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PANIC GARDENING IN THE END TIMES: AN INTERVENTIONAL STUDY OF HOMESCALE GARDENING ON FOOD SECURITY DURING TIMES OF CRISIS

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PANIC GARDENING IN THE END TIMES: AN INTERVENTIONAL STUDY OF HOMESCALE GARDENING ON FOOD SECURITY DURING TIMES OF CRISIS

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BY THE COMMITTEE CONSISTING OF

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This study as well as the scholarship that came from it was conducted on occupied territory that is traditional home of the "Hasinais" Caddo Nation and "Kirikirʔi:s" Wichita & Affiliated Tribes as well as a hunting ground, trade exchange point, and migration route for the Apache, Comanche, Kiowa and Osage nations.

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Abstract

While the 20th century was characterized by decreasing food insecurity globally due to innovations in food production and distribution, disruptions in both energy availability and climate stability in the 21st century are presenting profound challenges to all populations dependent on the industrial food system.

Proximity to subsistence farming has proven to be the most durable characteristic of food security. This thesis examines the fragilities built into the industrial food system and reports on an intervention designed to model the potential impact and challenges associated with subsistence gardening in peri-urban settings under conditions designed to mimic a low-carbon, climate-disrupted environment.

The study finds that time, expressed in multiple dimensions, is the greatest limiting factor for growing enough food to meaningfully offset dependence on the industrial food system with dietary choice ranking second. Developing a low-input method for starting seeds apart from the gardening space is also recommended to maximize impact.

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Introduction

The industrialized world is entering a time of great uncertainty emerging from the friction between an organizing ideology of limitless growth and the reality of limits to that growth set in place by natural laws as they are currently understood. While this struggle is manifesting across the many systems that make up industrial modernity in myriad ways, none touch the daily lives of every human being on the Earth quite so intimately as that of food security.

At first glance, the application of industrial processes to the production of food can be seen as one of the unqualified triumphs of modernity, resulting in food surpluses without parallel in human history. However, a diligent inquiry into the resilience of the industrial food system uncovers profound fragilities in that system that emerge from those dissonances between the status quo and the limits to growth imposed by nature. While common sense might suggest that the most valuable inputs to growing food might be seed, soil, water and sunlight, in practice, byproducts of fossil hydrocarbons are the most determinant factor in the yield of industrial agriculture.

Farm machinery, used for tilling, sowing and harvesting, is produced using industrial processes powered by fossil hydrocarbons and, in turn, that machinery is fueled predominantly by them. The soil is amended using fertilizers derived from them. The crop is sprayed with pesticides that are produced from them. Fossil hydrocarbons fuel the collection of harvested food, its transport away to processors and markets, the distribution centers where food is purchased by consumers, and, in many cases, the systems used at home to store and prepare for food consumption.

Some elements of this system can be powered through other means. Proponents of a ‘green transition’ advocate for electrifying many of the industrial processes (agricultural and otherwise) that are currently dependent on burning fossil hydrocarbons and producing that electricity through alternative methods such using solar photovoltaics or wind power, among others. Setting aside the debate about the practicality of such a strategy in the eventual absence of fossil fuels used to manufacture the infrastructure necessary to pursue these so-called alternative energies, there are no alternatives currently in play to match the multiplying effect that chemical fertilizers and pesticides have had on the human capacity to industrially produce food at a global scale.

Even assuming a transition back to relying on more traditional forms of food cultivation that use organic fertilizers, we are soberly returned to our more common-sense limiting factors: soil and water. After a century of intensively and industrially farming the soil, the most productive land for farming has been exhausted. The United Nations Farm and Agriculture Association (2022) put out a recent warning that more than 90% of arable soil would be degraded beyond the capacity to produce food by 2050 unless remediation efforts were undertaken immediately. Similarly, fresh water sources are being rapidly depleted by human use and exacerbated by a warming climate. Recent droughts in California and Arizona, two of the most agriculturally intensive regions of the US, have lain the tension between primary use for daily life and secondary use for food production into stark relief.

Even if fossil hydrocarbons were not a finite resource, the warming of the climate due to the buildup of greenhouse gases (GHG) in the atmosphere would necessitate our pivoting away from them as an energy source. The relationship of that warming to our ability to mass produce food is a complicated one that eventually arrives at a negative sum. It is widely understood that plants need carbon dioxide (along with water and sunlight) in order to engage in photosynthesis. It follows logically that an atmosphere containing more carbon dioxide would allow for more photosynthesis to take place which, in turn, would stimulate plant growth that would not occur under different conditions. However, it is telling that when farmers fertilize soil, they aren't adding carbon dioxide but, instead, nitrogen and phosphorus. That's because carbon dioxide is plentiful and nitrogen and phosphorus, much less so.

The Intergovernmental Panel on Climate Change (2019) speculates that plant growth *might* be stimulated by higher carbon dioxide as much as 30% under conditions where nitrogen and phosphorus were also plentiful. Given that we currently amend soil using fertilizers derived from fossil hydrocarbons, we can see that those conditions can only be achieved by pumping even more carbon dioxide into the atmosphere. If additional plant growth were the only side effect of that strategy and fossil hydrocarbons were an infinite resource, perhaps that would be a way of growing our already overtaxed industrial food system to double our population yet again; but, of course, it isn't and they aren't.

Agriculture was only possible due to the Earth's climate moving into an almost unprecedent period of stability following the last ice age. This era, known as the Holocene (from the Greek, meaning 'wholly new') brought the global mean temperature into a narrow zone where stable gradations from winter to summer could be anticipated annually and, therefore, planting could take place on a schedule. We call that schedule 'calendar time' and our civilization still revolves around it today. Our names for the months, our seasonal food preferences, our settlement patterns, our diet all derive from this sense of being able to *more often than not* predict how the weather will unfold across a given year.

Of course, the years when we got it wrong were a calamity and helped us retain at least a distant understanding that there was something risky about relying on sedentary agriculture. Our nomadic hunter-gatherer ancestors didn't have this problem, at least not to the same degree. If winter took a little longer or summer overstayed its welcome, one simply picks up the group and keeps walking until arriving where the food or game is available. Once a people become reliant on stationary infrastructure for their well-being, the options outside of starving in place become increasingly desperate. In a way, our current global industrialized food system is just an elaborate scheme to play the climate odds on everything, everywhere, all at once. If the avocado crop fails in Mexico, there is always another grower somewhere else who is likely to sell, especially if your nation has the resources to be the highest bidder.

But what if the climate everywhere, of every kind, all at once stop behaving according to predictable norms? That's global warming, which is probably more accurately described as climate chaos. Think of the climate as a pot of water. For the last one hundred fifty years, we've been turning up a burner located below the pot. We can't see it directly but the signs of that energy being added into the system are unmistakable. To begin, the water is getting warmer. It's getting warmer everywhere but not uniformly. The water near the bottom of the pot gets much warmer much faster than that near the surface. Tiny bubbles eventually form and then detach from the bottom floating up to the top. For a period of time, those bubbles might be the only way that a molecule near the top might be able to directly observe energy being added to the system.

In time, though, it becomes hot everywhere. Once the temperature reaches one hundred degrees Fahrenheit, it will begin to boil. This phenomenon demonstrates an important principal in systems theory, emergent properties. Just looking at water at rest and at room temperature in a pan, there's nothing there that prepares the observer for what water does at a boil. Boiling water isn't just hot. It's chaotic. Its movement becomes unpredictable. It becomes dangerous to organic materials that were once dependent upon it in its more docile, unboiling state. That is climate chaos. When it's hot, it's too hot. When it's cold, it's too cold. When it rains, it rains too much. When it's dry, it's too dry. Too much of everything, everywhere, and all at once. That's just what we've observed and the climate, in our analogy, is not yet boiling. It's just hot and getting hotter. The known properties, we can plan for and, to some extent, adapt to. The emergent properties are the unknown unknowns.

Viewed through these critical lenses, the sextupling of the global population over the past century and a half is less a cause for celebration and more descriptive of the scope of the dangers we now collectively face. Just as the industrial food system is global, decentralized, and asymmetrically distributed, so too are the hazards of its fragility. This research study and resulting thesis was prepared and executed in the context of the global COVID-19 pandemic, when mandated lockdowns and supply chain snags brought food security issues into sharp focus for people who had previously lived in a world where grocery stores were fully stocked, and food security was an issue for developing nations. Even assuming a future where this particular pandemic was an isolated incident not descriptive of problems to come, it is plain that other predicted stressors like climate instability and energy resource depletion will continue to exploit and magnify these systemic fragilities while exposing more people to food insecurity.

The industrial food system was designed for a world that no longer exists. A world with ample, rich topsoil. A world with a surplus of freshwater for irrigation. A world with a stable climate. A world powered by cheap and abundant energy. As the gap between that ideal world by and for which the system was designed and the world that we inhabit widens, so do the fragilities inherent in that system. This thesis was prepared with the intention of contributing to an emerging field of study that Servigne and Stevens (2015) call collapsology. This transdisciplinary field of inquiry investigates the demonstrated feature of civilizations to fail suddenly with a particular eye cast toward considering the potential outcomes that might arise from the collapse of this one.

In this sense, this research study was undertaken to see what challenges might await peri-urban inhabitants who suddenly found themselves in urgent need of growing their own food. It assumes no prior experience, limited access to external inputs (including power derived from fossil hydrocarbons), access to a small amount of land that hasn't been primarily used for, an unpredictable climate (as modeled by Oklahoma's rather erratic and dynamic weather which is, itself, already disrupted by a warming climate), and a measure of collaborative effort available. It also took place under stressful external social conditions including, but not limited to, a global pandemic, social unrest, political violence, random mass murder and political uncertainty—all of which adds up to an ideal model environment to simulate collapse conditions if they are not, in fact, conditions of one already in progress. A more detailed explanation of collapsology is offered in the chapter to follow.

Literature Review

Collapsology

The term ‘collapsology’ was coined by Servigne and Stevens (2015) to describe a transdisciplinary study of the fragilities of industrial civilization and the harms that might emerge from its collapse. While the emergence of collapsology as a discipline is relatively recent, its roots stretch back into antiquity.

As civilizations have gone through boom-and-bust cycles down through the ages, philosophers, historians, and other holistic thinkers have long wondered why civilizations collapse. To describe the rapidity with which complex systems often collapse, Bardi (2017) drew inspiration from the Roman writer Seneca who, some two thousand years ago, observed that, “Whatever structure has been reared by a long sequence of years, at the cost of great toil and through the great kindness of the gods, is scattered and dispersed by a single day.” The British historian Edward Gibbon published a six-volume treatise on one of the more famous and well documented collapses in *The History of the Decline and Fall of the Roman Empire* (1790).

Through the course of the tumultuous Twentieth Century, scholars from a variety of disciplines continued to contribute to the body of works that laid the foundation for collapsology. Spengler applied the “Copernican overturning” as it applied to the rise and fall of civilizations in his landmark work *The Decline of the West* (1939). Toynbee mined similar territory with *A Study of History* (1971), though his work was read more broadly outside of Germany than Spengler. Systems ecologists Howard and Eugene Odum (1959) contributed greatly to our understanding of systems in nature and were particularly keen to draw human-created systems into that framework to better understand how fragility develops and what it looks like at work in a failing system.

The foundational text of collapsology emerged in 1972 when Meadows, Meadows, Randers, and Behrens published *The Limits to Growth*. In it, Meadows et al. created a system model to examine the consequences of interaction between human and natural systems and used the most powerful computers available at the time to plot likely outcomes. While the scope of the report and its findings were broader than the concerns of this study, the central finding was that without a substantial reduction in the rate at which the human enterprise was consuming natural resources, the most probable outcome was a rapid and uncontrollable decline in both human population and industrial productivity. These troubling models were supported by Georgescu-Roegen (1971) who identified modern civilization as what Odum (1983) would later characterize as a “dissipative system,” that is a system requiring increasing amount of energy to process the entropy (waste) produced by its maintenance until it collapses in the absence of them.

Georgescu-Rogen’s work laid the foundation for a new field of inquiry in economics called biophysical economics. Hall (2018) describes biophysical economics as one that recognizes the limitations that natural resources place on human activity and the economies that emerge from it. Hall’s focus on energy as the meta-resource that allows for the consumption of most other resources in the modern economy was of particular interest to later scholars in assessing the impact of the peak and decline of fossil hydrocarbon use on the industrialized global economy. In particular, his formulation of the concept of energy return on energy invested (Cleveland, Costanza, Hall, & Kaufmann, 1984), or EROI, as a metric to measure the potential for social complexity drew attention well outside of the field of economics.

