual basis. Other organizations including the Hawai‘i Farmers Union United, Kamehameha Schools, and private groups of individuals also sponsor small seed exchange events around the island. These events often feature an educational aspect, such as a speaker or workshop, and are an opportunity for farmers and gardeners to exchange planting material with people who they may not otherwise encounter. Charne describes how she and a group of friends started the first seed exchange event on Hawai‘i Island:

> The first one was on Kona side and everybody got really excited … the first seed exchange in all of Hawai‘i! And we had a great time...people just were in a vacant field and everybody just brought their trucks and shared plants and seeds and stories and information. And then after that we decided, ‘We need to do this every year! There’s really a lot of interest.

As well as sharing seed via one-time events, some Hawai‘i seed savers share seed at seed share stations, seed libraries or in online forums. Seed share stations are small, unmanned stations placed in central areas that were first popularized by the Oahu-based program “Eating in Public.” People who use the station take seed as needed and return excess seed to share with the community. These small structures require little maintenance, but because they usually are not monitored, sharing of old seed or even invasive species can become a problem. Seed libraries, in contrast, are sharing systems that are located in a public place – often a public library – and monitored by a “seed librarian.” This model of seed sharing is growing in popularity across the United States, as it allows a central place to share seed. In addition to managing donations, distribution and seed quality, seed librarians can monitor what seed patrons check out, and tailor educational events to the interests and skill level of the community (Pretty & Smith 2004; Gilliam 2013). There is currently a seed library at the Kailua-Kona Public Library.

In addition to friend networks and formal seed exchange events and spaces, seed savers may obtain growing material from public places or even strangers. Peggy, for instance, told me about obtaining a Mulberry cutting from the yard of a stranger who was having a garage sale and rescuing an old "Filipino Wine Grape" vine from the yard of the house that was being demolished. Passionate seed savers may even turn to other states or countries in order to find tropical varieties that are likely to do well in Hawai‘i. Joseph and his wife received seed for a short day, tropical onion from Guatemala through an event that she attended in California. I myself have networked with individuals in Cuba and imported a promising variety of long bean seed through customs. Other seed savers who I know exchange vegetable seed with people in Pacific Islands, Indonesia, Thailand and elsewhere in the tropics. It is important to acknowledge that importing *any* germplasm to Hawai‘i is a potential vector for the transport of invasive species and should always be done under the guidance of the US Department of Agriculture and Hawai‘i Department of Agriculture. I discuss the challenges of invasive species and seed exchange in section 4.3.5.

4.3 Challenges for seed saving and exchange on Hawaii Island

4.3.1 Storage

Inadequate seed storage presents a major struggle for many seed savers in Hawai‘i. Ideally, seeds should be stored in cool, dry conditions. The common rule of thumb is the "rule of 100," which suggests that the sum of temperature and humidity of storage conditions should total less than 100. This presents difficulty in Hawai‘i, as Charne and Frank explain:

> We have like 80% humidity and our temperatures [are] 70° to 80°…. so the germination of the seeds really drops off rapidly if … not refrigerated and not dried down to like 6% or 7% moisture. You'd probably lose your viability in 2 to 3 years … on the mainland, it's dry and you can find cool places to save it … usually you can store it for much longer without hassle. Here, we have to store it in packages that are don't have moisture… and also in refrigerated environments. (Charne)

> I refrigerate it, climate's pretty tough … wet, humid, moist tends to lead to rot in a quick, fast decomposition cycle … so it's tough… we've got an old refrigerator in the garage that is just full of nothing but seeds. (Frank)

Many regard a dedicated seed fridge as an ideal place to store seed, but even this can be risky if power is not reliable. One elder who was interested in sharing information about a variety of daikon that that he has been saving for over 50 years decided against being interviewed when someone unplugged his fridge and he lost his seeds.

Several participants did not have access to reliable refrigeration, either because they live off-grid or because they don't have adequate refrigerator space to store their seeds. Although, as Linda says, "having refrigeration would be awesome," many seed savers who live off-grid have alternate systems in order to keep seed as dry and cool as possible. ʻAnoʻano, for instance, used to keep her seed in a broken refrigerator:

> I was serious about that refrigerator in Pa'auilo. I had a dead refrigerator that was completely my seed refrigerator. It was all organized … it kept the temperature constant… had labels that were really clearly marked … I found it to be super dry inside, I had a few desiccants…within the plastic bag *and* desiccant within the whole refrigerator.

Although this system does not ensure cold temperatures, it at least ensures conditions that are drier and more constant than the ambient conditions. Other systems include storing seed in jars with desiccant in the coolest part of the house, Charne reflected on the efficacy of this method:

> Yeah, it would probably work, if you put it in a jar with a little bit a silica gel just to keep the atmosphere dry. But then also, temperature is a factor… So if they can find a cool place. … it will be longer, but it's still not going to be as great germination as refrigeration or freezing.

This method is better than just keeping seeds on the counter, but it is only effective if the seeds have been thoroughly dried down before going into storage.

> I have one of those military boxes I thought since it has an airlock it would be really good … I didn't use the silica beads to actually get things all the way dry. So stuff got moldy in that box. Now that box, you open it and it doesn't smell well. A lot of my seeds went away from that. (Linda)

As Linda reveals, drying seed can also be difficult here, many seed keepers use silica gel with color changing indicator beads to dry their seeds. These beads change color when exposed to moisture, often from orange to green and seed keepers can tell if their seeds have been dried all

the way down by the color of the indicator beads. Nick mentioned that in the absence of silica gel, seed savers can use oven-dried rice to help remove moisture from seeds. It is important to note that actually storing seeds long-term on a desiccant may present problems for some species, especially beans, which can get too dry and will not germinate.

Once seeds are dry and stored, seed savers need to be vigilant about how they handle them in order to prevent moisture from entering seed packets.

