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## Seeding Coexistence: Understanding the Potential for Seed System Pluralism Through a Mixed-Methods Research Study of Vermont Growers

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SEEDING COEXISTENCE: UNDERSTANDING THE POTENTIAL FOR SEED  
SYSTEM PLURALISM THROUGH A MIXED-METHODS RESEARCH STUDY OF  
VERMONT GROWERS

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## ABSTRACT

Visions for the future of the global agri-food system are often polarizing. Facing such issues as climate change, social and political unrest, and decreasing biodiversity, communities are increasingly facing critical decisions relating to how food systems can transform to better meet the needs of society and the environment. Seeds – an often-overlooked input that, throughout history, have encapsulated agri-food system paradigms as well as hope for how they might be changed – sit at the nexus of many of these decisions. In the last half-century, increasing privatization and industrialization across the agricultural sector have profoundly transformed seed systems globally. In much of the Global North, including the United States (US), seed systems are marked by the near hegemony of the formal sector through which commercial seed flows. Through such mechanisms as seed hybridization and intellectual property rights, seed itself has also fundamentally changed from what was once considered a ‘common good’ to a universally exchangeable commodity. However, even in this highly commercialized context, opportunities exist to re-embed social value into seeds and, in doing so, increase resilience across agri-food systems. Through a mixed-methods exploration focusing on concepts of resilience and commodification, this thesis explores how pluralistic seed systems within the United States can foster positive change.

Recognizing that the COVID-19 pandemic has had an illuminating effect across nearly all industries, the first article concentrates on the pandemic’s effect on seed sourcing in the state of Vermont as a way to understand seed system resilience. I use a mixed-methods approach which includes data from online surveys (n=158) and semi-structured interviews (n= 31) with seed growers and farmers who grow crops from seed in Vermont. Findings from these growers suggest that while more than half of those sampled had some sort of difficulty obtaining seed during the first year of the pandemic, growers were able to respond positively to these challenges. Furthermore, as illuminated by both quantitative and qualitative findings; growers seemed to have the most difficulty with pervasive problems which (although compounded by the pandemic) points to the need to address systemic issues to reduce the vulnerability of seed systems in the state. More broadly, the insights from this study illuminate the importance of supporting both commercial and non-commercial seed systems in the US to enhance resilience across various groups and to help growers meet and adapt to manifold challenges.

Following findings from the first article that suggest embracing multiple value systems is important to seed system resilience and sustainability, the second article seeks to focus on the viability of plurality by interrogating the spectrum of commodification within informal and formal seed systems in the US. As informed by Margaret Jane Radin’s concept of *incomplete commodification* which attests that something can have a price *and* be priceless, this paper argues that seed growers who vary in involvement within informal and formal systems seek to reintegrate non-economic value into seeds, principally through seed saving. Qualitative insight from interviews with 31 commercial and non-commercial seed growers in the state of Vermont suggests that, although often acting separately, seed savers work to protest the commodification trajectory and instead foster individual and community autonomy, resilience, and democratization – all of which are important to the future sustainability and equitability of agri-food systems in the US and elsewhere.

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## CHAPTER 1: INTRODUCTION

The global agri-food system faces protracted challenges as climate change, biodiversity loss, industry consolidation, and socio-economic disturbance threaten its current and future viability. The Intergovernmental Panel on Climate Change (IPCC) is now projecting an average temperature increase of 2.1-3.5°C by the end of the 21<sup>st</sup> century if greenhouse gas emissions stay the same (IPCC, 2021). The direct effects will be felt throughout the agricultural sector, with intense precipitation, increased frequency of hot temperature extremes, and prolonged droughts already becoming the norm for many agricultural producers around the world. Biodiversity also continues to be lost globally, with only 9 crop species now accounting for 66% of total crop production despite there being more than 6,000 cultivatable plant species (FAO, 2019). The diversity vital to adapting agricultural systems to climate change and providing food for a growing global population is thus in the process of being eroded. Without this diversity, the global food production and distribution system is made more vulnerable.

As underscored by the COVID-19 pandemic which disrupted agri-food systems globally and set back decades of gains in food and livelihood security (Swinnen & McDermott, 2021), it is increasingly necessary to bolster agricultural resilience to natural and anthropogenic catastrophes. Seeds, which form the core of crop production and serve as the vessels of crop genetic diversity, are particularly important to current and future adaptation and conservation strategies (Khoury et al., 2014; Zimmerer et al., 2019). However, seed systems, like the agri-food systems to which they belong, are generating their own debates and obstacles, many of which surround the resilience of multiple forms

of seed systems and the degree to which they are in line with the values of their diverse stakeholders.

Until the 20<sup>th</sup> century, seeds were not highly contested – farmers held autonomy over what seed they used, how they used it, and where they sourced it from. Only recently has the history of seeds altered to the point where four agrochemical/seed firms control over 60% of global proprietary seed sales (Howard, 2018). Among many factors, the advent of seed hybridization and the proliferation of intellectual property rights (IPR) have fundamentally disrupted the reproductive cycle of seed both biologically (i.e., hybrid seeds don't grow “true”) and institutionally (i.e., legal repercussions for any farmers who attempt to replant patented seeds) (Kloppenburg, 2014). Additionally, technologies such as genetically modified organisms (GMOs), and more recently genetically engineered organisms (GMEs), have grown increasingly popular and constitute more than 30% of total seed sales (Bonny, 2017), with GMO crops covering 189.8 million hectares globally as of 2017 (ISAAA, 2017).

Although farmer-managed seed systems remain important, particularly in the Global South, and provide an estimated 80-90% of seed in some countries (Otieno et al., 2017), farmer seed systems in the Global North have been dwarfed in comparison by the commercial seed sector. That said, increasingly pervasive private interests in seed systems in the Global South, along with international consumer demands, regulations, and standards, also threaten the persistence of farmer seed systems in these areas. Considering that farmer seed systems hold an abundance of the world's crop diversity (Pautasso et al., 2013), this has profound implications for crop diversity globally (Khoury et al., 2022), as

well as rural food and livelihood security (Almekinders et al., 1994). Any efforts to combat climate change and other challenges in agricultural systems thus cannot exclude the centrality of seed and the importance of diversity, access, and cultural acceptability within seed systems. Recognizing this fundamentality, this thesis focuses on seed systems in a particularly understudied context: the United States (US). As will be elaborated on in the following thesis, the US, and more specifically the state of Vermont, provides an in-depth view into contemporary, complex seed systems that are entrenched in deeply contested, yet equally critical debates over the future of seed systems that are applicable across local, national, and global scales.

### **1.1. Problem Statement & Objectives**

Farmer seed systems in the US are now generally considered an anomaly due to the dominance of the commercial seed system. More specifically, seed systems can be generally broken up into the two categories of formal and informal. Formal seed systems refer to both public (i.e., governmental) and private (i.e., commercial) actors that disseminate principally certified and improved seed, whereas informal systems refer to farmer- and gardener-managed seed systems that often maintain high degrees of crop diversity through the maintenance of locally adapted and landrace varieties (Sperling et al., 2013; Gill et al., 2013). Although formal-public and informal seed systems were the norms in the US until after the Green Revolution began in the 1960s, the US seed system has transformed over the last half-decade owing to policies that have gradually allowed for the commodification of seed and concurrent dominance of the formal-private system

(Kloppenburg, 2004). Due to this systemic shift, many farmers have gone from saving their own seed to buying seed year after year from commercial sources – concurrently reducing the prevalence of seed saving and other forms of traditional agricultural knowledge throughout the US (Breen, 2015).

This is not to say that informal seed networks are obsolete. Indeed, there has recently been increased interest in informal seed networks, particularly seed saving, sharing, and community seed libraries, across the US (Soleri, 2018; Atalan-Helicke et al., 2021). Initial evidence suggests that these systems may hold high degrees of crop diversity vital to adapting to climate change that may not be captured by national estimates (Veteto, 2014; Isbell et al., 2021). Efforts to fundamentally transform formal seed systems have also been undertaken, including the Open-Source Seed Initiative (OSSI) which has tried to create a ‘Seed Commons’ by using the very same legal means (i.e., contract law) large seed firms use to deny farmers the right to save patented varieties (Kloppenburg, 2014; Montenegro de Wit, 2017). Several businesses and civil society groups have also sought to create seed company models which emphasize goals beyond obtaining a profit, often including explicit objectives to benefit communities through the conservation and dissemination of heirloom and culturally significant varieties (Helicke, 2015). These movements indicate a renewed emphasis on promoting agricultural education, community resilience, and consumer freedom in the US as led by plant breeders, farmers, and non-commercial seed savers who seek value from seed and seed networks beyond what conventional seed companies offer (Soleri, 2018).

Given the unique context of the US which is undoubtedly dominated by the formal-private seed system but in which an informal and alternative (as exemplified by regional and organic seed companies) movement does exist and continues to grow, questions arise over how lessons from both formal and informal systems can inform a resilient future in which they may become integrated. That is, while efforts have almost squarely been focused on enhancing the formal sector (Louwaars, 2007), scholars are increasingly calling for renewed attention to informal seed systems which are critical to non-commercial and smallholder farmers globally (Sperling et al., 2013; Zimmerer et al., 2019; Sperling, 2020). However, before policy changes can be confidently pursued, it is important to first weigh the relative strengths of both informal seed systems and their formal (commercial) counterparts in supporting seed system resilience (Almekinders et al., 1994).

The importance of taking this step is underscored by recent disruptions across US seed systems due to the COVID-19 pandemic which has affected both informal and formal seed systems, albeit in disparate ways (Sperling et al., 2020). Furthermore, beyond the practical understanding of strengths and weaknesses, the value-laden nature of seeds as expressed by various seed movements in both the Global North and South (Peschard & Randeria, 2020), draws attention to the necessity of understanding what different stakeholders perceive as important in the seeds which they save, grow, purchase and share. Therefore, seed system resilience entails not just the capacity of systems to adequately respond to pervasive challenges and sudden shocks as demonstrated by the ability of their primary stakeholders to adapt to stress, but also the ability of these systems to support *all*

stakeholders and their multiplicity of preferences, needs, and values. Given these considerations, the overarching goals of this thesis are to:

- (1) Understand how farmers and gardeners respond to stresses (e.g., disruptions to seed access due to COVID-19) given the resilience capacities of formal and informal seed systems, and;
- (2) Explore the values that underlie seed systems in the US given its highly commercialized, yet continually contested, context.

My ultimate goal through the following chapters of this thesis is to assemble and report on evidence regarding the nature, vulnerabilities, opportunities, and visions for seed systems in the US – all of which can inform policy and programs that seek to support equitability and resilience across agri-food systems on broader scales.

## CHAPTER 2: COMPREHENSIVE LITERATURE REVIEW

### 2.1. Seed System Definitions and Structures

Although frequently debated and discussed, the term “seed system” is often ill-defined. In general, seed systems are often considered instrumentally – as networks and exchanges through which seeds flow to reach a farmer. This definition signifies a paradigmatic shift that has occurred within agriculture, especially within the last century (Kloppenburg, 2004), where a farmer is considered the end-user or consumer of seed, and the producer is mysteriously veiled as some sort of external source. This may be why seed system scholars such as Niels Louwaars refer to seed systems more narrowly as “seed *supply* systems” (p. 32, emphasis added) – fundamentally squaring the term in a realm of economics and trade: as a commodity that is produced to be sold. However, this view of seed systems obscures the multitude of complex historical processes, values, and norms that are embedded within seeds from production to diffusion. Taking insight from how the term “food system” has been defined and operationalized as “the sum of actors and interactions along the food value chain ... including the enabling policy environments and cultural norms around food” (IFPRI, 2019), it follows that seed systems are also a function of broader economic, social, and natural environments which have continuously reconstructed how seed has been culturally viewed and treated. Seed systems should thus not solely be considered by the face value of their exchanges, but by their distinct characteristics that reflect current trends and orthodoxies surrounding agri-food systems more broadly.

Within the last fifty years, seed systems have undergone an immense transformation as seeds have shifted from a farmer-maintained input to one whose production is commonly externalized off the farm. At the core of this shift is the transition away from farmer seed systems, also called “informal” systems (which are characterized by saving one’s own seed and farmer-to-farmer exchanges of seed), and toward “formal” seed systems, which are “comprised of certified seeds of improved varieties produced by scientific breeding and distributed through commercial seed channels” (Lipper et al., 2010, p. 19). However, the latter definition is importantly unfinished, as it leaves out public entities that were essential in transforming seed systems in the middle and latter part of the 20<sup>th</sup> century. For this reason, as outlined in Figure 2.1, there are at least three basic categories of seed systems, which include the formal-public system, formal-private system, and informal system, each with their distinct actors.

<p style="text-align: center;"><b>Formal-Public:</b> Universities, national research institutes, international agricultural research centers, regulatory bodies</p>	<p style="text-align: center;"><b>Formal-Private:</b> Medium-to-large seed companies, multi-national and national seed companies, agro-input companies, agro-dealers, financial service providers, seed trade associations</p>
<p style="text-align: center;"><b>Informal</b> Farmer and gardener exchanges, seed saving, groups outside of markets, community-based seed initiatives, seed libraries</p>	<p style="text-align: center;"><b>Alternative-Private</b> Small-scale or ‘micro’ seed companies selling heirloom, open-pollinated, organic, etc. varieties</p>

**Figure 2.1. Seed system structures and actors (Adapted from Sperling et al., 2013)**

This characterization provides an important starting point for understanding seed system structures and their development over time. However, further nuance can still be sought with the prominence of “integrated seed systems” – or those that seek to leverage the beneficial characteristics of both formal and informal seed systems – increasingly recognized as fundamental to farmer livelihoods, particularly in the Global South (Sperling et al., 2013; López Noriega, 2021). Moreover, in reference to the fourth quadrant in figure 2.1., “alternative” or “semi-formal” seed systems – essentially an extension of the informal system as influenced by formal seed system structures – have also been gaining interest (Sperling, 2018), especially due to the rising interest in seed saving and sharing networks in the US (Lyon et al., 2021). This recent interest highlights the complexity of interactions that have led to the development of highly dynamic and changing seed systems seen around the world today.

## **2.2. Seed Systems, Regimes, and Policy in the United States**

To understand the historical transformation of seed systems over the last few centuries, it is also important to consider the changing nature of seeds and the interactions that surround them as part of larger shifts in food systems or what some might consider “food regimes.” The term ‘food regime’ was first identified and discussed by Harriet Friedmann and Philip McMichael (1986) to help explain the transformation of agri-food systems alongside the world capitalist economy. Food regime analysis outlines three distinct eras of history defined by changes in the political economy through time: (1) the settler-colonial regime, marked by the globalization of food systems and the extraction of

resources from the Global South to the Global North via colonialization (1870-1930s), (2) the development project regime (1950s-70s), which is principally characterized by the Green Revolution and the extension of market relations into rural areas, and (3) the corporate food regime (1980s-present), which is partly characterized by highly consolidated vertical supply chains, but also the emergence of new opposing food movements (McMichael, 2009). Categorizing critical food system transitions in history this way is useful in understanding the ways that power and capital have shifted throughout the last hundred-plus years and contributed to the creation of the contemporary agri-food system – and efforts to reform or overthrow it – today.

Drawing from this framework, seed regime analysis has since developed (Kuyek, 2007; Lyon et al., 2021). Similar to food regime analysis, Lyons et al. (2021) categorize the three seed regimes as based on (1) settler colonialism and appropriation of seed from Indigenous people, (2) the promotion of hybrid, GMO, and “improved seed” by the public sector, and (3) the highly consolidated and uniform seed system we have now. This third regime, as elaborated on by Kuyek (2007) in their analysis of Canada’s seed systems, involves “the state...transfer of decision making over seeds into the hands of a few transnational corporations that seek proprietary control of seeds as a way to build new markets and secure their positions in a restructured global agrifood system” (p. 32). The characteristics of the third seed regime have led to extreme contestations and divisions within the seed system, sparking alternative seed movements globally in defense of farmers’ rights to have autonomy over what they grow (Peschard & Randeria, 2020a), as

well as in defense of the ecological necessity of diverse seed systems which the third seed regime has (intentionally or unintentionally) discouraged.

Clearly, seed systems in the US have transitioned dramatically to be dominated by a highly consolidated commercial (formal-private) seed sector within the third seed regime. The development of the commercial seed sector in the United States has been well-documented over time (see Table 2.1., adapted from Howard (2015)). Until the late 20<sup>th</sup> century, little interest lay in seed systems beyond their practical purposes, with the job of plant breeding and improvement firmly in the hands of the formal-public sector (i.e., public research offices, agricultural extension stations, and farmers). Indeed, while the 19<sup>th</sup> century saw an increased interest in ‘exotic’ germplasm appropriated from biodiversity hotspots in the Global South, even this was at first distributed freely by the state for experimentation by farmers (Kloppenborg, 2004). The transfer of seeds from a publicly distributed good to a private one began to change as scientific plant breeding advanced, thus becoming more lucrative for investment by private companies.

While sexually reproducing plants (i.e., seeds) were not officially patentable until 1970 with the passage of the Plant Variety Protection Act, the Plant Patent Act of 1930, as well as the mass popularization of hybrid corn in the years following, acted as a harbinger of things to come (Howard, 2008). By 1981, five companies controlled approximately 68% of the total market share for corn seed in the US (Kloppenborg, 2004). Moreover, the cases of *Diamond vs. Chakrabarty* (1980) and *Ex parte Hibberd* (1985) extended the ability to obtain full utility patents on living organisms, including seeds and transgenic bacteria. Through these policy changes, as well as a concurrent gradual defunding of public

agricultural research, private interest in the seed industry was facilitated and institutionally supported.

**Table 2.1. Key US Policy Changes**

<b>Year</b>	<b>Policy</b>	<b>Impact</b>
1930	Plant Patent Act	Patents on asexually reproducing plants
1939	The Federal Seed Act (amended 1988)	Requires certain quality standards for interstate and foreign seed commerce. Non-commercial sharing is exempt.
1970	Plant Variety Protection Act	Patent-like protections for sexually reproducing plants
1980	Bayh-Dole Act	Patents allowed for publicly-funded research outputs
1980	<i>Diamond vs. Chakrabarty</i>	Transgenic organisms patentable
1985	<i>Ex parte Hibberd</i>	Plants patentable under general utility patent provisions
1987	<i>Ex parte Allen</i>	Multicellular animals patentable
1994	Amendments to the Plant Variety Protection Act (1970)	Selling seed without a license from the owner prohibited
1995	<i>Asgrow vs. Winterboer</i>	Increased restrictions on selling saved seed
2001	<i>JEM Agricultural Supply vs. Pioneer Hi-Bred</i>	Saving seeds with utility patents prohibited
2013	<i>Bowman vs. Monsanto</i>	Enforces contract provisions beyond the first sale

Source: Adapted from Howard (2015) *Intellectual Property and Consolidation in the Seed Industry*

It is also through this trend in policy changes that the dichotomy between informal and formal seed systems began to emerge and be cemented, with formal seed systems now nearly ubiquitously associated with, and dominated by, the commercial market system. Indeed, informal or farmer seed systems, which are managed by farmers and are often composed of diverse seeds adapted to local conditions (López Noriega, 2021), were dominant before the 20<sup>th</sup> century. It wasn't until after the 1980s, after a period of increased

efforts by the formal-public system, that the hegemony of the formal-private (commercial)<sup>1</sup> system gradually became the norm throughout the Global North. In fact, the formal seed system, which is comprised typically of conventional certified seed, high-yielding varieties, GMOs, and GMEs (Lipper et al., 2010) is so predominant that some estimates indicate that fewer than 5% of farmers practice seed saving in the US (Mascarenhas & Busch, 2006). Furthermore, due to such lawsuits as *Asgrow vs. Winterboer* (1995) and *Bowman vs. Monsanto* (2013), seed saving is legally disincentivized to the point where even small seed libraries have opted to close rather than deal with the complicated legal consequences of informal seed saving and sharing, even if at small scales (Atalan-Helicke, 2021).

### 2.3. Seed Commodification

In his seminal work *First the Seed*, Jack Kloppenburg (2004) argues that US seed policy from the 1930s onward led to what he considers as the ‘enclosure of the seed commons.’ Furthermore, he argues that the process of commodifying seed decoupled farmers from their means of production, which propelled them into a perpetual state of dependency. From this viewpoint, the commodification of seeds can be considered an essential shift in the commoditization<sup>2</sup> process in agri-food systems which championed

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<sup>1</sup> From this point on *formal-private seed systems* will be referred to as *formal seed systems* unless otherwise specified.