Tainter (1988) used EROI as his organizing principle in conducting an archaeological survey of collapsed civilizations throughout history. Using it as a metric applicable to the development and maintenance of complex societies, Tainter was among the first to focus on collapse as an inherent function of civilization that is both predictable and quantifiable, wryly noting that all civilizations have failed but one. His definition of collapse as a rapid decrease of social complexity has also gained considerable purchase among collapsologists and was popularized outside of academia by writers like Jared Diamond in books like *Collapse* (2005). Both Tainter and Hall were cited at great length by writers associated with concern over peak oil when interest in it hit a peak of its own in the early 2000s in books like Heinberg's *The Party is Over* (2004), Kunstler's *The Long Emergency* (2003), and Orlov's *Reinventing Collapse* (2008). Peak oil as a topic of scholarly interest, in this regard, can be thought of as a subsection of collapsology that focuses on energy flow as the meta-resource that controls the flow of the others and as fossil hydrocarbons as a metonymy for the flow of that meta-resource at its most optimized.

Among collapsologists, greenhouse gas pollution is one predicament in a long slate of converging crises. Still, books like Gore's *An Inconvenient Truth* (2006), Hansen's *Storms of My Grandchildren* (2009), Jamail's *The End of Ice* (2020), and, more recently Gates's *How to Avoid a Climate Disaster* (2021) have all contributed to the general public's awareness of the possibility of systemic level disruptions to our modern way of life. Other movements including the Transition Town movement in the UK, the Dark Mountain Project, Extinction Rebellion, and, most recently the Deep Adaptation agenda are multimedia, transdisciplinary responses to a variety of collapse-related topics including peak oil, ecological overshoot, population pressure, climate disruption, and more.

Scholars who self-identify with the emerging academic discipline of collapsology have arisen mostly from the European milieu. Servigne and Stevens (2015) are credited with coining the term ‘collapsology’ as well as creating social awareness in France and beyond about its implications. Like the aforementioned Transition Town and Deep Adaptation movements, collapsology in its infancy has been focused on how best to prepare society for a transition from a state of high energetic flow to a much lower one. Bendall et al. (2021) embrace the transdisciplinary nature of collapsology perhaps the most directly in the collection of essays contained within the *Deep Adaptation*, drawing on academic resources from the disciplines of sustainability, psychology, social justice, sociology and more to map out a spectrum of possible responses.

Collapsology is not a monolith and just as its adherents take varied positions on the central questions associated with it, so do its critics use different approaches to critique it. Costello, Maslin, Montogomery, Johnson & Ekins (2011) describe the anticipation of collapse from climate change as one extreme of a spectrum of responses to climate warming that is boundaried on the other end by climate denialism. Nicholas, Hall, and Schmidt (2020) label the acceptance of collapse as unfounded and detrimental to the motivation necessary to correct what they see as problems with potential solutions. Davidson (2023) validates the concerns raised by collapsology while relegating claims about likely outcomes to a kind of imaginative play that can veer into unproductive territory without vigilance.

Industrial Food Production

The modern food system lies at the intersection between the two great historical human cultural revolutions, the Agricultural Revolution and the Industrial Revolution. Indeed, the very possibility of civilization is predicated on the annual cultivation of productive grasses that allow for sedentary populations of human beings to produce surplus food and, from it, social complexity. As Tainter (1988) notes, the Agricultural Revolution was, above all else, an energetic revolution, transforming solar energy collected over time into living things, whether cultivar or domesticated livestock, which were used as a kind of battery for delayed consumption. In this sense, the Industrial Revolution can be seen as an intensification of the Agricultural one, developing technologies for extracting and harnessing fossil fuels, which contained solar energy embedded over *millions* of years, to replace human and animal labor with that of machines powered by this energy. The marriage of these two revolutions can be found in the industrial food system (IFS), a complex global regime for the production, harvest, marketing, distribution, purchase, consumption, and disposal of food.

Agriculture has always depended on certain functions of the environment, what Matson, Clark, and Andersson (2016) describe as ecosystem services, such as soil fertility, sunlight, predictable precipitation patterns, and access to other sources of freshwater, in order to function smoothly. Industrial agriculture freed its non-industrial counterpart from the nitrogen cycle, which Odum & Odum (1959) identify as one of the key natural limits to foliar growth, by introducing petrochemical fertilizers to modern farming practices. Converting the human labor associated with agricultural cultivation into that of machines, powered by fossil fuels, also opened up industrial agricultural practices to a scope never before conceivable. The benefits of industrial agriculture to human civilization have been many and, under this competitive regime, human population has grown from just over one billion people in 1850 to nearly eight billion in 2020 (UN, 2019).

With that great power comes great fragility. Even as more of the world becomes dependent on the IFS, the two legs that keep it upright, ecosystem services and industrial energy production, are showing signs of considerable stress. The accumulation of greenhouse gases (GHG) associated with industrial processes is responsible for the destabilization and general warming of the climate. As the Intergovernmental Panel on Climate Change (2019) notes, this phenomenon has a double interaction with agriculture as not only is industrial agriculture responsible for as much as 25% of the annual GHGs emitted into the atmosphere, but a warming climate and the associated effects of that warming destabilizes the very ecosystems upon which industrial agriculture is partially dependent. Strategies for limiting GHG emissions from human activity necessarily means transitioning from fossil-fuel based energy strategies to anything else that doesn't involve the burning of hydrocarbons. But, as Odum (2007) demonstrates, system complexity is dependent not only on the amount of energy available but the quality of that energy. As of yet, none of the alternate energy regimes being explored comes anywhere near the ratio of energy return on energy invested (EROI) enjoyed by industrial modernity as it fashioned the industrial agriculture system upon which we all depend.

Proximity to subsistence farming is the greatest indicator of food security (IPCC, 2019). According to the United Nations (2019), the world's population is becoming increasingly urban and, thus, more reliant on the industrial food system (IFS) to provide food security. In the United States, more than 50% of its residents currently live in peri-urban (or suburban) locations that, in many cases, act as a transitional space between urban centers and the rural lands that are capable of food production (Kolko, 2018; Forsyth, 2012). There is also a proven correlation between proximity to urban centers and scarcity of land attached to dwellings that might be suitable for food production (IPCC, 2019). As such, peri-urban spaces represent a meaningful intersection between population density and land attached to dwellings available for potential food production (Holmgren, 2018). Per Milesi et al. (2015), much of this land is currently under turfgrass, at a considerable annual energy and water cost to maintain.

There has been considerable research looking at the impact of community gardening and urban agriculture on food security across a number of dimensions. The impact of home-scale gardening, in contrast, is less well-documented and the literature reveals no interventional studies designed to measure and bolster food security through planned home-scale gardening projects for people living in peri-urban areas of the United States. The proposed study will seek to show that IFS dependence can be reduced for a population of peri-urban dwelling households through cooperative, home-scale gardening projects conducted over the course of a year.

Research Methods

The research methods associated with this study can be assigned to three broad areas, profiling, gardening, and assessment, and gather both qualitative and quantitative data in order to answer the central question as well as provide insights into a number of associated subquestions reflected in the methodology of the intervention.

The central question of the study asks, “To what degree can a household’s dependence on the industrial food system be mitigated by a collaboratively planned gardening intervention using a particular set of resource limitations in spaces designated broadly as lawns?” Those ‘resource limitations’ speculate on a climate-disrupted, energy declining future where questions of improving food security on the household level may rise well above the urgency of academic inquiry. They carry a secondary set of questions about the impact of climate disruption and energy scarcity on the individual household’s ability to improve food security through home-scale cultivation that are resonant in the findings of the study, if obliquely.

Some of these limitations were imposed in the selection of the participant pool. Applicants were taken from a convenience sample of persons known or known by association through civic institutions by the study’s author. Applicants were solicited via e-mail as well as through posts on social media platforms like Facebook and Instagram. Applicants were given a modicum of information (“A gardening study”) and invited to apply. In all, the author received eleven applications. Upon submitting an application for consideration, applicants were sent a simple consent form to collect information and, upon return of the consent form, a short application was sent to each. Application responses were used to determine the pool of eligible potential participants.

The applicants were considered by the following criteria. A successful applicant would occupy residential land that could be considered peri-urban. They should not be currently growing food in that space. They should demonstrate legal control over how the land is used. They should be willing to participate. While the study's author was prepared to consider further factors related to ensuring the most diverse population of participants, the convenience sampling method unsurprisingly yielded applicants which mirrored the study author's racial identity and socio-economic status. This, along with the relatively small pool of applicants, rendered the utility and necessity for these additional criteria moot. Six applicants were determined to be good candidates for participation. The study's author met with each of the six potential applicants via a virtual meeting software to further explain the nature, scope, and duration of the study in order to better inform their choice regarding participation.

One declined the offer, leaving the initial pool of participants at five. Once the population had been determined, participants were given a copy of their rights as a participant and asked to sign a second consent form. The completion of this form ended the profiling phase and transitioned shortly thereafter to the gardening phase.

The active, data collecting component of the study began in January 2021. All five participants were asked to keep information about what food they purchased and from where. The study's author presented an option for tracking food purchases that involved archiving receipts either in their physical form or in digital form (ie a photograph taken of a receipt) with the understanding that the author would be responsible for coding them. The individual method for actual data collection was left up to the participant.

While this research design choice did result in an asymmetry of data quality across the population of participants, this particular dataset was understood from the outset as being descriptive rather than empirical in nature. To gather food data that can withstand rigorous statistical analysis, invasive burdens must be placed on participants. In the case of this study, the study's author asked them to log food data for four months, roughly half the duration of the study.

Four of the five participants agreed to use the method suggested by the study's author. The fifth used a slightly modified version of the spreadsheet created for the study to capture food data for dual use by the study and by the participant for household management. Of those four, three elected to collect physical receipts and periodically turn them over to the study's author for entry. The fourth took pictures of their receipts and placed them into a shared but private folder accessible to both through the internet. Those food expenditures were entered by the study's author into the accompanying spreadsheet. Despite the divergences in how the data was collected, each participant's food expenditures were captured in this form. Data quality is not correlated in the final analysis with method of collection but with the discipline of the participant in capturing it.

This data, gathered over a period of six months, served multiple purposes in the study. At the beginning of the program, the study's author used it primarily to design interventional strategies for reducing dependence on the industrial food system. In more pragmatic language, the food purchase data was used to determine what kinds of grown food might be valuable and acceptable to each household thus, ideally, replacing some item that might otherwise be purchased.

In addition to food purchase data, garden planning was informed by a number of design factors that merit discussion. This study is particularly interested in gardening approaches that could operate under particular conditions; namely, a disrupted climate and relative energy and resource poverty. Though these may seem like arbitrary limitations to the average resident of the industrialized north, they are not to people who have always lived in energy and resource poverty relative to the global north, many of whom are already coping with extreme weather conditions due to climate disruption. By modeling for these two conditions, the study's author hopes not only to make the study relevant to an audience outside of the global north but also to researchers in the future who will almost certainly be operating in environments characterized by less climate stability and relative energy and resource poverty relative to conditions under which the study was undertaken.

In addition to modeling for climate disruption and resource scarcity, the study's author drew upon a number of gardening methodologies sensitive to the ecological harms associated with food production as well as addressing some of the challenges posed by climate-disrupted, resource-poor environments. Of these, one warrants an exploration of how it contributed to garden planning. The study's author drew primarily upon the GROW Biointensive Method popularized by gardener and researcher John Jeavons. Jeavons (2018) has conducted field trials on methods first demonstrated to him by master gardener Alan Chadwick at the University of California - Santa Barbara in the 1970s. Chadwick combined the classical French intensive horticulture method with the principles of biodynamic agriculture. Though Chadwick's transcribed lectures on the topic are intellectually impenetrable to the point of reading like parody, his actual methods of planting intensively (that is, with markedly higher density relative to traditional planting strategies) utilizing a variety of plants thought to be complementary to one another (called guilds) have proven to be durable and successful under the right conditions. The study's author was particular drawn to Jeavon's methodology because it explicitly considers climate instability and energy and resource decline in its approach to garden planning. The

GROW Biointensive method has also been exhaustively documented over the course of four decades, presenting the study's author with a wide range of conceptual tools for dealing with the peculiarities of garden planning for this study.

One of the profound limitations of this set of interventions in relation to utilizing the GROW Biointensive method was the limited time available to prepare the growing space for optimal success. The GROW Biointensive method places a high emphasis on the rehabilitation of soil through compost crop production, growing root vegetables in order to break open compaction occurring under the topsoil, and returning a measure of the growing space to the wild in order to improve biodiversity. As the gardens had to be planted within the period of the study, the study's author used an alternative method for garden plot construction, a method commonly known as lasagna gardening.

