Can Composting Change the Future of Farming in Aisho Town? A Viability Study

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Can Composting Change the Future of Farming in Aisho Town? A Viability Study

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Abstract

The goal of this project is to evaluate the viability of an organic recycling system centered in Aisho Town. In addition to this, we hope to foster the development of organic farming through the implementation of a facility. We aim to gain a deeper understanding of the current organic presence in Aisho Town in order to best support the needs of organic farmers. Through interviews with organic farmers and sustainable companies, we gathered information on current organic presence and practices in Shiga prefecture. In partnership with our sponsor, Miyoko Kuzutani, our group outlined two plausible organic recycling methods: static pile composting and a mini biogas plant. With this added information we hope to support our sponsor in her goal to supply organic farmers with safe and environmentally friendly farming materials.

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Executive Summary

Since the early 20th century, chemical interventions have been increasingly more prevalent in farming around the world. These chemicals reduce the workload for farmers and increase crop yield while being sold at a lower price than sustainable products. For older farmers these benefits are very appealing as they are unable to carry out strenuous labor and commonly experience financial insecurity. Since it has been almost 70 years since synthetic fertilizers became common practice, many generational farmers have ingrained chemical products in their familial practices. The continual use of these practices has been proven to cause adverse effects on the environment. The longstanding history of chemicals in modern agriculture has proven to be a challenge with the reintroduction of sustainable practices. The tradition of chemical farming has affected the progress of organic presence in conjunction with economic factors. The cost of organic tools is greater than the current conventional farming tools, deterring many farmers from switching to organic practices. The economic aspects of organic farming need to be evaluated and changed to allow more farmers to experiment with these sustainable practices.

As previously mentioned, the negative effects of chemical interventions are being observed throughout the environment. Issues such as global warming, pollution, and human health risks are prominent topics discussed in society today. In the case of Japan, there is a growing awareness regarding the effects of chemical pollution on the water and soil. Lake Biwa is a large concern specifically for the Kansai region. This lake provides drinking water and irrigation to surrounding major cities and farms. Farms in the area that overuse chemical interventions cause runoff which flows into nearby streams and rivers. This poses a threat to both the ecosystem and those who rely on it for water. Unfortunately, this is not a problem isolated to Lake Biwa, many water sources around the world have been deemed “superfund sites”. These sites are disaster areas where pollution has made a location uninhabitable, therefore gaining the attention of the government. Work on superfund sites involves land decontamination of the area as well as restoring it to inhabitable levels. To prevent more bodies of water from becoming superfund sites, action needs to be taken to reduce pollutant use.

Our sponsor, Miyoko Kuzutani, is a member of the Aisho community who is looking to make a difference in agriculture. Prior to this project, Miyoko studied in Washington state to get her master's degree in leadership and communications. During her studies, the Washington compost waste system first sparked her idea of composting. Once she graduated, Miyoko returned to Aisho Town, where she joined the Local Revitalization Corperation (LRC). The LRC sponsors people around Japan looking to start a sustainable business in rural areas. They supply individuals with a stipend for 3 years to start up their company with the hope that this business will make a positive impact on the community. Miyoko has now asked us to help her evaluate what composting or organic recycling method would fit best into her vision. The objectives we outlined to achieve this goal are as follows:

1. Research different organic recycling methods, including composing
2. Research what is currently being done to organically recycle in Japan
3. Evaluate the viability of the top composting methods we explored

In addition to preliminary research, we also conducted a series of interviews with farmers around Kyoto and Shiga prefectures. During these interviews we were looking for information about current farming methods, attitudes toward organic farming, and personal passions in farming. Through this data we hoped to gain insight into what is currently being done in Shiga prefecture, as well as what farmers want. Other important data factors we tracked were if farmers define themselves as organic, if a farm was generational, and their market presence.

We also wanted to learn what difficulties farmers have been facing on their farms. The two most consistent challenges we heard were store bought compost having a lack of nutrients and pests destroying their crops. To address store bought compost's notorious lack of nutrients, farmers currently have to either add ingredients to it or supplement it with other methods. This is additional work for farmers and decreases the overall appeal of using compost. As for pests, farmers currently use various methods for dealing with them. This ranges from relying on the crop's inherent resilience against pests to implementing chemical pesticides.

We collected various responses during our interviews: however, we had some trends consistent amongst many farmers. The most common theme in the Shiga farming community is the focus on microbial presence. This has become a large part of our project as we feel the key to a successful composting facility is the microbial presence in the product. To best cultivate a strong microbiome in the compost we recommend the implementation of one of two systems:

1. Aerated Static Piles
2. Mini Biogas Plant

Both of these methods of organic recycling will yield a high-quality organic fertilizer for farmers in Aisho. Based off the community perceptions we have gathered, plant-based materials are the ideal waste input. Cow manure is also a possible input; however, many farmers expressed disinterest in using it due to it being perceived as unhygienic. This makes it a less ideal choice. This stigma is the reasoning behind recommending plant-based compost. Community and cultural perceptions play a role in the management of this recycling facility as it decides what factors will be perceived by the community best.

The 14 weeks we have spent on this project have allowed us to gather large amounts of data on both Japanese farming culture as well as current methods being used. Unfortunately, our time constraint did not allow us to explore every possibility for our project. If we had more time, we would have liked to interview a JAS certified organic farmer. There are few JAS certified organic farms in Shiga, which has made it difficult to find interviewees in this focus group. We feel that future exploration into the JAS side of organic farms would be beneficial to see how larger organic farms are managed. In addition to this, we also would have liked to interview an existing composting facility. We were able to gather data from Shimamoto Farms and their vime food production; however, there are many questions left to be answered. If we had more time another set of interviews would have been with current composting facilities. These interviews would have allowed us to better understand current methods of waste collection, compost distribution systems, and composting methods being used. Including the data from those two focus groups will add to the success of Miyoko's project and another layer of depth to the research being done. Despite these limitations, establishing two viable methods as well as the data we collected will help design the conceptual framework of the composting facility.

Chapter 1: Introduction

1.1 - The Problem:

Beginning in the 1950s, the use of synthetic fertilizers and pesticides quickly spread and has since been used by farmers globally. While these products make farming easier, the quantities they are being used in are not sustainable. These products can both increase the risk of serious illnesses to people who are over-exposed to them and destroy the surrounding environment if applied carelessly. The problem of chemical farming is especially pressing in Japan, with the country being one of the largest consumers of chemical pesticides per area of crop land in the world (Kubo, 2017)!

The effects of chemically intensive farming are harming the ecosystem and communities in Japan, specifically, around Lake Biwa, a major water and fishery source for the Kansai region which feeds into major cities like Kyoto (Tsuda, Fujita, Kojima, Aoki, 2003). By introducing more sustainable farming methods into the area, the negative impacts of chemical intensive farming could be greatly reduced. Our project issue revolves around finding viable organic recycling methods, such as composting or biogas, that are both economically friendly and scalable to fit in the current land available in Aisho Town. Our sponsor's end goal is to service the greater Shiga region while being based out of Aisho Town. Because of this another problem will be to investigate what method of organic recycling would fit best into Miyoko's project vision, while keeping in mind the current farming practices in Aisho Town.

1.2 - Previous Projects and Global Efforts:

While organic agriculture practices have struggled to become widely implemented, there have been many attempts around the world. These include raising awareness and regulations, teaching the community how to use helpful resources like compost, using techniques like crop rotation to lessen the impacts on the soil, and more.

The 1960-70's in Japan saw rise of the *Teikei* movement, where producer and consumer alike worked to grow and distribute organic produce (Kondo, 2021). The movement idealized small, sustainable agriculture to benefit the larger community through publicly agreed upon pricing and a co-partnership between consumer and producer. *Teikei* groups began emerging during this time, beginning a new agricultural reform within Japan. An emphasis on organic farming led to a rise in commercially available organic produce in the 1980's. Shortly after this in the 1990's the number of *Teikei* groups began to decline, with the remaining groups having altered their practices to address other challenges they have faced.

There have been many programs and studies conducted around the world to help spread awareness of organic farming. Eco Thailand is one of these projects, initially supported by the Canadian Fund for Local Initiatives, it has since grown to be a major presence on the Thai coast. (Eco Thailand, 2023). The project aims to provide farmers with a low-risk environment to explore and learn about organic farming, and even offering materials to compost on their own. This environment has been successful at promoting the benefits of sustainable organic practices.

Recology is a waste management company based out of San Francisco which handles much of the Bay Area's household and solid waste. Beginning in 1996, Recology took an initiative to better deal with organic matter in its waste systems (Collins, 2017). This program focuses on turning organic matter from household waste into usable compost for residents and nearby farms. Implementing a mandatory curbside composting bin in a majority of the Bay Area, Recology is able to collect 650 tons of organics a day and can produce 350 tons of usable compost (2017). Additionally, Recology offers delivery services through their website to farms in surrounding areas, aiming to provide them with a reliable source of compost.

Furthermore, students from Worcester Polytechnic Institute (WPI) have been working in collaboration with Chuck Kayser, owner of Midori Farm, to address challenges in sustainability efforts. The Kyoto Composting Project from 2018 implemented a composting system on Midori farm and established a network of environmentally active people to stimulate the presence of organic. Empowering composting at Midori Farm in 2019, developed a plan for a cost effective solar powered composting system (Bhatia, Pachon-Puentes, Rossum, Stabile, 2019). The most recent group in 2022, called The Kyoto Organic Urban Farming Initiative, worked to evaluate why organic farming is not widely used and built a classroom for Chuck to teach organic farming methods to residents.

1.3 - Project Goal:

Our goal is to help our sponsor, Miyoko Kuzutani, research the viability of an organic recycling plant in Aisho Town, to help alleviate the impacts chemical farming has had on the surrounding area. Secondary goals include helping to reduce the cost of organic tools for local farmers and support the presence of sustainable farming.

1.4 - Findings:

After our seven weeks in Japan, we had gathered key aspects of our project such as the microbial presence in the soil. Through our interviews we observed 3 types of organic recycling: green manure, static pile composting, and vime food additive to compost. Each of these methods gave us valuable insight that will be used to design an efficient facility. Based on our findings, we recommend the design of the composting facility be focused on microbiology. By focusing on the microbial presence in the recycled waste our sponsor will be able to create high quality, healthy compost.

Chapter 2: Background

Farmers have struggled to switch from chemical to organic farming methods due to a variety of challenging factors such as the high cost of certification through the JAS (Babajani, Muehlberger, Feuerbacher, Wieck, 2023). The negative effects of these chemical interventions, though, are becoming more prevalent in today's climate with environmental pollution and climate change becoming increasingly threatening issues. These issues are becoming more pressing for the community members in the Shiga prefecture in Japan; specifically, the farming community. Farmers are more inclined to rely on chemical interventions because of factors like age and economic stance. Extraneous manual labor is not a viable option for the farmers of Shiga, where an average of six out of ten farmers are over the age of 65. (J.J O'Donoghue, 2018) J.J O'Donoghue, writer for Japan Times, stresses the need for accessible organic farming tools during this turning point in Japanese farming history. Japan is on the edge of losing farming due to the aging farming population and the lack of younger individuals investing in farming. Owning a farm is not financially ideal for the younger population (2018). Keeping this in mind, our sponsor is working to solve this issue, our project seeks to help our sponsor, Miyoko Kuzutani, create an organic recycling facility in Aisho town, a small farming town in Shiga prefecture, Japan. By doing so, we would help to alleviate the negative impacts that have emerged do to chemically intensive agricultural practices that have persisted in Japan since they first gained popularity in the 1950s.

