DECOMPOSING OUR DILEMMAS:

How composting can divert 70% of food scraps from Rutland County's waste stream.

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INTRODUCTION

In 2012, Vermont legislators set waste diversion as a priority for reducing greenhouse gas emissions, promoting healthy food systems and saving money by passing Act 148: Universal Recycling law, which bans food scraps from the landfill starting in 2020 ("Vermont's Universal Recycling Law"). Rutland County has not made significant progress in this area since the law was enacted, but that means that great impacts will be made upon its implementation.

A major dilemma inhibiting progress in this area is describing the issue as "food waste." The noun "waste" suggests that it is inevitable to dispose of the material, and does not hold the person or organization accountable that is committing the act of wasting. I use "wasted food" in order to frame the problem as a resource that must be used to the highest potential. I encourage the reader to do so as well.

This report informs the reader about the issue of wasted food from many perspectives, and describes one of the solutions to be implemented in Rutland County now: composting. The report addresses the importance of reducing food that is overproduced and feeding people and animals with excess food, but the focus on composting identifies a way to divert large amounts of food scraps from the landfill and generate revenue. Different methods of composting are compared, and summaries of interviews with farmers and composters offer models of composting that could be implemented immediately. To conclude. a case study of one compost facility business model is presented, and recommendations to the public, non-profit, and private sectors are set forth to achieve the goal of zero food scraps in the landfill by 2020.

BACKGROUND

Climate change is creating seasonal chaos in every country. When one accounts for all the impacts of food supply chains, including emissions from food production, processing, distribution, and disposal, wasted food is third in line of greenhouse gas emitters, behind China and the US (*Global Initiative* 3). As U.S. citizens, we wasted 62.5 million tons of food in 2015, which is 40% of all food produced in the United States (*Roadmap* 13). Fifteen years before that, the percent of total food produced that was wasted was also 40% (Gunders 1). While it has fluctuated slightly since then, there are few signs of the trend reversing. As the *Roadmap Towards Reducing Food Waste by 20 Percent* depicts, "if all of [the United States'] wasted food was grown in one place, this mega-farm would cover roughly 80 million acres, over three-quarters of the state of California. Growing the food on this wasteful farm would consume all the water used in California, Texas, and Ohio combined. The farm would harvest enough food to fill a 40-ton tractor every 20 seconds" (10). These numbers solely discuss food that goes to landfills, though there is still wasted food that is recycled into soil or animal feed. Many people, organizations, states and municipalities are creating for solutions to prevent food from going to waste.

In 2011, up to 39% of the 413,517 ton waste stream in Vermont was organic materials, and nearly 20% of municipal solid waste was food scraps (*State of Vermont* 15). The previously mentioned Universal Recycling Law sets a goal to change that by banning food scraps from the landfill in phases. By July of 2017, food scrap generators wasting over 18 tons of food are required to send it to a certified processing facility within twenty miles radius; by 2020, all food scraps are banned from entering the landfill in Vermont ("Vermont's Universal"). This landfill

ban is intended to reduce the associated greenhouse gas emissions by 37% and thus, the environmental impacts (*Universal Recycling* 7).

Vermont currently has thirteen certified compost facilities accepting food scraps from the public ("Universal Recycling Materials"). There is also one anaerobic digester accepting public food scraps at VT Technical College in Randolph. There are many other composting and digestion facilities throughout and surrounding the state that aren't required to be certified by the Department of Environmental Conservation, which means they cannot process more than 100 cubic yards (up to 40 tons) of total compost in one year. These are located on farms that compost/digest manure, or other private operations, so the amount of food scraps recycled through them is uncertain. Rutland County does not have any certified compost facilities, though two of them in neighboring counties are collecting food scraps in Rutland City. They both travel over 30 miles one way to pick up in Rutland City, which can adversely affect the climate, contrary to the intention of Act 148.

While there are many challenges that municipalities, organizations, and individuals face in order to fulfill the requirements of Act 148, these challenges present opportunities for businesses and other organizations to implement facilities and innovative models of dealing with "waste." There are 99 farms in Rutland area as identified by RAFFL's Locally Grown Guide, and at least 31 of them are beef or dairy farms. These businesses are often pressed for time to add extra responsibilities, but they often have the required infrastructure, area, and feedstocks for processing food scraps into compost. I have identified and interviewed several potential farms that could begin a certified facility. The response from individuals and entrepreneurs in Rutland County is lacking the action needed to meet the requirements of Act 148. The purpose of this

study is to analyze the solutions in Rutland County that will prevent most food scraps from entering the landfill. In the following section, I have compiled my analysis of wasted food and composting in Vermont and Rutland County.