> I'm using … multiple plastic bags and desiccant … one plastic bag and seeds inside the other plastic bag and then it goes in the storage fridge…I'm really anal now about not taking it out on a wet day [or] getting condensation on the inside. (Jasper)

Even after seeds are stored properly, opening storage containers immediately upon removing them from the refrigerator can let condensation get into a packet. It is best to always let seeds come to room temperature before opening the storage packets.

Another storage-related struggle for Hawai'i seed savers is insect and fungal infestation, as Frank points out, "there's not much of a kill cycle here." Several seed savers mentioned that insects in bean seeds were a significant problem. Charne shares about difficulties saving beans:

> Some of them are real prone to weevils and they're also prone to sprouting in the pod, so saving seed can be tricky... I just pick them when they start showing a color change. Some of the black seeded beans, the color change will be slightly rosy… others slightly yellow. And then I really examine the seed, cause it's hard to see if the weevils are in it. You have to inspect every seed … still might have to freeze them … weevils don't freeze easily so you have to do it over a couple of days. You can't just put it in for 24 hours.

Choosing varieties that are more resistant to weevils, harvesting seeds at peak ripeness (rather than letting them dry on the vine, as is suggested in many seed saving guides), inspecting individual seeds and freezing beans all will prevent seed loss due to weevil infestation. Failure to do this can result in losses to insect pests. Another strategy that Linda and other seed growers use to address this issue is storing them with diatomaceous earth:

> The way that I store my bean seeds now is I have open jars and I put them in there with some diatomaceous earth … I leave the cap off in a part of the room that I feel like probably stays pretty cool…without being behind a shut door where it could get moldy. They seem to last a bit in there.

Struggles with inadequate storage conditions can be frustrating to both novice and experienced seed savers. When we put significant time and effort into producing a crop of high quality seed, it is frustrating to not be able to preserve that seed properly. One suggestion from the focus groups was that centralized, refrigerated seed storage spaces may be useful for off-grid seed savers, particularly those who would be willing to share some of their seed with other members. Charne commented on this: "Even an air conditioned place is better than ambient temperature… if you had a centralized place with a refrigerator … at least it would be better than having it just in your house."

4.3.2 Lack of Growing Space

In addition to limited storage space, limited space in which to grow out seed is a challenge for many seed savers. This can prevent them from being able to grow population sizes large enough to maintain genetic diversity, which in turn can lead to inbreeding depression. Charne describes how this affected her Tahitian Squash:

> I grew [it] for many years, saved seed. I don't think I grew a big enough population and I got inbreeding depression. The vigor is not good… And I've tried to get that seed from some other seed companies and I'm just not having the same vigor … I wasn't growing a big enough population. I was able to grow that variety pretty well for seven years and it has no vigor now. I need to find new seed, and I need to pay attention to saving [from a large population size.]

A strategy that Robert suggested to address this lack of space to grow sufficiently large population sizes is to have multiple growers plant a small number of plants of the same variety and then come together to pool the resulting seeds. This requires that all of the people who are saving seeds are following similar protocols for preserving seed quality. When Charne found that the vigor of her Tahitian squash had dropped, she turned to people who she had saved seed with and found that much of their seed had out-crossed with other squashes

> Because I can't do big isolation distances, I tend to only grow one variety at a time and I'm not surrounded by neighbors. The seed that I shared … a lot of people, they grew a lot of other stuff too and they didn't do hand pollination… And so theirs morphed like crazy … instead of being long and thin like a giant Butternut, they were fat and round and look like a Kabocha. So they really crossed.

Like Charne, other seed savers have also expressed concern about lack of isolation distance. Proximity to farms that are growing genetically modified papaya and corn could lead to possible cross-pollination. Because both of these crops are out-crossers, there is a possibility of genetically engineered genes getting into the seed saver's stock. Frank elaborated:

> I guess really the only way you'd really and truly find out is to get testing done. Which is expensive ... I'd imagine, from everything I've read …over the amount of space for pollen drift we are pretty safe … it's maybe 50 miles or better [to the ʻŌʻōkala dairy], and a lot of gulches and trees and everything in between. But maybe 10 or 15 years from now we learn that the pollen drift was 10 times more than we ever expected it to be and we do have some contamination. It's to be seen … the more that [GMOs] come here, the more worrisome that is. I don't think we've really experienced enough of that here in Hawaiʻi as much as, say, someone in Iowa or Wisconsin or something like that. Where they have it on all sides.

As Frank suggests, although this is a concern for some seed savers in Hawaiʻi, it is not as great a concern as it is in areas that are dominated by industrial agriculture, where it has led to lawsuits against biotech companies (Gilliam 2013).

4.3.3 Communication

In addition to physical challenges of storage and space, seed exchange can present difficulties related to interpersonal communication. Problems can arise when there are different perceptions about the nature of exchange. Ellen & Plattern (2011) differentiate between reciprocal "seed swaps" and "delayed exchange," where one party gives seed to another with the understanding that they will receive in kind at a later date, and "a succession of gifts". Their study found that exchanges were usually *not reciprocal* and were seen as gifts. Experienced gardeners in their study gained status and self-esteem, while the recipients expressed gratitude to the givers. They suggest that, within this context, there are different unspoken rules for established gardeners, novice gardeners who have yet to prove themselves, and novice gardeners who have proved themselves by demonstrating their dedication. The established gardeners would gladly share germplasm with the promising novices but were wary of sharing with novice gardeners who had not yet proved themselves (Ellen & Platten 2011). Pretty and Smith (2004) also highlight the importance of trust and common social norms in cooperative actions such as seed exchange. At public events, where people are sharing seed with strangers, conflicts can

arise if all participants do not understand these social norms. Charne, who has been extensively involved in organizing seed exchanges on multiple islands, discussed some of the difficulties that arise:

> It's mixed…. It's really nice to see people come out and be interested…Everybody [sets up seed exchanges] differently, the way we do it here is: just put your seeds out on the table. Have the information: What are they? When did you harvest them? What's your elevation? So that people can decide [if it is] gonna be something that will grow well for them. So that's the goal. My experience is … it kind of doesn't work that way. Many people don't understand what it takes to grow seed. It's very precious, it's like currency. They just grab big handfuls of it and they don't realize what it took you to save that seed. Plus [they're] not allowing other people to have the ability to get seed. I've had people take seed and … throw all the seed that they're collecting from all the different crops in one bag… with no identification of what they were…just all mixed together. I said 'Wait a minute, now, you need to put these in the envelope and identify them.' and they said "Oh no, I'll know what they are" … I've been saving seed a long time and I wouldn't even know what they are!

Experienced seed savers tend to share a lot of information about seeds when they are exchanging them. Study participants said that both when receiving and when giving, they talked about uses, growth habit, flavor, possible weediness, pests, elevation, and the original source. Sean emphasized that he likes to get as much information as possible when he receives seed and also to share that information when he is giving it away: "So they know how to take care of it and (because) it's just fun talking stories about seeds!" When novice participants at seed exchanges don't express an interest in these seed stories, it can be frustrating to the growers, who put significant time and care into preparing high quality seeds of varieties that it may have taken several years to develop. Although the recipients may simply not understand the unspoken rules of the exchange, these interactions maybe interpreted as a lack of respect.

Compounding this frustration is the fact that, in many instances, only a few new seed keepers bring seed to the exchanges:

> After [13 years]… the disappointing thing is we're not seeing a lot of people come back with seed each year. The idea when you share seed is: you grow it out *and then you share that seed*. We're seeing a few, but given how long we've been doing it and how much seed we have given out, it has been disheartening to see the people just take and don't return. Kauai, on the other hand, has … a big seed sharing group and they, at their seed

> exchanges, have a lot of people bringing in seed… which is interesting … different communities, different mindsets. (Charne)

Large seed exchange events can feel like a free-for-all or giveaway. Some seed savers have told me that they think that people don't value the seeds that they receive at these events simply because they are free. Experienced seed savers donate their time, effort and seeds to these events. But they do this with the intent of growing the seed saving community, when this growth isn't evident, it is frustrating to veteran seed savers This dynamic is one of the factors that led to the end of the large seed exchanges at the Amy Greenwell garden.

I asked Charne if she thought that people might be sharing seed with friends when it became ripe rather than saving it for seed exchanges, she replied:

> Could be. And hopefully, that's without going on … I don't know … it's interesting because the few seed share stations that we have … people come back [and return seed] to those … so that's kind of exciting. And it may be that just a one-day event is too much for people to handle or deal with, or to have seed ready for. It takes *me* a lot of energy and effort to get ready for it. And so it may be they just want to go to experience it and collect some seed, and then maybe sharing it somewhere else.

Again, this suggests different motivations for sharing germplasm with small familiar groups and for sharing with strangers at events.

In addition to communication difficulties at seed swaps, participants expressed a desire to know more about what other growers are doing. Several seed savers said that they would like to see improved systems to communicate about the varieties that are available on island and how they perform in different microclimates. Access to this kind of information could help to facilitate sharing and duplication of germplasm in multiple locations. Jasper, for instance, expressed desire to:

> Let people know what other people have. In particular, I was thinking, there's that collection of bananas in Seaview. That guy's got 100 different varieties of banana! And not a lot of people know that … it would be amazing if there was redundancy to that collection … if that redundancy was recorded somewhere … some sort of institutional knowledge documenting where the diversity is held in the system, held in the group. I think that is really important.

Unconnected, fragmented networks of small groups of seed savers may significantly limit the ability of seed exchange networks to function as *in situ* mechanisms of diversity conservation (Calvet-mir et al. 2012). Some participants suggested using digital tools, like the SVST (see Chapter 3) or the Center for Food Safety's Global Seed Network Database to share this information. The challenge in using these types of tools is how to advertise them, incentivize people to contribute, and fact check information.

Charne reflected on how centralized seed share stations / seed libraries (discussed above in 4.2.3) or shared storage systems (discussed in 4.3.1) could be a way to improve information sharing among and between seed savers:

> Having them in one place could be interesting …even if it was just a refrigerator or something simple … could bring people together more often ... and [they could] talk about seed sharing and also … get together and say: Here are the seeds that I have, does anybody want to grow these out? Because the more you grow them out, the better it is. And [they could] then get feedback … you could really generate a lot more data just by, you know, "people science."

This model, of a group of seed savers meeting regularly to discuss variety performance is sometimes called a Seed Circle. Charne laughed as she described this idea as "kind of like a book club… with storage and then communication." Peggy also called for information sharing clubs saying: "How about starting garden clubs all over the island? Everybody keeps talking about it, no one keeps doing anything about it though."

Several participants also saw a need to bring more people into the seed saving community. Frank, for example said, "It's pretty unfortunate that there's not that much people to share with. Because not everybody is willing to take it on and say 'Oh yeah, that's wonderful, I'd love to have some!'" Jasper echoed this desire to recruit new seed savers:

> I think encouraging more people to save seed and to get into it in creative ways [is important]. To get people excited about it, give them reason to. Because the more people we have saving seeds, the more seed there is, the more genetic variety there is, the more redundancy in what we actually have there is…if it's impacted in one place, at least we have it held in another place ... I think that's really critical ... having more people involved [is important].

Jasper sees seed saving networks as a key aspect of food sovereignty, and the more nodes there are in the networks, the more resilient he believes our food systems will be.