2.1 - History of Agriculture globally:

From the 1900s to the 1950s American farmers had been up taking new machinery to replace much of the manual labor. Machinery like vehicles pulled plows, mechanic hay bailers instead of making bales by hand, and new bale pickups to do the heavy lifting. These technological advances allowed farm sizes to grow from an average of 30 to 70 acres (US Census Bureau, 1950). This period of farming existed 50 years before the widespread introduction of chemical interventions to farms.

After their introduction, farming chemicals quickly became widely used all around the world (as seen in Figure 1). This has persisted until today, with chemicals now being the industry norm due to their low prices and ease of use. These chemicals are not a sustainable form of farming and pose threats to the environment, surrounding ecology, and human life. Dangers from synthetic farming products reach humans and the environment not only through the soil but the air too. Based on scientific evidence, it has been found that an exposure to pesticides in any form can lead to negative health impacts ranging from irritated skin and respiratory problems all the way to chronic diseases including hematologic and hormonal abnormalities, infertility, miscarriages, fetal malformation, neurological diseases, and cancer (Lopes-Ferreira, Maleski, Balan-Lima, Bernardo, Hipolito, Seni-Silva, Batista-Filho, Falcao, Lima, 2022; Thorpe, 2017).

Furthermore, if applied carelessly, these chemicals can cause negative impacts on the surrounding area. This is especially the case with pesticides, which can indirectly harm the surrounding area. Synthetic insecticides like organophosphates and organochlorines are often banned or restricted due to the impacts they can have on consumers and the environment, while neonicotinoids are under scrutiny due to the possibility of harming bees (Thorpe, 2017).

Additionally, organic pesticides, also known as biopesticides, can also cause harm through insecticides like rotenone being extremely toxic to fish if it reaches a body of water through runoff (2017).

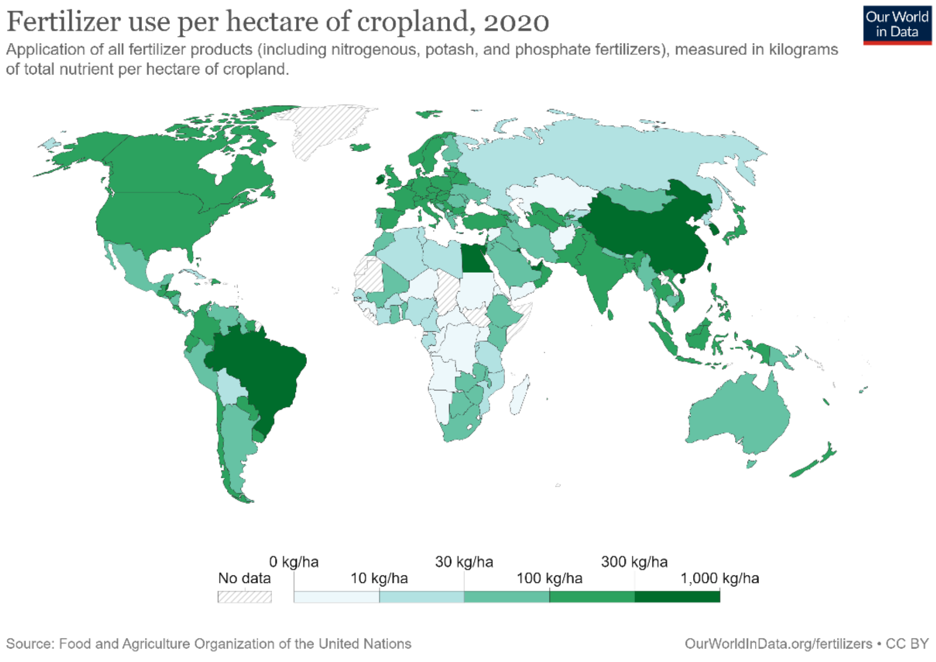

Figure 1: Map of synthetic fertilizer (kg) per hectare organized by country

Figure 1 above shows the global usage of synthetic fertilizer in terms of kilograms per hectare. The darker green colors symbolize high chemical usage in the area. The use of synthetic fertilizers and pesticides causes harm to the soil and the complex soil ecosystem. These microorganisms decompose organic matter within the soil and turn it into a natural fertilizer for plants. Chemical fertilizers do not decompose though, and they are instead directly absorbed into the plant. This leads to the microorganism in the soil not getting any food, starving, and ultimately dying off. A lack of microorganisms in the soil allows for plant pathogens and pests to breed, putting the plant at risk. If these pathogens and pests are addressed with chemical pesticides though, the microorganisms in the soil can also be killed. This further decreases the nutrient producing capabilities of the soil while also increasing the potential of threats to the plant (Kubo, 2017).

2.2 - Japanese History of Agriculture:

The post Second World War period of rapid economic growth signaled the end of an era for Japanese agriculture. Many traditional practices utilized before the war were replaced with agrichemicals and heavy machinery (McGreevy, 2011). This push coincided with rural depopulation efforts, moving many full-time farmers towards the city to work their farms as a secondary occupation. At the time, many saw this push as an improvement to the lives they were living before. Prior to migration, many farmers had been living a subsistence lifestyle, living harvest to harvest and sometimes not even that (McGreevy, 2011).

As many farmers migrated closer to major cities and began farming part-time, large areas of once farmland were repaved as major roadways (McGreevy, 2011). To streamline the agricultural sector, other projects began to consolidate and construct central irrigation networks. Many rural farmers saw these drastic changes to their lifestyle and welcomed them, feeling this was a means to move past their socially stigmatized pasts (2011). These changes also allowed many to stop living harvest to harvest and begin to stabilize their income with other jobs in larger cities. The ability to have a second source of income also allowed many households more freedom in how they lived, with this new income typically (2011).

As agriculture became more industrialized across Japan, public health concerns began to arise due to the adolescence of many practices. This led to a string of food safety scandals in the 1950s and 60s. One prominent scandal was the Morinaga Milk arsenic poisoning of 1955, which was reported to have killed around 100 young children (Dakeishi, 2006). As a result, public confidence began to waver and led some to look for safer alternatives (Kondo, 2021). Housewives had a particular interest in safer foods, leading to the creation of coalitions called *Teikei* groups where community members would work directly with smaller farms and farmers. This co-partnership led to several innovations in alternative food networks (AFN's) and organic farming movements which have existed or evolved over the last several decades. One of the largest innovations was the practice of producers and consumers alike being involved in the production and distribution of food. The practice of consumers assisting in the growth of food led to many benefits, including a reduction in operating costs for farmers and little price fluctuation for consumers. The *Teikei* movement thrived well into the 1980s. However, the 1990s saw a drastic decrease in *Teikei* groups across Japan. The popularity of the movement was hampered due to the rise of organic food appearing in markets and stores (Kondo, 2021). Additionally, many children of the pioneers of the movement also had different views from their parents, feeling that the ideas and implementations of the *Teikei* movement were too labor intensive to be worthwhile, leading to a labor shortage.

Keeping the agricultural history of Japan in mind, there are several important things we need to consider when looking at Aisho town, Since Aisho town consists of small farms, we will focus on smaller scale farms. We also have the goal of creating a scalable process that could be applicable for larger farms as well. To better know how widespread our project will be, we will need to acquire certain on-sight information. This includes information such as the general size of the farms in Shiga, and how receptive the local farmers are to organic farming practices.

Shiga prefecture has taken small measures to increase the number of sustainable practices through legislation starting in 1980 with the Clean and Recycling Agriculture (Nishizawa, 2015). The CRA act came from the Department of Agriculture and Forestry to manage fertilizer and water usage. This Act carried into the 1997 Water quality protection in Lake Biwa and measures for agricultural runoff Act sparked the beginning of sustainable farming acts (2015). This legislation regulated the nitrogen and phosphorous discharges from factories. In March of 2001, Shiga released their first "Vision for Agriculture and Forestry" statement, that has since bene updated every 5-10 years (2015). This laid the foundation of sustainable farming processes in Shiga that still exist today, Including a certification system. This system gave products a label of Eco-farming if they used more than 50% less chemicals (2015). All these efforts lead to the number of eco-farmers increasing from 0 in 1999 to 9,700 in 2014 (2015). These numbers have increased since then. Leaving us today working to support these existing eco-farmers with compost.

2.3 - What We Know So Far:

Shiga prefecture has a long history of agriculture, with roughly one sixth of the prefecture's total land being used for agriculture. Much of this is rice flats and cattle farms. Additionally, organic farming is not widespread, with most still using conventional farming practices. Agrochemicals are still largely encouraged by the Japanese government, continuing accessibility to many of these products (Honma, 1993). With these products being easily accessible combined with the shrinking and aging farming population in Japan, it is a possibility that much of the potential competition against chemical farming comes face-to-face with this daunting opponent.

Within Shiga prefecture, and across Japan as a whole, the median age has been steadily climbing since the 1950s. This population aging has affected farmers more than nearly any other group, with a roughly 60% decrease in farming population between 1985 and 2015 (Nippon.com, 2018). While other countries main workforce for farmers average age ranges from 20-30 years old, Japan has the oldest work force with ages starting at 55 and above.

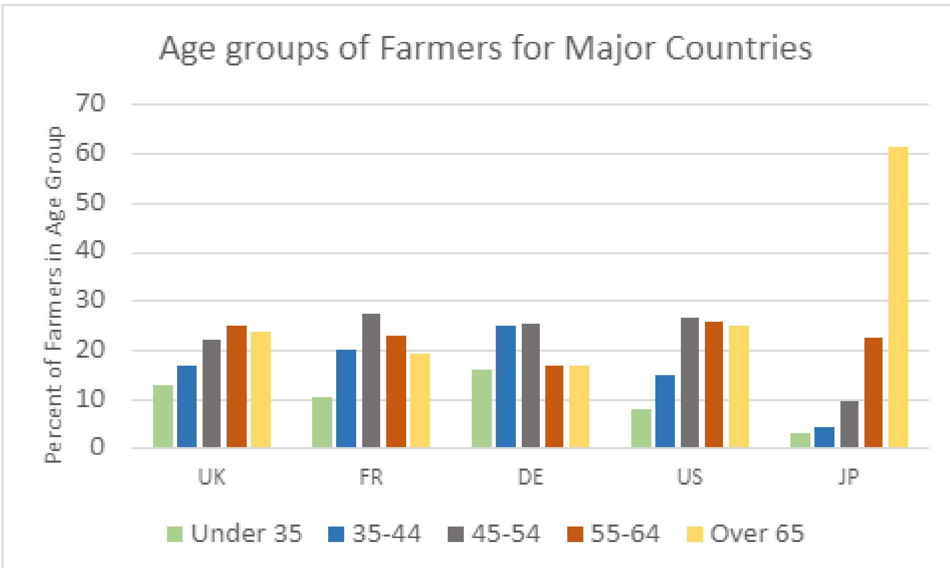

Figure 2: Average age of Farmers in United Kingdom, France, Denmark, United States, and Japan (Hayashi, Eiji. 2019) Adapted from: Hayashi, Eiji. 2019

Given the above issues, the strain on many Japanese farmers has increased significantly over past decades. It can be inferred that this has also had a drastic impact on many older farmers' mentalities, given the shift from smaller farming groups to a more centralized and industrial system (McGreevy, 2011).

Our group is operating under the assumption that many of these increased yields can be loosely attributed to the use of agrochemicals. These chemicals can easily affect a wide range of pests or be specialized for certain crops to stimulate more vegetative growth or fruit. Fertilizers can contain high amounts of specific nutrients to stimulate certain growth, such as nitrogen for vegetative growth. With different stages of a plants' life cycle requiring different fertilizers and leading to an average absorption rate of between 30-35% (Lawrencia, Kiat Wong, Yi Sern Low, Hing Goh, Kheng Goh, Rungsardthong Ruktanonchai, Soottitantawat, Han Lee, Ying Tang, 2021), much of the fertilizers are prone to runoff and polluting the surrounding areas.