LITERATURE REVIEW & RESEARCH

Rutland County Food Scrap Recycling Assessment

Out of the 469 tons of food scraps per week that are wasted in Rutland County, around 41% of those are currently being diverted by employing a diverse number of solutions (*Rutland Regional* 4). Gleaning and food recovery programs provided less than half a ton of food per week to those in need in 2015 ("Locally Grown Guide"). Many farmers are accepting food scraps to feed to their chickens and pigs. An on-farm manure digester in Bridport, VT has been equipped to handle food scraps, and receives some from Rutland County through Casella hauling. Additionally, residential backyard composting is estimated to process up to 22% of the recycled food scraps (26 tons/week) in Rutland County. In 2014, only 8 tons/week of food scraps were processed by compost facilities, while the total capacity that nearby compost facilities can handle is 76 tons/week (*Rutland Regional* 8). If all recycling opportunities were utilized at full capacity, even accounting for a 70% estimated participation rate in diversion programs, there will still be a gap (and an opportunity) of over 100 tons of food scraps per week that could provide a necessary feedstock for composting operations (*Rutland Regional* 5).

Figure 1: Rutland County Estimated Food Scrap Generation and Recycling (Tons/Week)

Food Scrap Generation						Food Scrap Recycling						
Total Food Scrap Generation	Food Scrap Density	Food Scrap Generation By Density	Food Scrap Generator Sector	Food Scrap Generation By Sector	% of Total Generation	% of Total Food Scraps Recycled by Sector	% Food Scrap Sector Recycled by Method	Food Scraps Recycled By Method	Recycling Methods	Total Food Scrap Recycling Dense By Region	Total Food Scrap Recycling	Total Food Scrap Recycling Rate
							22%	20	Home Composting			
			Residential	89	19%	4%	0%	0	Residential Drop Offs			
							0%	0	Curbside Collection			
							5%	8	Composting			
	Dense Populated Regions	405	Commercial / Institutional	177	38%	5%	10%	18	Animal Feed			
							0%	0	Anaerobic Digestion	171		
							0%	0	Composting			
			Food Manufacturing / Processing	140	30%	27%	90%	126	Animal Feed			
									Anaerobic Digestion			
									Rendering Services			
469											194	41%
							22%	6	Home Composting			
			Residential	25	5%	1%	0%	0	Residential Drop Offs			
							0%		Curbside Collection			
							0%	0	Composting			
	Dispersed Rural Regions	64	Commercial / Institutional	22	5%	0%	10%	2	Animal Feed			
							0%	0	Anaerobic Digestion	23		
							0	0	Composting			
			Food Manufacturing / Processing	17	4%	3%	90%	15	Animal Feed			
									Anaerobic Digestion			
									Rendering			

(Adapted from *Rutland Regional Food Scrap Recycling Assessment*, Pg. 8)

Those 275 tons per week of food scraps that enter municipal solid waste in Rutland County contribute greatly to materials entering the landfill: 14,300 tons per year. Even with Rutland County comprising less than 10% of Vermont's population ("Rutland County"), it contributes at least 18% of the food scraps entering the landfill in Vermont.[1] The relatively densely-populated towns and Rutland City in Rutland County make for lots of potential of feedstocks, but there is a lack of composting infrastructure.

Not only is it important to have compost facilities in Rutland County due to the current lack of capacity, but also for financial and environmental reasons. "A compost or AD facility located 50 miles closer to a city than a landfill would on average result in a $20 per ton system cost savings [along with environmental costs] stemming from lower truck depreciation costs and

[1] Calculated by dividing the tons of food wasted in Rutland County by total food wasted in Vermont (State of Vermont Waste Composition Study 15). 14,300 tons / (413,517 tons MSW * .194 proportion Food Wasted) = .18

the bypass of transfer station fees, which can be shared with the hauler in the form of lower tipping fees" (*Roadmap* 57). If composting solutions are to be implemented in Rutland County in time to comply with Act 148 requirements, then they must be financially attractive, and lower costs will help that come to fruition.