In order to create gardening spaces, the study's author laid down cardboard and thoroughly soaked it with a water hose. Then, soil was placed on top of the cardboard in such quantity as to create a 6" layer of soil atop the cardboard. The soil was then covered with a 2" layer of straw as a mulch. The importation of soil was a major concession by the study's author against the low-input methods used elsewhere throughout the study. This soil was purchased at a local soil supply outlet and is marketed as "garden ready" soil, containing a volume of 40% of a proprietary compost mix. This soil was collected from the supplier using a bulldozer (which loaded it into the back of a truck), the truck used to haul it to the garden sites, and through human labor shifting it from the truck bed to the garden site using a wheelbarrow, two shovels, and the labor of two human beings. In total, the study's author used six cubic yards of garden soil in the study at a cost of about $400.

The purpose for using the external input of purchased soil was two-fold. First, it served as a valuable tool for creating a level playing field for individual participants in the study, a kind of control wherein the study's author could argue that identical inputs went into all five garden sites despite the differences those sites presented in terms of optimization for growing food. Secondly, the imported soil saved the study's author from untold hours of grueling labor conditioning the soil in five garden plots using the GROW Biointensive methodology. This methodology involves garden site preparation using a broadfork to dig up all soil down to a depth of 12" and shift it to another position in the bed using a series of buckets and human labor. While the study's author concedes that this strategy of soil disruption to simulate the beginning of a pioneer ecosystem would pay rich dividends over the long-term, it could only be realized through a multi-season growing strategy. The potential harm to otherwise loaned growing spaces in the absence of such a strategy is considerable and, in the study author's mind, was an unacceptable risk not in line with ethical research practices. The human labor associated with these methods would also have necessarily forced the study's author to narrow the scope of inquiry to such an extent as to make the study less meaningful to other researchers.

Future climate disruption and resource scarcity was modeled in the study through design choices regarding irrigation. The study was conducted in Norman, Oklahoma, which lies within the USDA's Plant Hardiness Zone 7B and is land-locked with no natural bodies of water and the closest river several miles away. While municipal water was available to all participants at minimal cost, conditions of water scarcity in other parts of the world are likely to be more widespread in the future. Moreover, water irrigation systems, often composed of rubber or plastic tubing and controlled by timers represented a degree of complexity that seemed inappropriate for this study. Gardens were designed in each of the growing spaces to be accessible with a simple watering hose attached to a spigot on the outside of the participant's house. Based on GROW Biointensive principles, the study's author set a minimum water threshold of 1" equivalent per week. This amount was chosen as the minimum on the basis of it being the minimum needed to keep plants alive. The study's author monitored the local precipitation throughout the course of the study and gave participants guidance via e-mail as to how much watering would be appropriate on a week-to-week basis. While it is true that some plants could benefit from water intervention well in excess of 1"/week (and indeed, local precipitation provided well in excess of this during some weeks), this baseline was provided to participants as the minimum necessary to keep their garden alive with the understanding that they were welcome to water more if they so chose. Some did and that choice was reflected in their garden's output. Some failed to meet that minimum threshold, which was also reflected in their final intervention data as well.

Planting strategy was also guided by the basic principles of the GROW Biointensive method. Traditional homescale gardening replicates the monocropping strategy of industrial agriculture. A particular section of the growing space is given over to one particular cultivar, which allows the grower to maximize efficiency in creating the growing conditions favored by that plant in that section of the garden. The biointensive strategy diverges from traditional cultivation methods in planting in guilds, or a collection of plants that grow cooperatively to increase plant density per square foot as well as reduce water, mineral, and pest stress. The intensive part of biointensive gardening refers to plant density. Rather than having a single plant in place with a certain amount of space between it and the next identical plant, the biointensive strategy places cooperative plants in close proximity to one another, often occupying different heights in order to create a micro-climate that keeps the ground cool around taller plants using ground cover crops. While Jeavons concedes that the productivity of each individual plant may be less than the conventionally planted crop due to competition for resources, the number of plants in a given area increases, thus bringing the yield per square foot up. Ground cover crops can serve a dual purpose of shading the ground as well as, in some cases, providing soil nutrients (including the critical element nitrogen) to the anchor plant growing above. Additional guild additions like herbs and flowers can provide benefits like repelling pest pressure (nasturtiums and marigolds repel common garden insects like squash beetles and looper moths) and encouraging pollinator activity through flower production. The individual garden designs employed these strategies through a series of four plantings undertaken monthly from March through June 2021.

After the garden spaces were installed in early March 2021, the study's author would visit each site on a schedule of either biweekly or monthly depending on the level of maintenance necessitated by the seasonal demands. Maintenance activities included further plantings, weeding, watering, and observation, which involved taking notes and photographs. The frequency of the visits was closer to biweekly during the spring. It rained heavily during March and April and more frequent visits were necessary to repair erosion damage caused by the heavy precipitation. Once all the plantings were in place and the summer was underway, visits stretched closer to monthly, as there was less maintenance as plants matured toward harvest. The study's author did communicate with participants on a weekly basis to provide guidance in regard to watering needs and to check in on any unforeseen emergencies which may have arisen.

Due to the diverse range of plantings for each garden, harvesting began as soon as thirty days after the initial planting. Participants were invited to harvest from their gardens as they saw fit, with guidance offered from the study's author about when different cultivars might be ready for consumption. In the case of self-harvest, participants were asked to report an estimation of how much was harvested. The data derived from the estimations ranged in precision from begin weighed with a digital scale to more casual descriptions ("I made a salad with it") but were accurate enough to provide meaningful values for the study. This self-reported data was added to a spreadsheet used to calculate harvest data from across the study. When harvest was performed by the study's author in the course of regular garden maintenance, a digital scale was used to measure the weight of the harvest and recorded in this same spreadsheet.

The study was completed in September of 2021. Participants were given the option to have the study's author come and remove the garden infrastructure from their property, but all declined. Each participant was given an opportunity to reflect on their experiences in the study using a set of questions designed by the study's author. These questions were designed to explore five domains of inquiry: Experiences in gardening; Dietary changes; Purchasing changes; Awareness of industrial food system; and Collaborative Intervention Strategies. The audio from these interviews were recorded by the author (with the participants' approval) and later transcribed for use in this thesis. All interviews were prepared using the same set of questions but all of the questions were not asked of every participant due to divergences in their interventional experiences and outcomes. These divergences will be explored in greater depth in the case studies section of the thesis.

Upon completion of the research study, the author compiled and coded the food purchase and food harvest data using methods described in greater detail in the data analysis section. That data was then analyzed to arrive at the findings presented in the data analysis and conclusions section.

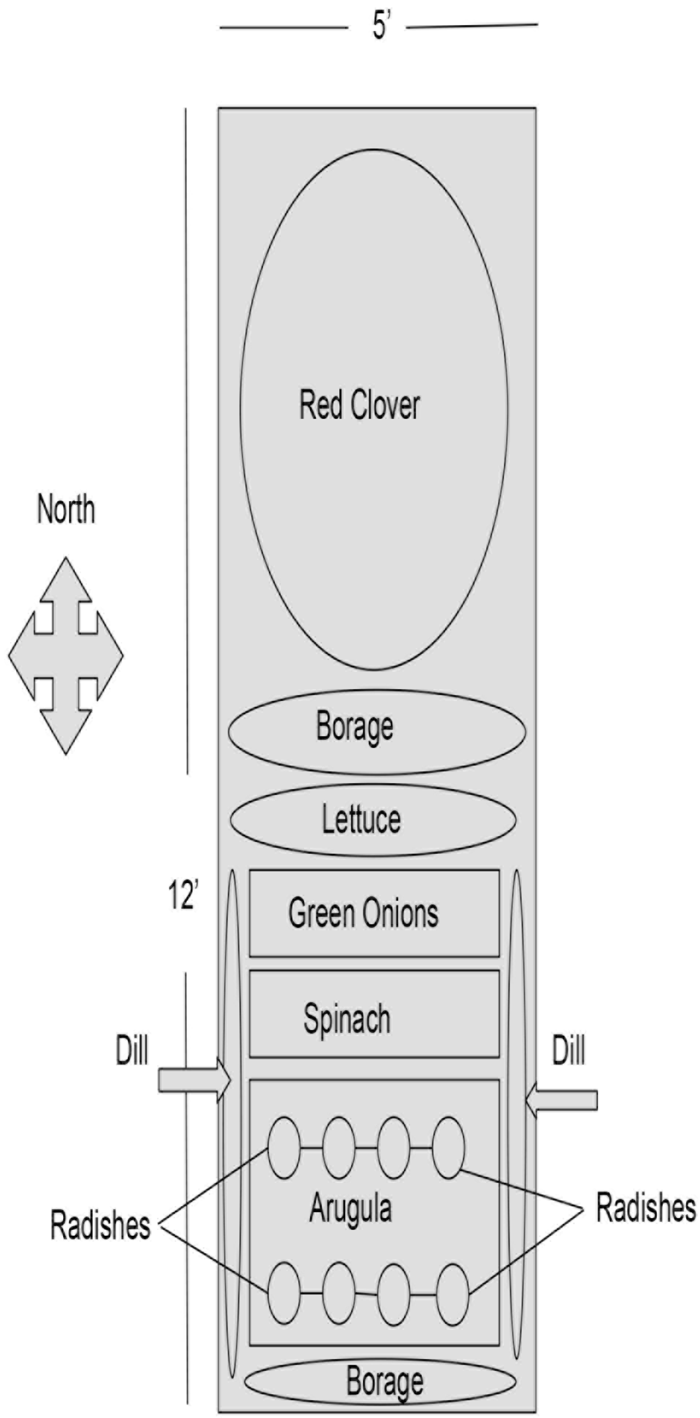
Case Studies

Case Study #1 (CS1)

CS1 is a household consisting of two adults and two children. The garden space was set in the backyard of a new residential development. The space made available for the study had recently been scraped to have its sod removed to accommodate new grass. It was also on a pronounced slope that added a layer of complexity to the garden installation. In addition to the lasagna garden approach described in the research methodology section, the study's author created a sizeable berm at the foot of the slope to stop the newly laid soil from eroding. The gardening plot installed measured 5 feet wide by 12 feet long, oriented north and south to maximize the space available.

Based on the initial food data captured, the planting schedule began with a border of borage on the southern edge. A flowering plant with edible leaves that can be used in salad, it was the study author's intention utilize borage to encourage pollinators to enter the garden space as well as provide nutritional benefits to the participant. To the north of this border, a three-foot section of arugula was placed, along with radishes interplanted. North of this, a smaller section of spinach was seeded, followed by a planting of a similar size plot of green onions. To the north of this was a small section of lettuce and a border of borage. Dill was set in on the east and west borders of the section from the arugula to the lettuce. Finally, red clover was planted in the space remaining north of the borage hedge to hold a place for hotter season crops that were to be placed in May. All of the initial planting was using seed.

The week after the initial planting, a series of heavy precipitation events and unseasonably cool weather resulted in substantial erosion to the prepared bed. As a result, none of the seeds planted germinated. A second planting replicating the planting design was attempted three weeks after the first, which was followed by more heavy rains, which again washed away the seeds. At the end of the first month, the participant requested to discontinue participation in the study, citing disruption to the backyard space, which was used primarily for leisure, and the rigor of the food journaling process. Upon reflection, the study's author determined that the space's north-south orientation, the pronounced slope, and the lack of natural erosion protections were collectively too precipitous for the already arduous process of germinating from seed to overcome.


5'
Red Clover
North
Borage
Lettuce
12'
Green Onions
Spinach
Dill
Dill
Radishes
Arugula
Radishes
Borage

Case Study #1

Case Study #2 (CS2)

Case Study #2 (CS2) is a residential home in a neighborhood established in the 1960s. The backyard is oriented east-west with no tree cover and no noticeable sloping. The participant had only recently moved into the house and the space showed no signs of previous development for food production. The gardening plot measured six feet wide by twelve feet in length. A second bed was installed just north of a small shed. That bed measured one foot in width and ten feet in length. Both were created using the lasagna gardening method.

The initial planting involved putting four broccoli plants on the western edge of the bed with radishes interplanted. Along the eastern edge, a small planting of beet and kohlrabi seed was put in. About a week later, the study's author returned to put in nasturtiums in the broccoli patch and a border of borage was seeded just east of that patch. Due to heavy rains and unseasonably cool weather, the beets never germinated, and the radishes came up very thinly.