When compared with organic counterparts, agrochemicals are typically easier to apply (Matthews, 1998). More common application methods include tractor sprayers, aerial spraying, and portable spraying (1998). Given that many farms in Shiga prefecture grow rice, we assume portable spraying is the most widely used method of application due to its versatility. Spraying works with a wide variety of agrochemicals, including pesticides and fertilizers such as urea and ammonium-based products. However, due to a lack of aerosolization or liquification found in many forms of compost, it is not compatible with these types of equipment. In trying to move existing agrochemical farms towards compost, we assume that many farms would be required to buy either new equipment or hire more laborers.

Most farms in Japan depend on chemical products like fertilizers and pesticides for farming. Additionally, the government has been subsidizing certain products and providing subsidies since the 1940s to help farmers and companies, though this process has become much more challenging in 2022 due to the ongoing conflict in Eastern Europe, where many agrochemical companies source their raw materials (Hatsumi, 2022), drastically increasing prices for raw materials. The government has started sourcing and heavily subsidizing raw materials from countries, such as Canada, in the place of Japanese private companies to keep products affordable for small farms (2022). Despite their efforts, prices are still steadily rising, which we assume has been leading many people to look for cheaper alternatives.

As the farming population ages, along with the dwindling workforce, many farms are either run by a handful of farmers or left abandoned (McGreevy, 2011). To increase the number of farmers and populate abandoned farms, the Japanese government has begun offering a variety of subsidies to entrant organic farmers moving from larger cities to more rural areas. Given these new subsidies, organic farming has significantly more support than in the past, making it a good time to start organic practices. Despite this, many new farmers are shying away from these subsidies, claiming that their size could lead to dependence and a non-viable farm in an economic sense (Zollet, Lall Maharjan, 2021). Even with these stipulations, some farmers are applying for and receiving funding to ease their entry into the agricultural landscape.

2.4 - Project Knowns:

The average farm size in Shiga is about 7.66 acres of land (Yoshikawa, 2023), though there are larger farms present. We plan to map the size, number, and location of farms we visit or know of to gain a better understand of farm sizes once we are in Japan. Based on this knowledge we can assume the majority of the farms we will work with will be around 7 acres of land, which will help to scale the amount of compost needed. On average, between 5-20 tons of compost are needed per acre of land to accommodate the soil's needs (Rittenhouse 2015). When picking a composting method, we will need to evaluate the average amount of compost that could be produced with each method. A large amount of compost will be needed to properly support the Shiga farmers. Based on our research, the main products sold in Shiga are rice and cattle products. This knowledge leads us to focus our compost materials to support mainly rice. Compost to support rice farming has been found to be most effective if it includes 74% rice by-products (Kadoglidou, Kalaitzidis, Stavrakoudis, Magdalia, Katsantonis, 2019). This knowledge tells us we need to focus on the creation of large amounts of crop specific compost as a supplement for chemical fertilizers.

Composting can be done in a variety of ways, depending on the desired product amount and effort needed. For our project, we have decided to explore methods that could support a larger output of compost. Below is a brief outline of possible composting methods for our project.

First off is **Vermicomposting**, or worm composting. This includes taking one of two possible species of earth worms, *Eisenia foetida* and *Lumbricus rubellis*, to add to a bin of organic waste. These worms break down the organic matter into something called castings. These castings are the compost that will be used in the soil (US EPA, 2023). The worms can break down food scraps, paper, and yard waste, meaning the type of organic matter collected for composting will be selected for those materials. The compost produced by the worms is nutrient rich and suitable for all types of plants. The worms require care to maintain their health to continue producing high quality compost. Meaning they will need ample nutrients and proper climate conditions. Ideal temperature ranges from 55 degrees to 75 degrees Fahrenheit (US EPA, 2023). Japan winters are colder and will require human intervention to maintain the temperatures within that range during the colder months.

A similar process provided by the US Environmental Protection Agency is **static piles**, which include taking piles of organic waste layered with a bulking agent to aerate the waste materials. Bulking agents include newspaper or woodchips which are very porous and allow oxygen to flow into the otherwards closed off pile. Static piles are suitable for producing large amounts of compost. Compostable material includes yard waste, food scrapes, and paper (US EPA, 2023). However, these piles cannot break down any grease of animal waste. Manual labor is less for this method and only requires careful monitoring to ensure the process is going correctly. The odors excreted by this method are not palatable and will require either masking or to be done far away from residential communities.

In-vessel composting is yet another viable method of composting. In-vessel composting takes a large vessel, either a drum or a silo to store the organic waste in to decompose into compost (US EPA, 2023). A large variety of organic waste materials can be used in this process. Animal byproducts, liquids, food scraps, yard waste, and biosolids can all be put into the vessels. The scale of these vessels can be changed to accommodate the size of facility. Small containers can be used in residential areas, while large industrial sized vessels can be used for larger communities (US EPA, 2023). This method takes little time to start producing usable compost, completing the process within a couple of months. Because the process takes place in a vessel there is less of a need for manual labor. Labor comes from the system monitoring and waste loading/unloading into the system.

The last composting method for our project is called **turned windrow** composting. This composting method includes making large, long piles of organic waste called windrows. Common dimensions of the windrows are around 4 feet in height and 14 feet wide. The windrows are aerated either manually or mechanically to turn the piles over (US EPA, 2023). This allows oxygen to enter the pile and supports the decomposition process. Windrow composting produces larger amounts of compost more suitable for farms to utilize. The organic waste allowed into the windrows is vast, including yard waste, liquids, and animal waste (US EPA, 2023). The hands-on labor needed for this method is greater than the of the other methods listed. People will need to turn the windrows, pile the waste, and then distribute the compost, which can be done manually or with a machine.

Furthermore, an experimental method of composting that is also viable for our project is a **mini-biogas plant**. In an enclosed system, organic waste is digested into viable compost while the gases expressed by the organic matter are collected. Biogas itself is the byproduct of anerobic digestion of the organic matter in compost (Energypedia, 2015). The gas from the digestion is commonly used as an energy source to power small functions like a household kitchen, though the system can be scaled to support the desired amount of output. Keeping in mind the scale, 1 kilogram of dried cow manure produces one liter of biogas (Ecovaper, 2023). Additionally, the compost created in this system is a good source of nitrogen rich compost for farms. Biogas plants can have inputs of animal waste, plant debris, and food scrapes making it a versatile system. Manual labor for this system comes from loading the waste materials into the system, monitoring the composting vessel, and compost collection.

2.5 - Similar Projects:

The Eco Thailand project is a role model for our project in Shiga. This program was created to promote healthier living through organic farming. By providing the community with compost it granted community members the ability to farm organically. The implementation of this project has increased accessibility to crops in this area. The main objectives of the Eco Thailand project included building a composting center as well as supplying the community with means to compost on their own. Composting mesh is also supplied to the community for households to partake in their own composting (Eco Thailand, 2023). This project was successful in implementing organic farming in their community which still operates today. A key aspect we are evaluating for our own project is the funding they receive from their Global Funding for Community Foundations (GFCF). This network of supporters donates money to upkeep the project needs. As we see it, removing the economic investment reduces worry and creates an open-minded space with the target groups.

There are many barriers associated with organic farming that make it less appealing to conventional farmers. One major barrier being the cost associated with the JAS organic certification. An organic certificate from the JAS costs $2,000 USD, which is costly upfront.

Figure 3: JAS stamp of organic produce

Another limiting factor is the compost type and machinery associated with it. Labor costs for adding compost to the soil can be taxing for an older farmer without help from machinery. Factors like these are what deter many farmers from investing in organic practices. A societal barrier we will face is the community's perspective on organic produce as a whole. We plan to better gauge the community perspective on organics and sustainability once we arrive in Shiga. As shown in Appendix A, the number of Organic farms in Shiga is low on the list compared to the rest of Japan with only 36 organic farms. Based on this we have developed a survey for the community members of Shiga to help us understand the residents' sentiment towards organic farming.

2.6 - What We Need to Know:

We would like to gain an understanding of the area so that we could better understand where a composting facility could fit into the community. Some composting methods produce distasteful odors and airborne pollutants, which is something we need to take into play. Adapting the facility location if needed to alleviate the less ideal outputs is important to the project success.

Another factor we need to investigate is whether there are enough farms in the area to justify the building of a composting facility. Furthermore, if enough of those farms express interest in organic farming to warrant the construction of said facility. It will be more efficient to support a pre-existing market rather than create a whole new market.

On a similar note, we would also like to gauge a community interest in organic farming. We are excited to talk with locals about why they choose to partake in chemical or organic farming. We are also interested in learning the motives behind conventional farming and organic farming. To further our understanding of the community ideals we would like to evaluate how organic farming fits into Japanese society.

2.7 - Project Goals:

Organic farming in Shiga could lead to improvements to the health of consumers, an increase in sustainability, and a better relationship with the surrounding environment. This, however, is dependent on what organic farming ends up looking like in Shiga. If a majority of local farmers are not receptive to organic farming methods, then, naturally, the benefits will not be realized.

One of the biggest questions we want to answer is how the local ecology will be impacted by a transition to organic farming. Chemical farming methods that are being used are harmful to ecological flora as well as the people living in the community. Sustainable farming is a viable solution to evading these ecological and humanitarian issues. We would like to explore the current education on sustainability to see how these practices are being used.

We would also like to understand how the cost of organic farming could impact local farmers. As opposed to chemical farming, organic farming is more expensive due to the cost of irrigation and labor (Durham, Mizik 2020). Additionally, a certain amount of infrastructure may need to be built to support organic farming. Looking into the costs involved in establishing a composting facility may also play a part in the direction we take the project.

Our project hopes to service Shiga and possibly surrounding prefectures from a depot in Aisho Town. It is a goal for our sponsor to eventually service as many consumers of organic compost as possible. During our seven weeks in Japan, we plan to create a conceptual design for the composting facility. Later IQP groups could potentially take on the project of constructing a facility for Miyoko, as that step is outside of our scope due to our time constraints.

2.8 - Project Proposal:

The composting facility ideally will produce large amounts of compost, more than an individual person would be able to transport without help. Our plan is to include a delivery and pickup system with commercial trucks to make the process easier. This in turn will also create more job opportunities in the transportation area. A variation of this idea includes creating a sector in the current waste management system in Japan that would collect and distribute organic waste and compost. Breaking from the current method of compactor container transfer, the waste management employees would introduce collection bins for organic waste as well as a new smaller compactor transfer system. Then, during their weekly pick up, they would collect the organic waste and deliver it to the composting facility. This collection method is similar to the one used in California, with their organic waste bins (CalRecycle, 2023). Our sponsor has been investigating this option by evaluating the current Recycling system in Japan. But, to determine how effective this system would be we plan to investigate the Waste Management system once we arrive in Shiga. Both of these variations would help to reduce some of the strenuous manual labor for the older community.

2.9 - Section Recap:

Based on our background section we have compiled many big questions to support our facility design and community implementation process. The biggest question we have yet to solve is what composting method will support Miyoko's facility best? And how can we implement our compost in the community to replace chemical fertilizers? In the next section we lay out how we plan to answer these questions and how we plan to implement the found data in our final proposal.

Chapter 3: Methods

3.1 - Project Goal:

Our project goal is to help our sponsor, Miyoko Kuzutani, research the viability of possible sustainable recycling methods with the intention of implementing them within Aisho Town, Japan. Our primary objectives for acquiring this information were to research different methods of organic recycling, evaluate the success of the organic recycling methods in the community, and to then use this information to assess the viability of each option and design a conceptual organic recycling facility. By completing these objectives, we hope to alleviate the impacts chemical farming practices have had on the surrounding environment, while also promoting more sustainable practices such as composting.