<sup>2</sup> There are some discrepancies in the literature between commoditization and commodification that are important to define for clarity. Although they are often used interchangeably, commodification refers to the changing of a good into something that bears exchange value, and which is sold through a market. In comparison, commoditization refers to the “historical process by which exchange-value comes to assume an increasingly important role in economies” (Long, 2003, p. 97). Although perhaps an over-simplified explanation, the commoditization process is most often associated with the destruction of pre-capitalism (e.g.,

private gain, profit accumulation, and efficiency above all else. Moreover, it cemented a complicated relationship between agricultural producers and seed companies, with farmers essentially licensing the right to use seeds that they do not fully own (Braun, 2021).

However, while Kloppenburg's (2004) insights into the political economy of seeds are undoubtedly essential to understanding the commodification process, it is also true that this process has been (and continues to be) anything but straightforward. As exemplified by the rising movement of seed sovereignty and seed commoning movements such as OSSI (among many other initiatives) not only in the Global South but also in contexts such as the US (Pottinger, 2017; Montenegro de Wit, 2019; Peschard & Randeria, 2020), individuals continue to contest the dominant formal system and reinvigorate the informal system. The commodification process has not necessarily led to the complete elimination of alternative forms of exchange and value, which have continued to persist and grow despite major shifts in seed systems in the US and globally due to policy changes that support total market control over agricultural production. As Long (2003) illustrates,

*“...although integration into markets and external institutional structures may reduce the range of economic alternatives available to farmers, the availability of non-wage household/family labor and resources, coupled with the maintenance of local networks based on kinship, friendship, or patronage, allows farmers to continue to resolve*

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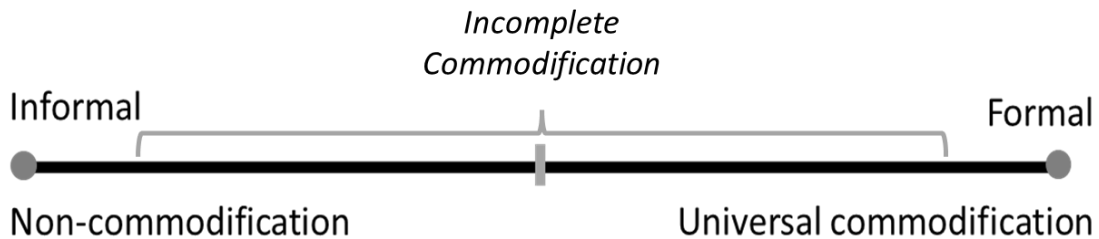
the peasantry) through market incorporation and processes of capital subsumption which serve to detach use and social value from goods and transform that value into a universally understood exchange value. As such, commoditization can be considered as a process that *creates a system*, while commodification refers to the transformation of a singular good *under a system* (fully commoditized or not). While both are important concepts in understanding changes in agri-food systems, my thesis will be primarily dealing with the concept of commodification.

*certain aspects of their livelihood and consumption problems outside the market”* (p. 103).

Here Long essentially states that, despite the spread of capital into traditionally non-market-oriented areas, alternative forms of exchange continue to persist. Or, extending this thought onto goods themselves: although goods and labor can be commodified, this does not mean that the values that undergird production and reproduction are, by association, also commodified since actors are also influenced by other non-market circumstances (see Tsing 2015 for further discussion of what she would consider as ‘contaminated commodities’). Instead, goods (such as seeds) can be composed of both commodity and non-commodity values as social and market influences interact and contest one another based on the interests, values, and resources of the actors that are invested in it (Long, 2003). Even though seeds in the US are generally highly commodified, a multiplicity of social values can still be attached seeds, with no one universal definition that can encompass how all individuals derive utility from them. This may result in a good that is in one sense commodified and reflective of some capitalist values (e.g., by being distinct, uniform, and stable) but also social values (e.g., by being locally adapted) and sometimes personal ones (e.g., by being culturally or spiritually important to one's identity). This is further exemplified by seed savers who sell their seeds or regularly purchase seeds, and by alternative seed companies who try to market and make profitable characteristics of seeds (e.g., heirloom, open-pollinated) that have not traditionally held much exchange value within conventional markets. As perhaps first amplified by Karl Polanyi in *The Great Transformation* (1944), regardless of the main principles that organize economic systems

(in this case capitalism), opposing values can nonetheless coexist and provide an essential counterbalance to the overarching dominant system – a quality particularly important for the future sustainability and resiliency of agri-food systems (Jones & Tobin, 2018).

In a similar vein, Margaret Jane Radin’s theory of *incomplete commodification* lends itself to understanding why commodification is often so contested even within highly commercialized societies. As Radin (2001) argues, complete non-commodification (referring to communities untouched by the capitalist system) and complete or universal commodification (the neoliberal idea of all things being commodifiable, or commoditization) are two extremes that, in practice, do not exist within contemporary societies. Instead, as Figure 2.2. illustrates, most goods exist on a continuum between complete non-commodification and universal commodification – these are what she calls incomplete commodities. They exist because, regardless of something being bought and sold or having a set exchange value, it is nearly impossible to completely detach personal values and social relationships from the good in question. That is, complete alienation is near impossible for many goods because of the human desire to attach nonmonetized value even to monetized goods – a point that others, such as Polanyi (1944), have also discussed. So, while formal and informal seed systems may indeed exist, they are rarely ‘pure’ and instead entail a mixture of non-commodity and commodity values that are constantly debated and challenged by multiple stakeholders.



**Figure 1.2. Visualization of commodification in relation to formal and informal seed systems**

To quote Radin, “What if it is not true that we cannot both know the price of something and know that it is priceless?” (p. 102). For instance, while it is important to acknowledge the efforts by indigenous (and other) communities in the US to rematriate seeds through non-market channels (Hill, 2017), it is also true that most seeds that flow even through informal channels in the US have, at some point, passed through a market by the very nature of many crops grown in the US being non-native to North America. However, taking note of Radin’s concept of incomplete commodification, the market or commodity aspect of a good also need not diminish its non-commodity aspects. This is demonstrated by the case of community seed libraries, which often rely on donated seed from seed companies to supply the bulk of their inventory (Atalan-Helicke et al., 2021), and yet are based on social principles such as access to education, community-building, and creating a culture of sharing (Soleri, 2018). To draw this back to Long (2003), things can move back and forth between being a commodity and being essentially de-commodified not necessarily because of the nature of all exchanges between when a good is created and where it ends up, but because of the commodity and non-commodity values which something embodies. Seeds are a perfect example of such a good: they embody

social values which are expressed both A) constitutionally, in the human-manipulated adaptation of varieties over space and time which effectively embed seed biology with cultural meaning, and B) extraneously, by representing and reflecting contested ideologies, goals, and visions for the future of agri-food systems through the policies and institutions that govern them. As such, not only can seed be considered an incomplete commodity because it cannot fully be detached from non-market spheres of influence, but also because seeds undergo various processes of commodification and de-commodification depending on the actors involved in their creation, adaptation, and maintenance.

#### **2.4. Seed System Resilience**

While seed systems are contested due to the values they embody, they are also undoubtedly contested by individuals who argue for the resilience and appropriateness of one over the other. In particular, formal systems are often championed due to their ability to quickly disseminate improved varieties and promote innovation (Bonny, 2017). However, other prominent seed system scholars argue that the informal system is the most important and the most resilient during periods of instability (Sperling & McGuire, 2010). Indeed, evidence from Seed Security Assessments (SSAs) globally generally supports the conclusion that informal seed systems are central to seed security during shocks and stresses by providing local sources of accessible, quality seed. However, as I illustrated in the previous section, informal and formal seed systems should not be treated as completely independent from each other, nor should they pose an “all or nothing” scenario, despite the tendency for development practitioners and other international actors to do so. Most

farmers use planting material from both types of systems, with the integration of informal and formal systems allowing for greater robustness in areas of accessibility, quality, availability, and preference that are all vital to seed system resilience (López Noriega, 2020). For instance, while the formal system may benefit stakeholders (particularly commercial stakeholders) by providing a reliable source of quality seed, informal seed networks are important for access to diverse and culturally significant seeds globally, particularly for smallholder farmers (Sperling et al., 2021). Additionally, integrated seed systems continue to emerge and proliferate globally. Integrated seed systems are often thought of as systems where the formal system acts as an efficient distributor of both improved and farmers' varieties that eventually make it into the informal system through sharing and seed saving (López Noriega, 2021) – thus enhancing the resilience of farmers through improving access to diverse forms of planting material. Emerging evidence suggests that integrated structures can be quite successful, with a recent paper from Vernooy et al. (2022) highlighting the potential for community seed libraries to not only enhance access to important crops but also promote community empowerment and provide a source of local income.

In its simplest form, resilience can be defined as "...the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al., 2004). Resilience principally depends on the adaptive or resilience capacities of an individual or system, which would allow them flexibility and options during times of hardship (Béné, 2020). This concept is particularly important as, although many studies attempt to measure

resilience (a long-term outcome), several more easily measurable steps must be present before that outcome can be realized. One of these indicators is resilience capacities which include a combination (or stock) of assets and capitals that individuals and groups can rely on to respond to a sudden shock within the overall system. In the context of agri-food systems, resilience also entails that individuals, households, and communities do not sacrifice their long-term wellbeing for their short-term wellbeing (Béné, 2020). Additionally, although there is no universally accepted definition for what constitutes a resilient seed system, Vernooij et al. (2019) state that a resilient seed system entails other important aspects such as farmer preferences, social networks and a diversity of connections, and gender equitability. By combining all these definitions, a resilient seed system must be adaptable, diverse, and beneficial to multiple stakeholders and their unique needs and desires.

During the beginning of the COVID-19 pandemic in the early months of 2020, seed systems were disrupted globally due to lockdowns, country-wide curfews, movement bans, and social distancing measures that interrupted production and distribution across the food chain (Shilomboleni, 2020; Béné, 2020). As recent rapid assessments in the Global South have highlighted, the pandemic particularly impacted the formal seed sector as seed companies and formal retail outlets had significant delays in distribution that impacted the types of crops farmers were ultimately able to grow (Boef et al., 2021). Moreover, accounts in the popular media suggest that the formal seed sector in the US faced similar disruptions and seed shortages due to heightened safety precautions and an increase in demand for seed (Nabhan & Kaufman, 2020; Held, 2021). Of course, informal systems were not unaffected:

restrictions on gathering and social distancing also impacted the ability of individuals to participate in group activities and local seed exchanges (Boef et al., 2021). That said, while it is known that both informal and formal seed systems were disrupted, research has not yet explored the long-term impacts or adaptation responses of various seed system structures which is essential to understanding the divergent capacities of informal, formal, and integrated systems. Nonetheless, seed system scholars have recently emphasized the need for seed system responses to the pandemic to support formal and informal systems alike to utilize the resilience capacities of both to promote positive responses and quicker recoveries (Zimmerer, 2020; Sperling et al., 2020; Sperling, 2020).

Despite widespread challenges due to COVID-19 that will undoubtedly reverberate many years into the future, emphasis on supporting diverse seed systems in their multiplicity of forms is necessary. While seed system aid and support have generally favored developing the formal sector (McGuire & Sperling, 2013; 2016), the COVID-19 pandemic has underscored the importance of informal and integrated systems as well, which many producers worldwide depend on (Sperling, 2020; Zimmerer, 2020). Indeed, informal and integrated seed systems have a great deal of untapped potential (Sperling et al., 2021), often maintain a high degree of crop diversity (Pautasso et al., 2013), and provide an alternative source of quality, often cheaper, and more readily available seed than the formal sector (Almekinders et al., 1994). Considering these strengths, it is reasonable to assume that supporting all systems (not only formal) can increase producer access to seed by increasing response diversity (i.e., redundancy), an often-overlooked component necessary to creating resilient systems (Walker, 2020).

Finally, a major yet often underemphasized component of seed system resilience is the ability of systems to satisfy the diverse preferences of all their stakeholders (Vernooy et al., 2019). For instance, while some farmers in the US may be content and prefer uniform hybrid seeds, many seed growers also value other characteristics such as seeds being organic, open-pollinated, locally grown, and unique (Pottinger, 2017). For this reason, resilience in the context of seed systems does not only mean adequate universal access but the incorporation of values that may or may not contribute to the sale value of that seed but instead the meaning that an individual attaches to it. In this way, ideas surrounding commodification and resilience intersect and further illustrate the way that incomplete commodification and integrated or alternative seed systems can support resilience and diversity across contemporary seed systems. For many countries in the Global South, this entails protecting informal systems from the overwhelming influence of the formal system. In the Global North and US, however, there is a need to revalue and relink non-commodity and informal systems to balance the conventional formal system which threatens to erode the non-economic value of seed which is integral to future agricultural resilience.

### **2.5. Imperfect Commodities, De-Commodification, and Resilience**

Although the topic of resilience is important across and within various parts of the agri-food system, the resilience of seed systems is of particular importance to both short-term resilience (e.g., by providing access to quality and culturally significant food) and long-term resilience (e.g., to sustain a robust genetic resource base necessary to adapt to climate change, disease, and environmental degradation) (Khoury, 2014; Kloppenburg,

2014). Indeed, seeds compose an essential part of agri-food system resilience as a whole and undergird the sustainability of various production systems. However, seeds have also undergone an extensive process of commodification (Kloppenburger, 2004) due to changing policies and public/private dynamics both within the United States and globally (Morfi, 2020; Braun, 2021; Lyon et al., 2021). With this process of commodification, farmers and gardeners alike are facing new obstacles and decreasing autonomy over their production. At the same time, the expansion of formal seed systems in nearly all areas of the world has created a situation in which seed commodification, and concurrently seed system integration, is the norm in the Global North and Global South alike (Thijssen et al., 2015; Lopez Noriega, et al., 2021). For this reason, there is a newfound necessity not to simply focus on seed system resilience in terms of binaries: whether that be organizational formations (i.e., formal and informal), scales or orientations (e.g., commercial and non-commercial producers), and concerning only the Global South or Global North. While differences in contexts are indeed important and should not be diminished, consideration of resilience requires less emphasis on traditional dichotomies in order to acknowledge contemporary complexity (Buttel, 2001) and to find commonalities and synergies between different contexts, conditions, and forms of organization.

Commodification is considered as positive (even necessary) by some and as completely detrimental by others (Radin, 1996; Kloppenburger, 2004). Seed commodification, which necessitates the alienation and appropriation of plant genetic material by some sort of private entity (Braun, 2021), has been particularly contested, with some arguing that it enhances innovation and access (Bonny, 2017), and others believing

that it completely delinks producers from their means of production (Kloppenborg, 2004; 2014). Significant activism has been witnessed throughout both the Global South (Peschard & Randeria, 2020) and in the Global North (Helicke, 2015; Lyon, 2021) in response, with the reinvigoration of seed-sharing networks being particularly prevalent in the United States in the last couple of decades (Lyon, 2021). Movements such as seed commons movements and seed sovereignty suggest a desire to de-commodify seed by moving the production and distribution of seed away from the market and the private sector to the public and community level. Various alternative agricultural practices spanning community gardening, community-supported agriculture, and home-provisioning of food reflect a desire to re-embed economies, and the goods which flow through them, with non-commodity values (Matacena, & Corvo, 2020). Moreover, sustainable agricultural initiatives also seek to create not only instrumental values such as profit but reciprocity and natural stewardship as well (Jones & Tobin, 2018). Through such initiatives and programs, alternative agriculture in the US can be considered a resilience initiative, through which incomplete commodification is a major part of enhancing the capacities of individuals and communities.

As Radin and Sunder (2004) discuss, the process of commodification is dependent on the reduction of subjects (goods or people, in their analysis) into things that have a sale value and that can consequently be owned. Commodification is often a naturally exploitative act resulting in a product that can be viewed directly (and often solely) by its saleable attributes, and which necessitates a certain degree of homogenization to ensure its universally understood exchange value (Braun, 2021). In comparison, de-commodification

or incomplete commodification, by which an ex-commodity can be created and a plurality in value is recognized (Appadurai, 1988), allows for greater diversity and uniqueness of a good. Because of this quality, incompletely commodified seed can contribute to more resilient agri-food systems because it is also more diverse, an essential yet often overlooked component of resiliency (Walker, 2020). Moreover, the quality of incompletely commodified seed to flow through informal networks (e.g., farmer-to-farmer exchanges) as well as formal networks (e.g., alternative seed companies), allows for a more robust weaving of seed networks that can better withstand disruptions in supply and distribution (Almekinders et al., 1994). Finally, the qualities of incompletely commodified seed to promote characteristics such as cultural suitability and public value are incredibly important for agri-food system sustainability (Lyon, 2021).

Understanding commodification as a process rather than a binary outcome is essential in allowing for diverse forms of production and distribution, which helps to better understand the structure of most of the US' seed systems which also often cannot cleanly be categorized as informal or formal. That is, there is a distinction between informal systems, also called farmer seed systems as they are primarily maintained by farmers and are composed of non-certified planting material, and what Lyon et al. (2021) perhaps more accurately described as “*seed-saving and seed-sharing networks*” (p. 14). Principally, informal seed systems assume a certain degree of distance from formal markets and transactions of commodities (Bonny, 2017). In comparison, the seed-saving and seed-sharing networks prevalent in the United States are in many senses highly ingrained within commodity channels: despite being driven by alternative values and not necessarily

entailing monetary transactions, they are nonetheless composed of seeds embedded with a mixture of histories, including crop species and varieties appropriated from the Global South and indigenous communities (Kloppenburg, 2004), and seeds that have undergone formal certification and quality processes through seed companies. The latter is especially true for seeds that make it into informal seed systems through donations: most seed libraries in the US rely on seed companies to stock their collections (Soleri, 2018; Altlan-Helicke, 2021). Moreover, this mixed nature of seed systems is not unique to the US: most farmers in the Global South and North rely on both formal and informal markets for seed (Lopez Noriega et al., 2021).

The contemporary state of many seed systems around the world can thus already largely be considered as integrated and composed of seeds that flow in and out of their commodity status. As Appadurai (1988) illuminates, commodities, in general, are “things that, at a certain *phase* in their careers and in a particular *context*, meet the requirements of commodity candidacy” (p. 16). Moreover, certain goods, such as seeds but also land, people, and natural capital which are not inherently created to be sold can be thought of as ‘fictitious’ (Polanyi, 1944), ‘quasi-commodities’ (Braun, 2021), or ‘imperfect commodities’ (Radin, 1996). All these distinctions are, in one way or another, indicative of a good's inability to be fully commodified – whether because of the values which make them up, or technical or institutional regulations that prohibit their full emersion and control by the market mechanism (Radin, 1996). In this way, while Kloppenburg (2004) and others were correct and rightly concerned about the enclosure of the seed commons through processes of commodification, room continues to exist where the process of

commodification can be disrupted, and in doing so, create areas in the agri-food system in which resilience can be enhanced through diverse seed that is able to go through continuous processes of commodification, de-commodification, and re-commodification.

## **2.6. Differences Between Farmers and Gardeners: Scale and Operation**

Although home gardening has risen in popularity since the COVID-19 pandemic, thus highlighting the importance of non-commercial growers as both users and consumers of seed (Sheth, 2020), the ways in which commercial and non-commercial growers engage with seed and seed systems are undoubtedly distinct. Principally, it is easier for home gardeners to be involved in seed-saving and seed-sharing networks than their commercial counterparts, and initial evidence from the US suggests that informal seed networks are largely composed of gardeners (Helicke, 2015; Soleri, 2018; Isbell et al., 2021). Commercial farmers are much more subjected to the market mechanism than non-commercial growers, who often view home provisioning and seed saving as a form of leisure or wellness exercise (Soleri, 2018; Niles et al., 2021), rather than a component of sustaining their livelihood. Additionally, commercial farmers are much more likely to be targeted by seed companies for infringing on their intellectual property rights (IPR) (Borowiak, 2004), and in many cases have little choice but to purchase hybrid seeds year after year, especially if involved in large-scale commodity production (Kloppenburger, 2004). Commercial farmers, especially in the US, thus live within the confines of a particularly rigid institutional structure that is dominated by large firms, subject to government incentives that mainly benefit large-scale commodity producers, and are facing

increasing pressures to specialize and intensify production (Hanson, 2008; Spanger et al., 2020).