Roadmap Towards Reducing Food Waste by 20 Percent

The Roadmap was implemented by a network of organizations called ReFED: Rethinking Food Waste through Economics and Data. Along with describing the problems associated with wasting food, it describes seventeen different scalable solutions to get food out of landfills. They fit in three categories: reduction, recovery, and recycling. Solutions within the reduction category prevent food from being wasted by end-use, such as consumer education campaigns, and tend to be the most cost-effective per ton prevented. Recovery solutions promote the use of edible and safe food to feed people, and have the potential to make the best use of food that is still over-produced. Food scrap recycling solutions include feeding scraps to animals, anaerobic digestion, and the different methods of composting, and ultimately have the capacity to prevent the greatest tons of food from being disposed of in landfills. Due to the tight time frame of Act 148, and the limited human and financial resources in Rutland County, action towards implementing composting is the most viable solution logistically and financially.

As set forth by ReFED, the primary barrier to implementing source reduction and food recovery solutions is that they require individual action from organizations or consumers. This in turn requires significant outreach by government or grant-funded organizations, which may be strapped for time and resources. Many of those reduction and recovery solutions are perceived as

risky, time-consuming, and nonessential, which limits the appeal of these ideas. For example, restaurant owners may be worried of lawsuits filed by organizations or people that they donate leftovers to. While the *Roadmap* shows that reduction and recovery solutions are generally the most beneficial socially, environmentally, and financially per ton of food diverted, they simply don't have the greatest potential to divert the most food from the landfill overall, which is a main point of Act 148 and the charge of this study.

The top four solutions from the *Roadmap* in diversion potential (respectively from greatest to least) are in the recycling category: centralized composting, anaerobic digestion (AD), water treatment facilities with AD, and commercial greywater systems (49). The first three generally have the same associated challenges: high startup, transportation, and logistics costs, low landfill fees, the danger of contamination from feedstocks, access to financing, feedstock supply and end-market assurance, and the siting and permitting of facilities. In general, AD facilities are predicted to have much lower diversion potential due to the greater or equal extent of all these challenges for their implementation and operation. For instance, "capital costs for a larger AD facility (50,000 tons per year) are expected to be over $20 million," (*Roadmap* 62) while compost facilities of 40,000 tons per year of processing capacity can be as low as $5 million (*Roadmap* 61). Wastewater treatment facilities with AD can be even more complicated to implement. Compared to usual materials flushed down the drain, "additional biological loading from food waste can significantly increase the operating cost at a [wastewater treatment facility], from $200 to $300 per ton" (*Roadmap* 63). Finally, commercial greywater systems are aerobic digesters that process food scraps on-site for restaurants or homes, and send the products to wastewater treatment facilities. These are quite expensive (up to $75,000), and are highly

questioned for their impact on pipe clogging and wastewater treatment facilities (*Roadmap* 64). Other solutions in the recycling category (home or community composting, and feeding food scraps to animals) are very useful on a small scale, and should be implemented wherever possible due to the extremely low costs.

While composting food scraps may not solve all the problems from wasting food upstream, out of all the solutions, it has the potential to reduce the most food from entering the landfill (*Roadmap* 49). Thus, composting will also be able to quickly eliminate the most greenhouse gas emissions associated with wasting food. Attaining the goals of Vermont's Act 148 will prevent more than 65,000 tons of compostable material from entering the landfill, only assuming a 60% diversion rate due to losses from contamination, and less than full estimated participation in waste diversion programs (*Systems Analysis* 15*)*. Thus, there will be a reduction of 27,273 Metric Tons of Carbon Equivalent (or 19,607 passenger cars) of annual greenhouse gas emissions associated with Vermont's materials management industry (*Systems Analysis* 129).

In summary, composting is a simple, affordable solution that can be implemented to divert the most food scraps from the landfill in the least amount of time. Challenges of composting differ greatly depending on which method is used, as well as the particulars of each site and project. These methods will be explored in the next section. Before comparing which composting solutions are most appropriate for meeting the requirements of Act 148 in Rutland County, more background information about food scraps and local composting will be useful. An analysis of each method will show entrepreneurs and government officials of how to prioritize choices. Throughout the rest of this report, I provide my own analysis of these methods, provide an example case study, and offer suggestions on how to proceed with further research.