3.2 - Project Scope:

Once an organic recycling method was decided on, the next issue to tackle was the scale of production. The scale on which we want to compost will affect the required size of the site. We needed to analyze the land currently being rented by our sponsor and determine the proper scale and accommodation that will be needed to properly support the facility.

Preliminary research has led us to believe that farmers are aware of organic farming and its benefits but are deeply rooted in their family's traditional farming methods. These family traditions could include the usage of synthetic fertilizers. Additionally, family traditions are an important part of Japanese culture, making it difficult to ask farmers to give up their practices. Preserving familial traditions will be an important aspect for us to consider when introducing organic fertilizer into current methods. Another important factor to keep in mind will be the cost of sustainable farming practices. For a farmer to reap the most benefits of organic farming they will need organic certification. Organic certifications through the JAS are costly and deter many farmers from shifting away from chemical practices. Evaluating these two aspects has helped us to frame our research scope to fit in the community.

Our current proposal is a conceptual design, due to the preliminary stages our sponsor is in with the project. After we leave Japan, we plan to have our proposal support Miyoko in her decision for how to implement an organic recycling system. Further development of this project will be determined by the efficiency at which the preliminary stages are completed during our seven weeks in Kyoto.

3.3 - Types of Composting:

Working off Figure 3, we calculated numerical data for the possible composting methods. To better support the general factors, we specified numerical factors that should be calculated, such as labor and money costs. These numbers will be calculated based on research found through facilities in Japan.

The turned windrow method requires some expensive pieces of machinery to be efficient. Bulldozers and tractors are expensive machines needed to aid in the turning of the piles. The alternative to machinery will be to turn the piles by hand with smaller handheld tools. This method requires a larger amount of land to accommodate the amount of organic material going in. Despite the land requirement, turned windrow piles produce large amounts of compost to better support larger farms. Turned windrow is also the most used method when composting at the commercial level.

Compared to in-vessel composting which takes about 10 weeks, vermicomposting takes 3 to 4 months to produce any compost. The scale of production is limited for vermicomposting, with the average size bin being 14 gallons to accommodate a single household worth of food scraps (Alvarado, 2023). This method works best for individual farms and gardens due to the smaller scale, nevertheless, this method produces nutrient rich compost.

Biogas plants, as mentioned before, have a versatile input ability. Biogas plants break down animal matter, plant byproducts, as well as food scrapes. The input of waste materials determines the type of biogas produced. There are two possible types of biogases: dairy and swine, and landfill gases (EcoVapor, 2015). Digestion time for these gasses' ranges from 10 to 30 days, depending on what is input to and anaerobic digestor (Inoplex, 2022). Lower digestion time correlates to whether the substance is primarily carbon or nitrogen based. Substances containing more cellulose or lignin will take longer time to digest (2022). Size can be scaled to match the desired output. This is a versatile system that can produce both compost and energy sources.

3.4 - Schedule:

During our first week in Japan, we will mainly try to identify possible farms we could interview in the area. We are hoping to set up interviews with both organic and conventional farms so that we can acquire multiple perspectives and avoid skewing our data in any way. Moving into the following week, we plan to continue identifying possible farms for interviews while also creating a set of interview questions that can be used. Additionally, we would like to meet with our sponsor this week. This way, we can see if what we have been planning fits within her vision, or if there is anything that she would like for us to change. Towards the end of this week, we will also begin reaching out to the identified farms with the hope of arranging interviews.

For the following two weeks, we will focus primarily on conducting interviews and compiling the data that we receive from them. Furthermore, we will also begin editing and revising our report. Moving into the fifth week, we will begin to shift our focus towards analyzing the data we have collected from our interviews while also continuing to work on the report. After our sixth week, we plan to have completely shifted towards data analysis, finishing up revisions on the report, and beginning work on the final sections of our report. For our last two weeks, we plan to finish up our report and create our final presentation, and then finish the project with our presentation.

3.5 - Project Objectives:

Our project focuses on three main objectives: researching different methods of organic recycling, researching what is currently being done in Aisho to organically recycle, and using the information to assess the viability of each option to design a conceptual organic recycling facility. Together, these objectives have allowed us to gain a comprehensive understanding of the agricultural landscape of Shiga prefecture and a better idea of the community's overall perspective on composting and organic farming. This in turn allowed us to create a better list of recommendations for our sponsor moving forward.

3.5.1 - What is Organic Recycling?:

Our first objective is researching what organic recycling is as well as how communities can partake in it. One very common method of organic recycling is composting. However, we would like to explore outside of composting to find other methods. One possible method of focus will be Mini Biogas plants. We plan to achieve this objective by collecting information on how each method works, the cost and labor expenses, and materials needed.

3.5.2 - Investigate the Current Organic Recycling Methods in Japan:

For our second objective, we conducted interviews with farms and composting facilities. Through these interviews, we learned about the success of the different methods that vary from the perspective of individuals in the field, and what they have done that has helped them be successful. We planned to conduct interviews in person; however, we recognized that this is not always possible, and thus, also planned for phone call interviews. The information we acquire will help to dictate the final product of our conceptual recycling facility. Data from these interviews will be coded for later use.

3.5.3 - Designing a Conceptual Organic Recycling Facility:

To design our organic recycling facility, we took into consideration what the facility produces, the ease with which it produces the recycled material, and how efficient the facility is from the perspective of cost and labor. Charts and design ideas can be made for each method we evaluate to help visualize data with more ease. Through collaboration with our sponsor, we evaluated the key ideals of the recycling facility and found what method fits the ideals best. The final goal of our project is to take the final data to develop designs for multiple methods.

3.6 - Approaches to Analyzing Data:

Our approach to tackling the data analysis relied mainly on empirical analytical and hermeneutic approaches. Seeing as most of our data consisted of personal accounts and opinions, we needed to use hermeneutic approaches to better understand our data and how it fits into our results. Through the hermeneutic approach, we were able to better understand what each account is conveying and apply it to the larger data pool.

Our project generated data in many different forms for future analysis. The brunt of our data came from interviews which required both interpretation and analysis. This data provided us with perspectives and information about what is currently being done to organically recycle. We were able to gain a better picture of how farmers define organic farming along with how these ideas impact their everyday lives. Upon analyzing this data, we also got a better understanding of certain demographics in the area and how this may play into their opinions, views, and practices.

Collecting qualitative data from interviews came with many challenges in processing. One of the larger issues in processing was separating person bias from the interactions with those interviewed and from the opinions collected. The data can also become skewed during processing due to an inability to separate personal feelings and opinions from those of the responses being reviewed. A data set was fully collected and organized before being analyzed in order to mitigate any potential discrepancies during the process. Peer review of the analyzed information was utilized whenever data was processed as a check for potential issues during analysis.

3.7 - Flaws and Limitations of Our Methods:

A limitation we have faced during our project was the transportation available to us. We were unable to travel to all the sites we wanted to. This made certain pools of data and certain interviews not possible unless an online meeting of some kind could be arranged. This pertained mainly to gathering information from current composting facilities around Japan but also impacted us while collecting data from local farms within Aisho Town.

Another limitation was how receptive certain people were to participate in our interviews. Due to the nature of our project, practitioners of chemical farming methods could have possibly felt antagonized, leading to an unwillingness to participate or be receptive to our suggestions. Depending on how this plays out, we could indirectly end up with a data set that fails to represent the actual opinions of the population. Preventing this from happening though was challenging due to the difficulty in identifying if it is happening.

On a similar note, due to the small nature of Aisho Town, English speakers were very rare, creating a language gap that needed to be overcame. This language gap also led to complications when gaining participants for our interviews, and also while conducting the interviews. Care will have to be taken to ensure that people’s opinions are not lost in translation.

Chapter 4: Data and Analysis

During our time in Japan, we have made connections in both Shiga and Kyoto prefectures with farmers and community members. During our interviews these farmers shared insight into their farming practices and the produce they grow. As a result, we were able to gather an understanding of what they do daily. Through the farmer's narratives we learned about the importance of nurturing the soil. In addition to the farming methods, we also collected each of the farmer's personal passions and values in farming. We got to experience firsthand how each farmer works while also getting taste all kinds of delicious foods. This chapter will expound on the data we collected using the methods chapter previously discussed. The qualitative data we gathered from our interviews will be used in parallel with our analyses of individual organic recycling methods to create our final recommendation.

4.1 - Interview Summaries:

Over the course of our project, we interviewed nine farms and two companies associated with composting. For each interview we created a set of 11 common questions to ask each farmer so that we could acquire comparable answers for our data (Appendix A). We also included personalized questions for each farm to help us better understand more about what made them unique, as well as teach us about topics we had previously not considered. Through interviews with nine farms, we gained valuable insights into the aspects of composting and farming.

Farm	Organic?	What Organic Tools Used?	Crops Grown	Generational
Katagi Koka En	✓	Compost	Tea	✓
Shimamoto	✓	Vime Food, Wood Compost	Seasonal Vegetables	
RE: ARTH	✓	Recycled Coffee Grounds	Shitake and Oyster Mushrooms	
Midori	✓	Compost	Seasonal Vegetables	
Ichi Gobiyori	✓	Compost	Strawberries	
Nanairoya	✓	Green Manure	Cabbages, Broccoli, Kale, and Other Seasonal Veggies	
Tsugio	✓	Green Manure and Compost	Seasonal Veggies and Sunflowers	
Kuyomon		N/A	Seasonal veggies and Yuzu	✓

Morii	✓	Compost and Green Manure	Tea	✓

Table 1: Brief introduction of each farm interviewed

Figure 5: Pictures from our visit to Katagi Koka En Tea Farm

The first farm we interviewed was Katagi Koka En Tea, a 300-year-old tea farm run by Mr. Takatomo Katagi. He is the seventh head tea master and inherited the farm from his father. Mr. Katagi decided to switch to organic farming methods in the 1970s after growing concerned about the impact of conventional farming. He described how his children played in the nearby river, and that he did not want to pollute it with runoff. He uses compost made of pressed sesame seeds, which he buys from a compost facility. The compost gets mixed into the soil by hand, which can become labor intensive at times. Due to the strength of his tea trees, there is no need for any additional additives or chemicals. This interview helped us to establish an idea of how compost is utilized on an organic farm.

Figure 6: Pictures from our visit to Omi Hachiman City

After interviewing Katagi, we accompanied our sponsor on a group interview with Mr. Yoshida, the president of Shiga Prefectures' NPO. Mr. Yoshida has served as the communications person between composting facilities and farmers for over 20 years now. In addition to that, he works as an educator about compost, working with a nearby elementary school. The fourth graders at the school learn about composting, make their own compost, and then use their compost to grow their own daikon organically at school. After harvesting their daikon, the students use them to throw an oden party! This is all in effort to increase the organic presence in Shiga. During this interview we also met Omi Sonoda farm, an organic rice and soybean farm. The owner, Mr. Sonoda, used a homemade mixture of different store-bought composts and various wastes that he acquires from various nearby businesses. We learned a great amount about how farmers in Shiga prefecture view organic farming and compost as well as some simple methods of composting and waste recycling.

Figure 7: Pictures from our visit to Shimamoto Farm

We took this newfound perspective into our next interview with Shimamoto Labs/Farm, owned by Mr. Kuroki. As opposed to the farms we visited previously, the method at Shimamoto farm emphasized the science behind composting. Using his knowledge of microbiology, Mr. Kuroki has been experimenting with methods of making compost to favor the microbiome within the soil. From previous knowledge from the biotechnological journal called *'Current Opinion in Biotechnology',* we learned that carbohydrates, mainly sugars and starch, determine their [vegetables] nutritional value, postharvest quality, and storage life (Yu, Jingwei, et al., 2022). Knowing this information, Mr. Kuroki showed us the above average sugar content of his daikon's, displaying how the strength of the microbiome can positively impact the nutritional value of his crops. Incidentally, supporting the growth of beneficial microbes also helps to minimize the risk they pose to the crops because of the lack of space and nutrients for pests. One of their biggest accomplishments was the creation of vime food, a mixture of clay and microorganisms, which they were able to use to compost wood chips! They were the first people to successfully compost woodchips and set a new precedent for composting. Through our interview with Shimamoto Farm, we were able to gain valuable information on how the composting process works as well as what benefits it can provide.