In addition to building interest in growing food/saving seed, it is important to continue improving the skill level of existing seed keepers, Charne explains:

> The education needs to be deeper … I talk to a lot of people about how they grow seed and save seed … [They] are not taking into consideration: cross-pollination, selection, proper preparation of the seed for storage, proper preparation of the seed for storage, proper storage. Those are things that I think really need to be deepened in our education. But they're not as juicy and interesting to people as the actual saving the seed or fermentation or dancing the seed … the hands-on things. They're more esoteric and I don't think people see them as that important right now … but if we're really wanting to save varieties *well* and all the genetic pool…it's important.

Basic seed saving involves learning about plant reproduction, how to dry and clean seeds, and how to store seeds. "Plant sex," seed cleaning and building a home seed bank are fun, hands-on topics and new seed savers get excited about these. But the more academic aspects of seed saving, such as isolation distance, minimum population size, and how to prevent the spread of seed borne diseases, are often bypassed and are easily forgotten.

4.3.4 Transmission of Invasive Species

Germplasm exchange is not limited to the sharing of seeds, but includes fruits, entire plants or material for vegetative propagation (including stem cuttings, root cuttings, runners, tubers, bulbs and corms) (Ellen & Platten 2011). For example, the seeds of many varieties of fruit trees will not grow true-to-type, and it is necessary to share them via scions or saplings. This is why Joseph grafts scions from Iaku's persimmon tree onto seedlings (Seed Story 1).

Many of the home gardeners and homesteaders that I spoke to emphasized that they grow many perennial plants that are not propagated by seeds. This is for multiple reasons: most traditional Hawaiian food crops are propagated via vegetative materials and perennials may be more hardy than annuals, which is of particular interest to permaculture practitioners. Nick, an agroforestry teacher, said "I'm more of a perennial kind of a person, I've grown so many seeds just trialing them. Most of them have failed. I use the STUN method: Sheer Total Utter

Neglect." This method, developed by permaculturist Mark Shepard, involves planting many varieties of a crop and allowing natural selection to eliminate weaker types (Rasmussen 2018).

Vegetatively propagated perennials are also advantageous because their propagation circumvents many of the concerns around seed saving and storage. Jasper, also a permaculture practitioner and teacher, talked about the benefits of vegetative propagation for easily creating a large amount of planting material:

> When I really started saving seed, it wasn't actual seed, it was cuttings … we would just get all the varieties that we could that took from cuttings … with the knowledge that in the future that we could cut those and actually have more plants [to] propagate.

In this way, using cuttings is preferable to seed because they can be stored in the ground and do not require a system of storage or attention to germination rates.

The focus on hardy perennials has created some challenges for seed exchanges here in Hawai‘i. Plants that require little attention may naturalize easily and escape cultivation – some of these can in turn become invasive species that are problematic for natural resource conservation. Charne discusses some of the difficulties around invasive species and disease that came up at early seed exchanges: "People were sharing invasive species. They were sharing things that could or couldn't become invasive, as long as you controlled them. And there was no information around that." People who are interested in sharing cuttings can consult the Big Island Invasive Species Council's (BIISC) "Plant Pono" website (http://www.biisc.org/plant-pono/), where invasive plants are identified using the Hawai‘i-Pacific Weed Risk Assessment (HWRA) (BIISC 2018).

> There is also a possibility of sharing seed borne disease during plant exchange:
>
> Some of the Brassicas can have a disease [black rot] inside of the seed, so treating the seed coat doesn't really do anything. You actually have to collect from clean plants. if you're sharing that seed, you're spreading that disease … It is hard. (Charne)

It is possible to hot water treat seeds in order to kill black rot and other seed borne diseases. But because this process can be difficult to do properly, HPSI has suggested that seed exchange participants avoid exchanging seeds from the brassica family altogether.

Sharing non-seed germplasm can present additional problems because, even if the plants themselves are not invasive species, they can be a vector for the transmission of pests and disease. Diseases can also be spread through exchange of vegetative material like kalo huli and banana keiki if they are not properly cleaned and treated. Although household bleach is not registered for use on kalo, some growers dip huli into a dilute bleach solution in order to kill Taro Leaf Blight (*Phytophthora sp.)* and other soil borne diseases and pests. The College of Tropical Agriculture and Human Resources (CTAHR) also recommends using hot water dips to treat huli (University of Hawai‘i College of Tropical Agriculture and Human Resources 2008). Even if they are disease-free, insect "hitchhikers" on cuttings can also present problems.

> Regarding [sharing] cuttings and plants: once the little fire ant (LFA) came on the scene in Hawai‘i we [HPSI] advocated for not sharing those things because you couldn't be sure it wasn't in there. Now, since the spread of LFA is so wide, some people have gone back to sharing those. I don't like to see that. I like to see that is just seed, unless you can treat your cuttings and your plants. Of course, everybody is more excited about having a plant or cutting than having a seed because it's so difficult … It's a longer process [to grow from seed].

HPSI has advocated that organizers consider the potential for sharing invasive species in the early planning stages of seed exchanges and that they use various strategies in order to share cuttings safely. Some events use tarps and kiddie pools to set up quarantine areas for cuttings; individuals who choose to take cutting material or plants from these events do so at their own risk of bringing home LFA. Other events have set up check-in stations manned by experienced seed keepers who examine material to inspect for LFA using microscopes, looking signs of disease or other pests. These check-in stations can act as an educational opportunity:

> We set up microscopes and check for LFA and, if we find it, we just bag the material and give it back ... The first time we did that at Honoka‘a, people were like: "I don't have LFA!" And then you check it and they did … that really freaked the people out … At the next seed exchange, they made it real clear: your plants will be inspected immediately... people really got it…I think it's really important … there are people that don't have it on their property. *We* don't have it on our property! …We keep it work really hard to keep it off., so I don't want to bring in plants or things that are gonna contaminate our land…I think we still have to keep the awareness that it's really important not to share ***any*** invasive species.