Given these differences in context, commercial and non-commercial producers face different pressures, with commercial farmers having greater incentives, and oftentimes a necessity, to be a part of the ‘technological treadmill’ which subordinates them to the capitalist system (Kloppenburg, 2004). However, despite the overarching differences in the political economy of commercial and non-commercial agricultural producers, both farmers and gardeners continue to contest the dominant regime to create more agroecological, just, and equitable food systems (McMichael, 2009).

### **2.7. Differences Between Farmers and Gardeners: Values**

While commercial farmers and non-commercial growers are subjected to divergent pressures depending on their positionality within the greater political economy, it is not fair to say that commercial farmers are driven solely by profit or other logic of the capitalist system simply because their livelihoods are heavily ingrained in them. Indeed, as Long (2003) explores, despite being within a capitalist system, actors express their own agency and are highly influenced by the “interrelations between commoditized and non-commoditized relationships” (p. 104), of which alternative value systems and forms of organization can co-exist. Through this mixing of value systems, commercial farmers and other societal actors can both be a part of an overarching system but think and act counterintuitively to its logic, as Maticena & Corvo (2020) explore in their qualitative inquiry into the motivations underlying market-based alternative agriculture schemes.

Furthermore, as elaborated on by Radin (2001), the fact that market and non-market systems can co-exist should not mean that the market system will always win out. Indeed, contrary to the commoditization debates of the 20<sup>th</sup> century, too little emphasis is given to the importance of non-commodified and de-commodified value systems in structuring the possible outcomes commercial and non-commercial producers operate under (Long, 2003). This has been a common critique of many alternative agriculture movements within the last few decades, but especially of such movements as food sovereignty, which often emphasizes the fact that peasants globally continue to resist capitalist structures through such things as communal land rights structures, self-provisioning, and community-based care initiatives.

By assuming that commercial and non-commercial can be and *are* active participants within the agri-food systems they belong to, several potential futures (or seed regimes) become possible. In fact, commercial farmers, plant breeders, researchers, and gardeners have already been working towards the goal of reintegrating public value (such as cultural significance, applicability, and suitability to local environments, etc.) into seed through participatory initiatives which seek not to simply reverse the historical trajectory of seed regimes in the US but integrate and improve upon them to support public values (Lyon et al., 2021). Moreover, there is substantial evidence that commercial farmers continue to act on alternative values that illuminate the importance of culture, community, and non-market exchange as an important components both expressed within their market involvement (e.g., selling) (Matacena & Corvo, 2020) and separate from it (e.g., gifting) (Poe et al., 2015). From this and theories relating to commodification, peasant forms of

production, and food regimes, it becomes clearer that commodification itself does not have to be naturally detrimental, depending on how it is used and how the power to commodify is distributed. For instance, as Radin & Sunder (2004) explain, “Under one view, commodification aids culture-building—individuals express and create commonality through markets. Under another view, markets strip away local meanings and contexts, universalizing a good and making it common, rather than unique” (p.7-8). That is, the non-economic values that undergird commodification are at least equally as important as economic values (Long, 2003) and can assist in transforming a corporate-led seed regime into one with greater equitability and democratic qualities both inside and apart from markets (Lyon, 2021).

Diverse forms of organizing public and common-pool resources are already profuse and exemplify the diverse governance systems that, when supported, can help redistribute power away from private corporations onto individuals and public actors (Ostrom, 2010). In other sectors, such attempts to promote democratization can be seen in the ‘sharing economy’, in which several actors work together to create a market and share the profits and burdens of commodification (Schor, 2016). Many seed companies have already emerged in the last couple of decades such as Southern Exposure Seed Exchange and Truelove Seeds among other for-profit and non-profit collaborations between universities and community groups (Lyon, 2021). Much in the same way that Kloppenburg (2004) concluded that genetically modified organisms (GMOs) are not inherently bad but instead are bad in the ways they are used and controlled, commodities, and more specifically imperfect commodities in which non-commodity and commodity values co-exist (Radin,

1996), can prove to be a powerful tool that can indeed help support cultural, social, and environmental values (Appadurai, 1988) and enhance local resiliency and autonomy (Thijssen, 2015).

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**CHAPTER 3: ENHANCING RESILIENCE THROUGH SEED SYSTEM  
PLURALITY AND DIVERSITY: CHALLENGES AND BARRIERS TO SEED  
SOURCING DURING (AND IN SPITE OF) A GLOBAL PANDEMIC**

**3.1. Introduction**

At the beginning of the COVID-19 pandemic in the early months of 2020, seed systems were disrupted globally due to lockdowns, country-wide curfews, travel bans, and social distancing measures that interrupted production and distribution across the food chain (Shilomboleni, 2020; Béné, 2020). In the United States (US), accounts in the popular media were profuse with stories of issues facing the commercial seed sector, often highlighting seed shortages due to heightened safety precautions and an increase in demand for seed (Nabhan & Kaufman, 2020; Held, 2021). The heightened demand coupled with a need to bolster food security through multiple pathways resulted in some states, including Vermont, labeling seeds as “essential” despite restrictions on in-person purchases for most goods (Vermont Agency of Agriculture, 2020). As recent rapid assessments of seed systems in the Global South have highlighted, the pandemic significantly impacted the flow of seeds globally as well, sometimes impacting the types of crops farmers were able to grow (de Boef et al., 2021) and causing reverberations across food supply chains. Informal seed systems – those managed by farmers and gardeners, and which typically have a high presence of diverse open-pollinated varieties – were also affected. Not surprisingly, restrictions on social gatherings combined with social distancing measures also impacted the ability of individuals to participate in local seed exchanges, markets, and

other community activities (de Boef et al., 2021), although initial evidence from the US suggests informal systems were able to pivot to support local communities in some situations, as exemplified by Soleri et al. (2022) in their investigation into community seed organizations and their responses following the onset of the pandemic (Soleri et al., 2022). Ultimately, it is clear that both informal and formal seed systems were disrupted globally. However, research into how COVID-19 – or also, importantly, any other disturbance (acute *or* chronic) – affected seed systems in contexts such as the US is lacking, despite the fundamentality of seed in supporting food production and agroecosystem sustainability.

Seed system scholars have emphasized the need to leverage the capacities of both formal<sup>3</sup> and informal seed systems where they exist to promote positive responses, quicker recoveries, and long-term resilience strategies in the face of system stress (Zimmerer, 2020; Sperling et al., 2020; Sperling, 2020). Considering the widespread challenges from COVID-19 that will undoubtedly reverberate many years into the future, emphasis on supporting diverse seed systems in their multiplicity of forms is necessary. While seed system development has generally favored the formal sector (McGuire & Sperling, 2013, 2016; Wise, 2019), the COVID-19 pandemic has underscored the importance of informal seed systems on which many producers worldwide depend (Sperling, 2020; Zimmerer, 2020; Lopez-Noriega et al., 2021). Informal seed systems have a great deal of untapped potential (Sperling et al., 2021), often maintain a high degree of agrobiodiversity essential

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<sup>3</sup> The formal seed system consists of both public and private entities that disseminate certified seeds of improved varieties, often through commercial channels (Lipper et al., 2010). For this paper, the term “formal seed” should be considered as synonymous with “commercial seed.”

to the health of multi-species ecosystems (Letourneau et al., 2011; Pautasso et al., 2013), and provide an alternative source of quality seed, often at lower prices than the formal sector (Almekinders et al., 1994). Considering these strengths, it is reasonable to assume that supporting all systems, not just formal systems, can increase access to seeds by promoting often-overlooked components of resilience, including functional diversity (i.e., diverse nutrient availability held within food crops) (Jones, 2017), and supply chain redundancy (Walker, 2020; Kliem & Sievers-Glotzbach, 2021). That said, the benefits of informal seed systems have often been overlooked, with policies in both the Global South and North generally favoring the formal sector (Atalan-Helicke et al., 2021; Otieno et al., 2017) despite farmer advocacy groups advocating for priority to be given to the informal sector (La Via Campesina, 2021). Indeed, while there is significant interest in informal seed systems in the US, especially among non-commercial growers (Soleri et al., 2022), this has yet to translate into policies that support their development alongside the formal sector (Atalan-Helicke et al., 2021), suggesting the underutilization of alternative sources of seed that could promote resilience across a wide array of growers.

As a state with established informal and formal seed systems, the state of Vermont presents a compelling example that may shed insight into how the COVID-19 pandemic impacted growers in the US who vary in degree of involvement within formal and informal systems. Building off previous scholarly insight on resilience in the context of agriculture, food, and seed systems (Walker 2004; McGuire & Sperling, 2013; McGuire & Sperling, 2016; Tendall et al., 2015; Béné, 2020; Kliem & Sievers-Glotzbach, 2021) as well as information on how seed systems have responded to the COVID-19 pandemic thus far

globally (de Boef et al., 2021; Soleri et al., 2022), this paper seeks to contribute to the literature on seed system resilience in chronically understudied contexts such as the US. Specifically, we use a combination of quantitative and qualitative data to explore how COVID-19 impacted seed systems within Vermont directly following the pandemic's onset (objective 1) and how different groups of growers (i.e., commercial and non-commercial) responded to these challenges (objective 2). These objectives examine the resilience of seed systems within the state of Vermont by investigating how various actors were affected by a significant shock in the supply chain, the respective system capacities that growers mobilized to respond to these challenges, and their resulting ability to adapt, thus providing insight into seed system resilience. This paper also begins to break down the temporal dimensions of resilience (and, in hand, vulnerability) by highlighting the immediate impacts of the pandemic and comparing them to pervasive and chronic challenges. The following paper provides important evidence as to the importance of diverse seed system structures by highlighting the fact that, despite definite challenges in seed sourcing caused by the COVID-19 pandemic, Vermont growers were still able to meet their seeds by drawing upon an array of capacities extant within both formal and informal seed systems. Given the centrality of seed systems to food system resilience in both the short and long term, the findings of this paper illustrate how bolstering a plurality of seed systems has the potential to support resilience, reduce vulnerability, and support sustainability across agri-food systems.

### **3.2. Background**

### 3.2.1. Seed System Resilience: Frameworks and Potential

Although operationalized differently throughout various disciplines, resilience can be defined simply as “...the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al., 2004). Social-ecological resilience, which acknowledges the interconnectivity of human and environmental systems, also entails the ability of a complex system to self-organize, learn, transform, and adapt to changing conditions (Holling, 2001; Adger, 2006). Social-ecological resilience depends on the capacities of a system that allows for flexibility and options during times of hardship (Béné, 2020) – essentially relating to the adaptability of actors within a system to both draw upon and influence resilience by way of adjusting and learning through encounters with various disruptions (O’Connell et al., 2015). Béné (2014) further categorizes these capacities into *absorptive* (persistence with minimal system change), *adaptive* (pro-active incremental adjustments), and *transformative* (working towards systemic change) capacities – all of which serve to reduce the vulnerability, defined as sensitivity and exposure to external stresses (Adger, 2006), of actors as parts of the system and the system overall.

Within conceptualizations of social-ecological resilience, individuals or actor-level responses to shocks within a system are often used as examples to understand the resilience of a system to which they belong (Gonzalez-Quintero & Avila-Foucat, 2019). Relating to Béné (2014), the capacities of a system can be considered as resources that individuals embedded within a system rely on to undertake positive response strategies when needed. Indeed, this is further grounded by ideas surrounding social resilience which specifically

is concerned with the way that social entities (e.g., individuals and communities) cope with various threats to their lives (Keck & Sakdapolrak, 2013). That is, while system capacities importantly do not always translate to individual resilience (social resilience instead usually centers on the utilitarian ideal of allowing for the most adaptability for the most amount of people (Pauley et al., 2019)) the ability of individuals to adapt is usually indicative of the adaptability of a system to which they belong. Individual and social-ecological resilience are thus importantly distinct (e.g., in the sense that a minority within a system may not benefit fully from it (Walker, 2020)) but related so that, when considering systems that are strongly influenced by humans (such as domesticated agriculture, of which seeds form the foundation), individual or community resilience often becomes a proxy for the social side of social-ecological resilience by way of directly influencing (and being influenced by) its adaptability.

While there are many capacities that individuals can draw on within a system depending on the system and shocks in question, diversity is particularly essential to the healthy functioning of social-environmental systems (Fraser et al., 2011; Dixon et al., 2014). Indeed, diversity supports resilience across multiple scales, from the heterogeneity of landscapes to the plurality of relationships between stakeholders and organisms (Cabell & Oelofse, 2012). Although often overlooked, diversity entails a greater number of buffers, ensuring that if a certain capacity is absent, another can be substituted to enable adaptability (Walker, 2020). For example, as McGuire & Sperling (2010) highlight in their analysis of Seed Security Assessments (SSA) in Sub-Saharan Africa, effective seed security responses mobilize not one but many responses such as direct seed aid, vouchers for seed purchases,

and engagement with informal ‘knowledge-brokers’ to provide variability and seed access across various channels. This array of responses highlights the importance of redundancy in functionality to system resilience, although redundancy is often disregarded for the sake of efficiency within the conventional global agri-food system and seed systems within it (Walker, 2020). Unfortunately, efficiency often comes at the detriment of social-environmental systems – making food supply chains particularly vulnerable to system deviations, as exemplified by the price spikes that occurred globally in 2007/08 which were the result of largely exogenous factors such as oil prices, droughts, global currency fluctuations, and commodity speculation (Hamilton, 2020). Similar vulnerabilities were highlighted by the COVID-19 pandemic, which brought to light vulnerability across the agri-food system, including for critical inputs such as seeds.

Despite substantial research into seed systems globally, and especially in the Global South, there is no universally accepted definition for what constitutes a resilient seed system. That said, the Alliance of Bioversity International and the International Center for Tropical Agriculture (Bioversity-CIAT Alliance) define a resilient seed system as one which “relies on the ability of seed system actors to absorb disturbances, regroup or reorganize, and adapt to stresses and changes caused by a perturbation in the environment” (Vernooy et al., 2019, p. 7) – a definition not dissimilar to the one that Walker et al. (2006) provide of resilience in general, but one that also recognizes the importance of individuals to overall system resilience. Other organizations and scholars push this definition further to explicitly include the importance of diversity, both social (e.g., seed source and network diversity and network diversity) and environmental (e.g., inter- and intra-crop species

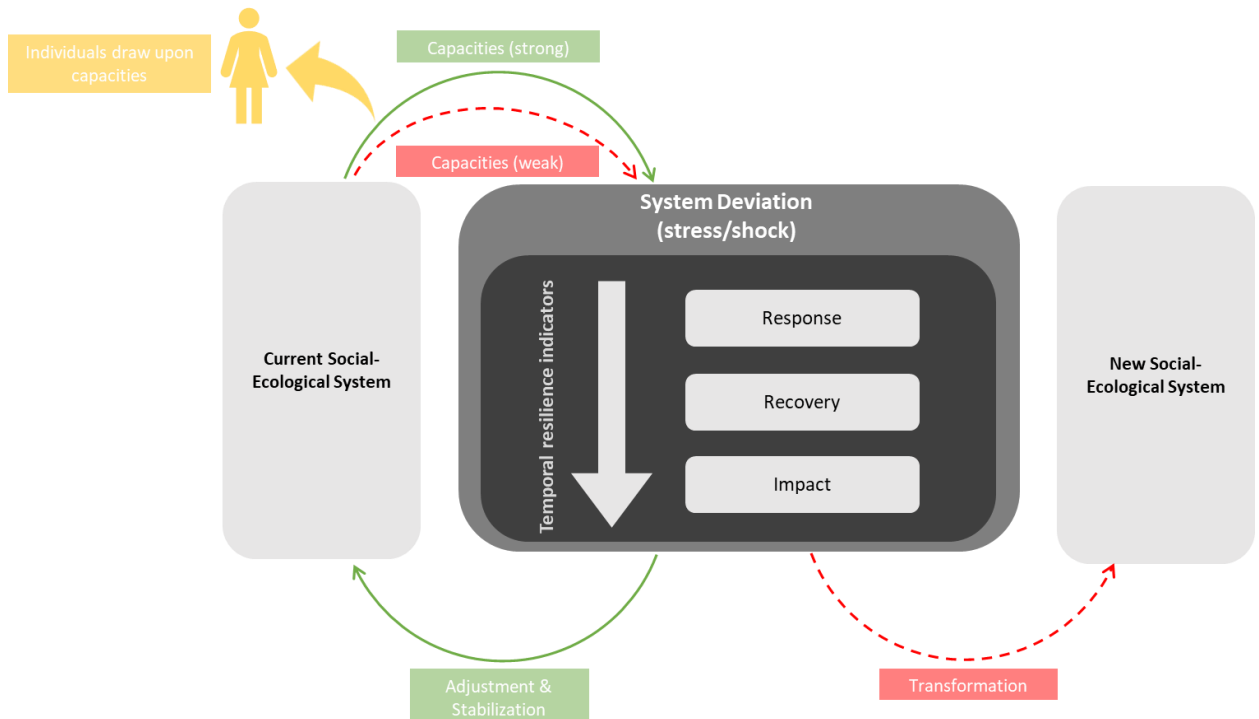
diversity), to seed system resilience (Kliem & Sievers-Glotzbach, 2020). Building on previous work by Cabell & Oelofse (2012), Kliem & Sievers-Glotzbach (2021) describe fourteen indicators<sup>4</sup> of agroecological resilience, many of which acknowledge the importance of not only social and environmental dimensions, but also how they interact to create diverse, and “optimally redundant” seed systems which can cater to a wide array of stakeholders and their unique environmental contexts. Resilient seed systems also incorporate such aspects as promoting multiple knowledge interactions and enabling choice among growers (Vernooy et al., 2019), especially women, who, importantly, are often the main actors within informal seed systems both in the Global North and South (Sachs, 1997; Helicke, 2015).

There are also temporal considerations that foreground the fact that resilience does not only manifest in immediate responses to acute shocks, but also relates to the long-term functioning and wellbeing of a system – although this is often overlooked empirically in studies attempting to measure resilience (Béné, 2020). As Kliem & Sievers-Glotzbach (2021) demonstrate in their conceptualization of agroecological resilience, this temporal aspect is especially crucial for seed systems considering not only the immediate and instrumental necessity of seed for growers’ livelihoods but also for the long-term security and adaptability of food systems globally to natural and anthropometric challenges.

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<sup>4</sup> All fourteen indicators are as follows: socially self-organized, ecologically self-regulated, functional and response diversity, optimally redundant, exposed to disturbance, coupled with local natural capital, accumulation of reserves and physical infrastructure, appropriately connected, builds human capital and encourages reflective and shared learning, conservative innovation that honors legacy, reasonably profitable, based on polycentric and decentralized governance structures, ensures resource access and broadens participation, and encourages complex adaptive systems thinking.

McGuire & Sperling (2010) also acknowledge this temporal dimension, suggesting both short-term (e.g., direct seed aid) and medium-term actions (e.g., supporting farmer seed exchanges) that should be taken after acute seed system shocks. This temporal consideration is highlighted in Figure 3.1, our conceptual framework, which provides the lens through which seed system resilience is assessed in this study. As displayed within the figure, a system's *response* indicates resilience (or lack thereof) in the short-term, *recovery* relates to the medium-term, and *impact* (either system transformation or adjustment and stabilization) relates to the long-term impacts of a shock, which can be considered as a culmination of various system deviations (Folke et al., 2010), as determined by the strength of a systems capacities. This points to the need to address vulnerability both in a shock's immediate aftermath (i.e., reducing acute vulnerability) and long after (i.e., addressing the structural causes of vulnerability) to strengthen a system and protect it from similar disruptions in the future.



**Figure 2.1. Conceptualization of Social-Ecological Resilience Pathways (Source: author)**

Considering that seed systems provide the necessary material to ensure both short and long-term sovereignty (i.e., the ability of communities to self-determine what their own seed systems look like) and environmental sustainability, seed system resilience must entail a greater understanding of the full set of challenges that farmers and gardeners face in obtaining quality seed (McGuire & Sperling, 2012). While COVID-19 and other acute challenges such as natural disasters and civil conflict provide valuable insight into ways to support formal and informal systems alike by illuminating potential vulnerabilities within system stability, resilience can only be maintained in the long-term through accommodation of diverse stakeholders and their needs – thus ensuring proper nourishment of all people and organisms reliant upon a social-ecological system (Vernooy et al., 2019).