Figure 8: Pictures from our visit to RE: ARTH

Alternative forms of sustainable recycling were also an idea we wanted to explore further through our interview RE: ARTH, owned by Mr. Hiroki. Currently, Mr. Hiroki is sustainably growing oyster mushrooms while also working toward finding a method for growing shitake mushrooms using recycled materials. He sells his mushrooms at restaurants, hotels, and farmers markets. Since mushrooms are grown so differently from other crops, we focused many of our questions on his homemade mushroom beds and his experience as a new farmer. While Mr. Hiroki buys beds for his shitake mushrooms, he makes his own beds for oyster mushrooms using woodchips and recycled coffee grounds. He gets these coffee grounds from nearby hotels and cafes that he has partnered with. Once Mr. Hiroki is done using the mushroom beds, he leaves them outside his greenhouse for farmers to take and incorporate into their fields as fertilizer. Mr. Hiroki also described the experiences he has had being a first-generation new farmer. He explained that while the government offers many subsidies and stipends, the processes to receive them can be difficult. This is especially so for mushroom farmers, since mushrooms fall under forestry instead of agricultural services. Additionally, JA groups have strict rules for how certain kinds of produce, like mushrooms, can be grown and sold. Mr. Hiroki noted how growing methods for shitake mushrooms are protected by copyright, limiting how they can be grown. He also described how the JA buys produce from farmers at a non-negotiable set price and charges a commission fee as well. This results in farmers receiving only a small percentage of what produce is sold for in stores.

Figure 9: Pictures from our visit to Midori Farm

During our background research we encountered Midori Farms, owned by Chuck Kayser. Mr. Kayser has done work in the past with other IQP projects focused on sustainable farming and provided good insight into how he started a compost pile. We observed the compost pile started by the 2019 IQP project group which was a static pile, and what materials they used as input. We learned during our conversation with Mr. Kayser that fall leaves are a key ingredient in making quality compost. He struggles with finding good compost to use on his farm because of the lack of Fall leaves in the area of his farm. With this in mind, we are now planning ways to incorporate quality leaves and green matter into our composting design. He is still experimenting with different composting methods and waste matter while he carries out his usual farming. Mr. Kayser sells his produce independently, like all the other farms we have met, usually by delivering to customers directly after harvesting.

Figure 10: Pictures from our visit to Ichi Gobiyori Farm

We again accompanied our sponsor Miyoko to explore an organic strawberry farm, and two other farms growing a variety of crops. Ichi Gobiyori, the strawberry farm owned by Mr.

Toshiyuki, uses compost to grow strawberries in the Winter season. Due to this being his first season growing strawberries, he has had minor issues with pests in one of his rows. Using alternative methods of pest control, for example spraying hot water, he was able to minimize the problem, but unfortunately, he was unable to completely solve it. This forced him to use trace amounts of chemicals to ensure the survival of the row. Despite this, he takes pride in being an organic farmer, as his philosophy excludes the use of chemical intervention. Mr. Toshiyuki's farm is thriving and will host his first strawberry picking session in early December.

Figure 11: Pictures from our visit to Nanairoya Farm

Later that day we interviewed Mr. Tominaga, the owner of Nanairoya farm. He is growing a variety of crops organically using only green manure, a process of cutting the crop back and leaving old crops to decompose and provide nutrients back to the soil. We later learned many farmers use a form of green manure in combination with compost. He also follows a philosophy of being in touch with nature and works beside nature when farming.

Figure 12: Pictures from our visit to Tsugino Farm

This idea of nature-based farming was carried into our final interview of the day with Tsugino farms with Mr. Murakami. They believe in healing the soil using methods they learned from Mr. Shimamoto. They use Mr. Shimamoto's vime food and compost to help heal their soil from the damage done by using too many chemicals. Since they sell to restaurants, they do use small amounts of chemicals to ensure the appearance of their products. They couple these chemicals with a more sustainable form of pest elimination method; a special yellow light they use in their greenhouses. The light lures the pests inside the greenhouse into a net, and scares away pests outside the greenhouse. This method helps to reduce the amount of pesticides needed. We learned a great deal about other methods of organically farming from these farms as well as how farmers are working to lessen their chemical usage with the help of the soil's microbiome.

Following this, we joined our sponsor for interviews with The Silver Center with Mr. Kitagawa and Kuyomon farm with Mr. Koboda. Mr. Kitagawa taught us about their efforts in helping retirees find new work. One job at the center is landscaping, which Mr. Kitagawa participates in through tree trimming. He spoke about the large quantities of waste the job produces, including tree branches, leaves, and weeds. Of the waste produced, the woody material is recycled into woodchips which they give to farmers for compost, and then dispose of the remaining weeds and leaves. The quantity of woodchips produced is too much though, and the remainder often needs to be disposed of too. Mr. Kitagawa hopes to combat this issue by giving Miyoko the remaining woodchips and other waste though for composting so that it can be disposed of sustainably. Later that evening we walked across town to interview Mr. Koboda at Kuyomon farm, a conventional farm in Aisho Town. The farm is currently 300 acres and is operated by Mr. Koboda, four full-time employees, and two part-time employees. While he grows a wide range of crops, the primary crops are rice, wheat, and soybeans. Recently, they began experimenting with growing some of their rice organically using chicken manure and organic fertilizers during the growing season. Mr. Koboda stated that when he inherited the farm 11 years ago it was only 30 acres and has since grown to the size it is now. When asked why he accepted the extra land, he described how he feels obligated to expand his farm as more farmers in the region retire to continue using their plots for the greater agricultural sector in Japan. This rapid expansion has proven to be challenging, since he struggles to manage all the land with his current staff, and finding new employees has proven difficult. As it stands, Mr. Koboda described that operating as organic is not feasible for a farm of this size with the number of employees he has now. Through this interview we were able to see sustainable methods from a conventional farm point of view, and also better understand why they choose to continue their practices.

Figure 13: Pictures from our visit to Morii Farm

During our first weekend in Kyoto, we met Morii Farm, an organic tea farm, at a local market. Due to his busy schedule, we did not get to interview Morii until several weeks later. Morii is a fourth-generation tea farmer who moved to organic farming about seven years ago. Morii makes his own compost using a process called bokashi. Bokashi is a mix of fermented rapeseed oil cake, rice bran, organic lime, and water. Morii has been experimenting with the process to better support his tea trees. This process of making compost usually occurs in January or February, so that it is ready to be mixed into the soil by the summertime. He also uses a form of green manure with tea leaf clippings. Morii grows his green tea in the spring and black tea in the summer. By doing this, Morii works with nature and the seasonal nature of certain pests to avoid the need for pesticides. Morii helped further solidify our understanding of the motivation behind why farmers choose to compost, while also further displaying how farming alongside nature is effective.

4.2 - Interview Themes:

Looking over the data we collected from our interviews, certain overarching themes began to emerge. One of the most apparent was the importance of the soil. Farmers who chose to cultivate the microbiome within the soil have seen large positive yields. These yields include the increased nutritional value and increased resilience of their crops. One of the best ways to improve soil health is the use of compost. A composting facility would allow farmers who have been previously unable to compost would now have access to this powerful resource and be able to give back to the planet.

4.2.1 - Overarching themes:

A recurring theme we found during our interviews was the emphasis of farming with regards to nurturing the soil. The idea of microbial farming was introduced to us as a possible solution to improve soil biodiversity by Shimamoto farm. Microbial presence in soil is a key element to ensuring healthy and quality crops, making it important to include them in our project. Following Shimamoto farm's example would be a great way to incorporate a successful microbial method of composting in the facility. Focusing on microbial compost would also help increase the nutrient yield of our compost. This would address another complaint many farmers have had with store bought compost: a lack of quality nutrients. To fix this, farmers choose to supplement it themselves with their own farm waste. While these methods yield usable compost, farmers like Mr. Kayser expressed interest in being able to buy higher quality compost.

Another one of the reoccurring themes we noticed amongst farmers was a desire to farm sustainably. This manifested itself predominantly through recycling their agricultural waste by making compost piles or using their unsellable crops to make green manure. We aim to stimulate this philosophy through our composting facility. Offering to take waste from around the community such as leaves and unsellable crops to create compost from them. To this end a connection has been established with Yumemachi Terrace Silver Center, where Miyoko will take their landscaping waste. This creates another circular relationship where both parties are getting benefits. Composting also aligns with Mr. Kitagawa's philosophy of being sustainable to reduce the effect of global warming. While other farmers' philosophies on sustainability varied, they all took care to minimize their negative impacts on the planet.

Human connection is another aspect of farming that consistently came up in our interviews. Mr. Tominaga was a great example of someone farming for the purpose of supporting other people. He grows his crops picturing each of his customers and the joy they can share through food. Getting to supply the community with healthy and safe food, while also getting to care for the earth gives Mr. Tominaga a great sense of joy. We also saw this theme in speaking with Mr. Kayser, who found a mentor in farming in his now home city of Ukyo. He created connections with people living in the Ukyo community alongside him to gain a deeper understanding of their sustainable farming practices. It is connections like this that our project aims to foster by establishing a network of organic farmers and companies to support this greater goal of sustainable life.

Many farmers have found a deeper connection to nature within their farming methods and philosophies. Ideas like seasonal farming as well as working with nature to help benefit their crops were popular ideas we encountered. Seasonal farming is helpful to both prevent pests and keep up with the market in Japan as many people here eat seasonally unlike in the United States. Seasonal food culture helps people to enjoy food at "shun" or its finest and tastiest. This has been a new concept to us and has allowed us to appreciate the food we are eating in Japan. However, this poses an issue for our composting facility of trying to find organic waste during the winter season. Since many crops are grown in the spring and summer seasons, the majority of waste collection will also take place during that time. The issue lies where most compost will be used in the spring, requiring a large amount of compost to be made during winter. To combat this issue a concrete floor and insulation will allow for the compost to be kept warm in the cold seasons.

4.2.2 - Common Issues in Organic Farming:

A large problem for many organic farmers is economics, mainly due to the legislation from the JAS. The JAS offers new farmer stipends designed to kick start these farms, but, as Mr. Hiroki described to us, this money does not support them in the ways they need. These stipends help to purchase farmland however, this land does not always include a farmhouse. JAS laws prohibit the building of concrete on farmland, and by relation a farmhouse. Lacking a farmhouse requires the farmers to package and distribute their products out of cars or nearby buildings.

Many generational farmers have a preexisting farmhouse that is passed down through the family, but new farmers are unable to obtain a house on their farmland.

Another similar issue is caused by the JAS crop grading system. This grading scale of A, B, and C is assigned to crops sold in supermarkets through the JAS. Starting with A being the highest quality reserved only for conventional farms supported by the JAS. Grade B is for Organic farms supported by the JAS, and C is given to independent organic farmers. For organic farmers to receive JAS aid, they must purchase a $2,000 certificate. These grading scales affect the profit farmers receive from their crops, which for our farmers usually means receiving the lowest profit return. Many farmers do not feel this price is obtainable as the financial returns do not compensate for the initial costs. Due to this reason many conventional farmers are also hesitant to switch to more sustainable practices.