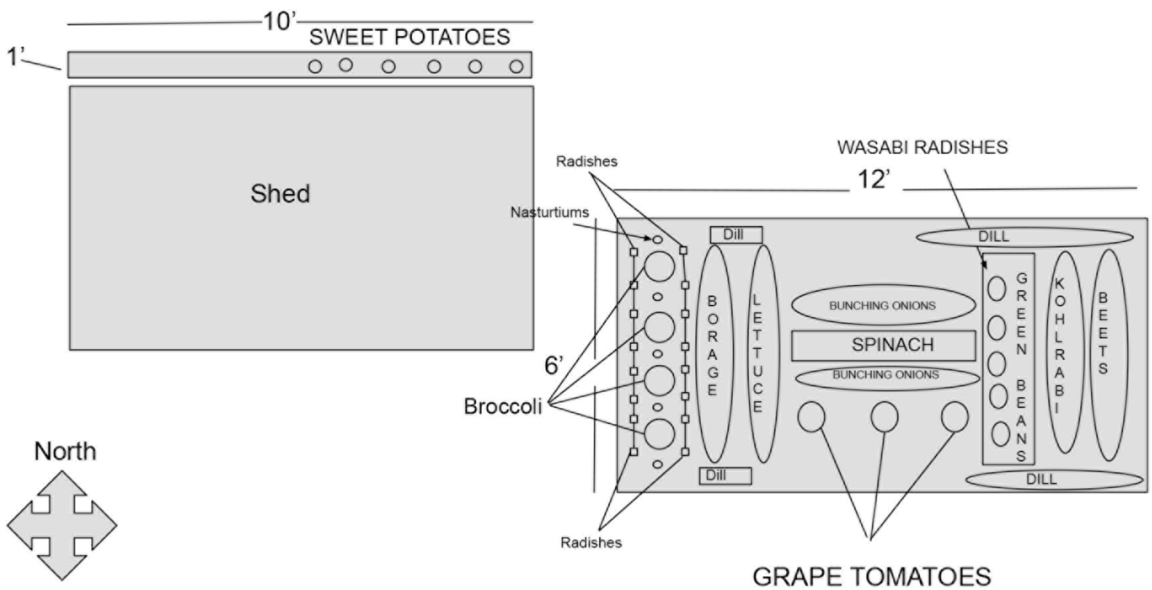
In April, a third planting was undertaken. Lettuce seed was broadcast just to the east of the borage border. A small line of spinach seed was put in a east-west line from the eastern edge of that patch to approximately one foot of the eastern edge of the bed. Bunching onion seed was spread on either side of that line and dill was planted on the north and south edge of the lettuce patch. Of that planting, only the lettuce germinated fully and the dill, only thinly. Though the broccoli plants were growing, pest pressure from large cabbage moths (*Pieris brassicae*) killed three of the plants outright and stunted the growth of the fourth to the point that it never produced the desired flower for consumption.

A fourth planting was undertaken in May. Three grape tomato plants were put into the middle of the bed. Green beans were planted in two small areas on the eastern edge, just west of where the kohlrabi was growing. In addition, wasabi radishes were interplanted with the green beans, aspirationally to create ground cover while the beans developed. While the radishes did germinate sporadically, the beans never did. A small border of dill closed out the north and south edges of the western side of the bed.

A small planting was undertaken at the same time on the bed just north of the shed using sweet potato slips. The plants died before the next maintenance visit.

The harvest from the garden was uneven and thin. The tomatoes were the most productive, yielding about two dozen fruits. The participant was able to harvest lettuce from the plants that survived a couple of times before they were burned out by the summer heat. The kohlrabi also produced six of the harvestable stems (which can be prepared much like broccoli). The radishes also produced some edible food early in the season. Everything else failed to germinate, was destroyed through pest or water pressure, or died from unknown causes. According to their own report, the participant didn't water as frequently as recommended, which impacted plant growth, especially during the very dry summer.

In the exit interview, the participant expressed a new appreciation for how much time, labor, and attention goes into food production. They found growing fresh greens the most rewarding as they regrow after harvest during their season and required the least amount of preparation to convert from garden crop to table food. They also struggled to use the radishes and kohlrabi as it wasn't food that they ate regularly prior to the study. They identified time as the most critical limiting factor in producing food in their yard outside of the study intervention. They also suggested that planning meals around what is coming out of the garden would be essential to using the food produced efficiently. When comparing producing food in the backyard to industrial food production, they identified scale as an important factor in limiting their ability to produce their own food. Producing enough of any given food to constitute a meal requires space as it often takes the output of several plants to make a meal sized portion of any given food. They described the impact of the intervention on their own dependence on the industrial food system as minimal, an observation reflected in the data.


10'
SWEET POTATOES
1'
Shed
North
WASABI RADISHES
12'
Radishes
Nasturtiums
Dill
DILL
BORAGE
LETTUCE
BUNCHING ONIONS
SPINACH
BUNCHING ONIONS
GREEN BEANS
KOHLRABI
BEETS
6'
Broccoli
Dill
DILL
Radishes
GRAPE TOMATOES

Case Study #2

Case Study #3 (CS3)

Case Study #3 took place on land adjacent to a residence located on property used for ranching and farming. While the property use could be described as rural, the location is not distant from the city and might be comfortably classified as peri-urban. The section of the yard utilized for growing had not been developed for that purpose previously and was prone to flooding during heavy or sustained precipitation events. The garden area was installed at the beginning of March, oriented north to south, and measured roughly 12 feet by 4 feet. The area had no tree cover and no meaningful slope. A second growing area, oriented east to west, was established just north of a shed and measured 10 feet by 1 feet.

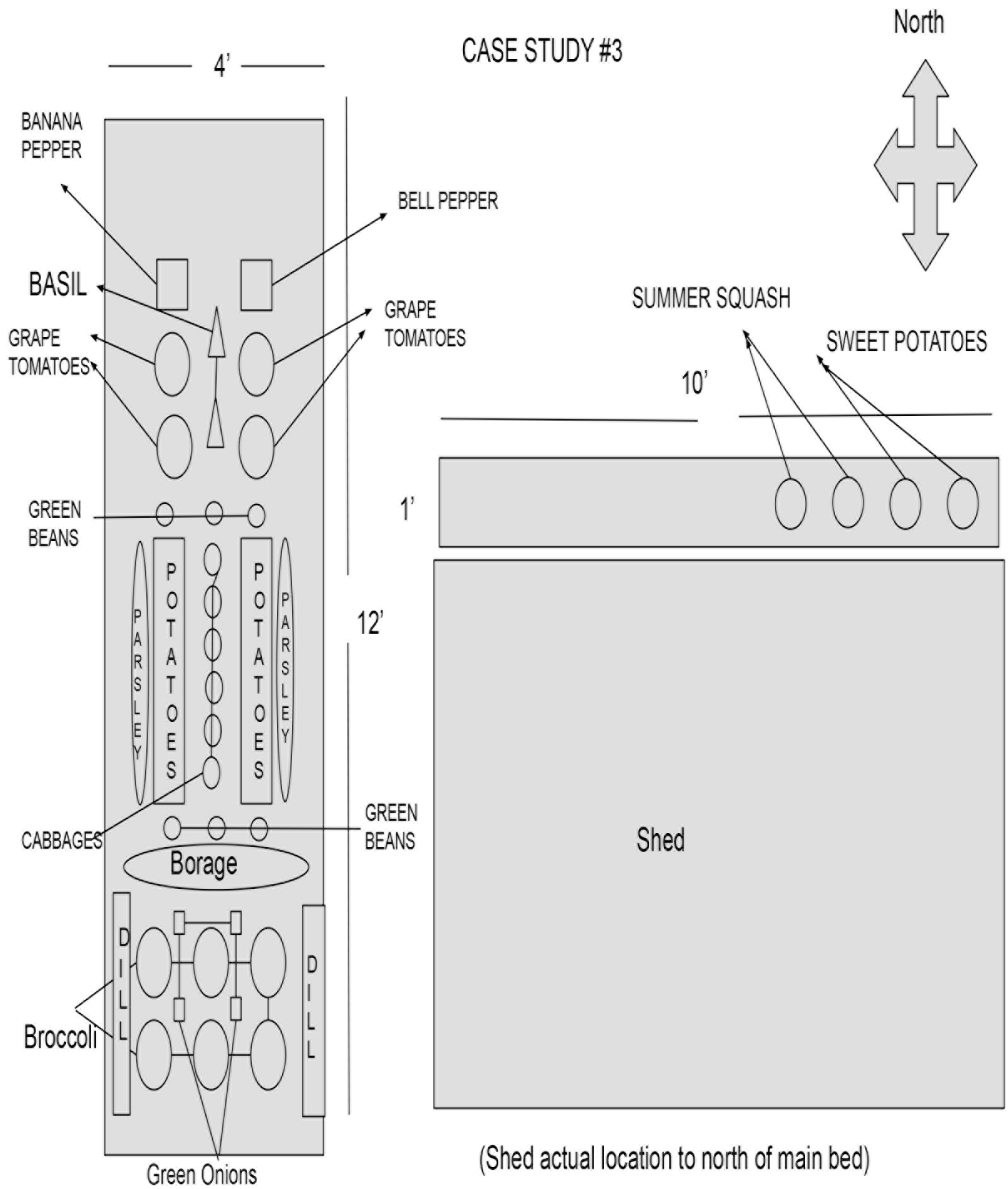
The first planting was undertaken one week after the bed was established. Six broccoli plants were put in on the southern side of the bed, with green onion starters interplanted with them. A border of dill was placed on the eastern and western edges and a hedge of borage seeded on the northern edge of the guild. One week later, ten seed potatoes were placed in north-south oriented rows evenly spaced from the center of the bed. Six cabbage plants were planted between the two rows of potatoes. Parsley seed was placed on the outer slope of both potato rows. Green beans were planted in a group to the north and south of the potatoes, in hopes they would create some shade for the potato plants.

In May, four grape tomato plants were installed to the north of the potatoes, along with basil plants interplanted to encourage pollinators. At the same time, one banana pepper plant and one bell pepper plant were planted, just north of the tomatoes. The secondary bed was also placed into production with two sweet potato slips and two summer squash plants.

As in other garden spaces, pest pressure from the dreaded *Pieris brassicae* decimated the broccoli about a month into the season and the green onions died as well from unknown causes. The dill didn't germinate but the borage grew robustly and provided both leaf for consumption and flower to attract pollinators. The potatoes also grew well and were harvested in mid-July. The *Pieris* also attacked the cabbage but wasn't as thorough, leaving a small harvest for the participants. The tomato plants also grew well and provided a robust bounty through the end of the study. The basil grew nicely. The banana pepper plant grew well and provided considerable fruit. The bell pepper plant grew but didn't produce meaningful fruit for harvest. The sweet potato plants died. The summer squash plants grew and produced fruit, but the plants were infested by squash beetles and had to be removed.

In their exit interview, the participant found the food journaling to be the most engaging part of the study. They were able to better see where their food dollars go. They found it informative to see the relationship between food and how much effort goes into growing it. Their family eats a lot of broccoli and determined they would never try and grow it again because of the cost/effort ratio is so poor. They can buy broccoli cheaply enough that the effort to keep it free of *Pieris brassicae* isn't worth it. Conversely, tomatoes and potatoes were almost effortless to grow, and they indicated they would continue to grow them in season in the future to reduce their future dependence on the industrial food system.

This participant had some experience growing food on the homescale as well as knowledge of farming on an industrial scale due to their family history. They acknowledged that growing staple foods like wheat, corn, or soybeans organically would be almost impossible due to cross-contamination of pollen from genetically modified crops being grown around them. While they described the impact of the intervention on their dependence on the industrial food system as minimal, the study was valuable for them in it demonstrated how reliant they are based on the clarity of the food journaling data.