Indeed, a major yet often underemphasized component of seed system resilience is the ability of systems to satisfy the diverse preferences of all their stakeholders (Vernooy et al., 2019). For instance, while some farmers in the US may prefer uniform hybrid seeds well-suited to the demands of wholesale produce requirements, many seed growers (especially non-commercial growers, as highlighted in Isbell et al., 2021) also value other characteristics such as seeds being organic, open-pollinated, and locally adapted (Pottinger, 2017). For this reason, resilience in the context of seed systems does not only mean adequate universal access to seed in general but to seed that also can contribute to the maintenance of agrobiodiversity and meet the preferences of the growers who use them. Furthermore, resilience is ideal only so long as it supports beneficial outcomes that reduce vulnerability. That is, a system can be both resilient and simultaneously perpetuate vulnerability among marginalized populations (Nelson et al., 2007). The potential negative impacts of a stable system that does not value or enable diversity underscore the need for resilient seed systems to serve the diverse needs of the growers who use them and adapt to these needs rather than remain stagnant. This is especially important given the fact that many growers face different constraints and have different opportunities depending on their positionality within the food system (Dale, 2020).

### **3.2.2. Role & Resilience Strategies: Commercial and Non-Commercial Growers**

Although home gardening has risen in popularity since the COVID-19 pandemic began (Sheth, 2020; Niles, 2021), highlighting the importance of non-commercial growers as both users and consumers of seed, the ways that non-commercial growers engage with seed and seed systems in the US are distinct from commercial growers. Principally, it is

relatively easier for home gardeners to be involved in seed-saving and seed-sharing networks than their commercial counterparts, and initial evidence from the US suggests that informal seed networks are largely composed of gardeners perhaps because of this reason (Helicke, 2015; Soleri, 2018; Isbell et al., 2021). Commercial farmers are often more beholden to market mechanisms than non-commercial growers, who often view home provisioning and seed saving as a form of leisure or wellness exercise (Soleri, 2018; Niles et al., 2021), rather than a component of sustaining their livelihood. Additionally, commercial farmers are much more likely to be targeted by seed companies for infringing on their intellectual property rights (IPR) (Borowiak, 2004), and in many cases have little choice but to purchase hybrid seeds year after year, especially if involved in large-scale commodity production (Kloppenborg, 2004). Commercial farmers, especially in the US, thus live within the confines of particularly rigid institutions that are dominated by large firms, subject to government incentives that mainly benefit large-scale commodity producers, and are facing increasing pressures to specialize and intensify production (Hanson, 2008; Spanger et al., 2020).

At the same time, commercial farmers also benefit to some degree from being a part of the conventional agricultural system – entailing a double-edged situation whereby they are both enabled and constrained by their association with formal food (and seed) systems in the US. Given this divergence, it must also be noted that the resilience capacities of a seed system used by commercial and non-commercial growers may be distinctly different in important ways. For instance, whereas non-commercial growers may be able to easily switch varieties and draw upon informal sources of seed to meet their home

consumption needs, commercial growers undoubtedly have more ability to interact and obtain priority within seed markets. Recognizing that non-commercial and commercial growers face different constraints helps to highlight the different capacities of seed systems, and their ability to be leveraged (or not) by different stakeholders to meet diverse needs.

### **3.2.3. Seed System Structures and Trends**

Seed systems are usually distinguished by their degree of “formality.” Whereas formal (or “modern”) systems, which consist of both public (i.e., land-grant universities, national breeding programs, etc.) and private entities (i.e., seed companies), are characterized by scientific plant breeding programs, seed aid, (inter)governmental institutions and the commercial distribution of certified seed, informal or “farmer seed systems” consist of unregulated exchanges of seed between farmers and gardeners (Kuhlmann & Dey, 2021). Although informal systems persist in many areas of the world, especially in the Global South where between 80-90% of farmers in some countries depend on informal sources of seed (Etten et al., 2017; Otieno et al., 2017), they have undoubtedly been marginalized in the Global North due to the prevalence of “modern” seed systems which have resulted in increased privatization and consolidation of seed production. With four agrochemical/seed firms controlling over 60% of global proprietary seed sales (Howard, 2018), combined with concurrent specialization in the US which has resulted in only three crops covering more than 65% of total cropland (Spangler et al., 2020), contemporary seed systems in the US are largely composed of high-yielding, hybrid, and genetically modified (GM) commercial seed.

The trend towards seed system privatization has raised serious concerns in several areas of importance which include the ability of modern seed systems to contribute to community and individual seed sovereignty (La Via Campesina, 2021; Soleri et al., 2021), maintain the agrobiodiversity necessary to adapt to challenges such as climate change (Etten et al., 2017), and support polycentric governance within the global food system (Tschersich, 2021). Despite these issues being well-documented and studied, especially within the Global South (Kloppenburger, 2004; Howard 2015; 2018; Bonny, 2017; Hendrickson et al., 2021), the formal private sector continues to dominate and influence agri-food system policies globally. The US seed system is often looked upon as a success story – resulting in global development agendas that seek to facilitate the expansion of commercial seed companies into “underdeveloped” areas (i.e., areas heavily dependent on informal seed systems). For instance, the Alliance for a Green Revolution in Africa (AGRA) championed by the Bill & Melinda Gates Foundation has sought to promote the formal seed system along with other commercial enterprises to promote agricultural development (Toenniessen et al., 2008), despite critiques that contend that the main yield from these efforts has been documented to be in the form of capital accumulation by a few transnational companies rather than marked improvements in smallholder productivity (Wise, 2019). Moreover, at the same time this is happening, research has shown that the commercial seed sector has stymied breeding progress in areas where it is most prevalent (Lourwaars et al., 2011).

#### **3.2.4. Opportunities for Change and Readjustment**

For this reason, food sovereignty organizations such as La Via Campesina actively denounce such programs, asserting that they erode peasants' ability to self-determine their own seed, and ultimately, food system (La Via Campesina, 2021) – a sentiment that is also being reflected in the Global North (Soleri et al., 2022). Others also warn that the hegemony of the formal private system will erode crop diversity, agricultural heritage, and cause long-term damage to the resiliency of food systems (Wise, 2020). Indeed, several alternative structures have been proposed in opposition to this trend which include a bolstered and reimagined informal sector led by peasant farmers (La Via Campesina, 2021), commons-based approaches which attempt to de-commodify seed through community-based exchanges (Soleri, 2021), open-source seed initiatives to reverse seed enclosures (Montenegro de Wit, 2019), and integrated systems which seek to leverage the benefits of formal and informal systems alike (Sperling et al., 2013; Lopez Noriega et al., 2019). These movements share the commonality of acknowledging equitability, diversity, and plurality over singularity within seed systems – albeit through sometimes different mechanisms.

Following insight from these movements, although informal seed systems have been the norm since the dawn of agriculture and continue to be an incredibly important source of seed for farmers globally (Sperling & McGuire, 2010), they continue to be largely disregarded in most countries' policy and regulatory frameworks (Frison, 2018). However, the persistence of informal seed networks despite economic globalization and privatization, as well as successful cross-system linkages between informal and formal seed systems (Gill et al., 2013), is important to note, and points to the capacity of informal systems for both transform and adapt to changing conditions (Coomes et al., 2013). An increasing amount

of research has highlighted the importance of informal systems in maintaining agrobiodiversity (Vernooy et al., 2014; Khoury et al., 2014; Etten, 2017; Zimmerer et al., 2019; 2020; Hann, 2021), a component vital to overall seed system resilience to both acute and chronic challenges. This, combined with a desire to localize food and seed production and support agroecological production methods, has resulted in informal systems in the Global North gaining more traction (Campbell, 2012; Veteto, 2014; Soleri et al., 2018; Soleri et al., 2021; Isbell et al., 2021), and even inspiring change within formal systems (Helicke, 2015). This growing movement in the US points to the need to acknowledge the capacities and potentials of informal seed systems as complementary (not substitutable, as is the dominant paradigm) to the formal system.

Despite the classic categorization of seed systems into “formal” and “informal”, prominent scholars have for years emphasized the need to take an integrative approach to seed system development that acknowledges the centrality of both systems to farmer livelihoods (McGuire & Sperling, 2010; Sperling et al., 2021). Most farmers globally rely on formal *and* informal seed sources to supply at least a portion of their seed (Lopez-Noriega et al., 2021), with COVID-19 highlighting how informal systems can enhance seed security and community wellbeing in harmony with local seed markets that are responsive to the growers that rely on them (de Boef, 2021). Moreover, although home gardeners and other non-commercial growers are often overlooked, it has become increasingly necessary given the rise in popularity of home gardening since the COVID-19 pandemic began (Sheth, 2020; Niles, 2021) to ensure that their needs are catered to as well to promote greater accessibility to all growers at whatever scale – an essential component to principles

of both food sovereignty and agroecology (Spangler, 2022). These insights are particularly important for places such as the US, where formal seed systems continue to dominate but, concurrently, are becoming more receptive to grower concerns, as exemplified by the proliferation of open-source, organic, and heirloom seed companies around the country (Helicke, 2015). What this suggests is substantial potential to enhance seed system resilience by bolstering diversity and plurality in seed systems to reduce supply-chain vulnerability to shocks like the COVID-19 pandemic. Focusing on the state of Vermont, the following sections seek to examine the current capacities and shortcomings of informal and formal seed systems with the goal of understanding if and how each contributes to overall seed system resilience amidst a global public health crisis.

### **3.3. Methods**

#### **3.3.1. Study design, population, and sample**

All data were collected in the fall and winter of 2021 and 2022 and relied primarily on remote recruitment and data collection methods due to social distancing and public health safety concerns. Before this project began, IRB approval was obtained from the University of Vermont (UVM) on October 17<sup>th</sup>, 2020, after ensuring the validity and reliability of all project instruments through field testing and pilot testing. The population of interest for this project was Vermont seed growers, defined for this study as individuals who grow seed for at least one food crop and are involved in varying degrees with formal and informal seed systems within the state.

To explore how the COVID-19 pandemic impacted formal and informal seed systems in Vermont, as well as to examine differences in adaptation response strategies between growers involved within each system, we developed a convergent mixed methods research design that utilized both quantitative survey data (n=152) and semi-structured interview data (n=31). As described in Creswell and Clark (2018), a convergent research design enables the merging of qualitative and quantitative results to facilitate the direct comparison of participants' perspectives gathered through various question formats. A convergent design entails data being collected and analyzed during a similar timeframe. For this reason, although the survey data were collected before most interviews, this study can still be considered convergent given the intent to “bring the two databases together for analysis and for comparison” (Fetters et al., 2013) within the design period. The design, implementation, and analysis of quantitative and qualitative data thus occurred in unison and are reported together within this paper using a constant comparison technique (Lewis-Beck et al., 2003), which entails an iterative process of interpretation and reinterpretation of findings.

Qualitative data used for this paper rely on two surveys that shared common questions – one of which was embedded in a larger resilience survey focused on farmer responses to the COVID-19 pandemic conducted by the Center for Sustainable Agriculture at UVM, and another that was sent by the authors of this paper to existing seed grower networks. The first online survey was deployed using the online software Qualtrics to commercial producers through listservs maintained by the Center for Sustainable Agriculture at UVM as well as advertisements sent by the Northeast Organic Farming

Association of Vermont (NOFA-VT) and UVM Extension. From this survey, a total of 61 complete responses were collected. The second survey, also deployed using Qualtrics, was sent to individuals known to be involved in informal seed networks and/or save their own seeds, as collected in 2019 for another research project (see Isbell et al., 2021). From this survey, a total of 100 responses were collected and merged with the previous 61 responses to create a single dataset. Of the 161 total responses across the two surveys, duplicates were removed, and 152 responses were deemed sufficiently complete to be used for analyses.

To create a sample of interviewees to provide qualitative data, the survey that provides half of the data for this paper, as well as former surveys conducted by the first and the second author, were used as a basis from which to sample individuals as a way to gain insight into seed system resilience in the state more generally. Purposeful sampling was the main strategy used for obtaining an interview sample, although some snowball sampling to assure diverse representation in perspectives. The interview sample totaled 31 individuals who all are involved to some degree in seed growing, purchasing, and exchanging (as well as selling, in some cases), in the state of Vermont. Furthermore, because the survey specifically sought out the opinions of commercial farmers, care was taken to create an interview pool that had adequate saturation of commercially oriented (e.g., farmers and individuals who sell seed) perspectives as well.

### **3.3.2. Quantitative questionnaires**

As informed by our resilience framework (Figure 3.1.), questions on the surveys sought to capture sourcing habits before and since COVID-19 to indicate potential

disruptions in sourcing (indicating a stress/shock), specific barriers/constraints to accessing seed during the pandemic (system deviations), and adaptation strategies (short-term response strategies which could indicate resilience). Questions specifically collected data for five key Vermont crops (tomatoes, sweet corn, lettuce, squash, and garlic) based on USDA NASS (2017a) Agricultural Census acreage data to capture information on important crops but to also avoid survey fatigue by prompting a larger list. Although the crops chosen to study were not necessarily those which take up the most land in Vermont (in which case, silage crops would dominate), they still are prominent acreage-wise for horticultural crops within the state. Furthermore, we built on our previous research to identify which important crops are commonly grown for human consumption within the state to inform our final decisions.

These data were used to understand the resilience strategies and capacities of seed growers within the state, and if any factors (e.g., market orientation, sourcing diversity, the involvement in informal networks) contribute to the relative capacity of some individuals over others to be protected from sourcing barriers – thus relating specifically to individual adaptability as a component of overall system resilience. Also, given that resilience has more to do with stability and adaptability rather than protection (Walker, 2006), we also took data on how growers responded (or adapted) to barriers (also considered as system deviations) if they were met. Importantly, while sourcing data were collected only for five key crops, challenges (which would indicate deviations within a system attributed to a shock or stress) and adaptation strategies asked respondents to reflect on all the crops they

grow. These resilience indicators are outlined in Table 3.1., along with general survey demographics.

**Table 3.1. Survey Descriptive Statistics**

<b>Variable</b>	<b>Total n</b>	<b>Mean</b>	<b>SD</b>
<b>Demographics</b>			
<i>Commercial farmer<sup>1</sup></i>	148	0.49	-
<i>Age</i>	144	55.00	14.93
<i>BIPOC</i>	136	0.18	-
<i>Education</i>			-
<i>Income</i>	138		-
Low	56	0.41	-
Medium	70	0.51	-
High	12	0.09	-
<i>Acres owned and/or rented</i>	139	35.26	111.75
<b>Resilience Indicators</b>			
<i>Used Formal &amp; Informal Source<sup>2</sup></i>	152	0.59	-
<i>Only used Formal source</i>	152	0.09	-
<i># Sources Used Since COVID-19 (range: 1-6)</i>	152	2.83	1.20
<i># Sources Used Before COVID-19 (range: 1-6)</i>	152	3.30	1.41
<i>Challenges (before COVID-19)</i>			
Variety unavailable	152	0.43	-
Unable to get preferred characteristics	152	0.22	-
High cost	152	0.16	-
Species unavailable	152	0.16	-
Amount needed unavailable	152	0.14	-
Long wait time	152	0.11	-
Unable to place order	152	0.07	-
<i>Challenges (since COVID-19)</i>			
Variety unavailable	152	0.39	-
Long wait time	152	0.20	-
Species unavailable	152	0.18	-
Amount needed unavailable	152	0.17	-
Unable to place order	152	0.15	-
Unable to get preferred characteristics	152	0.15	-
High cost	152	0.08	-
<i>Adaptation Responses (since COVID-19)</i>			
Grew different variety	152	0.30	-
Found another source	152	0.26	-
Grew different species	152	0.18	-

Used own seed	152	0.15	-
Planted late	152	0.11	-
Took no response	152	0.05	-

<sup>1</sup>For the purposes of this survey, a commercial farmer was considered someone who sells more than \$1,000 in agricultural products as per the USDA definition. <sup>2</sup> Formal sources include commercial seed companies and retail outlets, while informal sources include seed libraries/banks, neighbors, and friends.

### 3.3.3. Qualitative interviews

A total of 31 semi-structured interviews were conducted by the first author in the winter of 2020-21 and the fall and winter of 2021. All interviews followed an interview protocol created in the winter of 2020-2021 which was pilot tested with two key stakeholders similar to the sample of interest to enhance qualitative validity, which enhances the trustworthiness and authenticity of the data collected (Creswell & Clark, 2018). The interviews focused on several key themes related to seeds and were created to provide deeper insight that would complement survey data, including (a) background in growing seeds and current practices, (b) sourcing habits, and (c) experiences with COVID-19, and other challenging events. Demographic data were also collected from each participant, including age, gender, income, and market involvement (i.e., if they sell seed, and approximately how much seed they purchase or obtain from sources other than their own production). Overall, the average amount of seed saved among this group was 32% of the overall stock that they planted, though this ranged from 1% to 100%. Additionally, about one-third of respondents indicated selling seed (usually on a very small scale) at some point in their lives. This reflects the fact that involvement in informal and formal seed systems varied widely with some being highly engaged in purchasing and selling seeds, and others obtaining seeds largely from their own stock or friends/neighbors. The

overall sample is described in Table 3.2. Thorough notes were taken during each interview along with interviews being audio recorded to ensure the completeness of the data gathered.

**Table 1.2. Demographics of Interviewees**

<b>Variable</b>	<b>Frequency</b>	<b>Percent</b>
<i>Gender</i>		
Female	20	0.65
Male	11	0.35
<i>Age</i>		
18-30	3	0.10
31-50	11	0.35
50-70	10	0.32
70+	7	0.23
<i>Seed System Involvement<sup>1</sup></i>		
Home gardener/ Homesteader	21	0.68
Seed librarian/ Seed group member	10	0.32
Commercial farmer/seed producer	8	0.26
Plant breeder/Seed company	4	0.13
<i>Years Seed Saving</i>		
0-5 years	6	0.19
6-15 years	6	0.19
16-25 years	10	0.32
26+ years	9	0.29

<sup>1</sup>Categories are not mutually exclusive.

### **3.3.4. Data Analysis and Reporting**

All quantitative analyses were conducted using Stata v.17. Data were cleaned, labeled, and organized to enable descriptive statistics and preliminary analyses. Analyses followed the objectives of this study which seeks to understand seed system resilience through both responses (i.e., a short-term resilience indicator) and capacities (i.e., resources of a system that can be drawn on by individuals). As data were taken in the first year following the pandemic, the data collected particularly lend itself to providing insight into short-term resilience in referencing back to our resilience framework, but also provide

initial insight into medium-term and long-term resilience by questions that asked growers about their challenges after COVID-19 relative to three years beforehand (with the intention of three years ago being a baseline that would illuminate potential pervasive challenges). Furthermore, although our intention is to focus on system capacities, we use aggregated individual experiences as a proxy for overall system resilience, as former studies have also done (Adger, 1997; Gil et al., 2017). To control for variation within individual capacities, we hypothesized potential individual capacities to be market integration (i.e., if someone is a commercial farmer or non-commercial grower) and multi-seed system involvement (using other farmers/gardeners, libraries, or banks as a source of seed as well as commercial and/or retail sources). As informed by our resilience framework (Figure 3.1.), we specifically looked at challenges and adaptation responses, which were determined through a series of choose-all questions which asked respondents to indicate if they had any challenges in obtaining seed both before COVID-19 and during the pandemic, as well as the responses they took to cope from these sourcing disruptions.

A series of bivariate and multivariate analyses were used and compared with findings that emerged from interviews using the cross-comparison method (Creswell & Clark, 2018). First, to determine how the COVID-19 pandemic impacted formal and informal seed systems in Vermont, we report quotes that highlight common themes found throughout interviews on the topic of seed sourcing, connectivity, and other barriers immediately following COVID-19 to indicate immediate or short-term resilience. This is then backed by quantitative data to understand the extent of barriers faced during the pandemic, where McNemar tests are used to understand if the challenges faced before

COVID-19 (in the three years prior to March 2020) were significantly different than challenges faced since COVID-19 (since March 2020), thus indicating system deviations as caused by the COVID-19 pandemic. Information from interviews is also reported that focuses on what individuals thought longer-term impacts of the pandemic might be on seed systems in the state.

Then, considering reports in the US of heightened gardening demand and concurrent restrictions on non-commercial growers on purchasing seed, another set of McNemar tests were conducted to determine if barriers and capacities were different for commercial growers versus non-commercial growers to answer objective 2. A set of binary logistic regressions were also conducted to determine how individuals responded to barriers, controlling for informal & formal seed system involvement, commercial orientation, as well as types of challenges faced to understand how market and seed system involvement may influence which capacities growers did (or did not) have access to during the pandemic. To reduce autocorrelation errors, challenge variables used for these regressions were aggregated into three types: *seed type challenges* which included “species unavailable,” “variety unavailable,” “amount needed not available,” and “unable to obtain seed with preferred characteristics,” *cost challenges* which were composed of only “high cost,” and *time challenges* which included “long wait time” and “unable to place order” as based on eigenvalues. These data were compared to interview data which focused on how individuals navigated seed systems during the pandemic, highlighting similarities and differences in responses between commercial and non-commercial growers.