Pests are an issue for farmers in all areas, but their impacts are especially felt by organic farmers. This is due to their ideals being against the use of chemical interventions and instead having to find alternative treatment methods. Throughout our interviews, we began to note how different farms chose to deal with pests. One of the most common ones was farmers relying on the strength of their crops. This method was mainly seen on tea farms, due to tea trees being naturally resilient plants. We also saw more unique methods too, like the yellow lights used at Tsugino Farm. We also noted how some farms still had to use chemical pesticides even though they contradicted their farming philosophies. This was due to a variety of reasons like produce appearance and plant susceptibility to pests. Nevertheless, many organic farmers shared disdain for pesticide use and have actively searched for a chemical free alternative.

4.3 - Composting in Aisho Town:

During our interviews we recorded current composting methods being used in both Aisho Town and Kyoto. There were three common methods of green manure, static pile composting, and the use of vime food in a static pile. We learned a great deal about the ease of using green manure, as well as the benefits of recycling crop waste back into the soil. Of the 11 people we interviewed, four farms participated in their own form of composting. Three of those four farms used static piles as their main method of composting. This is due to the ease of throwing waste and porous material into a pile to decompose into quality compost in a few months. In addition to ease static piles also can decompose a variety of wastes, such as those outlined in appendix O.

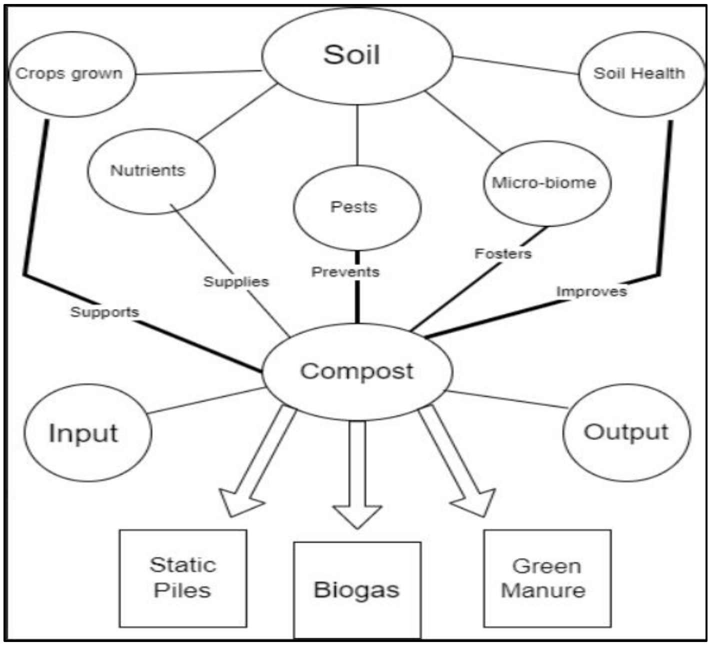

Figure 14: Diagram showing the relationship between compost and soil

One unique method being used by Mr. Hiroki is recycling coffee grounds as compost. Additionally, we learnt how his used mushroom beds can be used as fertilizer for farmer's fields. This is from the healthy soil created from the mushroom spores and the nutrients of the coffee grounds. Our biggest take from this section is that the inputs of compost are the key to a quality compost in addition to finding an efficient method.

4.4 - Evaluating Composting Methods:

Based on the interview data above we analyzed aspects that would make a composting method ideal. We evaluated the pros and cons of each method in order to eliminate the less ideal methods. Evaluation data includes aspects like cost, labor, and space requirements. Below is the table that we used to categorize the pros and cons for analysis:

Composting Method	Low-cost	Scalability	Large Space Requirement	Low labor Intensity	Few Harmful Byproducts	Any Organic Material?	Required Technical Training
Vermicompost	✓			✓	✓		
Static Piles		✓	✓				✓
In-vessel		✓			✓	✓	✓
Turned Windrow		✓	✓			✓	✓
Biogas		✓		✓		✓	✓

Table 2: Table comparing each of the four listed Composting Methods considered for the creation of a facility.

Our sponsor's interest in a biogas plant has led us to establish this method as one of our viable options. To best support Miyoko, we will also evaluate a viable system for composting. Based on the information above, we eliminated vermicomposting due to the lack of scalability of the system. Our facility will need to produce more compost than the vermicomposting system could feasibly produce. There is also a limitation to the input materials that the worms would be able to break down. We are looking to implement a system to process many types of green matter and farm waste. We also decided to eliminate the in-vessel method because of the cost and technical training needed to run the system. Despite the low labor costs of this system composting vessels are expensive and also require specific training to properly manage the system. Eliminating those two methods leaves us with static piles, turned windrow, and biogas systems. These processes are all versatile in scale and pose low risks to the environment and people around them.

When evaluating different methods cost is the most prominent factor for consideration. Static piles and turned windrow are cheaper than a mini biogas plant due to the cost of the biogas machinery. However, static piles and turned windrow will require more flat space and surveillance from staff to maintain a suitable environment for the compost during arid or cold seasons. After evaluating these basic factors, we determined there was not enough variance between turned windrow and static piles to determine the best system design. We decided to next create a second table to analyze the more in-depth factors. We next calculated data for the static piles and turned windrow composting namely the land, labor, and mechanical costs. By researching each individual method, we were able to calculate and determine the economic breakdown.

Composting Method	Capital Investment ($USD)	Input to output ratio	Labor hours per year	Machinery needed to operate
Turned Windrow	160,000	3:1	3,055	Tractor, Solid Manure Spreader
Static piles	21,150	5:2	273.0	Tractor

Table 3: comparative table showing the numerical differences between Turned windrow and static piles composting methods

As seen above on table 2, there were large cost discrepancies amongst the two composting methods. While the two are similar processes, turned windrow composting is significantly more expensive than static piles. In addition to the increased cost, turned windrow also produces less compost per unit of input. With this new comparison we have decided that turned windrow composting is not ideal for our project. Having made this decision, we have decided to pursue both a mini-biogas plant and static pile composting as viable organic recycling methods.

4.5 – Comparison:

During our interviews we left space for our interviewees to ask us questions as well. Interestingly, many farmers shared a curiosity toward how farming in the United States compared to farming in Japan. Given California's leading position in the American organic market at 32% of the US total, nations we felt it was best to focus our comparison primarily within it (USDA, 2021). California and Japan have both adopted legislation to compensate organic farmers.

Location	Reimbursement	Government Involvement	Legislative Laws
California	Organic Certification Reimbursement	CDFA, CDPR, CDPH, NOP, SOP, ACA's	AB 1826 – California Organic Food and Farming Act
Japan	Stipend to purchase sustainable materials	JAS and MAFF make legislation for agricultural laws	Measures to Conserve Land, Water, and Environment

Table 4: Comparing and Contrasting Japan and California Agricultural Scene

Sustainable farming rose to prominence within Japanese politics through the 1990s and well into the 2000s, reaching a pinnacle in 2007 (Nishizawa, 2015). In the Measures to Conserve and Improve Land, Water, and Environment legislation introduced a direct payment plan for agricultural materials. Farmers who designed long term plans gained financial compensation to carry out specific sustainable farming methods as well as to grow certain crops sustainably. Meanwhile in California, the Federal Cost Share program worked with the California Department of Food and Agriculture (CDFA) to reimburse organic farmers for their registration fees (California Department of Agriculture, 2023). This program can reimburse up to $750 to farmers for each certification registered (Ross, 2023). These programs worked to make organic farming financially viable for many farms during a time when the organic presence was still growing. This new legislation has proven to be instrumental in the development of organic agricultural practices.

Both Japan and California both made increasingly powerful strides in organic agriculture in the 2000s, however, their policies took different turns in the early 2010s. In 2009, Japan saw a change in dominant political parties, and with it a wave of drastic agricultural reform. The new plan called the Direct Assistance for Environmentally Friendly Agriculture, came with stricter requirements and a decrease in payment amount (Nishizawa, 2015). Due to this, many farmers opted to not renew their certifications. California, however, passed a revision to its State Organic Program's legislation (SOP). This revision transitioned the program from a derivative of the National Organic Program (NOP) towards an educational program (California Organic Food, farming act signed into law, 2016). This halved the costs and number of required documents for organic farmers along with providing a new means of organic education (McCaffrey, 2020). In addition to this, Japan has a much narrower range of governing bodies around the agricultural sector. Nationally, the main bodies are the JAS and MAFF, with JAS covering the organic farming sector. On the other hand, California has the CDFA, California Department of Pesticide Regulation (CDPR), and California Department of Public Health (CDPH) for general agriculture. These parties are then aided by NOP, SOP, and USDA Accredited Certifying Agencies (ACA's) for organic farming (USDA, 2023). The methods to which Japan and California are working to increase the organic presence are very different. Today California continues to progress and improve upon its existing infrastructure, while Japan is now working to reverse the damage caused by past practices.

Chapter 5: Conclusion and Future Recommendations

5.1 – Conclusion:

Prior to arriving in Japan, we spent seven weeks exploring the main issue at hand: How can we support organic farming in Shiga prefecture? We aim to answer that question in partnership with Miyoko Kuzutani through a series of interviews and observations of organic farms in Japan. Through aid from the Local Revitalization Corperation Miyoko has been able to start developing her organic recycling business. This is where our team goals come in. We strive to develop a theoretical design of a recycling system to support the organic farmers in Japan.

After 14 weeks of research and data collection, our team has established two separate designs for our sponsor. Both static pile composting, and a mini biogas plant will offer an organic farming tool to farmers in Aisho Town. In addition, farmers will not only be able to dispose of their waste, but also reap the respective benefits associated. Sections of Chapter 2 outline the reasons behind why organic farming has struggled to take off as a common practice. We took those roadblocks and worked to find ways to resolve or reduce them to encourage more sustainable practices. Since organic farming is labor intensive compared to conventional farming, many farmers are hesitant or unable to switch practices. As outlined in the background, many farmers in Japan are over the age of 65. Also explained in Chapter 2 is the economic side of organic farming, namely the low revenue. Aging farmers, low revenue, and costly maintenance expenditures lead to a decrease in not only organic farmers but conventional farmers as well. Keeping these issues in mind, we focused our preliminary research onto the history of farming in Japan as well as background knowledge into composting itself.

Our seven weeks in Kyoto were spent exploring both Kyoto and Shiga prefectures visiting organic farms as well as sustainably focused companies. From our visits we learned a great deal about current farming methods as well as the varying passions behind farming. One crucial topic we found is the connection farmers make in the community with their work partners as well as customers. Making others happy was a recurring idea that we also enjoyed hearing about. On the other hand, some farmers had a very scientific take to farming through focusing on fostering microbial presence in their compost to improve the nutritional content of both the soil and their crops. While these two ideas are very different, they both strive to improve the current farming methods to help the ecosystem and people. We not only learned information about our project but also about Japanese culture. One of our favorite concepts to learn about was "shun", the idea of eating food at peak perfection. Instead of growing and eating food year-round, it is only enjoyed when it is made to taste best. For example, oranges and strawberries are best when eaten from November to March. While the topic of shun may seem unrelated, understanding its relevance to the farming culture has been an important factor in helping us better support the needs of organic farmers in Shiga. In the recommendation below we have encompassed the needs of organic farmers in the designing of an organic recycling facility.

5.2 - Future Recommendations:

For the last seven weeks we have been evaluating different organic recycling methods to fit in Aisho Town, Japan. We have interviewed 11 farmers and companies to gather data on compost and organic farming. Due to our time constraints, the following recommendation was developed from a small sample size. This data is not representative of the entire population of farmers in Aisho Town or Kyoto. With that in mind, we have developed two separate recycling methods for our sponsor.

5.2.1 - Static Pile Recommendation:

From our data analysis, we determined that the most efficient and cost-effective method of composting would be aerated static piles (ASP). Static pile composting allows for a mix of green and brown materials such as yard waste and food scraps (Appendix O). The waste input materials are broken down aerobically, meaning with the help of oxygen. The oxygen for our design would be supplied through negative aeration, which works to pull air down and out of the compost and through a biofiltration system. This filtration process reduces the unpleasant odors created during the material decomposition. Negative aeration also removes risks created by the ammonia vapors released by the compost, which improves working conditions in the facility. In order to make this a possibility, a concrete foundation will need to be constructed to provide insulation. Additionally, the installation of a pipe aeration system, along with its respective biofiltration system, is required to be incorporated into this foundation.