Case Study #4 (CS4)

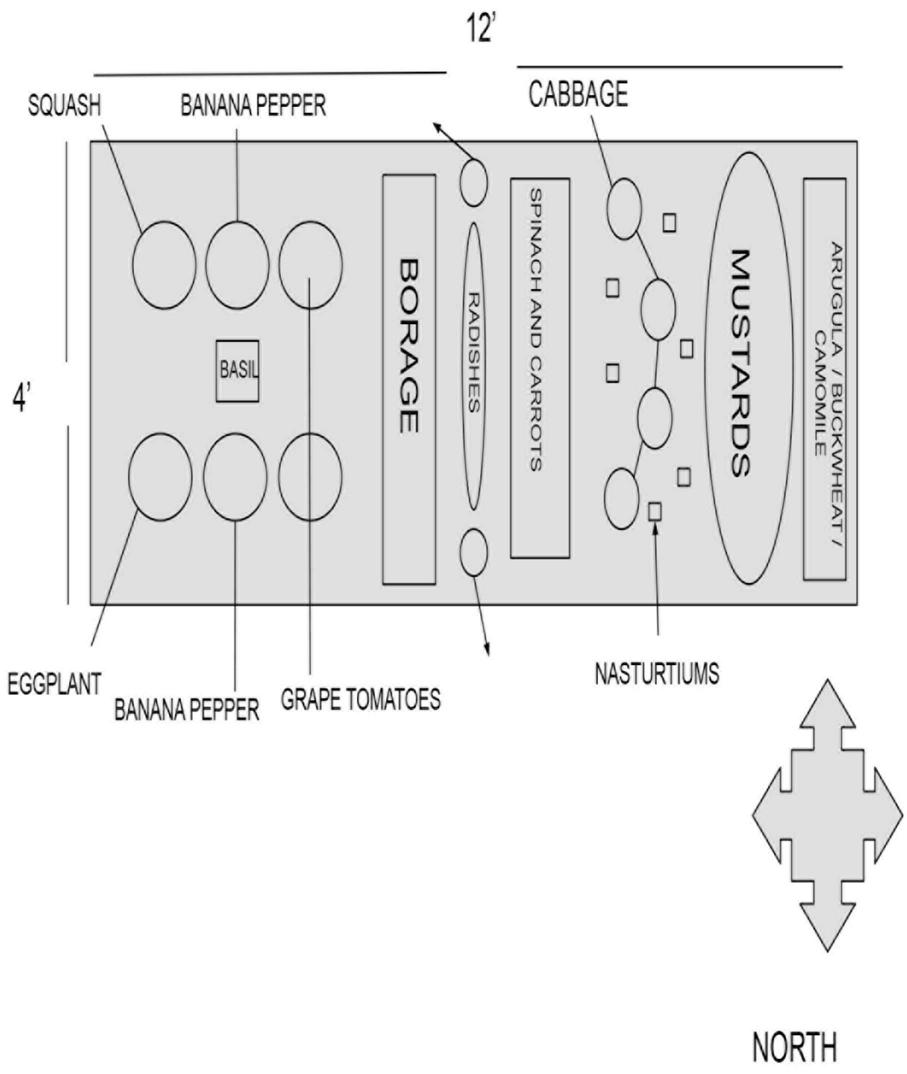
Case Study #4 took place in a small backyard of a rental property where the participant got permission from the property owner to have a garden. The residence was situated in an area developed in the 1950s and the yard was surrounded on every side by trees. The underlying soil was in very poor condition, barely able to support grass, possibly due to the relative paucity of available sunlight. The gardening area was four feet by 12 feet and oriented east to west with no noticeable slope.

The initial planting was light, consisting of arugula, buckwheat, and chamomile seed in the eastern most part of the bed and a row of mustard just to the west of that guild. A week later, a second planting was undertaken, which included cabbage, nasturtiums, spinach, dill, and borage as well as carrots and radishes. Due to heavy rains, most of that seed was washed away with only the buckwheat, mustards, and nasturtiums germinating.

In April, a third planting was undertaken, this time utilizing starter plants. The study's author installed two grape tomato plants, two banana pepper plants, summer squash, and an eggplant along with some basil. This round of planting proved to be the most productive and yielded the fruit that would serve as the basis for most of the eventual harvest. Overall, the tree cover proved to be a major impediment until deep summer, at which point it provided valuable shade that allowed the high heat plants to thrive.

In the exit interview, the participant indicated that the difficulty in growing food under the less-than-ideal conditions to be instructive about how inexpensive food at the grocery story is. They enjoyed the novelty of being able to pluck mustards fresh from the garden and eat them while working outside. Having access to fresh tomatoes and peppers improved their experience of eating salads and they developed a liking for eggplants due to their availability. While they indicated that they were fairly efficient about using food available from the garden, it only represented a tiny fraction of their weekly food expenditure. As a result, they described the impact of the intervention on their dependence on the industrial system as “a little.”

CASE STUDY #4


12'
4'
SQUASH
BANANA PEPPER
CABBAGE
BASIL
BORAGE
RADISHES
SPINACH AND CARROTS
MUSTARDS
ARUGULA / BUCKWHEAT / CAMOMILE
EGGPLANT
BANANA PEPPER
GRAPE TOMATOES
NASTURTIUMS
NORTH

Case Study #5 (CS5)

Case Study #5 took place in a residential neighborhood established in the 1960s. The participant was the property owner and had previous experience with gardening. The garden was right next to the house and there was infrastructure for watering nearby. The participant was also retired, giving them more time to tend to the garden's needs. In addition to a twelve-foot by four-foot garden plot installed by the study's author, the participant had a raised bed space with highly amended soil optimized for gardening that measured roughly two feet by four feet that was also used in the study. Both plots were oriented east to west with some tree cover on the western edge of the installed plot. The area was prone to some flooding during heavy or sustained precipitation events.

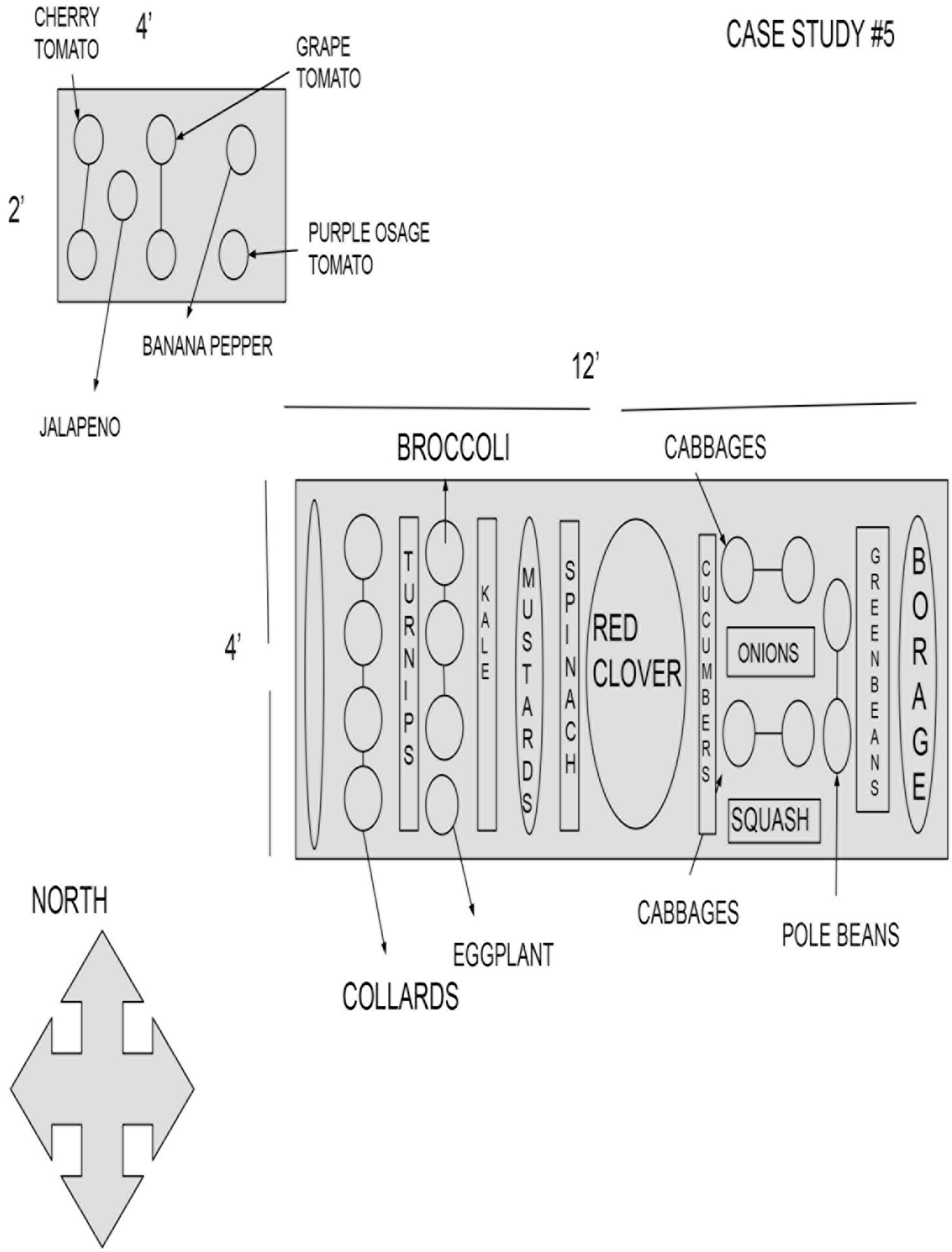
The initial planting took place on the eastern side of the installed bed and included turnips, mustards, collards, kale, broccoli, and spinach with nasturtiums and borage interplanted to reduce pest pressure and encourage pollinator activity. As with the other beds, the broccoli and kale were eventually destroyed by *Pieris brassicae* larvae but the collards, mustards, and turnips survived to harvest. The spinach failed to germinate.

The second planting included cabbages, green beans, onions, and red clover, along with a hedge of borage along the western edge. Those seeds were lost in a heavy rain event and failed to germinate.

The third planting mostly utilized starter plants including jalapeno, banana, and bell peppers, as well as three kinds of tomatoes including grape, cherry, and purple osage. In addition, an eggplant was installed along with butternut squash, cucumbers, and pole beans. The cucumbers and pole beans failed to germinate but everything else benefited from the sunny yet mild conditions and produced well beyond the scope of the study.

In the exit interview, the participant described the impact of the intervention on their dependence on the industrial food system as “some.” The participant is a self-described vegetarian and the availability of borage, tomatoes, mustards, and peppers in the summertime reduced the frequency of visitation to the grocery store to procure fresh produce. They acknowledged that their preferred sources of protein, primarily legumes, would be difficult to produce on the home scale without investing a lot more time and energy into gardening. The eggplant produced well for them and made for a centerpiece to meal planning in a way that the other vegetables produced could not. They also commented on the intangible quality of vitality in food picked fresh from the garden in contrast to even organically produced food shipped in from elsewhere and purchased at the grocery store.

CASE STUDY #5


CHERRY TOMATO
4’
GRAPE TOMATO
2’
PURPLE OSAGE TOMATO
BANANA PEPPER
JALAPENO
12’
BROCCOLI
CABBAGES
4’
TURNIPS
KALE
MUSTARDS
SPINACH
RED CLOVER
CUCUMBERS
ONIONS
GREENBEANS
BORAGE
SQUASH
CABBAGES
POLE BEANS
EGGPLANT
COLLARDS
NORTH

Data Methodology

This interventional study gathered two sets of data. The first set consists of self-reported food expenditure data gathered from study participants. The second set captured information about the food harvested out of the installed garden plots.

Food expenditure data was self-reported by participants and fixed using a spreadsheet. Considered most broadly, the purpose of this data was to capture a picture of how much money participants spent on food and how that money was allocated. Due to the limitation of the study parameters, considerable variation occurred in the mechanisms by which the data about food expenditures was collected as well as in the quality of the data collected.

Food Expenditure Data Collection

Each participant was presented at an initial entrance interview with a suggested method of data collection, which involved their retaining all food expenditure receipts. These receipts would encompass both food purchased for preparation at home as well as food purchased that had been prepared by individuals outside of the home. Those receipts would be received, either in paper form or digitally, regularly by the study's conductor and entered into a spreadsheet. The spreadsheet would capture the following information about each purchase.

1. The date of the purchase
2. A description of the food purchased
3. The quantity of food purchased

4. The cost of the purchase

5. The location at which the purchase was made

In addition, the study's author created six broad categories for coding each line of data entered. These categories were designed to be descriptive of not only the type of food but capable of carrying ideas about *how* the food was created. Those five categories were Dairy, Grain, Meat, Out, Produce, and Shelf.

While the author suggested this method to each participant, the decision for how to collect food expenditure data was ultimately left up to the participant. The reasons for this flexibility in design were manifold, though not without consequences for the integrity of the data collected. Primarily, the goal of the suggested method was to remove as much of the burden of data collection from the participant. The study was conducted over a period eight months and represented a not inconsequential investment of time and attention from the participants. As such, more invasive design approaches that may have yielded more granular data were deemed by the study's author as likely to cause participant burn-out and a high rate of early exit from the study. As noted elsewhere, even using a light-touch approach to the intervention, 20% of participants dropped out before the conclusion of the study for reasons discussed below and throughout. Once the possibility of applying the most rigorous expectations to the food expenditure data had been abandoned, an approach that foregrounded ease-of-participation to each individual participant was employed.

Of the five initial participants, four elected to use the method suggested. Of the four who elected to use the suggested methodology, only one managed to complete the study with a data set judged by the study's author to fulfil initial expectations for the food expenditure log. The participant who exited the study early was very thorough in their retention of food expenditure data, but found the process, among other elements of the study, too invasive to continue after approximately sixty days. Another turned over two months' worth of data before falling terminally behind on receipt collection. The fourth participant failed to produce any receipts.

The fifth participant elected to capture and code the first four points of data listed above on a shared spreadsheet. This allowed the participant to use the data for their household management purposes. This participant completed the study with a data set that met the study author's initial expectations of integrity.

While the initial design called for capturing food expenditure data for the full eight months of the study, feedback from participants, coupled with a preliminary examination of data collected, led the study's author to conclude the data capture at the end of the fifth month. Participants were universally exhausted from the preoccupation with saving and delivering receipts. Moreover, the data suggested clearly that food acquisition habits were consistent across all data sets, indicating diminishing returns of certainty that would have produced marginal improvement in data integrity while yielding more participants dropping out of the study.