Some seed exchanges have instituted soil-free policies to help prevent the spread of LFA, Rapid ʻOhiʻa Death, and soil-borne diseases. Others have gone to seed-only policies, asking people to share cuttings and plant keiki outside of the event:

> What we did at one seed exchange is… we said no plants or cuttings and then we put a [cutting] sharing board up. Like: 'I have these banana keiki and here's my contact info." And people put up what they had…that didn't go over that well because people put a lot of information up there, but when it really came time to people contacting … they didn't … I think that's still worthwhile …maybe it could be through social media

Several Facebook groups allow individuals to meet up with others who have plant material to share. These one-on-one interactions may allow for improved communication about invasive species and potential pests outside of the distraction of a large seed exchange event.

4.4 Chapter Conclusion

The seed savers interviewed for this project have a wide variety of experience; some have been saving seed for over 50 years, while others have come to it within the past five years. Some were instilled with the concept that growing food was part of life in early childhood, while others came to growing food in adulthood. HPSI has held several events in the Hawaiian Islands in order to help improve the overall skill level of the seed saving community. Skilled seed savers focus on best practices for selecting desired traits, preserving varietal characteristics and ensuring high quality vigorous seed through proper cultivation and storage. Most, but not all, participants in this study were familiar with advanced concepts like isolation techniques and minimum population size, illustrating a need for further community education. Seed savers interviewed for this project shared seeds both with family groups and at seed exchange events. One of the main motivations for exchanging seed was to create a backup within the seed network in case of possible crop loss. Seed savers also share seed with others in order to encourage a more resilient local food system here in Hawaiʻi.

As HPSI's current funding cycle comes to an end, coordinators are thinking about further directions for seed work in the Hawaiian Islands. Charne explains: "The question is… how to honor the private funders who have been so involved in so many of the wonderful things that make our islands better. How do we … continue it in some way? It's not going to be seed

education or seed exchanges … because that's already happening. So I'd like to figure out what that would look like." The workshops and training that HPSI has provided over the past six years have empowered individuals and groups to do their own workshops and expand seed exchanges. So the question for this organization and others seeking to promote seed saving and exchange in the islands becomes: what are the current needs of the seed saving community?

Seed savers identified a number of challenges to effective seed saving here in East Hawai‘i These included physical challenges, such as inadequate storage conditions, pest problems, lack of adequate growing space to maintain minimum population sizes, and difficulties isolating crops from genetically modified plants on neighboring farms and gardens. Sharing seed also posed several interpersonal challenges, which include different norms around seed exchange, a need for improved systems for sharing information, a need to recruit new people to the practice of seed saving, a need to increase the level of skill in the seed saving community and a need to continue to address the possible transmission of invasive species.

Joseph's and Frank's Stories: Portuguese Collards/Cabbage

We were at the seed exchange over here around 2003 or 2004; this guy at the end of it, he came over and had this little baggy of these chunks of some kind of stem. He said, "My grandmother was 87 years old, she comes from Portugal. And she said their family brought this over when they came over. And he says, "It will grow every year perennial." And so we took it home with us. We planted it out and we got it in the same bed down there for the last fourteen years. In the same bed still growing. It's a beautiful plant. It grows twelve months a year and you can harvest it twelve months of the year. It is very tasty and very hearty, bug resistant, drought resistant. We've spread this everywhere around the island. You know, we brought stalks of it to seed exchanges and stuff, gave away dozens of them to people and told them "This is a perennial collard!" They have not seeded, but a couple of times actually, I have seen some blue flowers on them, but nothing like the usual display.You just stick the stem in the ground and the top two buds will start coming up and the other buds will be the roots. And so much easier than planting by seed. It's a great survival plant. Greens all year long. It's a great little plant. (Joseph)

I always *thought* it was a type of collard green. A few years ago I ran into a book I'd ordered from somewhere that was like an encyclopedia of the world's cultivated food plants. In that book there is a page that was devoted to Portuguese Cabbage or Portuguese Collards. They gave a lot of different common names for it like Sea Kale and a bunch of different things. And sure enough it is not a true collard, it's a cabbage!! It is a plant that you can basically cultivate by direct propagation, though I try to save seed. It takes about three years for her to go to seed. I find the seed growing plants are a lot more vigorous, more of a perennial that will last longer, I can cut from it for a longer period of time. The stock propagated ones tend to grow very tall and then fall over. I'm assuming you've got a more proper or stronger root base from seed It's got its taproot, so it's a stronger plant. So it's well worth setting a couple aside, so that we've got the genetic diversity to save seed from. And then when it starts seeding. You get thousands of seeds off of a few plants. And that'll keep you for many, many years. (Frank)

Chapter 5: Synthesis of Findings

This project analyzed semi-structured interviews (both individual and in focus groups) to identify some of the varieties of food and medicinal plants that were brought to Hawai‘i during the late plantation era and to document their stories, six of which are presented as "Seed Stories" between the chapters of this thesis, and others of which are discussed in its contents. The project also sought to identify, through data collected via seed keeper interviews, motivations for saving seed and challenges to seed saving and exchange here in the islands. Major implications of these findings and directions for further study are discussed in the sections that follow.

5.1 Implications: Seed Stories

One significant finding of this project is that there is a continuing need to document existing agricultural knowledge held by aging seed savers on Hawai‘i Island. This work highlights six key seed stories, but due to its limited scope, I was unable to include many of the seed stories shared with me. For each of the stories collected during this study, there are many more that are at risk of being lost. During this study, three elderly seed savers who were interested in sharing with me chose not to do so because they became ill or because they lost access to their seeds. These seeds and stories are important to document and preserve because they hold cultural significance and because, after being grown in specific regions of the island for many decades, they are likely to exhibit unique local adaptations that can contribute to food sovereignty and food system resiliency. Preserving these seeds and stories is a way to both honor and remember lessons from the past and to provide knowledge and resources for the future.