For qualitative data, the authors relied on an emergent coding approach to capture key themes that emerged from the 31 interviews. After interviews were transcribed, data were uploaded to the software NVivo v.16 for qualitative analysis. We first used within-case analysis before moving on to cross-case analysis to develop codes that correspond to ‘meaning units’ (Malterud, 2012) such as quotes and remarks. As outlined by Creswell (2016) several steps were taken to reduce subjectivity and enhance the robustness of the data analysis process which includes continuous reflection before, during, and after each interview, the creation of a list of significant statements coded by emergent theme, and a written composite description to summarize key-takeaways (the “essence”) from the interviews and notes as a cohesive group.

### **3.4. Findings**

#### **3.4.1. COVID-19’s Impact on Seed Systems in Vermont**

##### **3.4.1.1. Indications of Deviations: Formal Seed System**

Our survey found that 52% of growers sampled reported having some difficulty accessing seed during the spring of 2020. Qualitative findings reinforce this split and suggest these disruptions occurred namely through formal channels, with many growers reporting delays, shortages, and other general supply chain disruptions, but others expressing hardly any issues at all. As one grower summarized, *“The month of April [2020] was crazy because no one could get seed. Everyone decided they wanted to be a gardener, and no one could get seed because all the seed companies shut down”* (female, 42, farmer and seed company owner). Indeed, many growers highlighted increased interest in

gardening during the pandemic both among new and established gardeners alike, which they hypothesized to cause an uneven supply and demand for seed in Vermont. As one grower expounded:

“When things become uncertain and certainly COVID was, you know, an uncertainty...one of the things people do is they plant gardens because ... [they realize] “that's one thing that, you know, I can grow some of my own food and, you know, have a little more food security in that way.” And certainly, on top of that with COVID, just because so many people were just stuck at home, I think also people were like, “Oh, I don't know what to do. I'll plant a garden.” So, there's no question that seed sales, like, went through the roof during COVID in large part because of the home garden” (female, 44, plant breeder).

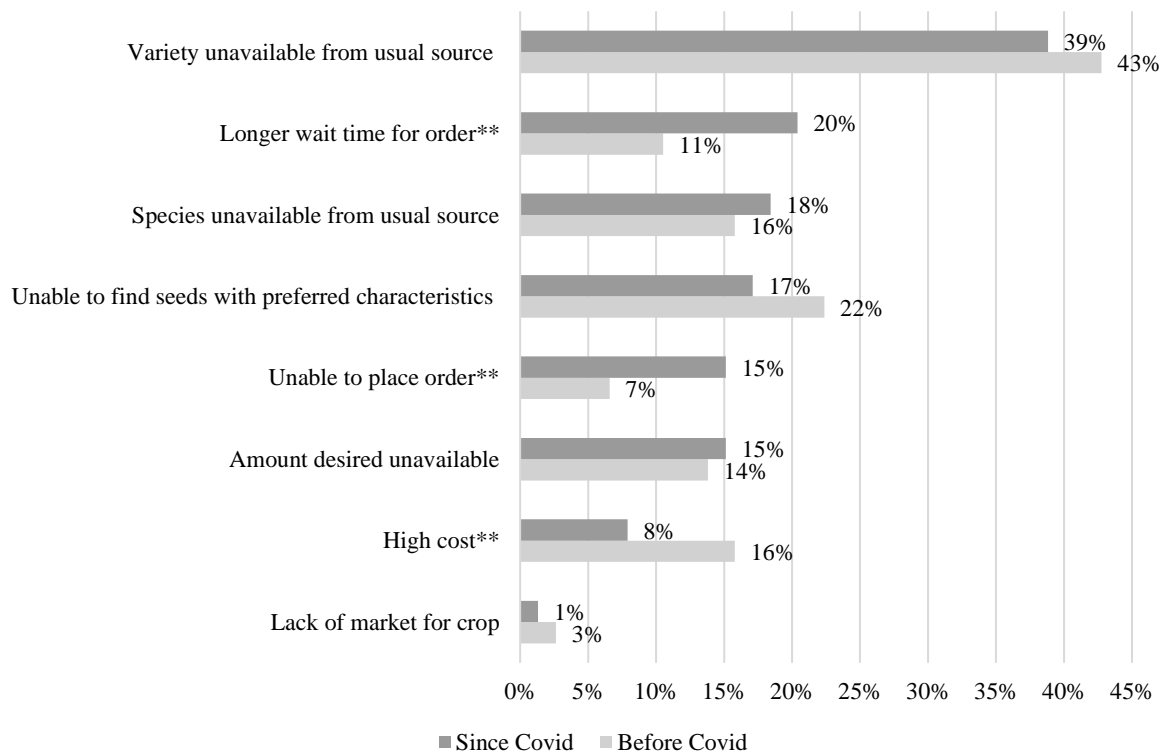
For some growers, this increase in demand meant that sourcing became more difficult for them as established growers. As one interviewee expressed in relation to sourcing in both 2020 and 2021: “*we did have a hard time. Like, last year [2020], and I guess this year [2021] ...I know that a lot of varieties were unavailable.... So, I probably bought less seed than I would have normally, just because so many of the varieties that I wanted to get were back-ordered. And didn't necessarily get substituted.*” (female, 38, home-gardener). This was reported among many other growers (both commercial and non-commercial) as well as they recalled certain popular varieties being out of stock earlier than they usually anticipated them to be. However, most growers stated that they did

eventually get what they wanted – but simply had to wait longer than in previous years. As recalled by one grower who described difficulties trying to order from her usual seed company:

“...every time I'd log in and fill up my order, it would bounce up with a little thing saying, “We're overwhelmed with orders. We have plenty of seeds, but you have to wait and order on, like, March 1<sup>st</sup>.” So, then I go on March 1st, and I get the same message, “you have to wait and go to March 8<sup>th</sup>.” And that kept happening for a couple of weeks. And I finally wrote and said, “Look, guys, you know, you tell me to wait until March 1st, then you tell me to wait until March 8th, am I going to get these seeds?” And they said, “Yeah, just be patient.’ And I did, I get my seeds. It was fine. It just...You know, I think that seed packing operation is slower.” (female, 60, home-gardener)

In contrast, other growers expressed that they felt like seed shortages were made out to be more serious than they actually were. As one grower expressed, “Well, it's funny - there were a lot of threats online. Like “*we're way behind*” [but] *we didn't really have any problems - not any big problems*” (female, 75, home-gardener). When comparing insight from interviewees with quantitative data from our two surveys, what appears is that even though more than half of our survey sample had some difficulty accessing seeds after the onset of the pandemic, many of the issues they faced were not markedly different than in the three years prior. As displayed in Figure 3.2., only such issues as “long wait time for order” and “unable to place order” were found to be significantly worse ( $p < 0.01$ ) since the pandemic. Our data also indicate that the issue of “high cost” fell from 16% of

respondents before COVID-19, to half of that since COVID-19 ( $p < 0.05$ ) – perhaps due to the prevalence of free seed packets and seed starting kits being distributed by public offices and non-profits throughout the state of Vermont during the same time. In comparison, the most common sourcing challenge “variety unavailable from usual source” (Before Covid  $P = 39\%$  Since Covid  $P = 43\%$ ) was not found to be significantly more or less difficult than in previous years, despite interview findings indicating that growers had difficulties with finding certain varieties.



**Figure 3.2. Proportion of respondents indicating various challenges in the three years before March 2020 (before COVID-19) versus in the months following (since COVID-19) (n=152).**

**Note:** \*\* $p < 0.05$

Issues in sourcing seed specifically following the onset of the COVID-19 pandemic thus point to disruptions in formal seed supply chains, considering that Figure 3.2. indicates the most significant change in challenges being the ability to place and receive orders, which may have hindered the ability of some growers to obtain seed over others. Moreover, seed growers who sell seeds or work for seed companies helped illuminate some of the difficulties on the other side of the supply chain by describing an overwhelming situation and simultaneous uncertainty. As one seed company employee summarized, “... *on the one hand, I think you saw a real increase in drive for seed sales for home gardens, but we saw a lot of, you know, customers that their accounts or wholesale accounts or restaurant accounts where they totally lost their market for the year*” (female, 44, plant breeder).

Other seed growers who sell their seed described a similar boom in their sales for garden seed, with one stating that “...*it's been a challenge to keep a good stock of seed and not sell out... and kinda, like, offer more than one variety of different things, for sure, because of the pandemic*” (female, 42, farmer and seed company owner). Moreover, as explained by another grower, “*So many people are gardening, so many people want my seeds that they sell very well. I think the COVID pandemic has encouraged people to buy more seeds. And some people are very interested in buying local and supporting local producers and small businesses*” (female, 74, farmer and seed company owner). Indeed, demand for seed even convinced one farmer that he could potentially switch full-time from being a market grower of produce to a full-time seed producer. In reflecting on how the pandemic ultimately impacted him, he responded by stating the following:

“I think I've just increased my customer base. Yeah, we say like long term impacts [of COVID-19] sounds negative. But it's like, no, I think it's good. I think people know I'm around, they know that these interesting, rare varieties have gotten into more people's hands. So that's really good. I think it has helped to refine my focus on the farm ... it's helped to kind of like narrow in a little bit and said, you know, "We'll leave the market gardening to other people and we'll just focus on seeds and home consumption” (male, 38, farmer and seed company owner).

This sentiment of increasing interest in seeds and gardening was shared among many interviewees, although not everyone agreed on whether this momentum would continue. Although growers cited increased interest in self-provisioning as one of the key positive impacts of the pandemic on Vermonters, many shared that they thought this would turn out to be temporary, with people eventually going back to normal after the effects of the pandemic are no longer so directly inhibiting to other (less isolated) activities. That said, speculation on the long-term effects of the pandemic varied widely, with some also thinking COVID-19 might be able to act as a catalyst for future change.

#### **3.4.1.2. Indications of Deviations: Informal Seed System**

As displayed in Table 1, 91% of those surveyed indicated having used an informal source in the last three years – indicating a sample with high informal seed system involvement. However, 59% of individuals reported using both informal and formal sources in the last three years, highlighting an overall reliance on both formal and informal sources for seed. Although the former section focused on the formal sector (which undoubtedly gained the most attention within the popular media during the pandemic),

interviewees generally described difficulties in exchanging and sourcing seed within informal seed systems as well, principally due to connectivity issues brought on by public health measures to slow the spread of COVID-19. Many home-gardeners described a double-edged repercussion of COVID-19 whereby they found themselves having a lot more time to devote to their gardens, but also felt extremely isolated, undoubtedly due to social distancing measures taken during the early months of the pandemic. For instance, one interviewee stated that *“I had more time to garden last year than I ever had before because I didn't go anywhere. So, my garden was great”* (female, 75, home-gardener), but also expressed an inability to connect with other gardeners due to the pandemic and a general lack of networks: *“I don't have anybody, which is sort of sad.”* Indeed, this captured the sentiment of many others, especially considering the high proportion of interviewees who are above fifty years old (P = 55%) and thus of greater risk of serious illness from COVID-19.

Despite challenges with connecting with other gardeners and farmers face-to-face, many growers nonetheless tried to help their communities access seeds through a variety of outlets, and often cited the importance of community, especially during the pandemic. Indeed, while many growers who were interviewed reported not having much personal difficulty obtaining seeds, they acknowledged that others in their community did - especially those with little growing experience or low incomes. In response, community initiatives proliferated across the state of Vermont, as described by interview respondents. Initiatives took several forms, from small acts of giving, as in the case of one interviewee that described setting out a basket on her front porch full of seeds that she had saved

available for anyone in her neighborhood to take, to larger cross-state initiatives such as one in which a seed saving group created a free online seed catalog directed at low-income Vermonters. Seed librarians also described seeking out new ways to reach out to people in need of seeds which included creating a better online presence, handing out seed-starting kits for popular varieties, and mailing out seeds to schools and individuals who requested them. One seed library even originated during the pandemic, with one of the founders stating that *“my hope would be that communities could save seeds together, that would be my ideal”* (female, 68, home-gardener and seed librarian).

Many growers also viewed the pandemic as an opportunity to reach out to individuals who previously might not have been interested in growing food or seed saving: *“Last year, our group had talked about ways in which we could share seeds given the pandemic and people...you know, we kind of knew that it was an opportunity to not only guide people towards growing their own food but educate them about the importance of seed saving and get local seeds in their hands”* (male, 38, farmer and seed company owner). Indeed, acknowledging the increased interest in growing food, paired with difficulties in sourcing seed in 2020, several growers discussed using the pandemic as an opportunity to promote the informal seed sector, which many felt was being underutilized long before the pandemic. Another grower described a separate initiative in a similar manner, pointing to the need to educate people about growing food in general before moving on to seed saving and other informal seed system activities:

*“...last year, we just collected vegetables from anybody that had vegetables. And a lot of the people that we put beds in for brought vegetables from the beds that*

we made for them. People said, "These are the best plants and the best vegetables and the best garden my friends have ever seen." And I said, "Well, that's because we used the best compost, and it was filled with love." But that had not much to do with seed savers because they weren't seed savers yet but we built infrastructure for future seed savers, long-range plan, teach people to garden first, then teach them to save seeds" (female, 68, home-gardener and seed group member).

In fact, increased awareness of seed saving came up within interviews as one of the most prominent medium-term recovery strategies of the pandemic, often inspiring growers to save more for subsequent years than they might have before. As stated by one grower, *"It [COVID-19] makes me more interested in growing more seed this year but also to keep educating other people about the importance of saving seeds because we don't need to be dependent on seed catalogs for our seeds"* (female, 60, home-gardener).

Ultimately, growers cited varied difficulties that occurred in both the formal and informal system due to the pandemic: uncertainties in sourcing, lack of availability, and difficulties in connecting with others that required alternative ways to disseminate and source seed than in previous years. That said, growers who interacted within the formal system did not express extreme difficulty in sourcing that limited their ability to grow what they wanted – a quality also seen in those involved in sourcing and distributing seed through the informal system.

### **3.4.2. Evidence of Capacities and Adaptation Responses**

### **3.4.2.1. Ability to Draw Upon Capacities: Differences between Commercial and Non-Commercial Growers**

As illuminated by comparing quantitative and qualitative data from before and during the pandemic, commercial farmers and non-commercial growers likely went into the pandemic with different abilities to navigate formal and informal seed systems during a public health crisis. Using McNemar tests again to examine the change in the proportion of barriers both before and since COVID-19, Table 3.3. highlights how barriers differed between commercial and non-commercial growers. In particular, these findings demonstrate that non-commercial growers in our sample were significantly more likely to be unable to place seed orders ( $p < 0.01$ ) and wait a long time for orders ( $p < 0.05$ ) since COVID-19 in comparison to commercial growers, but also had less trouble with high costs ( $p < 0.05$ ), perhaps due to higher degrees of involvement in informal seed systems. In comparison, commercial growers did not have as much trouble in 2020 versus previous years, except in terms of obtaining species from their usual sources ( $p < .10$ ). Moreover, robustness checks to check the impact of other demographic factors (age, income level, and race) were not significant – suggesting that these differences in barriers likely have more to do with the ability to access various system capacities as determined by market positionality rather than individual capacities of growers themselves.

**Table 3.3. McNemar’s Tests for Challenges between Commercial and Non-Commercial Growers**

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**Chi<sup>2</sup> Statistic**

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Challenge	Non-Commercial (n=75)	Commercial (n=70)
Lack of market for crop	0.00	1.00
High cost	<b>-6.23**</b>	1.00
Amount desired unavailable	1.00	1.32
Unable to place order	<b>8.07***</b>	0.07
Unable to find seeds with preferred characteristics	0.20	1.80
Species unavailable from usual source	1.00	<b>3.56*</b>
Longer wait time for order	<b>4.76**</b>	2.00
Variety unavailable from usual source	0.18	2.13

**Note:** \*p<0.10, \*\*p<0.05, \*\*\*p<0.01

Interestingly, the inability to obtain certain species was not as explicit within interview findings: while some expressed shortages of varieties, total lack of species availability did not occur for most individuals – and when it did, those growers sought out other sources to fill their need. That said, many growers, in general, did express difficulty in finding certain species such as garlic and potatoes during COVID-19 – two relatively easy-to-grow and popular species among both veteran and new growers alike. Moreover, while only brought up a few times, some growers did point to being unable to find entire crop species they wanted in organic or open-pollinated varieties through formal sources, which one grower pointed out was particularly important for farmers running Community Supported Agriculture (CSA) businesses to attract customers. Ultimately, this divergence suggests that interactions with formal and informal seed systems following the pandemic (regardless of commercial or non-commercial status) varied widely across samples in some areas.

Additionally, many non-commercial growers were unable to order seeds until later in the spring as many seed companies prioritized commercial growers. Within interviews, many non-commercial growers described long wait times to obtain the seed that they

ordered, as triangulated with quantitative findings shown in Figure 3.2. For example, one grower recalled:

“So, the first year, really when things hit and got kind of crunched, we, luckily, had our big order in with [seed company] early. And, so, that was really unaffected. But then sometimes I’ll make a follow-up order because I forgot something, and I did, I had forgotten something and I tried to make an order, and they were actually not taking orders from home gardeners, they were only taking orders from commercial farms at that time, I think in 2020. And, so, I appreciate that, I think that was a smart move for them to make. And worthy too, like of course we need to make sure that our commercial farms get the seed first. So, I appreciated that but also, you know, had to wait, you know, for those forgotten seeds that I eventually did get” (male, 43, homesteader).

#### **3.4.2.2. Adaptation Responses: Indications of Short-Term Resilience**

Although both qualitative and quantitative findings suggest that commercial and non-commercial growers faced divergent challenges to their seed sourcing, our findings suggest that these challenges ultimately did not result in a difference in abilities to adapt. To confirm this, we ran a series of binary logistic regressions where the dependent variables were potential responses (“grew a different species,” “planted late,” “found another source of seed,” “grew a different variety,” and “used own seed stock”) the independent variables were whether or not an individual identified as a commercial farmer and whether they used at least one informal source, and the controls were time, seed type, and cost challenges.

The findings from these models were all insignificant except for one – the fact that individuals (regardless of commercial orientation) who used an informal source of seed were more likely to respond to challenges by using their own seed stock ( $p < 0.01$ ). What this suggests is that growers (commercial or non-commercial) were ultimately able to respond positively using a variety of adaptive capacities in the face of challenges to accessing seed, with only 5% of growers indicating that they did nothing to respond to challenges.

These insignificant quantitative findings can be further explained by our qualitative findings, which suggest that growers generally did not have that much difficulty dealing with sourcing issues caused by the pandemic. For instance, one grower who could not obtain a variety she wanted stated that *“it’s not that big of a deal”* and that she was not devastated because *“you know that you can try again other years”* (female, 38, home-gardener). Moreover, the average gardening/farming experience of individuals interviewed was 16.7 years, indicating substantial experience responding to seed system dynamics within the state that, along with established networks, can also contribute to their resilience capacity. For instance, interviewees who reported not facing significant barriers often attributed their lack of challenges to purchasing seed early (in the winter, prior to pandemic scares in spring 2020), saving at least some of their own seed (32% on average across the 31 growers interviewed), and established connections with other growers both within the state and outside of it. As recalled by one grower in response to a question asking him about the ramifications of COVID-19:

“I guess it just made us feel really fortunate. I mean, there's always things we do well and things we screw up, but people who are like, "Oh, my gosh, like, we might have to grow our own food," like, and they're starting now from a place we started at 16 years ago or 17 years ago. So, I just felt really blessed that we've been working on this thing. And people are like, "Where are we gonna' get potatoes?" I'm like, "Oh, my God." I was talking to my mom, she could not find potatoes in the height of [the pandemic]...like, "Mom, I have pounds. I have, like, dozens and dozens of pounds of potatoes." She lives far away where I couldn't give them to her. So, I just felt really blessed” (male, 43, home-gardener).

Indeed, many growers told similar stories, while also acknowledging their capacity to adapt due to a learned understanding of seed supply chains which are inherently dependent on many external factors. As recalled by one grower in response to a question about if she anticipated supply chain issues to get better post-COVID-19:

“Well, yeah, you would think that seed companies would sort of like ramp up, but I know there's just because they're living things that you can't always, you know, some things take two years to produce and there's all the different, various supply chain issues. There's fires out West. There's, you know, all kinds of factors that seem to be interrupting the supply chain” (female, 46, farmer).