Remediating Food Expenditure Data

The purpose of the food expenditure data is to create a picture of dependence on the industrial food system. As noted above, the picture that would have provided the most clarity would have been unsustainable within the scope of this study. As such, the data sets collected represent snapshots of varying clarity and depth. As the interventional study's primary focus was on food production, rather than food acquisition, these variations in the quality of data collected was deemed unavoidable. Nevertheless, the radical divergence in the quality of food data necessitated an approach of designating three degrees of certainty when making generalization based on that data. The two data sets that met or exceeded the study author's expectation will be designated as *low uncertainty*. The data set that completed two of the five months will be described as *medium uncertainty*, and the data set that completed none of the months, *high uncertainty*.

In order to render the data useful, steps were taken to remediate the medium and high uncertainty sets. For the medium uncertainty sets, the study's author elected to accept the two months given as generally representative of eating habits as they would have continued across the remaining three months. This decision was supported by conclusions implicit in the more complete data sets.

For the participant who did not produce any receipts, the study's author and the participant collaborated prior to the exit interview on a broad-stroke picture of their eating habits. While far from robust, this outline sketch did provide a meaningful contrast for the food production data. Conclusions drawn from that comparison were further explored in the exit interview, providing a qualitative complement to render the admittedly scant quantitative analysis more robustly. Despite these remediations, conclusions drawn solely from this dataset will be designated as bearing a degree of *high uncertainty*.

Data Analysis Methodology

After cleaning and coding the data, it was aggregated and entered into the following table.

	Total Expenditures	Shelf	Grain	Meat	Dairy	Produce	Out
Month 1							
Month 2							
Month 3							
Month 4							
Month 5							
Monthly Average (% of total)							

This table foregrounds the elements of the food expenditure data set of greatest comparative value to the food production data. It produces a dollar value that may be thought of as descriptive of industrial food system dependence. The six categories that follow break down that aggregate value into food types that each carry a connotation of complexity in that dependence, a point which will be explored in greater depth in the following section. The bottom row of the table averages the prevalence of each type over five months. The data for this table can be found in Appendix 2.

Coding Food Types

The six food types represent a helpful model to understand both the type of food being acquired and, secondarily, a commentary on the complexity of the processes involved with producing, acquiring, and consuming it. A different model could have been conceived that introduced additional categories to represent interstitial food that didn’t adhere fully to common-sense expectations for what these descriptors mean. In lieu of the complexity that approach would introduce into the model, the author has decided instead to offer commentary on how some of those cases were resolved into this simpler model.

Produce. Being able to compare food grown with food purchased was the primary aim of collecting this data. All the food grown during the study falls under the Produce food type. However, not all food purchased that *could have been grown* fell cleanly into this category. A common-sense understanding, for example, of canned tomatoes or dried cranberries, might otherwise classify them as Shelf items. For the purpose of this study, almost everything that could be grown in the course of a growing year was included in order to facilitate the most direct contrast between food produced and food grown with a notable exception discussed below. Because of this ecumenical approach, one should assume items in this category occupy some point on a complexity continuum ranging from very simple to moderate.

Grain. A separate type, Grain, was created for grains and grain-based foods *of relatively low complexity*. While grain can be produced, even on a home scale, during one growing season, they represent a special use case as they represent the output of perhaps the most industrial of all grown foods and also represent a meaningful portion of most participants' food expenditure. This category includes wheat, rice, oats, and other assorted grains, as well as flours derived from those grains. Additionally, foods like bread and tortillas that represented a relatively low complexity in processing and delivery were included. One should assume items in this category occupy some point on a complexity continuum ranging from simple to moderate.

Shelf. The food type, Shelf, broadly represents durable food products that undergo substantial processing before arriving at the customer. Some food derived from grains, such as toaster waffles or honey buns, were included predominantly in the Shelf category. Other foods such as frozen dinners might include components derived from other categories, but the complexity derived from building in durability (not to mention the simplicity in thinking of them as a single foodstuff, rather than the conglomerate of many) relegated them to this category. One should assume items in this category occupy some point on a complexity continuum ranging from moderate to very.

Meat. This is probably the simplest food type to parse, including all uncooked and preserved meat. There is still, of course, plenty of variation in complexity of delivery ranging from whole chickens and ground beef to preserved luncheon meat and canned tuna. Items of this type can be imagined on a continuum ranging from somewhat (due to the care with which meat must be processed and delivered) to moderate.

Dairy. This food type contained more exceptional use cases than the name might imply. Of particular note was the inclusion of milk substitutes like soy, almond, and other nut milk (and butters). The reasoning behind including them was due to the direct substitution for animal-based dairy products they represented as well as the common infrastructure used for storing them both. In addition to these, items derived from soybeans like tofu and tempeh were included in this category.

Though these are traditionally eaten as meat-substitutes, it was decided that the processes to produce them had more in common with cheese-making and, as such, needed to be grouped with the other soy products. Like meat, dairy products are heavily regulated in their production and distribution. As such, items of this type also demonstrate a continuum of complexity ranging from somewhat to moderate.

Out. This final food type is a catch-all for food purchased outside of the home. It seemed like an exercise in absurdity to try and evaluate each purchase on the basis of its constituent elements. Also, food purchased outside the home *necessarily* represents a higher degree of complexity than even those same dishes created in the home from purchased ingredients. Foods in this type should be thought of as occupying the moderate to very range on the complexity continuum.

Food Production Data

The second data set produced in this study captured data about food produced during the study. In some cases, food was harvested during the study author's visit to perform routine garden maintenance. In others, participants harvested food as needed to facilitate the easy transition from garden to table. In the former case, food was weighed and/or counted and the data was entered into a spreadsheet. In the latter case, participants were invited to either weigh or estimate food weight and/or count where applicable. In either case, the following data was collected about harvested food.

1. Date Harvested
2. Type of food
3. Quantity/Weight

In addition to these three data points, two others were added during the analysis phase. The first, Grocery Value, was calculated using a convenience sample of similar food at the study author's local, organic-only grocery store. The second, Comparative Value, was calculated by multiplying Quantity/Weight by the Grocery Value. This value was calculated by multiplying the weight and/or quantity of food by the value of similar food at the study author's local, organic-only grocery store.

For the final analysis, the Comparative Value of all foods harvested were tallied and contrasted with Total Expenditures, both across all food types and more specifically with food purchased in the Produce category.

Data Analysis

As previously mentioned, this study collected both quantitative and qualitative data surrounding the interventional study. The quantitative data captured information about food purchases and food production. The qualitative data captured participant attitudes surrounding food acquisition and product, as well as their understanding of the industrial food system. The qualitative data served to provide context for the participants' experience and is captured to the extent that it provided that context in the Case Studies. As such, this section will be confined to an analysis of the quantitative data drawn from the study.

The first phase of the quantitative data collected recorded food purchased by the participants during the first five months of the study, February 2021 through June 2021. In assessing the integrity of this data, it is meaningful to note that the ideal of capturing data on every food purchase was aspirational at best. The inclusion, for example, of money spent on food prepared by others outside the home posed a unique challenge in *coding* said data. For example, eight dollars spent on "a burrito platter," explains little about the relative value of the individual ingredients used to prepare it, not to mention the cost of utilities to keep the restaurant open, or the cost of service workers to prepare and/or serve it. Of the four participants who completed the study, only one ate every meal at home, recording zero dollars across a five-month span in the "Out" category. It's an impressive demonstration of eating discipline but probably not descriptive of household eating patterns even across the socio-economic dimension that households otherwise represents.

Of the four participants who completed the study, two self-reported food expenditure data that can be considered complete; one captured data ably for two months; and the remaining participant captured no data, though they were able to collaborate with the study's author in the exit interview to come up with descriptive estimates of monthly expenditures. Rather than disqualifying the incomplete data sets, the study's author found it valuable instead to think of the four sets of data as occupying points on a continuum of data integrity ranging from low certainty to high certainty.

Considered thus, the study's author was able to average data across the four data sets to draw broad conclusions that seemed to be borne out by all of the data sets while relying on those demonstrating high integrity for more granular analysis. Before looking at the data in aggregate, some observations of divergences between the data sets are in order.

The total dollars spent by each participating household were driven most directly by the number of people being fed by those dollars. Among the two data sets with the highest integrity, the household that fed three permanent members (two adults and child) recorded the highest expenditure. However, it can be clearly seen that making the choice *not* to eat food prepared outside the home kept the difference between the three person household (CS3) and a two person household (CS5) relatively narrow. Early in the study, for example, there were still concerns about the safety of eating in restaurants that diminished over time, attitudes that are reflected in CS5's expenditures in the "Out" category.

CS5	Total	Out	% of total
Feb 2021	$ 327.98	$ 22.00	6.71%
March 2021	$ 403.54	$ 48.18	11.94%
April 2021	$ 505.88	$ 82.76	16.36%
May 2021	$ 513.43	$ 74.38	14.49%
June 2021	$ 328.00	$ 100.57	30.66%

As that percentage increases over the span of months, CS5's expenditures approach and then exceed those of CS3 (in May 2021). Notably, as that percentage increases, the integrity of the data set erodes as the specific proportion of the different coded categories is lost to the vagaries of external food preparation.

Total Exp	CS3	CS5
Feb 2021	$ 718.31	$ 327.98
March 2021	$ 573.61	$ 403.54
April 2021	$ 528.76	$ 505.88
May 2021	$ 434.15	$ 513.43
June 2021	$ 247.30	$ 328.00

In the two data sets of relatively low integrity, we find a much greater reliance on food prepared outside of the home.

	CS2 Total	CS2 Out	CS2 % of total	CS4 Total	CS4 Out	CS4 % of total
Feb 2021	$ 161.01	$ 15.86	9.85%	1000*	350*	35.00%
March 2021	$ 223.03	$ 85.56	38.36%	1000*	350*	35.00%
				* est values		

Given that CS2 was a single-occupant household and CS4 a dual-occupant household, it strains credulity that CS2 only spent $161.02 on food in February of 2021 in comparison to CS4 self-reported estimate of $1000. Another reading of the data (and one that is supported by the data collected from CS5) is that the more a household is spending on food outside of the house, the less their awareness of *how much money* is being spent. Indeed, one can make the assertion that the integrity of the data collected was correlated inversely by a participant's dependence on food produced outside of the home; that is, the more food dollars spent outside of the home, the greater the difficulty in tracking those purchases.

Another interesting divergence in the data sets can be attributed to dietary/lifestyle choices. CS3 and CS5, which exhibited a higher degree of data integrity, have specific dietary restrictions visible in that data. CS3 self-reported a carbohydrate restricted diet, spending an average of 2% of their food budget on foods coded into the grain category. The data suggests that those “missing” calories were met from additional spending on produce and dairy. While their spending on meat was comparable to the other participants, the participant self-reported supplementing meat from hunting that would not be otherwise captured in food spending data.

CS5 self-reported as following a vegan diet. Unsurprisingly, their reported expenditure on meat was 0% across the course of the study. Their expenditures on dairy, recorded at almost 9%, reflect milk-substitutes like almond or soy milk products. The data suggests that the calories lost to abstinence from eating meat and milk products were recovered in additional shelf purchases of snacks like cookies, nuts, and nut butters.

Both CS3 and CS5 ranked at the top among participants for spending on produce, at 35% and 25% respectively. This is notable because the intervention undertaken by the study is aimed squarely at this category. Indeed, the effectiveness of the intervention might be best described as sitting at the nexus between dietary choice and gardening success. Comparing the produce expenditures across the participant pool, we see a range of potential impact measured from 20% to 35%, with the rank correlated with the integrity of the data used to measure it. The average across the study is 25%.

Produce	% of Total Expenditures
CS4	20%
CS2	22.80%
CS5	25.20%
CS3	35.30%

Like the food expenditure data, the harvest value data exhibits a spectrum of integrity calculated across a number of dimensions. As much of the harvest data was self-reported by participants, some measure of uncertainty has to be built into the data collected. While some participants carefully weighed the food harvested, others self-reported more casually and included estimations by their own report. Moreover, the value of food is by its nature fluid and was calculated by comparing reported quantities of food harvested against local food prices being sold in stores specializing in organic produce. While the study's author concedes that a fair market price might better be compared to farmer's market pricing (which replicates in many cases the smaller scale and relatively low complexity at which this food was produced), none of the participants reported shopping at farmer's markets (which were not active during this phase of the pandemic). As such, the cost of replacing produced food with food procured from the industrial food system seemed more appropriate and valuable to the study's conclusions.

The design decision to limit food acquisition data collection to a period largely not synchronous with harvest also added another layer of complexity to the calculation. It would have been more precise to compare food harvest value to produce expenditures happening simultaneously. In practice, all participants were reporting fatigue at collecting food acquisition data long before harvest begun and so the study's author allowed that data to conclude in order to preserve the participant pool. As such, monthly harvest data was compared against an average of money spent on produce monthly across the food acquisition period. The case studies are listed in the table below in descending order of presumed data integrity based on these mitigating factors.