Once a facility foundation is built the next step would be to source waste input and arrange a collection method. As stated in the previous chapter, Miyoko has established a connection with Mr. Kitagawa to collect the Silver Center's landscaping waste. This will provide her with a large amount of brown matter which is key in a good compost. On the other hand, there is still a need to find more green matter to add to the piles. We recommend the development of a food waste collection system to repurpose community waste into organic waste input. This green waste would contribute as a source of nitrogen for the compost. We could source green waste from both farms and businesses. By adding more green matter to the compost input, a healthier balance between carbon and nitrogen will be established, in turn creating a higher quality compost.

There are some risks associated with static pile composting, as there are with every recycling method. One risk mentioned above is the exposure to ammonia gas which is a corrosive material. Exposure to concentrated amounts of ammonia gas can burn the eyes, nose, throat, and respiratory tract (Department of Health, 2011). This risk is mitigated using the negative aeration system that reduces the possibility of the gas entering the open air. Another related issue is the release of unpleasant odors to the surrounding areas, which affect people living or working near the facility. This is fixed by keeping a sealed cover around the aerated piles in addition to the negative aeration system. Despite these risks, there are solutions available to fix each issue and improve the overall quality of the composting facility.

Once a pile is established the compost will be ready to sell in about 2 months. As stated in a previous chapter in Table 3, the output ratio from the static piles will be a 5:2 ratio. 5 represents the waste input while 2 is what will come from the piles after decomposing. The compost made will support lots of green growth in plants and foster a large microbial presence in the soil, which will aid in crop growth and flowering plants. This facility's construction will require new land to be purchased that would allow for concrete building. The land currently rented by Miyoko does not permit concrete construction and will require a smaller wood platform to accommodate the insulation and aeration systems.

5.2.2 - Biogas Recommendation:

A second option for organic recycling brought up to us by Miyoko was a mini biogas plant. In order to construct a miniature biogas plant, an underground digester will first be needed. The digester needs to be underground to maintain the required temperatures for the AD reactor. An AD reactor is the system that creates a digested slurry from the composted materials and collects the gases produced during this process. The next material needed will be a gas tank, that will store the collected gases to be used as an energy source. A biogas facility would take up less space than a composting facility because it is mainly underground. Not only that but the size of the biogas tank can be scaled to fit our sponsor's needs.

Biogas relies greatly on animal and human byproducts such as manure and blackwater, which is wastewater from sewage. Additionally, mini biogas plants have the ability to process plant matter, but in much smaller amounts compared to the byproduct waste. In order to support this system, we would recommend establishing a connection with a cattle rancher in Aisho Town to collect manure from as a waste input. While manure is not widely accepted as a fertilizer in Japan, it would be the most accessible material in terms of volume and cost. Once the necessary waste is collected, it will be put into the digester. The internal temperature of the digester works best above 15 degrees Celsius; it still functions at temperatures below that but at decreased efficiency. Maintaining a warmer temperature is required for proper waste decomposition. Without maintaining the temperature, we would be unable to turn waste into a slurry of fertilizer. The result of the decomposition will be fertilizer slurry that can be used on farms in the place of chemical fertilizer and pesticides along with a gas energy source. This system works anaerobically, meaning the decomposition process is done in the absence of oxygen. The lack of air flow in or out leads to accumulation of the gases that will then be collected for energy. The gas product is composed mainly of methane and carbon dioxide, making it helpful to power gas stoves.

When compared to static piles, biogas plants have a few more risks involved. The biggest risk being improper maintenance leading to a gas tank explosion. In the event of a tank explosion environmental damage and the release of carbon dioxide will threaten anyone in the vicinity. This also goes for the additional risk of bioaerosol pathogens, which can be released alongside the gas. Because the waste input is animal and human byproducts there are existing pathogens that do not get removed during incubation time. These pathogens can harm people and animals that inhale the gases during release. Incomplete pathogen removal is a risk that can be reduced by adding extra filtration systems in the gas tank to reduce the number of pathogens present. Even with added precautions there is currently no complete fix for these risks in the biogas system.

Overall, a biogas facility would provide both a fertilizer slurry and a small energy source for people in Shiga. For our sponsor’s project, the starting scale would be rather small with only a little bit of output. However, this will change as time goes on and she is able to increase the size of the facility and her market base. To construct a biogas plant Miyoko would be required to purchase new land that could be dug up to build the digestion tank. One downside of this system will be the return on investment. A considerable sum of money will be invested up front to build and kickstart the facility, which will not all be returned in the revenue. After establishing the biogas system fertilizer slurry can be produced as quickly as a month later to be sold to consumers. The biogas system is more efficient in the sense of time when compared to the static piles, however, it will produce less product output.

5.3 - Market Recommendation:

Our recommendation for the compost market would be to offer an online shop where farmers can purchase what they would like, and either pick it up from the facility or have it shipped to their location. Another option would be to sell the compost in farmers markets around Aisho Town for farmers to collect from the store itself. This would require Miyoko to pay a percentage of her profit to the market. Making the compost accessible on multiple platforms would increase her connections to a greater area than just selling at one location.

5.4 - Future IQP Recommendations:

Due to the time constraints of our project, we have highlighted areas we were unable to explore. We feel that further research into these topics would be beneficial to the overall success of organic farming. One large aspect of our project we felt was missing was a database of the farms in Shiga prefecture. We were limited to interviewing farms that we learned about through either an internet search or through word of mouth. This reduced the number of smaller and personal farms we were able to talk to. To easily research farms around Shiga the idea of a database was considered. A database would be helpful to track the organic presence in Shiga by documenting the location and details of current farms. Yearly updates could be done to track the organic presence over time. This would also benefit future groups to see an established farming network for interviews and other project ideas.

Our second topic of research would be composting waste inputs. We were able to do preliminary research into composting waste inputs and what kind of growth they support, however we were unable to do a deep scientific dive into the topic. We also felt including the topic of fall leaves and brown matter in this section is another key aspect. As we learned from many farmers, finding quality waste inputs can be challenging and lead to lower quality compost. From what we understand, fall leaves are an important source of carbon that is readily available. Without fall leaves it is hard to find a porous, carbon material to help with nitrogen uptake. Researching this issue further would solve issues for many farmers who work to make their own compost. A deeper understanding of the chemical and scientific breakdown of waste would benefit the organic farming presence in Shiga.

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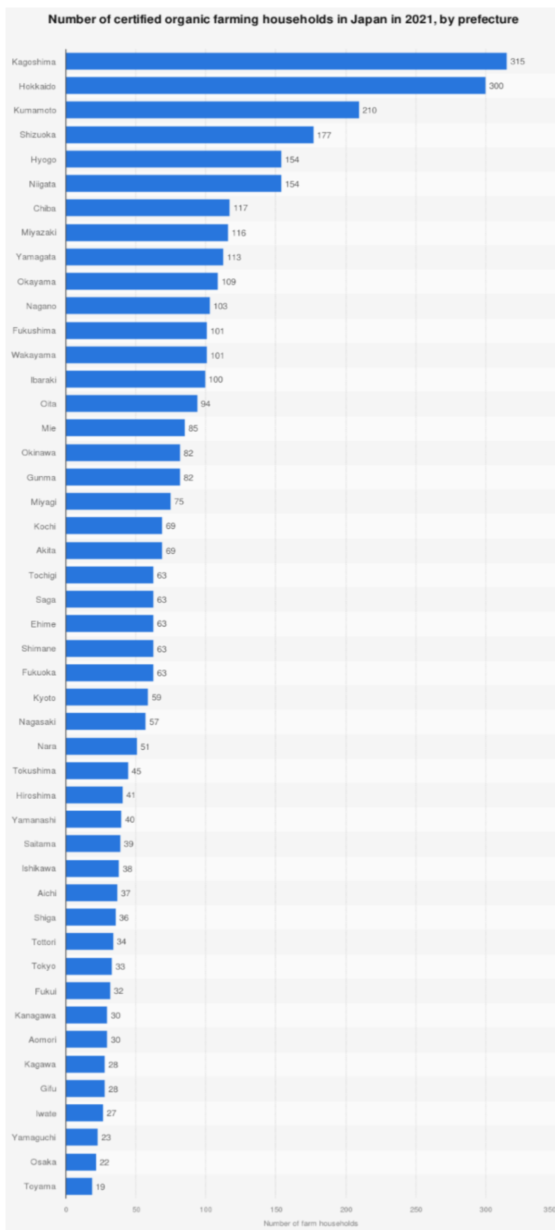
Appendices:

Appendix A: Number of Organic households in Japan by prefecture (MAFF, 2021)

Appendix A below shows data collected by the Ministry of Agriculture, Farming, and Forestry in 2021 for every prefecture in Japan. The data collected includes the number of JAS certified organic farms in each prefecture. Having the JAS certification allows farmers to sell their organic crops through the organization, allowing them to sell them for the best profit. Farms not certified by the JAS are legally not allowed to label their products as organic and sell the products independently.



Appendix B: Interview Questions Framework:

To create consistency among the interview data we have created a set of systematic questions to include in every interview. Our goal is to evaluate any connections or recurring themes that are present in the focus group responses.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
    b. Where did you learn your knowledge on farming? Did you have a mentor?
2. Do you have a farming philosophy? Can you tell us a little about it?
3. Would you describe yourself as an "Organic Farmer"?
4. What are your reasons for becoming an organic farmer?
    a. What kinds of organic practices do you use on your farm?
    b. Why did you choose to use these practices?
5. What are some of the things you love about being an organic farmer?
6. Do you use any compost/Organic waste on your farm?
    a. Where do you source this organic waste?
    b. Does the compost you use meet all of your needs? Do you face any issues with the compost you use?
    c. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
7. What crops do you grow organically?
    a. Why did you choose these crops?
    b. What are some of your favorite crops to grow?
    c. Do you have any crops you would like to grow in the future? Why haven't you grown these yet, are there any limitations to growing the crops?
8. Do you sell your crops through the JAS or Independently?
9. What are some challenges or difficulties you have faced as an organic farmer?
10. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho Town?
11. What are some of your favorite memories with your farm?
12. We would like to open the floor to you to share anything you would like to with us, even if it is not farm related!

Appendix C: Interview questions for Midori Farm:

Based on the framework questions in Appendix B we worked to create a set of personalized questions for. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. What got you into farming?
2. What are the reasons for going organic?
3. What organic tools do you use?
    a. How has your experience been making your own compost?
        i. Where do you source the materials needed to make your compost?
    b. How receptive has the community been to your education on composting?
4. What is your passion behind offering education on your farm? How have these educational classes made an impact in the community?
5. How have the past IQPs made a difference on your farm? Did you see the changes immediately or over time?
6. What crops do you grow organically?
    a. What made you choose these crops?
    b. Are there any crops you grow for your own personal consumption rather than to sell?
7. Do you sell your crops through the JAS or Independently?

    a. What is your bestselling crop(s)?
    b. What is your favorite thing to grow? Is there a reason behind it?
8. Do you use any pesticides or chemical interventions at all?
9. What difficulties have you faced on your farm?
    a. Were these challenges created by growing organically?
    b. How have you worked past these issues?
10. What is your vision for the future of your farm?
11. What is your community involvement, farming or otherwise? Do you participate in any festivals or holidays?
12. Do you have any advice for us as we complete our IQP?