Despite widespread challenges in the seed system, interviewees generally expressed feeling very privileged in their access to seeds, networks, and knowledge to fare well during the pandemic. As one grower expressed:

“I felt incredibly fortunate because even as, you know, we've seen that there are seed companies now who are having a lot of difficulty filling orders, and there are people who are trying to get seeds and can't. And I feel, you know, really, really fortunate because I have everything I need. And I've been able to just go in the basement and go into the root cellar or the little refrigerator and pull-out whatever seed I need to grow what feeds us pretty much year-round. So that does feel very powerful. Very powerful” (female, 75, home gardener and seed saving group member).

In the end, what these quantitative and qualitative findings suggest is that, in general, commercial and non-commercial growers were able to adapt using both formal and informal channels by drawing on different capacities that were most easily available to them given their role within the agri-food system.

### **3.5. Discussion**

#### **3.5.1. The Effect of COVID-19 on Informal and Formal Seed Systems**

Despite the acute and chronic challenges facing seed systems in Vermont during the Covid-19 pandemic, this research highlights how the capacities of seed systems in the state were leveraged by various individuals to allow for adequate response strategies. Seed systems in Vermont were subject to substantial system deviations: in formal systems, this took the form of supply chain disruptions that meant long wait times for seed orders and shortages in certain species and varieties; in informal systems, uncertainty came from social distancing measures that meant less access to traditional methods of interacting and

exchanging seeds. However, despite 52% of the survey sample indicating having some trouble obtaining seed directly following the onset of the pandemic, a lack of significant differences in challenges pre-COVID versus since-COVID (Figure 3.2.), combined with interview data that indicates challenges faced by growers were minimal, suggests that the pandemic simply compounded issues in seed sourcing that very much already existed rather than introducing many new ones. In relating these findings to our original framework (Figure 3.1.), what this suggests is that, at least in the short term, the ability of individuals within a system to recover indicates a strong potential for adjustment and stabilization to return to a stable post-COVID state that is very akin to the pre-COVID state – although whether or not this is favorable still requires further discussion and investigation.

Resilience in the short term can be measured by the responses individuals within a system take to reduce acute vulnerability. As qualitative data from growers within the state exemplified, growers took many steps to support their communities in accessing seed. Whether by offering extra seed to neighbors, shifting seed library ordering strategies to accommodate social distancing measures, or facilitating free-seed programs, growers leaned into informal seed systems to meet increased demand for seed when formal systems could not. This research thus supports the notion that informal seed systems provide an essential source of seed, especially during periods of crisis, even in highly industrialized contexts like the US (McGuire & Sperling, 2010; Sperling et al., 2020). Moreover, although seed system research has mainly been concentrated in the Global South, these findings support previous research from the US which suggests informal systems continue to be robust in many areas and simultaneously provide an important form of sovereignty

among communities (Campbell, 2012; Veteto, 2014; Helicke, 2015; Soleri, 2018; Isbell et al., 2021; Soleri et al., 2022).

### **3.5.2. Temporal Resilience**

While data from this research showed that certain challenges such as waiting a long time to place and receive seed orders from commercial companies worsened due to the pandemic, other common barriers such as the unavailability of species, varieties, and seeds with certain characteristics (e.g., organic, open-pollinated) did not appear to worsen significantly. Qualitative data support these findings, suggesting seed system vulnerability in the short-term had to do with slow-moving supply chains that could not adapt quickly to changing demand, while in the long-term seed systems face pervasive challenges such as formal systems not being able to adequately reflect the preferences of the growers who purchase from them. In one sense, these findings can be taken as positive: the fact that certain challenges did not worsen is indeed beneficial to many stakeholders. Yet, in another sense, what makes these findings particularly insightful is that so many challenges are so pervasive in the first place. For example, more than a third of respondents indicated that, regardless of COVID, they have had difficulty obtaining seeds for preferred varieties in the last three years (Figure 3.2.). Again, this is supported by qualitative findings, with many growers discussing the prevalence of systemic issues rather than those specifically associated with COVID-19. Given the shift towards specification and privatization in seed systems in the last fifty years (Howard, 2015), these findings are not unsurprising but foreground the need to support seed networks which are driven by the demands of their diverse stakeholders rather than the market.

Considering the importance of diversity and supporting the preferences of growers for both seed system resilience and sovereignty (Etten et al., 2017; Vernooij et al., 2019; La Via Campesina, 2021; Kliem & Sievers-Glotzbach, 2021), the findings of this paper underscore the need to bolster seed systems by ensuring that they are reflective of the goals, values, and needs of the growers that use them. As found throughout resilience literature, diversity and redundancy are two incredibly important avenues to supporting sustainable, equitable, and resilient systems (Walker et al., 2006; Folke et al., 2010; Cabell & Oelofse, 2012; Béné, 2014; Walker, 2020). Relating this to seed systems specifically: while formal seed systems have undoubtedly been given priority in development initiatives and dominate throughout the Global North, informal seed systems provide an important alternative that can help complement the formal system, suggesting that seed system plurality (i.e., supporting the coexistence of both informal and formal systems) may be one way to help address systemic challenges in formal and informal systems alike, from diminishing agrobiodiversity to under-connected networks. Again, while our findings suggest certain stability of current seed systems, it should be remembered that this is not necessarily positive if it simply perpetuates negative outcomes. Drawing on Kliem & Sievers-Glotzbach (2021), ensuring resiliency in seed systems should entail not just that the system is stable, but that it is just and contributes positively to social-ecological systems.

### **3.5.3. Differences in Capacities and Responses by Commercial and Non-Commercial Growers**

The findings from this study indicate that commercial and non-commercial growers faced divergent challenges after the onset of the COVID-19 pandemic. For non-commercial growers, this often meant longer wait times to obtain seed from commercial companies. This finding is supported by popular accounts in the media which described commercial companies as giving preference to their commercial customers (Held, 2021). Qualitative findings support this, although also add nuance in that many growers (regardless of their market orientation) were able to eventually get what they needed. In general, this points to understandings of how agricultural producers use both informal and formal seed systems to meet their needs, and how interactions with these systems vary depending on the types of crops needed and the market orientation of the grower (Lopez-Noriega et al., 2021), as well as the importance of multiple seed sources and established ties in supporting resilience (Kliem & Sievers-Glotzbach, 2021). For instance, qualitative and quantitative findings suggest the informal seed system was a key source of seed for many – ensuring that they were able to find seed (which is also often free, perhaps also explaining the lower cost of seed since COVID-19 found in Figure 3.2.) despite an increase in challenges. Moreover, many of those interviewed felt particularly lucky in that they were able to overcome challenges to their seed sourcing relatively easily – whether through formal or informal seed channels. Thus, the findings of this study foreground how system resilience can be leveraged by various stakeholders, and how a plurality of sources is key to their ability to draw on a wide diversity of system capacities.

### **3.6. Limitations**

We believe that the findings of this study make important exploratory contributions to conceptualizing resilience within seed systems. However, findings should still be interpreted with care. For instance, due to using non-probability sampling for both qualitative and quantitative data collection, our results cannot be generalized to any group outside of our specific sample. As such, future work should particularly focus on groups that were not well-represented within this survey such as people of color and immigrant communities, who are often important stewards of crop diversity through seed saving (Phillips, 2016). In addition, it should be noted that many of the questions on our survey focused on only five common crops – leaving room for future inquiry into the effect of the pandemic on sourcing for less commercially-popular crops, which are particularly essential for maintaining agrobiodiversity (Khoury et al., 2022). Finally, although groups and individuals are often used as proxies for which to study system resilience (Gonzalez-Quintero & Avila-Foucat, 2019), this method nonetheless excludes a variety of other components of a system which may relate to resilience, including formal institutions, governing bodies, supply chain stakeholders (e.g., distributors, wholesalers, etc.), and so on.

### **3.7. Conclusion**

The COVID-19 pandemic has undoubtedly affected the world in profound ways and simultaneously challenged the systems on which individuals and communities depend for food. As exemplified by cross-disciplinary studies in the last few years (Béné, 2020; Niles et al., 2021 O'Hara & Toussaint, 2021) and as supported by this paper, food and seed

systems in the US were not immune. Even localized seed systems have been challenged due to worldwide shortages, supply-chain disruptions, and social distancing measures which have hindered the ability of many growers to obtain seed (Poudel et al., 2020). Globally, seed system disruptions have most notably been seen within the formal sector, but informal systems have also faced their fair share of uncertainty (de Boef et al., 2021), highlighting the fact that dependence on any one source makes growers vulnerable to seed insecurity – already a well-known fact that seed system scholars have emphasized (Delaquis & Almekinders, 2020).

At the same time, findings from this study illuminate the fact that, despite some challenges to seed sourcing caused by system deviations during the pandemic, Vermont growers ultimately were able to meet their seed needs through drawing on a diverse array of sources and capacities within informal and formal seed systems. While there were some differences in the degree of challenges faced by commercial and non-commercial growers (namely in terms of wait times to purchase seeds), what our findings highlight is a need to address systemic challenges to make positive strides toward seed system resilience, rather than perhaps fixating on the immediate impacts of the pandemic. This would include giving equal weight to informal and formal seed systems in the US to ensure a robust seed stock that is not only stable but can adequately meet the needs and preferences of both commercial and non-commercial growers (Vernooy et al., 2019). As our findings suggest, informal systems provided an important source of seed for many, as well as showcased the ability of communities to adapt to difficulties obtaining seed through the formal sector. These insights, combined with the resilience framework developed within this paper,

provide a foundation to build future studies which seek to interrogate the relationships between various seed system capacities and seed system resiliency for both the short and long-term. Furthermore, our findings suggest that perhaps a stable system does not necessarily entail a perfect system – leaving ample room to continue questioning what a truly just, sustainable, *and* resilient seed system may look like.

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**CHAPTER 4: INCOMPLETE COMMODITIES AND SEED SYSTEMS:  
INTERROGATING THE SPECTRUM OF COMMODIFICATION THROUGH  
SEED SAVING AND EXCHANGING IN VERMONT**

**4.1. Introduction**

The “commodification of agriculture” evokes thoughts of the major shortcomings of the modern industrial agriculture system and its failure to prioritize feeding people over generating profits. Prompting wide and varied debates, the commodification of agriculture has been further crystallized by the commodification of inputs fundamental to its perseverance: seeds. Especially in the last half-century, seeds have undergone a swift process of commodification, leading to a situation where four companies now control more than 67% of the global market share for proprietary seeds (Howard, 2018). Countries such as the United States (US) are dominated by the commercial seed sector which is characterized as maintaining ever-narrowing diversity (Mooney, 2017). More generally, the commodification of food and seeds is linked to disastrous consequences as exemplified by the global food price spikes of 2007-08 which were fueled by speculation about future commodity prices (Clapp & Helleiner, 2012) as well as recent food shortages caused by global supply disruptions following the onset of the COVID-19 pandemic (Falkendal et al., 2021). At the same time, the concept of commodification – relating to the transformation of something that has traditionally been outside market realms into something which can be bought and sold (Radin, 2001), often obscures key issues underlying agri-food systems.

While some would argue that commodification by its very nature is morally wrong (Radin, 1987), commodification within agri-food systems has often been used as a blanket buzzword for wide-ranging socio-economic issues associated with power imbalances and neoliberal governance structures (Deibel, 2012). The normative employment of commodification within both scholarly and popular discourse has resulted in some crucial contradictions. This leads some to reduce commodification to a process distinct to capitalism and neoliberalism (Oliver & Robison, 2017) while others refer to commodification as a culturally universal (and arguably neutral) phenomenon through which goods are exchanged (Kopytoff, 1986). Undoubtedly, the current agri-food system needs transformation (Béné, 2022), but to inform this transformation, there is still a need to engage in critical inquiry over the role of markets and economic exchange in either facilitating or hindering change.

Within the field of economics, commodification has long been debated as a fight between two ideals – with complete non-commodification on one side, and universal commodification on the other (Radin, 1986; 1996). However, while commodification has been of great interest to agri-food system studies over the last century (Polanyi, 1944; Long, 2003; Kloppenburg, 2004; Braun, 2020; Maticena & Corvo, 2020), particularly as it relates to furthering market rhetoric within non-market spheres (e.g., social institutions) little work has explored commodification as a spectrum and process which does not necessarily entail the prevailing assumptions of neoclassical economists whose theories rely on the private property and free contract (Appadurai, 1988; Radin, 2001). This is especially important in terms of seeds and the systems through which they flow as many

farmers, gardeners, researchers, and plant breeders alike have expressed a desire to reintegrate seeds within both market and non-market exchanges with social, public, and cultural values (Helicke, 2015; Sievers-Glotzbach et al., 2020; Lyon, 2021) – qualities that no so-called “pure” commodity should be able to possess according to traditional commodification theory (Long, 2003). Indeed, as exemplified by the work of Karl Polanyi (1944) and many theorists since, attempts to embed markets (and products of those markets) with non-economic values are critical to the protection of social well-being. Yet, too often, commodities and non-commodities are posed as mutually exclusive, thus preventing the possibility for pluralistic values to be attached to a single good. Albeit often unintentionally, social movements which are adamantly centered on pursuing revolutionary change and are (rightfully) critical of the dangers of commodification often perpetuate this dichotomy – potentially having the effect of stifling positive change in which existing structures (e.g., markets) might be used to the benefit of social progress in the interim (Radin, 1986).

Although few would argue that seeds and seed systems have undergone a process of commodification, there is room to consider how seeds may continue to adapt to changing socio-economic conditions to be exchanged through markets without being reduced to something without social significance, constituting what Margaret Jane Radin (1986; 2001) would consider as an “incomplete commodity.” Writing within the field of legal studies, Radin provides many examples where the concept of partial commodification is demonstrated, including labor, health care, and real estate. Although not necessarily positive in terms of supporting societal well-being (particularly when considering the moral

consequences associated with the commodification of healthcare (Pellegrino, 1999)), all of these epitomize ways in which individuals attach personalized value to goods that are sold (e.g., a house being more than shelter in that it also can be a home, or work being both a way to obtain wages but also find fulfillment in one's life) provide a crucial counterbalance to the hegemony of market rhetoric which usually characterizes commodities. In general, the quality of a commodity being incomplete entails that it retains relational importance, thus actively acknowledging the non-economic values that humans maintain within a good that is nonetheless sold. Within food systems studies, this quality is essential to advancing the goals of alternative food (and seed) movements, many of which may be reliant on capitalistic markets, at least temporarily (Matacena & Corvo, 2020). For example, many alternative agricultural initiatives continue to utilize market forms of exchange (e.g., farmer's markets, community-supported agriculture, etc.), but attempt to reintegrate other values into food that is sold through localizing production, promoting farmer-consumer relationships, and upholding agroeconomic practices (Fernandez et al., 2013).

Following this scholarship, this paper argues that incomplete commodification of seed systems within formal and informal networks in the US characterizes a pragmatic solution to modern commodification dilemmas. Through an understanding of incomplete commodification, this paper suggests that market and non-market forms of exchange can not only coexist but create systems that are more reflective of important societal goals. Using qualitative insight from 31 interviews with seed growers in the US state of Vermont, we seek to better understand the commodity and non-commodity values attached to seed,

as well as the ways that growers seek to recognize the nonmonetizable aspects of seeds through social arbitration.

## **4.2. Background**

### **4.2.1. The Commodification of Seed Systems and Potential for Non-Ideal Justice**

Within the last century, seeds have moved away from a farmer-maintained input to one whose production has been externalized off the farm. The outsourcing of seed production has been precipitated by the entrance of both public and private interests within cultivar development, especially as made lucrative by intellectual property rights (IPR) and biotechnologies (Zerbe, 2015). Due to the critical role that seed plays in influencing production all along the food chain, as well as shaping upstream policy agendas, critical shifts in agri-food systems have also frequently been marked by changes in seed technologies and governance. For instance, hybrid seed was essential to the success of the Green Revolution of the late 1960s-70s, while the proliferation of genetically modified organisms (GMOs) a decade later correlates with a massive shift toward global agri-food system corporatization (Kloppenborg, 2014; Bronson, 2015). While the first represents a public-led initiative and the second follows the explosion of private investment in agri-food systems, each has sparked its fair share of controversy. As outlined by Lyon et al. (2021), these eras or ‘regimes’ (inspired by Harriet Friedmann’s and Philip McMichael’s (1989) concept of ‘food regimes’) have succeeded in modifying norms and relationships within agri-food systems – broadly resulting in the commodification of seed and its simultaneous enclosure.

However, due to their fundamentality to agricultural systems, seeds have been gaining interest across the US and globally as various actors contest such issues as the concentration of seed companies and the application of IPR to plant genetic material. These manifestations of the neoliberal governance of agri-food systems (Busch, 2010) narrow and restrict the use of seeds, a resource once generally considered to be a ‘common good’ (Montenegro de Wit, 2019). Especially for peasants and indigenous farmers in the Global South, the integration of seeds into global markets has been deemed as a form of dispossession (Kloppenburg, 2004), akin to the enclosure of common land that facilitated the spread of capital into rural areas (Polanyi, 1944; Gerber, 2020). Yet farmers and gardeners in the Global North are not unaffected nor necessarily content with these trends. For instance, while some activities in the US such as seed saving have decreased precipitously since the mid-20<sup>th</sup> century as farmers began adopting commercial hybrid seeds en masse (Mascarenhas & Busch, 2006), some farmers and gardeners throughout the US continue to engage in traditional agricultural practices, including saving and exchanging seed through non-market channels (Campbell & Veteto, 2012; Soleri, 2018; Isbell et al., 2021; Soleri et al., 2022). These practices highlight the persistence of alternative forms of agricultural production, indicating pockets of resistance around the US that continue to counter neoliberal influences within agri-food systems, particularly those surrounding the commodification of food and labor used in its production.

Many have pointed to the commodification of seed as an antecedent of negative externalities which include crop genetic erosion (Khoury et al., 2022), environmental degradation (Kerr, 2012), corporate hegemony (Howard, 2018), and cultural imperialism

(Wattnem, 2016). Moreover, discourse around treating seeds as a commodity is often linked to the various ways that seeds have been appropriated, including through technological (e.g., hybridization), institutional (e.g., patents and strict certification schemes), and social (e.g., subject to market rhetoric and methodology) means. As a result, contestation surrounding seeds have often made it to the forefront of alternative food movements (Preschard & Randaria, 2019), with commodification frequently blamed for the negative externalities of the global agri-food system. There is thus a need to undercut the complete commodification of seed and the market rhetoric it brings forth, yet exactly how this is done must be approached with care. As stated by Radin (1986), “The issue thus becomes how to structure [a solution] that takes account of our nonideal world yet does not foreclose progress to a better world of more equal power” (p. 1924) – or what she would consider as “non-ideal justice.” Following this line of thought, the following sections begin to interrogate (but not entirely disregard) the practicality of markets and commodities within food systems with the intent of highlighting the ways that efforts of non-commodification or de-commodification can help provide a counterbalance to the dominant market logic within agri-food systems as they currently stand.

#### **4.2.2. Defining a Commodity**

Immediate reactions to the term “commodity” often provoke images of mass-manufactured and globally tradable goods from oil to grain to valuable metals. Yet, in its simplest definition, a commodity can be considered as any object, good, or service which humans gain satisfaction (or in economic terms, utility) from (Marx, 1867). Stated in a

slightly different manner, a commodity is something that has a subjective economic value attached to it as dictated by society, and which can be exchanged for a product of similar value (Simmel, 1978) – also considered commensurability (Radin, 2001). Critically, the value that a commodity contains has been highly debated among economists throughout history. For instance, Marxists consider both the use value (i.e., direct utility obtained by the user) and exchange value (i.e., worth of one commodity in relation to another) of a good as generated through human labor measured in the duration of time it takes to produce (Marx, 1867). In comparison, neoclassical economists, as informed by the writings of David Ricardo and Adam Smith, operationalize value at the margins – thus distinguishing value as something generated not by the homogenous labor put into production, but by the amount of a good exchanged (Taylor, 1996). Either way, value in economic terms is something strongly associated (and translatable) to price whereas, in other disciplines, such as anthropology, value has more to do with the relations embodied within objects (Appadurai, 1988). Moreover, within economics commodities are generally viewed as distinct from all other types of goods which are non-commodified, also considered ‘relational goods’, defined as goods whose value depends on connections between people and their social environment (Oliver & Robison, 2017). In comparison, commodities are sometimes characterized as being valued for only their physical properties – thus entailing a detachment from other socio-emotional values.