In addition to documenting specific varieties, there is a need to document other aspects of agricultural history on Hawai‘i Island. Many elder seed keepers shared plantation era stories about traditional agricultural practices and food preparation methods. For instance, Michiko told me about a technique that her father used to make yeast from potatoes. Elderly participants were often eager to talk about culturally significant heritage crops even if they didn't recall specific varieties. Rogelio spoke at length about Filipino food heritage, including the cultural significance and traditional uses of marungay (moringa), ampalaya (bitter melon), sitaw (long beans), kangkong (water spinach), katuday (tree orchid), singkamas (jicama), rimas (breadfruit), saluyot, alocon, and lansones. Perlita and Rowena shared about medicinal preparations of Dangla and Sambong. Hiroko and Michiko both spoke about how to grow and prepare Dasheen, and

Michiko and Tadashi told me about medicinal and culinary uses of Shiso. It is beyond the scope of this project to relate all of these stories here, but preserving these food and medicinal traditions is important and Hawai‘i’s elders are eager to share.

When I spent the morning with the senior activity group, Arthur, who does not grow food but worked for the Department of Hawaiian Homelands for over 20 years, asked to talk to me so that he could tell me about an orchard that was planted on Mauna Kea in the 1940s, and has since been abandoned. He wanted to share its story because all of the people with whom he had visited it had since passed away. I thought at first that Arthur was speaking about Keanakolu Orchard, which is managed by the Division of Forestry and Wildlife, but he was quite sure that it was on the other side of the mountain. These high elevation orchards hold hundreds of temperate fruit trees. The old varieties there have been grown in Hawai‘i for nearly a century. These, too, are valuable resource that should be further studied and preserved. It is worth noting that, although I have been able to locate some historical planting maps of Keanakolu Orchard, none of them list the varieties planted there. Identifying which varieties still exist in these orchards, mapping their locations and collecting scion wood from ones that are still thriving should be a research priority for those interested in preserving agrobiodiversity in the islands.

Although I chose my two study communities with the expectation that I would identify mostly heritage varieties brought from Japan and the Philippines, this was not reflected in interviews. Participants did discuss some heritage varieties that were from Japan or the Philippines, these were not the majority of the varieties that they talked about. This may be in part because of my methodology, most of my participants were identified through snowball sampling and not through school community surveys at schools in the target areas. Studies that wish to identify specific heritage varieties from specific ethnic groups would do well to better target their sampling methods, perhaps by working with cultural affinity groups.

There are a number of citizen science-based strategies that could be used in order to better document the significant agricultural history, including but not limited to seed varieties, food traditions, and planting and harvesting practices, that is held by elders who live on Hawai‘i Island. The wide accessibility of mobile phones that can be used as recording devices and online interview archives create the potential for a group of people to rapidly document and archive a large amount of interview data. The StoryCorps App (https://storycorps.org/participate/storycorps-app/), released in 2015, allows any person with a

mobile phone to record and upload interviews to a searchable online archive. All interviews are also preserved at the American Folklife Center at the Library of Congress. Because the App allows users to tag interviews with key words, a group of people could collect interviews around a specific topic (such as Hawai‘i’s agricultural history), mark them with a unique tag, and effectively create a large searchable database of interview data around that topic. Seed Savers’ Exchange has initiated a campaign to encourage the public to identify heirloom varieties using this tool. However, as of this writing, only two interviews carry their tag. Working with specific groups of dedicated interviewers, such as college students, may be more effective at identifying seed keepers and collecting seed stories than general appeals to the public.

Although the lessons that I developed for use in classrooms were not effective in the three trial classes, this student outreach strategy has been an effective tool for identifying seed keepers in other contexts (Nazarea et al. 1997; Rhoades 2013; Kent 2013). I believe that it was not effective for this study because of the way that I chose to administer the lessons and survey. I went into classrooms to deliver preliminary lessons and, afterwards, asked teachers to encourage students to complete the seed saver survey in their families and communities. This disconnection may have resulted in students losing interest in the project. It is important to recall that several students did say that they knew seed keepers when I spoke to them during my classroom visits. An alternative strategy would be for teachers to both deliver the background lessons and administer the survey, allowing for ongoing follow-up.

Focusing on social science classes rather than garden classes also may be more effective. Nazarea et al. (1997) have developed a short text designed for specifically secondary school students involved in seed saver interviews and memory banking. It is notable that this work focuses on the social aspects of seed saving rather than the biologic. As Jackson (2007) notes, because seed saving involves interactions between humans and plants, it has both biologic and sociocultural aspects. Discussion of the social components of the practice may be more appealing to young people and the general public. Additionally, Nazarea et al.’s (1997) work does not ask students to identify seed keepers, but gives them extensive background on how to conduct interviews themselves. An effective method to document more of Hawai‘i’s agricultural history could involve teaching students interview skills, instructing them in the use of the StoryCorps App, and encouraging them to seek out people with stories to share (either in their families & communities or by facilitating connections between classes and senior living groups). This

strategy would present educational benefits to the students and perhaps psychological benefits to seniors, while helping to capture and archive the valuable stories of Hawai‘i’s agricultural history. Individuals or organizations that use such a strategy to collect information should obtain informed consent from all participants and exercise caution in protecting both the privacy of participants and intellectual property rights to unique technical knowledge that they may share.