CS3	Value of Harvest	% of avg produce expenditure	% of avg total expenditure
July 2021	$ 22.38	12.67%	4.48%
Aug 2021	$ 12.30	6.97%	2.46%
Sep 2021	$ 10.70	6.06%	2.14%
CS4			
July 2021	$ 32.15	16.08%	3.22%
Aug 2021	$ 26.13	13.07%	2.61%
Sep 2021	$ 19.87	9.94%	1.99%
CS2			
July 2021	$ 6.18	14.11%	3.14%
Aug 2021	$ 4.73	10.80%	2.40%
Sep 2021	$ 3.87	8.84%	1.96%
CS5			
July 2021	$ 36.48	35.09%	8.82%
Aug 2021	$ 27.54	26.49%	6.66%
Sep 2021	$ 22.71	21.84%	5.49%

As demonstrated in the table above, the success of the intervention measured against the sum dependence on the IFS (total monthly food expenditures) ranged from just below 2% up to almost 9%. Placing a heavier analytical weight on the first two studies, which exhibit a greater degree of data integrity, that range narrows to roughly 2% to 5%. This aligns with the participants' observation in the exit interviews that the study, on whole, made only a minimal impact on their food expenditure.

Comparing the total harvest against just produce expenditures yields more promising results for future interventional strategies. There, a broader range of 6% to 35% can be observed, with a more conservative reading drawn from only the sets with higher integrity (CS3 and CS5) yielding a range of of 6% to 16%. Assuming a social environment where food can only be acquired that could be produced locally and on the home scale, expenditures on produce might replace those on grains, shelf, meat, and food prepared outside the home in seeking adequate calories for human flourishing. We see this strategy at work already in dietary limitations self-imposed by participants (ie eschewing grains, dairy, or meat) with meaningful shifts in food type percentages attributed to these choices. Future research might focus on calories rather than cost in order to more precisely weight the value of growing one particular food over another.

Conclusion

Growing food from seed without substantial external inputs is profoundly difficult. Successful gardening is the result of hard-won incremental gains in maximizing seed fertilization, improving soil, and timing planting to optimize water made available by seasonal variations. In choosing to model climate-disrupted, resource-scarce conditions to grow food, the study's author limited the impact of the intervention by design.

In spite of these challenges, there are a number of observations that can be extracted from the data that may provide valuable insights for future research. Dietary choices shape the conditions for homescale gardening to make the biggest impact on dependence on the IFS. The more calories a person derives from produce, the greater the opportunity to reduce dependence on the industrial food system. This strategy creates an additional set of challenges in selecting the right produce to achieve minimum daily calorie requirements while also acquiring the broad spectrum of nutrients necessary for human flourishing is no simple task. It demands time and attention.

Indeed, in looking back over the interventional study, it is the study author's conclusion that time and attention proved to be the limiting factors between a robust harvest and a meager one. Germinating seeds demand either rapt attention to ensure that soil conditions remain optimal for as many as fourteen days for some more stubborn crops, or an automated system powered by cheap and abundant energy and mechanical labor. While the latter resources are still available, many will, no doubt, find it preferable to substitute them for the former. Should they prove scarce in the future, the future of food security will depend on the reallocation of time and attention to make up for their lack.

But time alone does not guarantee success in growing food successfully. More than one participant indicated that the complexity of timing harvests with food demand limited their ability to effectively use harvests taken from the garden. Knowing how many of which plant and when to plant it in order to yield a harvest that can be converted into a meal is a skill that can only be won through experience. It is this experience that allows a gardener to make decisions all through the growing season that may result in one meal several months later. While this experience may be (and has been) codified into gardening instruction, the additional challenges of understanding the local context in which this operation will be undertaken necessarily limits the effectiveness of remote learning from books, videos, or seminars. Extant resources like county extension offices and master gardener programs can play a vital role in connecting developing gardeners with invaluable experience for managing their gardens in their local context.

One dimension of food security that couldn't be explored fully in the study due to time limitations was the critical role that perennials like fruit and nut trees can play in supplying additional food security. Unlike annual crops, which make many demands on those who would cultivate them, tree crops are comparatively self-managing and have served as the basis for indigenous food systems for millennia prior to the development of agriculture and the subsequent industrial food revolution. While these crops rarely present as an opportunity for a rapid intervention in the case of IFS crises, early investment in tree crops before a crisis arises can pay rich dividends.

Similarly, perhaps the most important investment a gardener can make over the long term is in the health and vitality of the soil in which they grow. The short duration of the study necessitated the acquisition of soil from a commercial vendor in order to create an even playing field for crop cultivation. This soil, while rich in nutrients like nitrogen and phosphorus that are critical to plant flourishing, pales in comparison to soil that has been enlivened by a robust and diverse biotic community native to the place in which it is utilized for growing food. Creating these conditions typically require years of careful planning and cultivation to achieve but result in growing conditions that are difficult to mimic through the deployment of external inputs.

While the climate-disrupted, resource-scarce conditions modeled in this study did effectively place limits on what tools and methods would be employed to achieve the final data, they are precisely the conditions in which the allocation of greater time and attention, the cultivation of context specific experience in cultivating foods, the development of a tree food infrastructure, and the investment into soil health are likely to return the greatest rewards for all seeking a more secure purchase on true food security. To gamble at this late date on food cultivation methods demanding more energy and a higher degree of complexity may be a strategy that makes sense to those who believe in the possibility of unlimited growth on a planet defined by limitations. With a human population approaching eight billion people facing an uncertain future, the stakes for this wager have never been higher.

Appendix 1: Exit Interviews

Case Study #2 –

How have your experiences gardening this year influenced the way you think about food at the grocery store?

It makes me think about the labor and the intensity it requires to produce the food we eat. It's not easy. It's really hard to produce fresh food. That's something we take for granted. When we go to the store and just grab the food, it's so easy. It's given me perspective on the process it takes to produce that simplicity.

Were there any plants that we grew that you particularly enjoyed watching develop into something edible?

It was interesting to watch the greens. I had watched head lettuce grow before but never headless lettuce so it was interesting to see a different variety.

If you were to continue gardening, which plants would you grow again and why?

Having greens were really nice. It was fulfilling to be able to go out there and just grab some. It makes a whole meal. You just add a protein and you're done. I really enjoyed tomatoes and they are versatile. You can eat them raw. You can can them and make them into sauces. I was disappointed that we didn't get beets. I would love to try those again. Onions, because those are things I use a lot. Try to figure out what staples I use in my cooking and then hone in on those plants and then expand out from there.

What would you elect not to grow again and why?

Radishes. I wasn't sure what I would do with them. I wasn't sure what to do with the kohlrabi, how to prepare and cook it. Those were two things outside of my wheelhouse.

We used organic methods to produce your food this year. Based on your perspective of that experience, why do you think organic food costs more?

It requires more intense attention and labor. It requires more upfront cost for seed, water, capital, labor.

Based on your experiences this year, what would be the biggest challenges in trying to grow all of your family's produce needs?

Time. The hardest thing for me was to keep track of when it needed water and when it didn't. Then if you factored in knowing when the right time to plant was, transplanting, all the time and attention and details that it requires to really get to the end product of an edible produce. There are so many other things demanding my attention and time. I would really have to be dedicated to growing for many hours of the week.

Do you feel like the food that we grew tasted any different than similar food that you had purchased from the grocery store?

Absolutely. Stuff from the garden or produced locally always has a more robust flavor palate, more nuanced. Just overall better quality.

Did you ever plan meals around produce coming available in the garden?

No but I should have.

Did you feel like you were eating more produce than before you kept a garden?

No, I already eat a lot of vegetables and fruits. That's a pretty big part of my diet. It felt like a supplement to that for me.

How effectively do you think you used the food that came from the garden?

I don't. Knowing what the right time frame, the schedule, when food is coming out. Knowing that schedule and planning a meal around it. That would have helped me utilize food from the garden. This being my first time of having a garden and not understanding that limited me from being able to maximize the food from my garden.

Did you have an emotional reaction to throwing away food that we had grown? If so, what was it?

Yes. It feels terrible. I feel more invested in that produce than in the produce I buy from the store. It felt like an investment of my time and resources. This should have been eaten. It felt like such a waste. That's not to say I don't feel that way about throwing away food I purchased but it was a new layer with food that we produced.

I've shared a little with you about the preliminary data I've gathered on your garden in regards to the monetary value of the food we grew. What in that data stuck out to you?

The food we grew was pretty minimal compared to what I spend on food. It could be more if you had the time and attention to put into growing more.

Which of the following term would you use to describe the impact of having fresh food from the garden on your grocery budget? None, A Little, Some, A Fair Amount, A Lot, or Transformative?

A little.

You indicated earlier that cherry tomatoes were the thing that you ate the most. An organically grown cherry tomato sells for an average of $3.50/lb. How do you think the cost of that food in the store reflects on the work it takes to grow it?

Tomatoes were fairly easy. You just have to water them. I feel like is a pretty fair price.

Did keeping a garden influence your experience in the produce section at the grocery store?

I don't think so.

This study is measuring dependence on the industrial food system. How would you describe the industrial food system?

Scale at which you're producing. The mechanism, the types of products you're producing. Are you getting subsidies from the government to produce certain products over other products? That all feeds into how food is produced and made available in our country. Subsequently, that has an effect on what is available for us to eat. All of those things play into what we see at the supermarket, what we see in restaurants, what is culturally acceptable, what gets mass-produced.

Having spent almost a year collaboratively gardening using non-industrial methods, how would you describe your household's dependency on the industrial food system?

Completely dependent.

What food in your diet do you think would be the hardest to acquire without the IFS?

Meat. Beef and pork. Maybe not chicken as much because we could keep those in town. I could make most of my yard into a garden if I needed to. Grains would be difficult. Not necessarily to grow but to break down into a usable form. You need a lot of it to make bread.

Did conversations we had about growing methods change the way you think about the food we produced?

It was a different experience from what I've had before. My dad does a significant garden. He puts a lot more stuff into it. He tills and creates rows with it. Some of them he has irrigation lines for. He weeds so he doesn't spray. It's a very routine schedule planting from seed, transplanting into larger pots, putting them out into cold frames to harden them off. I'd never experienced putting a seed directly into the ground outside and then trying to watch it grow. His process babies and cultivates the plant before it gets to the point of growing outside. So it was interesting to me that anything would grow without that time intensity. He would also use grass clipping to insulate his plants so that was familiar to me. It was a much more bare-bones, raw experience. I was surprised that as much grew as it did.

Case Study #3

How have your experiences gardening this year influenced the way you think about food at the grocery store?

Yes. It has made me more interested in the amount of money we spend on consumables, fresh fruits and vegetables, t was interesting to see that the bulk of our purchases are these things when we've been trying to reduce these things (shelf). It was interesting to see where our dollars go.

Were there any plants that we grew that you particularly enjoyed watching develop into something edible?

I always love watching tomatoes, t was really cool to see how plentiful the tiny tomatoes were. I've always tried to grow these giant tomatoes and it just never turns out well. That is what we discovered. You put them in the ground and they grow great. I just stuck the basil out there as a companion and I was pleasantly surprised at how they just grew,

If you were to continue gardening, which plants would you grow again and why?

Next year, we're growing a lot of tomatoes. We're giving up on broccoli because we can't produce enough of them to make it economical. Also, bell peppers. That is something we eat a lot. I'm also going to do potatoes in a cage structure.

What would you elect not to grow again and why?

Not gonna grow squash or cucumbers. We don't do anything with them. The squash bugs out here are just murder.

We used organic methods to produce your food this year. Based on your perspective of that experience, why do you think organic food costs more?

It's more difficult to maintain a weed-free, grass-free, bug-free environment, It takes more effort on the farmer's part to do that on a mass-produced setting to get that to the end user.

Based on your experiences this year, what would be the biggest challenges in trying to grow all of your family's produce needs?

The ability to keep it watered, The quantity of plant we'd need for each type of vegetable or fruit would be substantial and the water fertilizer etc to yield the amount of food we'd need.

We grew quite a few different kinds of food together this year. What do you think you ate the most of?

Cherry tomatoes.

What was your favorite food to eat that we grew?

Tomatoes and potatoes. The flavor on the cherry tomatoes was very good. The quality was a lot better in comparison to the ones we bought,

What was your least favorite thing that we grew?

I was disappointed that the broccoli didn't do well. The squash was probably my least favorite because of the bugs,

Did you ever plan meals around produce coming available in the garden?

We do breakfast every Wednesday, We had enough potatoes too do that meal on our regular rotation.

Did you feel like you were eating more produce than before you kept a garden?

No. I think we eat a pretty fair amount of produce already. I don't think having the garden made us increase that. It just made us conscious of the types of things we purchase that we could grow.