The evolution of the term commodity (and, relatedly, commodification) has continued to expand through normative discourse to now evoke a good which lacks its own unique identity, character, or social import (Radin, 1986). Accordingly, while many things,

including humans and their labor, have been commodified (although disagreement exists over whether these would constitute true commodities, as elaborated on below), the characteristics which can be sold, exchanged, or gifted must be extracted as to no longer be tied to a person or an object's personality (Lukas, 1971). Through this process, things are "reduced" to a commodity – perhaps resulting in common associations of commodities as something which are lacking humanistic qualities (Vandenbroeck, 2019), and thus detrimental to societies that rely on them due to their presumed inability to adequately encapsulate non-market values. Indeed, due to the tendency for a commodity to be conceptualized as something that (i) lacks its own identity and (ii) reduces the labor put into its production to something homogenous (i.e., disregarding the mode of which labor power is expended, even if that labor was exploitative), commodities are generally viewed as a negative tool distinct to capitalism and thus frequently operationalized within political economy discourse as goods which dissolve links between people, things, and the labor power used to produce them (Appadurai, 1988). This has sparked heated debate surrounding commodification, starting perhaps with Marx (1867) and what he coined as "commodity fetishism" – the tendency for commodities to obscure the social relations and labor that go into their creation (Kosoy & Cobera, 2010).

However, while commodities are frequently associated with capitalism and are foundational to critiques of it, others stress the fact that commodities are not, in and of themselves, necessarily negative. For instance, Appadurai (1986) suggests that "the term commodity has narrowed to reflect only one part of the heritage of Marx and early political economics. That is, in most contemporary uses, commodities are special kinds of

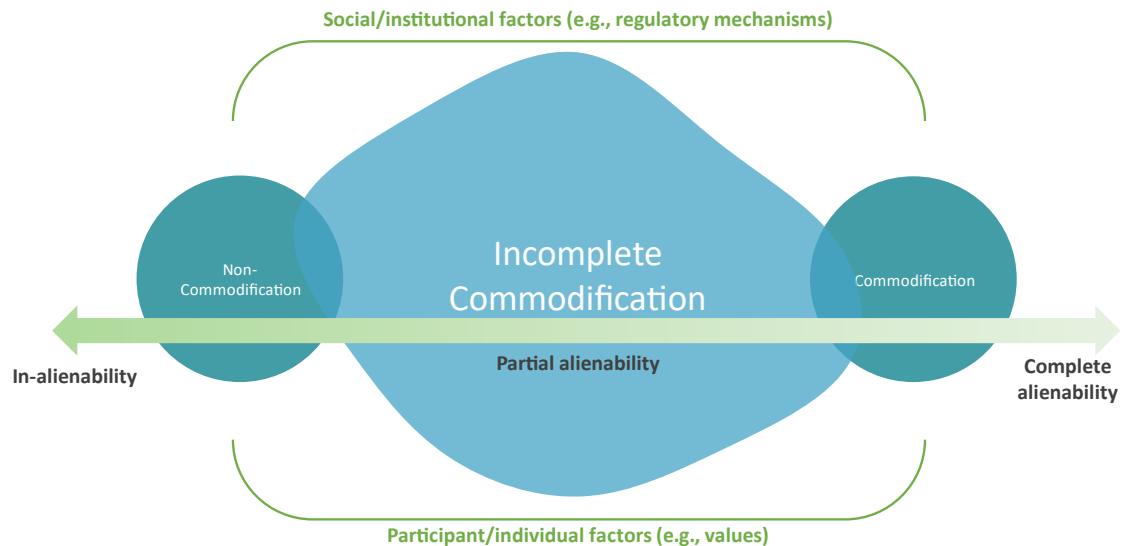
manufactured goods (or services) which are associated only with capitalist modes of production and thus to be found only where capitalism has penetrated” (p. 7). This statement serves as a critique of the transformation of the term commodity from simply a good which is alienable (i.e., transferable, via gift or sale) to a subclass of goods that are produced for sale on a market, and thus necessarily inferior. Of course, this would imply that some goods which are often treated as commodities within markets (such as land and labor) are actually not commodities – thus constituting what Polanyi (1944) would consider as “fictitious commodities.” Others, such as Kopytoff (1986), would disagree with the economic definition of commodities altogether, stating that commodities are a “universal cultural phenomenon” that differ between societies only in the way in which “commoditization as a special expression of exchange is structured and related to the social system” (p. 70). Yet regardless of divergences in definition, critiques of commodification principally argue that commodities become destructive to human societies once they no longer reflect the principles of social systems but of economic systems, relating to what Polanyi (1944) would consider as “disembeddedness” or economic transactions which are not based in social reciprocity but instead in self-interest. That is, if commodities are exclusively embedded with market rhetoric and subject to market methodology, they no longer (or only partially) reflect social goals and interests – thus resulting in the many negative externalities associated with the spread of commodification into traditionally non-market spheres such as the environment, or in the case of this paper specifically, agroecosystems.

#### **4.2.3. Incomplete Commodification**

Considering the potential destructiveness of market rhetoric in non-market spheres, it remains critical to foster alternatives to complete commodification to honor what Radin (2001) would consider as “internally plural understandings” (p. 107) of commodities. Radin’s theory of *incomplete commodification* lends itself to understanding commodification as something detrimental only if it functions to further market rhetoric to the point where all other forms of value associated with a good are erased: the idea that “commodification for some means commodification for all” (p. 125) inherently entails that commodification is somehow superior and “natural” to humans, thus subjugating all other forms of value and exchange as something which surely cannot survive if both forms of commodification and non-commodification are allowed to coexist.

Contrary to this belief, Radin takes insight from political economy theorists such as Polanyi to argue that complete non-commodification (social interaction absent of markets) and complete or universal commodification (all things being exchanged through markets) are two extremes that, in practice, do not exist within contemporary societies. Instead, most goods exist on a continuum between complete non-commodification and universal commodification – these are what she calls incomplete commodities (see Figure 4.1.). Incomplete commodities exist because, regardless of something being bought and sold or having a set exchange value, it is nearly impossible to completely detach personal (or use) values and social relationships from the good in question. That is, complete alienability is impossible for many goods because of the human desire to attach nonmonetized value even to monetized goods. While a seemingly pragmatic solution to commodification dilemmas, this theory fundamentally recognizes that commodities are

continuously contested rather than always destined to “win out” as other commodification theorists might suggest (see Long, 2003); in fact, it suggests the opposite.



**Figure 4.1. Conceptual Diagram of Incomplete Commodification**

This speaks to what Radin (1986) considers as the *participant* aspect of incomplete commodification, stating that “for many interactions in which money changes hand market rhetoric cannot capture this [non-market] significance” (p. 1918). Moreover, she also describes a *social* aspect of incomplete commodification, which “recognizes that things have nonmonetizable participant significance by regulating (curtailing) the free market” (p. 1918) – or essentially extending the participant aspect of incomplete commodification into some sort of socially recognized restricting of self-regulating markets. This is in line with several other theorists who have argued that commodities are socially determined and contested (Kopytoff 1986; Appadurai, 1988; Long, 2003), thus allowing for the commodification of things without the prevailing market logic on all things, even if

commodified. Although not named as such, examples abound of goods within agri-food systems that can be considered incomplete. For instance, Lind and Barham's (2004) historical analysis of the transformation of the tortilla in mainstream culture from a Mayan staple to a standard of fast-food cuisine in the 21<sup>st</sup>-century highlight attempts to ensure the commodification process is disrupted. In that example, they discuss how individuals contest the appropriation of tortillas by corporate interests through processes of creating menus and recipes that uplift cultural meaning back into the tortilla, thus allowing for greater consciousness within Latin American cuisine.

Although Radin herself focuses on legal forms of regulation when considering social aspects of incomplete commodification, incomplete commodification can be further expanded to include informal forms of social arbitration by producers, consumers, and institutions – as in the cases that Lind and Barham (2004) describe of home meal-makers who actively contest the tortilla industry simply by continuing the practice of making home-made tortillas. Moreover, as exemplified in the work of Elinor Ostrom (2002; 2009), institutional arrangements beyond markets and state-level governments are often as important in shaping the norms that govern the exchange of goods. In relation to seeds specifically, agrobiodiversity is already subject to a variety of non-market and intergovernmental arrangements that are meant to protect and conserve plant genetic material. These arrangements include multi-national and sectoral initiatives such as the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) to the creation of farmer-maintained seed banks that often facilitate reciprocal exchanges of germplasm between farmers and gardeners within and across communities (Vernooy et al.,

2015; Sievers-Glotzbach et al., 2021). The latter of these two institutional arrangements is particularly important and often influential in creating a counter-balancing force to more formalized social institutions (e.g., markets and governments). This is done by helping to maintain and uphold morals, traditions, and cultural conventions within social systems (Miller, 2007), often simply due to the tendency for these social institutions to operate at smaller (ideally more representative) scales.

Incomplete commodities are essential to debates surrounding commodification as the concept inherently refutes both compartmentalization (i.e., the splitting of society into market and non-market realms) and what Radin (2001) would consider as the Domino Theory which “holds that there is a slippery slope leading from the toleration of any sales of something to an exclusive market regime for that thing” (p. 99). Incomplete commodities are also important when considering how to address social justice issues, allowing for things that are important to humanity to still be sold if protected by some form of regulation, but also allowing for non-market redistributive practices based on community and gift exchanges. This is especially important for certain goods whose exchange through markets has become necessary but are simultaneously threatened if allowed to be completely commodified and left solely to market whims – as perhaps exemplified by the privatization of land and its negative outcomes on rural communities and environments (Polanyi, 1944). Like land, seeds constitute another good that is increasingly and significantly compromised due to increasing concentration within the seed and agricultural industry within the last century.

#### **4.2.4. Incomplete Commodification and Informal and Formal Seed Systems**

In terms of seed systems specifically, Radin's distinction between universal commodification and non-commodification draws similarities to the rhetoric surrounding informal and formal seed systems. Informal seed systems, which are maintained by farmers and gardeners and primarily rely on non-market modes of exchange, encapsulate more "traditional" forms of agricultural exchange that are still principal sources of seed throughout much of the world (McGuire & Sperling, 2016). In comparison, formal seed systems, which are characterized by private seed companies and formal institutions (e.g., governments, NGOs, etc.) that function through markets have increasingly gained prevalence within the last fifty years and are often framed as "modern" sources of seed for farmers (Louwaars, 2007). Growing alongside the prevalence of formal seed systems, commodification in the US and other countries in the Global North is thus particularly widespread, perhaps one reason that seed systems have largely been overlooked in the Global North. Indeed, the power that agrochemical/seed companies have in steering political interests globally, as well as determining research goals and agendas, has led some to believe that transformation of seed systems may be impossible (Béné, 2022).

However, while it is undoubtedly true that there is an incredible imbalance of power across the agri-food system, this narrative obscures the importance of informal seed systems not only in the Global South, where most research to date has been focused (see McGuire & Sperling, 2016) but also in the Global North, where recent research has indicated that informal seed systems continue to persist (Veteto, 2014; Helicke, 2015; Soleri, 2018; Isbell et al., 2021; Soleri et al., 2022). This is perhaps why 'seed commoning' approaches, which promote equitable and efficient seed governance (Sievers-Glotzbach et

al., 2021), have been gaining more traction globally. For instance, beyond recognizing that farmers and gardeners frequently rely on both informal and formal sources for seed (Lopez-Noriega et al., 2021), discourse on Seed Commons focuses on redistributive governance strategies that allow for the integration of multiple knowledge systems into the production and distribution of seeds (Sievers-Glotzbach et al., 2021). In this way, Seed Commons presents an alternative way of regulating seed systems that utilize both informal (e.g., social) and formal (e.g., market/state) regulations to integrate a multiplicity of values into seeds (Beumer et al., 2021).

Using Radin's theory of incomplete commodification, it stands to reason that seed systems may already be a promising area in countering universal commodification across agri-food systems. Moreover, potential can be found in both informal seed systems and formal (alternative) seed systems – with the rise in interest in organic seed in recent years heralding opportunities for change among commercial companies (Hubbard, 2022), and with renewed interest in seed librarians and seed sharing groups reigniting people's interest in understanding how to grow their own food in ethical and sustainable ways (Soleri, 2018). The incomplete commodification of seed through participant aspects (e.g., the alternative values people embed within seed) and social aspects (e.g., through the contestation of conventional seed systems and the concurrent promotion of alternative forms of growing and exchange) suggests that seed systems in the US are not only not a “lost cause” – but instead provoke opportunities which individuals and social institutions can integrate nonmonetizable value even into something so profusely commodified. Ironically, what this suggests is completely counter to conventional commodification theory which suggests

that commodification is a dangerous and slippery slope that will lead to the destruction of all other forms of value and exchange (Lindon & Robinson, 2017). Instead, incomplete commodification of seed may have promising and significant implications for agri-food systems by allowing for coexistence or pluralism of meaning within seed that can facilitate the growth and maintenance of diverse, culturally appropriate, and resilient seed systems.

### **4.3. Methods**

#### **4.3.1. Research Design and Site**

To interrogate the efficacy of commodification within seed systems and specifically look at the ways that individuals attempt to embed non-market meanings into seed through both participant/individual and social/institutional mechanisms (Figure 4.1.), this study relied on a phenomenological qualitative approach (Creswell, 2016). Specifically, an open-coding strategy was used to capture key themes as they emerged from semi-structured interviews (n= 31). Once these initial codes were created, the authors used a thematic analysis technique as informed by Braun and Clark (2006) – whereby codes used for this paper were trimmed and recategorized to fit into central themes relating to the original research questions. Furthermore, care was taken throughout the data collection and analysis process to develop as accurate as possible an account of each interviewee’s experience through reflexive and constant comparison strategies (e.g., journaling before and after each interview, feedback on coding strategies by the co-authors, and other experts, and a review and practicing of the interview protocol with community stakeholders) to ensure trustworthiness (Cope, 2005). Importantly, the use of thematic analysis allowed for

flexibility in rethinking and evaluating the core research question (Braun & Clark, 2006) so that, while all interviews were guided by a protocol that sought to get at values surrounding seeds, it wasn't until all data were initially coded that themes related to commodification emerged as the most appropriate way to display our data as grounded within an argument.

As guided by our methodological approach, this research study focuses on the state of Vermont in the Northeastern United States. Vermont is a small agricultural state home to approximately 6,808 farms, most of which are dairy farms, with an average of 175 acres (USDA NASS, 2017a). The state has both informal and formal seed networks (Isbell et al., 2021), and is home to several alternative seed companies, the largest of which is High Mowing Organic Seeds, which is known across the US for its dedication to selling solely organic seed (Helicke, 2015). Despite the prevalence of dairy as the main agricultural sector within the state, the horticultural sector continues to grow in Vermont (Vermont Sustainable Jobs Fund, 2019). Additionally, recent research within the state suggests that people are highly engaged with subsistence practices, including an estimated 34.7% who garden, with Niles (2021) also reporting an uptick in gardening in the state since the beginning of the COVID-19 pandemic. Evidence also suggests that seed savers in the state maintain a high degree of crop diversity and are motivated by myriad values spanning environmental, community, personal social, economic, and cultural spheres (Isbell et al., 2021).

#### **4.3.2. Population and Sampling**

The population of interest for this research includes seed growers who are involved in both informal and formal seed systems in Vermont (i.e., individuals that both save and buy/sell some amount of seed). Using a purposeful sampling strategy, a sample of 31 Vermonters that ranged in the degree of involvement in formal and informal systems was collected, as elaborated on in Table 1. Potential interviewees were identified and recruited via one of two methods: (1) networks through previous research studies or (2) snowball sampling (e.g., after each interview participants were asked if there was anyone else, they thought the researchers should talk to), with approximately half resulting from each method. The inclusion of non-commercial growers was strategic given the increased interest in gardening throughout the United States due to the COVID-19 pandemic, which suggests that gardeners (who are often more active in informal networks) may be an important, yet understudied, consumer group (Sheth, 2020). Furthermore, recent studies in Vermont and elsewhere have emphasized the importance of non-commercial producers for community food security and wellbeing (Theodorou et al., 2021; Niles et al., 2021).

**Table 4.1. Demographics of Interviewees**

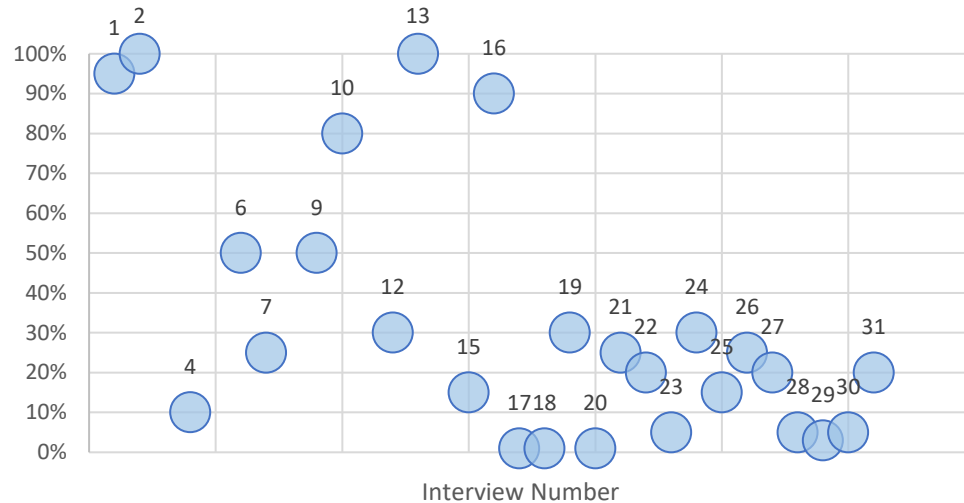
<b>Variable</b>	<b>Frequency</b>	<b>Percent</b>
Gender		
Female	20	0.65
Male	11	0.35
Age		
18-30	3	0.10
31-50	11	0.35
50-70	10	0.32
70+	7	0.23
Seed System Involvement <sup>1</sup>		
Home gardener/ Homesteader	21	0.68
Seed librarian/ Seed group member	10	0.32

Commercial farmer/seed producer	8	0.26
Plant breeder/Seed company	4	0.13
Years Seed Saving		
0-5 years	6	0.19
6-15 years	6	0.19
16-25 years	10	0.32
26+ years	9	0.29

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**Note:** <sup>1</sup> Categories are not mutually exclusive

Since initial criteria for involvement in this study necessitated that a grower actively save seed for at least one food crop (to ensure that, regardless of purchasing other crops, interviewees practiced some sort of informal sourcing, be it through their own production), data were also collected on approximately how much seed they estimated came from their own saved seed stock versus from another source (formal or informal). As displayed in Figure 4.2., the amount of seed saved by each interviewee ranged from 1% of the total seed used for their crop production to 100%. The average amount of seed saved by the sample was 32%. All but one of the interviewees (Interviewee #2 in the figure) reported obtaining seed from a formal source at least once in the last three years. Finally, approximately 1/3<sup>rd</sup> of interviewees engages in selling or marketing seeds or had been involved in seed selling activities in the past. This suggests a spectrum of involvement within the sample with both formal and informal seed systems within Vermont.



**Figure 4.2. Percent of total seed grown which is saved by sample**

### 4.3.3. Data Collection and Reporting

Incomplete commodification was broken down to report findings according to the research questions posed at the beginning of this paper: the first of which relates to non-commodity and commodity values (individual/participant aspects of incomplete commodification), and the second relating ways in which individuals attempt to socially contest or reform universal commodification (social/institutional aspects). As informed by the literature on commodification, non-commodity values were hypothesized to be associated with use values as well as community values, while commodity values were hypothesized to be associated with exchange values, including the labor and economic value (e.g., price, cost) embedded within the commodity, which also relates to the alienability of that good (Radin, 1986; 2001). The second set of findings relates to social/institutional aspects of incomplete commodification, which essentially relate to any action desired to be taken or actually taken by individuals to change societal norms surrounding the commodification of seed. As informed by Radin (2001), this can take

several forms, including through formal reform mechanisms (e.g., instituting laws and regulations) as well as informal arbitration (e.g., changing norms, forms of exchange, and contesting rules and conventions).