5.2 Implications: Seed Networks

The information generated by this project allowed me to identify several themes relevant to seed saving and seed exchange in Hawai‘i. Seed savers spoke extensively about their motivations to save seed. These included a wide range of different motivations from the practical to the philosophical. Although these motivations may overlap and different motivations appeal to different people, it is clear that effectively encouraging seed saving among a wide diversity of people will require addressing multiple motivational strategies. Organizations and individuals who wish to encourage people to save seed would do well to emphasize a combination of tangible and intangible benefits including: connections to nature, personal enjoyment, economic and agricultural benefits, preservation of cultural history, conservation of biological diversity and strengthening food and seed sovereignty here in the islands. Issues of food and seed can become highly controversial in today’s political climate, but the saving of seeds does not have to be political. Diverse groups of people save seeds for different reasons, and all the reasons are valid motivations to save seed. Creating a climate of inclusivity around seed saving, where multiple points of view are not only tolerated but also welcomed, may help to preserve more varieties, benefiting all seed savers. Furthermore, this kind of inclusive approach could potentially create connections and friendships between people with differing opinions and experiences, thereby facilitating dialogue and understanding around other food and agriculture related topics.

Small sample size limits conclusions that can be drawn from this study, which is mostly descriptive in nature. Larger-scale studies could help to understand better motivational patterns among different demographic groups of seed savers and create models of why these patterns exist. Larger-scale studies could also examine the number of varieties that individual seed savers keep and analyze the significance of heirloom versus modern varieties in seed saving. However, it is important to remember during study design that interview data preserves the nuance and richness of participants’ knowledge that survey questionnaire data cannot capture.

Seed savers discussed not only the process of saving but of sharing seed. People in this study exchange seed for variety of reasons, including to ensure access to that seed in the future through a social seed network, to build social capital, and to build food security here in the islands. There are a number of significant challenges to effective seed saving and exchange in the islands that need to be addressed. These include: storage difficulties, lack of growing space, a need to recruit new seed savers, a need to continue to build the skill set of the existing seed network, a need for improved communication about diversity held in the network, and a need to continue to address the possible transmission of invasive species and disease via seed exchange. Continued education and outreach are clearly also essential to maintaining a network of skilled seed savers. In addressing these issues, it is important to remember that seed exchange with known individuals and friends are different in nature than seed exchange that occurs at large events or over social media.

A degree of trust is involved in any seed exchange -- with friends or with strangers -- and building that trust is one function of the seed saving network. Pretty & Smith (2004, 633) note four critical aspects in building social capital for biodiversity management. These are: " (1) relations of trust; (2) reciprocity and exchange; (3) common rules, norms, and sanctions; and (4) connectedness in networks and groups." As we in the Hawai'i seed saving community continue to build and expand our networks, we would do well to keep in mind the importance of these four factors and consider them in planning.

In the context of large seed exchange events, addressing these factors may look like clearer communication of social norms around invasive species, information sharing, and reciprocity with novice seed savers. This could take the form of a check in station with in-person instruction, a short handout, or differing event start times for first-time and experienced attendees, which would give the experienced a chance to share seeds amongst themselves before sharing with the larger community. Another strategy involves encouraging novice seed savers and those who do not bring seed to exchanged to volunteer in event set-up and clean-up. This time could serve as an opportunity to discuss the norms of seed exchange, while simultaneously emphasizing the idea that the event is and exchange of not just physical seed but of time and labor involved in growing the seed.

Outside of public seed exchange events, encouraging seed savers to share information about how varieties perform in their microclimate, either online, or in-person through a seed

circle or seed library can help to build trust and connectedness. Cooperatively-held growing and storage spaces can be an effective strategy to address these and other network needs. Such facilities can serve as a hub for both information sharing and seed exchange and are an effective means of strengthening seed networks (Helicke 2015). These place-based models for seed sharing appear to hold several advantages over event-based models. For example, a seed librarian at a seed library can effectively communicate social norms to new seed savers, screen for invasive species, monitor seed quality, and provide education and information-sharing services. Additionally, centralized seed libraries circumvent the logistical and scheduling problems around seed exchanges. Patrons can share seed when it becomes ripe and at their own convenience. At the time of this writing, the Laupāhoehoe Public Library is considering starting a community seed library and other local communities have expressed interest in doing the same.

The agricultural diversity and agricultural history held by Hawai‘i seed keepers are important assets to Hawai‘i's food systems. Using interview data, this study allowed me to identify some of the important varieties held by seed keepers and some of the factors that motivate them to save and exchange seed. It is likely that some of these motivations also apply to seed keepers in other places and the methodology described here could be used as a model for similar research elsewhere. In the sections above, I have suggested strategies for encouraging seed saving and exchange for documenting both agricultural diversity and agricultural history before it is lost and for strengthening existing seed saving networks in Hawai‘i. By documenting locally adapted heritage varieties and agricultural history, as well strengthening local seed saving and exchange networks, future work in this field will help Hawai‘i to build stronger food systems that are more resilient to environmental and social change.