Did you have an emotional reaction to throwing away food that we had grown? If so, what was it?

No. It just went into my new compost pile.

Which of the following term would you use to describe the impact of having fresh food from the garden on your grocery budget? None, A Little, Some, A Fair Amount, A Lot, or Transformative?

Minimal.

You indicated earlier that cherry tomatoes were the thing that you ate the most. An organically grown cherry tomato sells for an average of $3.50/lb. How do you think the cost of that food in the store reflects on the work it takes to grow it?

Hard to say, We do a lot of purchases at Sam's which may or may not be organic. I will gladly pay what it costs for broccoli to never have to grow it again. It doesn't compare to the amount of work and effort and weather happenstances that broccoli requires the thrive and flourish. We can get a giant bag of it for almost nothing.

This study is measuring dependence on the industrial food system. How would you describe the industrial food system?

The majority of food is mass farmed on non-organic land. Speaking from experience from just around our residence, we have corn, cotton, and wheat farmers. It's damn near impossible to grow organic due to cross-pollination from wind. Same with wheat unless you have acres and acres to sacrifice to incoming pollens. The majority of food is mass produced and shipped thousands of miles. The only way they can keep costs down is to mass produce it.

Having spent almost a year collaboratively gardening using non-industrial methods, how would you describe your household's dependency on the industrial food system?

We’re probably 85% dependent. We get eggs from up the road. We don't grow hardly anything but small farmers markets allow us to get what we can. We're dependent on Sam's and Sprouts and Wal-Mart. [Husband] does hunt and that provides us with meat that feeds us four or five months, eating venison once a week.

What food in your diet do you think would be the hardest to acquire without the IFS?

Broccoli. We could get away with tomatoes and potatoes. Oats.

Case Study #4 –

How have your experiences gardening this year influenced the way you think about food at the grocery store?

It has given me a better appreciation of how hard it is to grow food. The mind boggles thinking about trying to do something as simple as growing a tomato plant and extrapolating from that that it has to be done so many times that my mind starts going into all these fractals about all the tomato plants that have to be grown to feed the world.

Essentially a greater appreciation for the scale of the operation and the difficulty in maintaining it.

Were there any plants that we grew that you particularly enjoyed watching develop into something edible?

I liked watching the eggplants. The pepper had a really nice color to them and I enjoyed them as well.

If you were to continue gardening, which plants would you grow again and why?

I would grow the ones that I saw bear fruit, tomatoes, eggplants, and peppers. They seemed to be able to grow.

What would you elect not to grow again and why?

I would give them all a shot again.

We used organic methods to produce your food this year. Based on your perspective of that experience, why do you think organic food costs more?

I assume because there is a lot more waste involved. If something GMO, I assume it grows better in a shorter span of time. Since organic takes longer, there's more work involved.

Based on your experiences this year, what would be the biggest challenges in trying to grow all of your family's produce needs?

Soil that could actually do it. You did a good job of working with a backyard that was not in the best shape. Many urban, suburban and probably rural areas have soil that is not conducive to growing that quantity of food successfully.

We grew quite a few different kinds of food together this year. What do you think you ate the most of?

Eggplant.

What was your favorite food to eat that we grew?

Mustards. I could go out back while working and pick mustards out and chew on them.

What was your least favorite thing that we grew?

Tomatoes.

Do you feel like the food that we grew tasted any different than similar food that you had purchased from the grocery store?

Yes. It tasted more earthy, dirt flavor to it. They all had the overall taste but not as sharp or pronounced as produce from Walmart. It's almost like a candy, a sharp and pronounced flavor. The ones we grew had the same aura but a bit more muted.

Did you ever plan meals around produce coming available in the garden?

No but we supplemented.

Did you feel like you were eating more produce than before you kept a garden?

No. OK, more eggplant.

How effectively do you think you used the food that came from the garden?

Moderately.

Did you have an emotional reaction to throwing away food that we had grown? If so, what was it?

Mild disappointment.

Which of the following term would you use to describe the impact of having fresh food from the garden on your grocery budget? None, A Little, Some, A Fair Amount, A Lot, or Transformative?

A little.

You indicated earlier that eggplant was the thing that you ate the most. An organically grown eggplant sells for an average of $2/lb. How do you think the cost of that food in the store reflects on the work it takes to grow it?

It's unimaginable. I can't imagine how it would cost that little. Between the amount of time it takes, the attention it takes. Tomatoes, it's not a ton of attention but I have to assume that if you are doing it on a mass scale you are hunting for bugs, sick leaves, it adds up.

This study is measuring dependence on the industrial food system. How would you describe the industrial food system?

Automation. Lots of machines. The reduction of the human element to base tasks. You do two or three things. Scale is important. It becomes industrial when we start trying to produce food for systems rather than communities. There is a sinister element about the dehumanization.

Having spent almost year collaboratively gardening using non-industrial methods, how would you describe your household's dependency on the industrial food system?

Totally dependent.

What food in your diet do you think would be the hardest to acquire without the IFS?

Peanut butter. I love peanut butter.

Did you share any of the food you grew with someone outside of your household?

No.

Case Study #5 –

How have your experiences gardening this year influenced the way you think about food at the grocery store?

I don't think it's changed a lot. My roommate and I are vegetarian. We eat seasonal food and fresh vegetables all the time. We put the same time and energy into cooking vegetables that others put into their leg of lamb or whatever. I'm not sure it changed my choice. We make lots of salads in the summer and there were times I didn't have to buy tomatoes because I had fresh tomatoes in the garden. So that encouraged me to buy more salad stuff. I wanted to be sure we used all those wonderful cherry tomatoes so to make sure we had plenty of salad greens to pair them. Or throw them in at the end of some sauteed greens. Whatever I have has something to do with what I buy. I don't want to waste things. That's part of my personality. If I buy beets, I eat the stems, I eat the leaves, You've got the bulb, chop up the stems.

Were there any plants that we grew that you particularly enjoyed watching develop into something edible?

I enjoyed the eggplant. The leaves are so beautiful, and the fruit. It was fun watching that grow. I think that was one of the prettiest. I like purple! It was fun watching the squash grow as well. The vining.

If you were to continue gardening, which plants would you grow again and why?

Tomatoes, peppers, Staple things like that. I just don't even buy tomatoes in the winter. I was surprised by the eggplant. I'd like to do more of that. I liked having the smaller eggplant because it was something you could run out into the garden at 5 and pull it for dinner. It wasn't a big production to prepare it. Edible greens are something I love. Everyone needs to be eating their leafy greens. I think they taste good. I like the ones that have good taste. I liked the borage, both raw and cooked. That was new to me.

What would you elect not to grow again and why?

Some of them didn't do as well. Broccoli. I don't know why that was. You want to stick with things that work but I would try again anyway. Peas, greens. I have grown those before but not in Oklahoma. I need to be better at watering them or maybe a better trellis? I like to give myself another chance.

I tried to grow cauliflower in Michigan. That was very difficult. You have to use cold frames and they still turned out terrible. But kale and collards, they'll grow.

We used organic methods to produce your food this year. Based on your perspective of that experience, why do you think organic food costs more?

I'll start with a story about a neighbor I have. His entire backyard is a garden and it's kind of an industrial garden. There are long rows of tomatoes, long rows of peppers, long rows of corn. He's an elderly man. We stopped to talk to him one day and he was talking about keeping the bugs off of his corn. He said, "I just get a little of this diesel oil and that'll keep them off" And I thought, yeah but who wants to eat that? You are going to have more spoilage and waste but it's worth the taste and the quality. The earthy minerals and not ingesting something that comes from petroleum.

Based on your experiences this year, what would be the biggest challenges in trying to grow all of your household's produce needs?

Watering and tending. Getting out there when it's really hot. It's fun for a while but when it gets really hot, if you haven't done what you need to do by 9 in the morning, you could die! You'd have to keep planting. You can't plant lettuce once because it'll all get done at the same time. A lot of time and energy planting and planning.

Which of the following term would you use to describe the impact of having fresh food from the garden on your grocery budget? None, A Little, Some, A Fair Amount, A Lot, or Transformative?

Some

You indicated earlier that cherry tomatoes were the thing that you ate the most. An organically grown cherry tomato sells for an average of $3.50/lb. How do you think the cost of that food in the store reflects on the work it takes to grow it?

Tomatoes aren't that hard to grow. I'm not sure you can quantify stuff that comes right out of your garden. Your experience of something from the yard. You cook it or chop it up and eat it. That's just a different kind of thing that something that's been shipped even from Texas or Mexico. Those fresh cells. That's not a quantifiable thing. I don't want to say 'aesthetic' because it's more than that. When my tomatoes are ripe in the yard, everyone's tomatoes are ripe. Tomatoes in the grocery store aren't expensive. The ones I grow myself, you watch them until they are the perfect color. There's a world of difference.

This study is measuring dependence on the industrial food system. How would you describe the industrial food system?

I'm tempted by the world food production if I go into the grocery store. I'm not going to say No you can't have a kiwi if it's shipped from overseas. Some of the exotic things that are possible because of the shipping industry and how long they can stay viable. I find that attractive sometimes. I did shop less because I had my own garden. I shopped fewer times at the Farmers Market, which is something I would usually have done. Take cash and try to find the best locally produced stuff I can from small and independent farmers. I find myself guilty of buying almond milk, which is crop that draws heavily from aquifers. But I would rather have a non-dairy source for that kind of thing. I don't have to buy almond milk but sometimes that's all there is that's unsweetened. We're sort of addicted to sugar. I don't like the sweetened version. To be conscientious and to think about how I invest my money for food in the industrial complex, sometimes I think about it more than others.

What food in your diet do you think would be the hardest to acquire without the IFS?

Beans. We eat beans every week. Beans are a constant protein source. Beans, peas, legumes. Whether organic or not, that's part of the IFS. Growing them requires a lot of room, water, work. It would be difficult to grow and store the amount we eat. Rice. Am I going to have a rice paddy? Wheat.

Appendix 2: Food Expenditure Tables

Case Study #2

	Total Exp.	Shelf	Grain	Meat	Dairy	Produce	Out
Feb 2021	$ 161.01	$ 18.11	$ 21.26	$ 45.02	$ 15.56	$ 45.20	$ 15.86
March 2021	$ 223.03	$ 23.46	0	$ 62.81	$ 8.92	$ 42.28	$ 85.56
Total	$ 384.04	$ 41.57	$ 21.26	$ 107.83	$ 24.48	$ 87.48	$ 101.42
Monthly Avg (%)		10.82%	5.54%	28.08%	6.37%	22.78%	26.41%

Case Study #3

	Total Exp.	Shelf	Grain	Meat	Dairy	Produce
Feb 2021	$ 718.31	$ 263.71	$ 16.44	$ 149.44	$ 68.20	$ 220.52
March 2021	$ 573.61	$ 196.58	$ 11.98	$ 126.16	$ 82.27	$ 160.09
April 2021	$ 528.76	$ 144.26	$ 14.46	$ 64.93	$ 96.50	$ 208.61
May 2021	$ 434.15	$ 175.88	$ 8.68	$ 13.72	$ 71.84	$ 164.03
June 2021	$ 247.30	$ 7.99	$ -	$ 67.58	$ 42.03	$ 129.70
Total	$ 2,502.13	$ 788.42	$ 51.56	$ 421.83	$ 360.84	$ 882.95
Monthly Avg (%)		31.51%	2.06%	16.86%	14.42%	35.29%

Case Study #4

Monthly Expenditures (estimated)							
	Total	Meat	Grain	Produce	Dairy	Shelf	Out
	$1000	$200	$50	$200	$100	$100	$350
% of total		20.00%	5.00%	20.00%	10.00%	10.00%	35.00%

Case Study #5

	Total Exp.	Shelf	Grain	Meat	Dairy	Produce	Out
Feb 2021	$ 327.98	$ 124.11	$ 49.43	$ -	$ 31.94	$ 100.50	$ 22.00
March 2021	$ 403.54	$ 172.70	$ 42.57	$ -	$ 32.81	$ 107.28	$ 48.18
April 2021	$ 505.88	$ 213.30	$ 63.85	$ -	$ 18.13	$ 127.84	$ 82.76
May 2021	$ 513.43	$ 196.05	$ 35.15	$ -	$ 70.35	$ 137.50	$ 74.38
June 2021	$ 328.00	$ 121.21	$ 10.24	$ -	$ 38.99	$ 56.99	$ 100.57
July 2021	$ 401.73	$ 140.25	$ 23.69	$ -	$ 28.52	$ 93.64	$ 115.63
Total Expenditures	$ 2,480.56	$ 967.62	$ 224.93	$ -	$ 220.74	$ 623.75	$ 443.52
Monthly Avg (%)		39.01%	9.07%	0.00%	8.90%	25.15%	17.88%

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