## **4.4. Findings**

### **4.4.1. What are the commodity and non-commodity values of seed growers in**

#### **Vermont?**

Considering the importance of alternative value systems (i.e., participant or individual aspects) to incomplete commodification, the first research question sought to understand the relationships growers have with the seeds that they grow. Our analysis found that farmers and gardeners have a wide array of values that they associated with their growing, sourcing, and seed exchanging activities. These values often translated to the types of seeds they preferred to grow crops from, as well as how they determined their own production practices. For instance, when discussing why they choose to save seeds from certain crops rather than purchase them, many growers referenced a preference for maintaining cultural and historical ties to the seeds which they planted. As one interviewee described, *“I guess I really do think of it as a connection, a really fundamental cultural connection with our past - with all the cultures that created the crops that we depend on that our ancestors created for us. And I guess I think of myself as kind of a link in a very fragile chain. I hope to pass that to the future.”* (male, 70, plant breeder and seed group member). This cultural connection was further elaborated on and discussed in terms of what many growers considered to be the most important seeds to them – with respondents

often citing familial connections, friendships, unique flavor profiles, and crop aesthetics as the main reasons for saving seeds for special varieties. One interviewee exemplified this sentiment by recalling how she obtained the seed for a tomato variety which she had saved for the longest amount of time, even though she mentioned largely limiting the practice of seed saving over the years due to increasing job demands:

“...the one seed that is, like, really special to me, is after I started to get interested in seed saving, my mom was talking to her cousin and just, you know, mentioned that this is something that I was doing, and my mom's cousin's husband ... he had a big garden at that time. And he had some tomato seeds that my grandpa had saved, and he called them old-timey tomatoes, because, you know, he thought they tasted like tomatoes' taste, you know. My grandpa was from Western Pennsylvania. And so then, my mom's cousin's husband had been growing that tomato in his garden, you know, long since my grandpa died in the '80s. So, he had been growing and saving the seed from that tomato. And then when heard that I was interested in tomatoes or seed saving, he gave me seed of that variety” (female, 53, home-gardener and plant breeder).

In general, growers expressed the importance of provenance when it came to both seeds that they saved themselves and seeds they purchased or were gifted. Growers often stressed feeling concerned that other gardeners and farmers were becoming increasingly detached from the source of their food and seed. As one interviewee described: *“I think we're really missing out when we just buy a seed packet and rip it open and push it in the ground, and we don't really think about where did this seed come from? Who grew it? Is it*

*organic? And what does it mean if it's organic or not organic? And was it grown in South America, or Africa, or South Carolina? I just don't know*" (female, 60, home-gardener).

Lack of connection was a principal reason why many decided to start saving seeds in the first place. For example, near the end of her interview one grower described how her seed saving and seed activism work related more broadly to the importance of reconnecting herself, as well as helping to relink others, to nature and traditional forms of agriculture:

“And I think it's extremely important for... the future of life on this planet, that people make that strong connection with the real world, with the natural world, and understand how much a part of that we are, that we are, in fact, what we eat and our ethics and morals are reflected in how we arrange to get that food. Do we support a system which is capitalistic and commodifies food or do we support a system that sees food as nourishment and that all living beings, entities require nourishment and we're just part of that cycle within the larger cycle and how everything we do impacts the rest of the circle” (female, 74, seed librarian and home-gardener).

At the same time, the average amount of seed that growers stated to save themselves was 32%, itself highlighting the general reliance that many growers within the sample have on obtaining seed from elsewhere, with only one grower stating that he had not purchased seed from a formal source within the last three years. As articulated by one grower who discussed his reasoning for purchasing at least some seed every year despite being passionate about seed saving, “*you're always purchasing because you wanna try something new*” (male, 37, farmer, seed group member, and seed company owner). This statement

highlights how many growers interviewed frequented seed companies in order to experiment with new varieties before potentially saving that variety themselves in later years. Moreover, many discussed having established relationships with some seed companies and growers that they purchased seed from, often stating that they appreciated certain characteristics of sold seed such as being certified organic, open-pollinated, or locally adapted. One grower who sells seeds throughout the state even mentioned that *“it's nice to make some income off of it [selling seeds] but really, it's more enjoyable to get them in people's hands, you know, certainly people's hands that want to grow it for food but more so, that are interested in at least trying to save seed and, you know, preserving these really important varieties”* (male, 37, farmer, seed group member, and seed company owner). This quote speaks to the importance he feels his seed company has in supporting people to reconnect with important varieties perhaps not found through more conventional seed channels.

Furthermore, for many individuals, the ability to purchase at least some seed is related to issues of accessibility and practicality. As one grower stated, *“...some seeds are challenging to be practical, other seeds are really very practical for the small scale, kind of home gardeners that we are”* (male, 43, homesteader). Likewise, another grower mentioned that *“seed saving is not the most ideal for many people ... even avid gardeners are usually too overwhelmed by the amount of production”* (male, 27, home-gardener). In fact, while this sentiment was largely held across home gardeners and commercial growers, one farmer brought up an important point by saying that *“I don't know how commercial growers ever save seed because it's just, you know, your focus is elsewhere”* (female, 44,

farmer and seed group member). This sentiment was further elaborated on by another grower who works for an alternative seed company, who stated that:

“I think that there's a level of interdependency that sometimes gets lost in the conversation of, like, regional variety development. Because there's only so much that we can do, you know, and like the farmers that I work with, they're spending every ounce of their energy in producing really high-quality vegetables. Like, they don't have the time to be also breeding and saving seed of all those vegetables, you know. And so I think that there's that piece of it too is, like, in order to really have a robust system, it has to be interdependent.” (female, 53, home-gardener and plant breeder).

Besides the time and labor required in saving seeds for certain crop species (particularly biennials, as mentioned by several interviewees), growers also expressed a preference for some types of seed they couldn't save – namely hybrids. For instance, as one grower recalled: “*Now, years ago, I had kale, I had all of that. Oh, you know why we stopped saving? Because my kids and wife like the Winterbor kale, it's a hybrid. I fought it, and fought it, and, guess what? Now I got over it and I plant Winterbor, and they eat a lot more kale*” (male, 43, home-gardener). Likewise, another grower mentioned: “*I've tried saving corn, but I have to say that, generally, like sweet corn ... I actually prefer some of the hybrid stuff - the yellow and white mix and stuff*” (female, 75, home-gardener). Importantly, both growers considered themselves to be highly dedicated seed savers who, in the past, have taught seed saving seminars or mentored other aspiring farmers and gardeners.

#### **4.4.2. What are the ways that growers seek to recognize the nonmonetizable aspects of seeds through social arbitration?**

Following the findings from the previous sections which indicate that growers use both formal and informal sources to source seed that is valuable to them, growers also expressed various efforts and aspirations to actively contest conventional seed systems and embed seed with nonmonetized value. Relating back to Figure 4.1., these acts of arbitration can be considered as the social or institutional aspect of incomplete commodification. Although already discussed in terms of values associated with seed saving, many growers viewed seed saving as a quiet yet direct way to contest the state of the current seed system. As articulated particularly passionately by one grower:

“I see seed saving as a fundamental cultural skill that our culture is losing. And there are huge potential consequences for food security and adaptation during this time of changing climate. So, my motivation is to kind of try to be...to have some role in maintaining the skill to pass it along for the benefit of future generations, if we can do that to provide some food security for future generations. And to break the grip that global corporations have on not only our food supply but on our seed supply. So, it feels very fundamental, it also feels kind of revolutionary, in a way” (male, 70, plant breeder & seed group member)

This sentiment was held across growers – even those who saved only a very small percentage of the total seed they grew. In this respect, seed saving among this population had much less to do with being completely self-sufficient (although for a few, this was an

important aspect as well) but instead being able to maintain a skill they feel is largely being lost. As another grower discussed: *“we may come to a time in the not too distant future, at the rate things are going, that we really do need to save our seeds. Because either we don't have good sources for seeds, or we just are losing some of our heirloom resources for seeds, we may be losing some of our heirloom varieties if we don't. So, I do believe in it for that reason, and want to add to my collection.”* Moreover, many discussed the act of seed saving as a way to promote a general “awakening” among populations that might help move agri-food systems to a more sustainable transition. As one grower discussed in response to a question about why she began getting involved with seed libraries, she recalled where she believes problems began, but also how things were beginning to change:

“So, agriculture was converted, at that point, and separated from the soil and became a commodity. Food became a commodity to sell in bulk. And the propaganda that made the money-making work included some messages to people. And they worked. And we've been manipulated to think food should be cheap, that it should be available all the time, it should be the same, you know, uniform quality, you should know, you know, a tomato is a tomato, it should be the same every time and that the only way to get this was big, that...well, at one point, the secretary of agriculture made this famous statement about agriculture in the U.S. is, ‘Get big or get out. That's the only way it's gonna work folks.’ And we've been so manipulated with this propaganda that generations have grown up accepting it. But it is turning around now, as people recognize we've been fiddled with in a bad way.” (female, 74, seed librarian and home-gardener).

However, in this case, and as illuminated through other interviews, she did not view seed saving as the only way to contest the current seed regime. On the contrary, not only did she and all other seed librarians and seed group members interviewed for this research mention an appreciation for alternative seed companies (especially in the case of seed librarians, as that's where the bulk of their donations come from), but many advocated for other growers to use these sources to obtain more diverse, locally adapted unique seed. Indeed, this is tied to the fact that the majority of growers interviewed discussed dissatisfaction with conventional seed companies and the lack of transparency around the seed they sold, with one grower articulating that *"I often wish that ... there was more information in the descriptions rather than just having to persuade us by the picture ... I'd like to know how many seeds are in the packet, whether it's open-pollinated. If it's an heirloom, where did it come from? Who grew that seed?"* (female, 60, home-gardener). Likewise, many growers expressed a lack of locally adapted seed from conventional seed companies with one interviewee stating that *"many seed companies buy seed from all over the United States or all over the world or have it grown all over the world. And that's not really what I want out of my seed. I want my seed to be adapted to the zone for growing that I'm in"* (female, 42, farmer and seed company owner). Others discussed that just because a seed company is headquartered in the Northeast does not mean that it sources its seeds from Northern growers – highlighting another potential area of less-than-ideal transparency.

Still, sentiments around the idea of "conscious consumerism" were widespread among growers interviewed, with another grower urging people to try and dig deeper into

the seed companies they purchase from: *“I’d love for more people to understand the concept of open-pollinated seeds and, of course, heirloom varieties and what they have to bring to our gardens. And so, you know, these masses of people who are buying seeds, what are they looking for? What are they buying? What do they know about seeds?”* (female, 64, home-gardener). And as discussed by another grower, *“when I buy seeds, I maybe try and buy my seeds from companies whose values I think may be aligned with mine”* (female, 38, home-gardener). Ultimately, growers cited many instances where they actively sought out companies that they felt were more ethically responsible – highlighting a way in which individuals within the sample contested the status quo of formal seed systems within the US and sought to create change both within and outside of market systems.

Additionally, another point that came up often during interviews was concerns around patenting and intellectual property rights (IPR) – especially in terms of it potentially inhibiting the ability of farmers and gardeners to save seed. This led to calls for at least some reform surrounding IPR, if not getting rid of it altogether. Indeed, many responses from growers were rather nuanced, with one grower stating that: *“I feel, like, it should be people’s rights that save seeds. But obviously, I understand where there’s, you know, a certain amount of ownership around things that have been developed.”* (female, 38, farmer and seed group member). Likewise, another grower expressed her own conflicts surrounding ownership issues relating to seed that reflected the sentiment of many others:

*“Well, I mean, I guess I’m a little conflicted, right? Because part of me wants to say, like, seeds are a free resource. And how can you own a seed? How can you*

own a variety? But, well it takes work to develop. You know, so I can kind of see it from both sides. Like, you know, yeah, I think it's wrong for, yeah, suing farmers because your, like, proprietary genetics end up cross-pollinating their crop, right? That's obviously wrong. But, like, I don't know. You wanna sell your whatever-variety for a premium because you developed it and it's better? Then, as long as there's alternatives, then maybe I don't care as much. I don't know. I guess I'm kind of conflicted on that one.” (female, 38, home-gardener)

At the same time – this sentiment was not shared by everyone, with a few remaining adamantly against any ownership of seed, instead suggesting that seeds should remain a commonly-held resource. As one grower expounded, *“I think that part of that whole sweep of commercializing agriculture and commodifying food and so on brought in this concept that seeds could be manipulated, hybridized, and patented and become private property, become property that someone could make money on. And that is just absolutely wrong”* (female, 74, seed librarian). Likewise, as stated by another grower *“...private ownership, and wealth, and stuff like that, and, like, that being the motive, that seems like not great to me. But also it's like happening and those companies have a lot of power. And so, I think, you know, but I think there's also a lot of power in small local communities, like, saving heirloom seeds, and exchanging those, and developing resilient varieties on a local scale”* (male, 25, seed librarian). Ultimately, what this suggests is a divergence in the ways that growers seek to create change within their seed system, with some seeking more transformational change, and others suggesting a need for greater reform and regulation.

As one grower stated along these lines: *“It’s a squishy...it’s a very squishy area, and our country really loves squishy areas...”* (female, 70, home-gardener).

#### **4.5. Discussion**

Seed systems continue to face similar challenges as agri-food systems more generally, including consolidation and subsequent power imbalances across supply chains (Mooney, 2017), decreasing crop diversity (Khoury et al., 2022), and diminishing connectivity between agricultural production and consumption (Philips, 2016). The commodification of food and seed sits at the forefront of these issues – threatening the ability of seeds and the systems through which they flow to reflect social goals. At the same time, the circumstances of contemporary seed systems cannot be ignored. For instance, the vast majority of farmers and gardeners in the Global North rely on commercial sources of seed, thus illustrating a double-edged sword whereby the exchange of seed through market channels has become necessary to support agricultural systems as they are, albeit often at the loss of traditional agricultural practices such as seed saving (Mascarenhas & Busch, 2006). However, the findings of this paper highlight that commodification does not have to result in the elimination of social, cultural, and environmental values. Indeed, the growers interviewed for this study all attached many forms of nonmonetary value to seeds, instead often considering seed in terms of historical linkages, culture, and relational ties – even those purchased through formal channels. What this suggests is that the incomplete commodification (Radin 1986, 2001) of seeds allows space for a plurality of meaning to be attached to seeds even in highly commercialized contexts such as the US.

As other recent research has shown (Helicke, 2015; Isbell et al., 2021) seed systems in the US cannot easily be segregated into market and non-market spheres despite the hegemony of conventional seed companies and the concurrent dependency of many farmers on purchased seed (Howard, 2018). As growers within this study highlighted, alternative values persist that inherently cannot be monetized, including the familial and cultural histories that growers attach to the seed which they save. Moreover, although important research has sought to understand the motivations and values of individuals exchanging seeds through the informal seed systems in the US (Campbell & Veteto, 2012; Atalan-Helicke et al., 2021; Soleri et al., 2022), the findings of this paper illustrate how growers incorporate diverse values into their seed growing and sourcing activities in both informal and formal channels, reflecting widely held practices that are often the focus of seed system scholarship in the Global South (Graddy, 2013; Pautasso et al., 2013; Gill et al., 2013). For instance, while many individuals interviewed discussed the importance of seed saving as a method to contest the current conventional seed system and preserve important varieties, a finding very similar to that of other studies (Lind & Barham, 2004; Maticena, & Corvo 2020), they also discussed an oftentimes equal appreciation of seed purchased through formal channels. Drawing on Radin's (1988) concept of incomplete commodification, these findings highlight the participant or individual aspects that allow for goods to retain non-commodity values even if sold through markets. That is, although many growers acknowledged the convenience that comes with treating seeds as a commodity (in the sense that it is alienable), this exchange aspect didn't necessarily detract from the use value of that the seed which they plant. Ultimately, this point stresses the fact

that growers maintain commodity and non-commodity values in both formal and informal seed systems – challenging the dichotomy of universal commodification and non-commodification as two diametrically opposing forces.

That said, it is also crucial to recognize that when considering formal and informal seed systems, the growers interviewed in this sample almost always were referring to the benefits of *alternative* formal seed sources such as regionally and locally based seed companies that operate on much smaller scales than the biggest seed companies such as Bayer-Monsanto, Dow-Dupont, and ChemChina-Syngenta which hold an oligopoly over the industry (Mooney, 2017). Alternative seed companies which often sell organic, heirloom, and unique varieties in comparison to conventional seed companies, thus demonstrate one avenue of incomplete commodification which interviewees stressed the importance of. Indeed, in many instances, these companies provide the foundation for which growers were able to engage with more thoughtful practices of growing – with several growers being able to link the oldest or most important varieties they saved to originally being purchased from a seed company. This exemplifies an already well-studied phenomenon within the Global South, whereby informal seed systems become a crucial form of dissemination of improved varieties from formal systems (McGuire & Sperling, 2016). Moreover, their travel through both formal and informal channels often acts to embed seeds with cultural norms and traditions to become better suited to local tastes (Lopez Noriega et al., 2021). In relation to the findings of this paper, growers often attached value to seeds not because of their commodity or non-commodity status, but because of the interactions and relationships that they associated with their seeds, purchased or not.

Although not the focus of this research, these initial findings provoke further questions on concepts of ‘de-commodification’ that are beginning to be addressed within research (Vandenbroeck, 2019; Maticena & Corvo, 2020), though could be expanded to help support alternative seed movements globally.

As Radin and other theorists have highlighted, it is impractical to consider commodification as a binary rather than a spectrum (Appadurai, 1988). In reality, goods can reflect completely different values depending on the individuals involved in the production and consumption of that good (Long, 2003), thus underscoring the fact that commodities can still hold important social value despite their alienability within markets. For example, our findings indicate a desire for growers to engage more deeply in the production processes of seed, as well as encourage others to think more mindfully about where they purchase or source their seed. Such characteristics as seeds being organic, open-pollinated, and heirlooms were cited frequently – and often as reasons why growers within the sample sought out specific seed companies which they trusted to sell these seeds. As such, while the term commodity has come to be strongly associated with lacking any true identity or purpose other than to be sold, as well as obscuring the labor put into their creation, our findings show how the act of creating a commodity does not have to be reductionist. Instead, these findings showcase how seed can be embedded with nonmonetary values and meaning (Polanyi, 1944), and thus better reflect the goals and aspirations of the individuals who grow them. In this way, seeds, as described by the growers of this study, are not doomed to be universally commodified – certainly countering the presumption that commodification must always prevail in spaces where it appears.

Through various forms of social arbitration, including the “revolutionary” (as phrased by one grower) act of seed saving itself, but also in advocating for greater consumer consciousness, transparency, and reform, growers within this study described acting in ways that can help in move agri-food systems towards greater sustainability and equitability. Relating to the social/institutional aspect of incomplete commodification (Radin, 2001), these actions foreground the ability of even commodified seeds to hold social import and the practices surrounding their production to recognize the full spectrum of meaning that people attach to seeds. In this sense, incomplete commodification allows for goods to be sold through markets without necessitating a concession of values – suggesting that markets (such as local, farmer-driven markets) can exist and support pluralistic value systems, rather than dismiss them. As the findings of this study highlight, growers expressed nuanced understandings of how seeds should be treated as objects, carriers of meaning, and property – with disagreement occurring over such things as the patenting of seeds. This variance provides evidence that there is no singular commensurable value that seeds maintain – even in a highly commercialized context such as the US. As such, the insights from this research provide an example of how multi-dimensionality can be embraced within agri-food systems in a way that both acknowledges and supports multiple forms of knowing, doing and exchanging.

#### **4.6. Conclusion**

Over the last few centuries, global agri-food systems have been continuously reconstructed through a series of historical processes that have fundamentally changed the relationships and interactions that people have with food. Even more recently, one such

process that has been particularly harmful is the commodification of food and the inputs required for its production. The US seed system as it stands is highly problematic and can be characterized by high degrees of corporatization that, along with other socio-political factors, has led to dwindling crop diversity and higher dependence on commercial sources of seed. However, the findings of this research also provide hope that it is not unchangeable. Although a seemingly optimistic perspective, the growers interviewed for this research generally expressed a strong drive to contest the current system – thus socially establishing the importance of non-commodification even with commodified spheres. Through informal and (alternative) formal seed systems, growers are providing an avenue toward agri-food system transformation by entailing that, through non-commodity values and forms of social arbitration, universal commodification must necessarily cede to pluralism rather than the other way around. As this paper displayed, the implications of incomplete commodification are manifold – not only foregrounding the fact that market logic must not always win out, but also that forms of non-commodification can infiltrate and indeed use market spheres to create meaningful progress.

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