Appendix D: Interview Questions for Morii Farm:

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. What got you interested in growing tea?
2. How long have you been growing tea?
3. What made you choose to grow your product organically?
4. Do you bring in any supplemental organic products?
5. Do you use any pesticides or chemical interventions?
6. Have you faced any difficulties on your farm?
7. What is your community involvement, farming or otherwise? Do you participate in any festivals or holidays?
8. What are the main plant products you use in your compost?
9. What crops do you grow organically?
    a. Why did you choose these crops?
    b. Do you have a personal favorite tea you sell?
10. Do you sell your products through JAS or independently, or both?
11. What is your vision for the future of your farm?

Appendix E: Interview Questions for RE:ARTH:

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. What got you into farming?
2. How does farming mushrooms differ from other kinds of crops?
3. What are the reasons for going organic?
    a. What was the shift from chemical to organic like? Were there any difficulties?
4. What kinds of organic products do you use?
5. What types of mushrooms do you grow organically?
    a. Why did you choose these types?
    b. Do you grow any other types of crops here?
6. What is the market like for these crops? Do you sell through JAS or independently?
7. Do you use any pesticides or chemical interventions in addition to organic compost?
8. Have you faced any other difficulties on your farm outside of switching to organic methods?

9. What is your vision for the future of your farm?
10. What is your community involvement, farming or otherwise? Do you participate in any festivals or holidays?
11. Is there anything you do on your farm that others don't?

Appendix F: Interview Questions with Katagi Koka En Tea:

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. What got you into farming?
2. Tell us about yourself, your ideals, and the story leading to where you are in your life.
3. What types of Tea do you grow here? What is your most popular tea? What tea is your personal favorite?
4. What interested you in growing this tea organically?
5. Have you always been organic? We know you are a 7th generation head tea master, what did you change and/or keep from your past headmasters?
6. Have you experienced any issues from being organic? Economic, logistically, or elsewise.
7. What tools do you use for organic farming? Where do you source these tools from?
8. Are you comfortable sharing with us some of the cost breakdown for your organic tools?
9. Do you know any other organic farmers, or suppliers that might be willing to talk with us as well?
10. Would you like to be updated in the future about the final product for our project?
11. Do you have any advice for us getting into the organic farming community?

Appendix G: Interview Questions for Ichi Gobiyori

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
2. Would you describe yourself as an "Organic Farmer"?
3. What are your reasons for becoming an organic farmer?
    a. What kinds of organic practices do you use on your farm?
4. What are some of the things you love about being an organic farmer?
5. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
6. What crops do you grow organically?
    a. Why did you choose these crops?
    b. What are some of your favorite crops to grow?
    c. Do you have any crops you would like to grow in the future? Why haven't you grown these yet, are there any limitations to growing the crops?

7. Do you sell your crops through the JAS or Independently?
8. What are some challenges or difficulties you have faced as an organic farmer?
9. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho?
10. What are some of your favorite memories with your farm?
11. We would like to open the floor to you to share anything you would like to with us, even if it is not farm related!

Appendix H: Interview Questions for Tsugino Farms

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
    b. Where did you learn your knowledge on farming? Did you have a mentor?
2. Do you have a farming philosophy? Can you tell us a little about it?
3. Would you describe yourself as an "Organic Farmer"?
4. What are your reasons for becoming an organic farmer?
    a. What kinds of organic practices do you use on your farm?
    b. Why did you choose to use these practices?
5. What are some of the things you love about being an organic farmer?
6. Do you use any compost/Organic waste on your farm?
    a. Where do you source this organic waste?
    b. Does the compost you use meet all of your needs? Do you face any issues with the compost you use?
    c. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
7. What crops do you grow organically?
    a. Why did you choose these crops?
    b. What are some of your favorite crops to grow?
    c. Do you have any crops you would like to grow in the future? Why haven't you grown these yet, are there any limitations to growing the crops?
8. Do you sell your crops through the JAS or Independently?
9. What are some challenges or difficulties you have faced as an organic farmer?
10. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho?
11. What are some of your favorite memories with your farm?

Appendix I: Interview Questions for Nanaroyima Farms

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
2. Do you have a farming philosophy? Can you tell us a little about it?
3. Would you describe yourself as an “Organic Farmer”?
4. What are your reasons for becoming an organic farmer?
    a. What kinds of organic practices do you use on your farm?
    b. Why did you choose to use these practices?
5. What are some of the things you love about being an organic farmer?
6. Do you use any compost/Organic waste on your farm?
    a. Where do you source this organic waste?
    b. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
7. What crops do you grow organically?
8. Do you sell your crops through the JAS or Independently?
9. What are some challenges or difficulties you have faced as an organic farmer?
10. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho?
11. What are some of your favorite memories with your farm?
12. We would like to open the floor to you to share anything you would like to with us, even if it is not farm related!

Appendix J: Interview Questions for Yummermachi Terrace Echi

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer’s specialties.

1. What got him into this business? What sparked his idea for this?
    a. How do wood chips get recycled? How does this process affect the surroundings
2. Who gets employed here? Do you have to have any special qualifications?
3. Where do they source the recycled materials?
4. Who do you sell to?
5. Can these wood chips be used in farming materials?
6. What kinds of Trees do they trim?
7. Why does he do this job?
8. Do they face any issues in their work?

Appendix K: Interview Questions for Kuyomon Farms

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer’s specialties.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
    b. Where did you learn your knowledge on farming? Did you have a mentor?
2. Do you have a farming philosophy? Can you tell us a little about it?

3. Do you use any compost/Organic waste on your farm?
    a. Where do you source this organic waste?
    b. Does the compost you use meet all of your needs? Do you face any issues with the compost you use?
    c. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
4. Do you sell your crops through the JAS or Independently?
5. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho?
6. What are some of your favorite memories with your farm?
7. We would like to open the floor to you to share anything you would like to with us, even if it is not farm related!

Appendix L: Interview Questions for Shimamoto Farms

Based on the framework questions in Appendix B, we worked to create a set of personalized questions for each farm. Research is done prior to every interview to help specialize the questions to each farmer's specialties.

1. Would you share a little bit about your love for farming with us? What led you to be a farmer?
    a. Are there any other people in your family that are farmers?
    b. Where did you learn your knowledge on farming? Did you have a mentor?
2. Do you have a farming philosophy? Can you tell us a little about it?
3. Would you describe yourself as an "Organic Farmer"?
4. What are your reasons for becoming an organic farmer?
    a. What kinds of organic practices do you use on your farm?
    b. Why did you choose to use these practices?
5. Do you use any compost/Organic waste on your farm?
    a. Where do you source this organic waste?
    b. Does the compost you use meet all of your needs? Do you face any issues with the compost you use?
    c. Do you supplement any issues with chemical pesticides or fertilizer? Or strictly just organic materials?
    d. Do you do any soil health testing in a lab to calculate the PFUs/CFUs of the different microorganisms in the soil? What testing do you do to your soil?
    e. What different types of microorganisms have you found in your soil? Are there a lot of one certain genomic type or a wide variety?
    f. Has there been any research done into seeing how microbial soil farming improves the quality of food in terms of nutrients?
6. What led you to explore Soil Koji? Can the koji support many types of organisms? Or just specific ones?
7. Can you tell us more about your wood compost method? What did you do differently than others that made it the first successful trail of wood fermentation?
8. Have you done any testing of your soil for Phage presence?
9. What crops do you grow organically?
    a. Why did you choose these crops?
    b. Do you have any crops you would like to grow in the future? Why haven't you grown these yet, are there any limitations to growing the crops?

10. Do you sell your crops through the JAS or Independently?
11. What are some challenges or difficulties you have faced as an organic farmer?
12. What is your vision for the future of your farm? Do you have any dreams for your farm and the community of Aisho?

Appendix M: List of Possible Farmers Markets and Events to Visit:

We have established a list of farmers markets to visit and explore the presence of organic products in. We plan to use this data to help us evaluate the presence of organic produce available to consumers.

1. Nishiki Market
2. Jinen and Ichiba
3. JA Farmers Market Ouminchi
4. Kasatu Farmers Market
5. Ohara Fureai Morning Market
6. Aisho Town Festivals

Appendix N: List of current composting facilities to interview in Japan:

The following is a list of composting facilities to whom communications were extended for the purpose of conducting interviews. We hope to speak to these composting facilities to help us better understand how they have been successful as well as the difficulties they may have faced.

1. Kagawa city waste composting plant
2. City of Kami katsu zero waste facility
3. Sapporo city composting system
4. Ogawa Machi Fudo Utilization Center

Appendix O: Composting Inputs Graph from the US EPA

This graphic was provided by the US EPA in their article describing how to get started composting at home. In the graphic there are two categories of materials: green and brown. Green materials are high in nitrogen while brown materials are high in carbon. The two types of waste material should be used together to help the plants uptake the carbon from the compost, as well as removing excess nitrogen from the soil.

What You Can Compost at Home	What to Avoid Composting at Home
Nitrogen-Rich Material ("Greens")	Meat, fish and bones
Food and vegetable scraps	Cheese and dairy products
Most grass clippings and yard trim	Pet waste and cat litter
Coffee grounds and paper filters	Produce stickers
Paper tea bags (no staples)	Fats, oils and greases
Eggshells (crushed)	Glossy paper
	Treated or painted wood
Carbon-Rich Materials ("Browns")	Aggressive weeds/weeds with seeds
Dry leaves	Diseased and pest-infested plants
Plant stalks and twigs	Compostable food service ware and compostable bags*
Shredded paper (non-glossy, not colored) and shredded brown bags	Cooked food (small amounts are fine)
Shredded cardboard (no wax coating, tape, or glue)	Herbicide treated plants
Untreated wood chips	Dryer lint

Appendix P: Consent form for Interviews and Surveys:

Before and after each interview our team confirmed the interviewee's verbal or written consent for their data to be used in our proposal. The data included could be pictures or quotes said by the person during our interview. Below is a written consent forn presented to our interviewees to inform them of the purpose behind our interview and how we plan to collect our data.

Our names are Meghan Urakawa, Mauricio Mergal, Natalie Leigh, and Peter Liehr. We are students at Worcester Polytechnic Institute (WPI), a university in the United States, who are working in partnership with Miyoko Kuzutani to explore ways to implement a composting business in Aisho Town. Our group seeks to (interview/survey) farmers and owners of composting facilities around Japan. The purpose of this study is to gather data on the perspectives of organic farming, current organic and non-organic farming methods.

You are invited to participate as a member of a (focus group) to share your experiences with organic farming and sustainability in Japan. Your participation is voluntary, as you can opt to stop (the interview) at any time. Your name and identifying information will be kept anonymous in the publishing of the data.

In person Interviews will take anywhere from 30 minutes to 1 hour to ask questions, tour facilities, and engage in conversation about the given topic. You can share as much or as little information as you feel comfortable doing during the duration of the interview. We may ask if you are comfortable with a voice recording of the interview to help us ensure we are gathering data correctly.

The university of Worcester Polytechnic Institute will publish our final reports that will include data gathered during interviews. We would like your permission to use a direct quote from you and/or a picture taken on your farm. If you wish to grant us permission to do so, please sign below.

Please feel free to ask any questions about this study before beginning or throughout the duration of your interview session. Should you have any questions after your session please email us at gr-KyotoCompostingProjectIQP. Thank you for your participation in our study.

___________________________________ ________________

Researcher's name & signature **Date**

___________________________________ ________________

Interviewee's name & signature **Date**

For more information about this research or about the rights of research participants, or in case of research-related injury, contact: (gr-KyotoCompostingProjectIQP. You may also reach out to the IRB Chair (Professor Kent Rissmiller, Tel. +1 (508) 831-5019, Email: kjr@wpi.edu) and the Human Protection Administrator (Gabriel Johnson, Tel. +1 (508) 831-4989, Email: gjohnson@wpi.edu .