Peggy's Seed Story: Bleak Hall Sea Island Cotton

So, this guy calls up from Maui wanting to buy an rabbit. He was telling me he was going to mix angora with cotton. I was looking for cotton, because it used to be a commercial crop in the islands. I've been looking for Sea Island cotton for ages and ages and the guy on Maui says "Oh yeah, I have some of that." So he brought me some of this when he came over to pick up his bunny.Bleak Hall is a tropical cotton, it can handle the humidity. It stays growing like an indeterminate tomato, once it gets growing, it keeps growing. Most cotton fiber has a staple a quarter of an inch long, this is over an inch, insanely long for cotton! This stuff is just crazy! The last commercial crop of this stuff was in 1922. It was one of the premier cottons, double the price per pound for this stuff than any other cotton on the mainland. And then they had a war across the cotton fields. Between the boll weevil and the Civil War, this cotton fell out of favor in the 1800's. The way the cotton gin works, they have these little saw teeth that rip the fiber, the lint, off of the seeds. So, this cotton is too long. When they would get the lint off the seeds, they would rip it to shreds, so it didn't work well with the cotton gin. This fiber now is grown in Barbados, you cannot get it anywhere else anymore. The Bleak Hall people sent me a note saying "Can we have some of the seeds?" They don't have any more over there because of the boll weevil and the Civil War got rid of them. So they said "Hey, send us some!" This stuff will spin finer and spin softer. It has a tiny bit of shine to it. Which is how you can tell it's a Sea Island cotton. It was collected in 1932 by the USDA . Joey was doing some kind of genetic experimentation and cotton has a very well documented genome. The name of this is Bleak Hall Sea Island White. Instead of Westfield 42, you know, or # 9846. So he got Bleak Hall Sea Island just because of the name! Joey got it in 1979, near 80. The USDA was handing out seeds like crazy. Now they won't give you any seeds because too many people ask from them. But Joey got these seeds. He brought me four plants, well actually brought me six, then I gave two to my friend in case something happens to these, then I will get them back. I haven't had any problem with boll weevil or white fly. Joey says his all got eaten by white fly and it's all gone.

Appendix A: Interview Guide

Background Information

This interview is part of my Master's research. I am studying old varieties of food and medicine plants that were brought to Hawai'i by people who migrated here before statehood. I am trying to gather the stories of these old varieties so that we can protect and preserve them for the future. Worldwide, many old varieties (sometimes called heirloom varieties) of plants are disappearing.

This is a problem because it means that we are losing important parts of our heritage and cultural history. It also means that we are losing agricultural biodiversity, which affects Hawai'i's ability to adapt to threats like diseases, pests and climate change. In order to try to preserve some of this heritage, I am interviewing people who keep old varieties of seeds that were brought here from other countries. I am especially interested in learning about unusual old varieties and those that do particularly well in one area of the island or another.

You have been identified as a seed keeper and I would like to ask you some questions about the plants that you keep. I am only collecting stories at this time. but if you are interested in donating seed to be preserved in the future, we can talk about that at the end of the interview.

I will take all of the interview data on seed varieties and seed keepers and look for patterns and I will write some papers on my findings. I am happy to provide you with copies if you are interested. You will be kept anonymous through this whole process.

Share consent form

I would like to record or interview, is that ok? If at any time during the interview yow old like to stop, take a break, or to have me turn off the recorder, please let me know.

Background questions about the participant

(*Only if not already gathered from student survey data – e.g., identified through snowball sampling*)

What is your name & age?

What is your family history in Hawai'i?

(*How long have you lived here, when did people in your family come to the islands and where from*?)

Where do you live in Hawai'i?

Have you or your family lived on other islands?

Questions about gardening /farming:

How long have you been gardening/ farming?

Tell me a little about your garden/farm

What kinds of things do you grow?

(*Any medicine plants?)*

Why do you grow?

(*Fun, food, tradition, money?*)

Questions about seed saving:

How long have you been saving seeds?

How did you learn to save seeds/ who did you learn from?

Why so you think it is important to save seed?

Are there particular types of seeds that you save?

(Looking for family here, not variety)

From where do you get the seeds of plants that you grow/varieties that you save?

Are there any varieties that you keep that were brought to Hawai‘i from another country?

Can you tell me about them?

For each variety:

English Name/ Other Names

Do you know where it is originally from?

Who did you get it from?

What is it like?

(*Physical characteristics- looks, taste, smell etc.*)

Do you have a photograph of it that you are willing to share?

What do you use it for? How is it prepared?

How do you grow it?

(Location, amendments, season, pests, pruning etc.)

Why do you think it grows well for you?

How do you harvest and store the seed?

(*Open-pollinated? Isolation distance?*)

Where have you grown it?

Are there any other special qualities about it?

(*Drought resistance, yield, disease resistance etc.)*

Do you know any stories about it?

(*How it got to Hawai‘i? How it got its name?*)

Do you know any other people who save seeds who might be interested in sharing their stories?

Are you interested in donating seed to be preserved?

Provide packets of seeds as thank you gift.

Thank you!

Appendix B : Themes & Codes

Specific Varieties/Crops

V1 What's in a name?
V2 Plantation era varieties
V3 Plantation era crops
V4 Source: what is known
V5 Source: what is unknown
V6 Why is it kept? Valuable characteristics?
V7 Post-plantation era specific varieties

Seed Saving Techniques

T1 Experience farming/gardening
T2 Where did they learn to save seed?
T3 Storage
T4 Best practices
T5 Challenges & needs
T6 Hawaii Public Seed Initiative
T7 Selection for characteristics vs. preserving variety

Motivations for Seed Saving

M1 Economic
M2 Local adaptation
M3 Teaching tool
M4 Specific characteristics
M5 Know how the seed was grown
M6 "Collector impulse"
M7 Fun/challenge/experimentation
M8 Beauty/aesthetics
M9 Preserve tradition
M10 Preserve diversity
M11 Backup for vegetatively propagated
M12 Story/human connection
M13 Food security & food soverignty
M14 Quantity for broadcast
M15 Political advocacy-food system
M16 Genetically modified organisms
M17 Medicines

Seed Sharing/Seed Exchange

E1 "The seed is stored in the network"
E2 Sharing to build food security
E3 Physical challenges
E4 Sharing cuttings
E5 Sharing network based on friends
E6 Sharing network based on others
E7 Social challenges

Plantation Era Life/Food

P1 Growing food as "a way of life"
P2 Plantation era stories (not seed specific)
P3 Change & loss of varieties /crops
P4 Food/cooking raditions

Other

O1 Traditional Hawaiian crops
O2 Hawaii School Garden Network
O3 Native plant seeds/restoration
O4 Cannibis seed
O5 Introduction of new crops
O6 Climate change
O7 Permaculture

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