Composting Systems[2]

The Northeast Regional Agricultural Engineering Service provides a very detailed description of composting principles. Composting is known as an aerobic process, meaning organisms consume Oxygen to use energy and produce Carbon Dioxide and heat. The different methods classified as aerobic may be categorized as passively or actively aerated. Passive systems allow air to flow naturally through the system, which occurs from a basic principle of physics: that hot air rises. In other words, the materials are formed into piles, placed in bins, and/or have pipes allowing air to easily penetrate the dense layers. Certified compost facilities are required to achieve temperatures of 131° F for extended periods of time, which destroy pathogens and weed seeds. Passive systems are very low-maintenance, and work well for backyard composting of residential food scraps, but don't generate the necessary heat for enough time to be allowed in large quantities. They still have a role to play, but will not process as much material as active systems. Thus, active composting, which can satisfy all of the requirements of a certified compost facility, will be examined in more depth.

Actively aerated composting is done so mechanically. The current options that exist are windrows, aerated static piles, in-vessel systems, or some combination of multiple methods. Along with being fit for regulation, active processing of food scraps and carbon materials can improve the end product by killing pathogens, weed seeds or chemicals, and blending ingredients for consistent breakdown. This method also speeds up the time it takes to break down and prevents adverse consequences of composting large quantities of materials, such as offensive odor and vectors (animals tampering with wasted food). The different types of active composting

[2] Information in this section is all compiled in order from Rynk, pages 29-40.

may have different outcomes for each of these issues, and other factors must be taken into consideration before choosing which method is appropriate for a site.

- Windrow Composting

Windrows are consistent piles of materials that are blended then "turned" (or flipped over) with mechanical equipment, such as a tractor implement, a skid-steer, or a specialized windrow turner. The only infrastructure required is the turning equipment, and potentially a gravel or concrete pad (depending on the soil type of the site), as well as access roads to the site. Windrow systems are quite simple, and have lower startup costs as a result. Some drawbacks of this method are that: the overall composting time is longer (up to 8 or 9 months), the amount of hours required to manage it are greater, and bulkier materials do not always mix well or break down, meaning there will be inconsistent sections that cannot be sold. All of the compost facilities accepting food scraps in Vermont practice windrow turning at some point in the composting process.

- Aerated static piles

This method generally uses piping and mechanical blowers to push or pull air through the pile. Materials may be layered in concrete bays over the pipes, or in open areas, while the blower operates to ensure that temperatures remain at an appropriate temperature range. The forced aeration method is costly, as sheltered concrete structures can cost upwards of $45,000 for three adjacent bays (such as the system designed for Green Mountain College by O2 Compost). This initial cost relieves the need for continuous turning, and greatly reduces the amount of labor required to run the compost, and thus offset the higher cost. The piles can be formed without concrete bays, but the piping can be easily broken by a tractor bucket, which can be a nuisance

and a cost for facility managers. A few of the certified facilities in Vermont used forced aeration for their operation, but one of them does not have concrete bays.

- In-vessel composting

In-vessel compost systems are just as they sound. A constructed container is where almost every step of the process occurs: mixing, aerating, and sometimes screening. Several models use a horizontal cylinder that rotates on a slight angle, which allows the materials to end up at the lower end mostly composted. There is still a curing period required, but not as long as other systems. In-vessel composters can be the most costly per unit of material processed annually, but there are some designs that use cheaper materials and can be built by a specialized contractor. One example is the North Country School composter in Lake Placid, NY, which cost about $15,000 in materials. In a cold climate these systems often need to be sheltered due to their loss of activity from contact with snow and negative temperatures. That can create a much greater cost unless there is a building with enough space to host one. There hasn't been an in-vessel system to be certified by the DEC in Vermont yet, but they meet the requirements and could produce over 100 Cubic Yards of compost in a year.

The following table is my own summary of the differences between the described active compost systems that would process similar amounts of food scraps:

	INITIAL COSTS	**LABOR INPUTS**	**AREA REQUIRED**
Windrows	Lowest	Most	Largest
Aerated Static Piles	High	Little	Little
In-Vessel Composters	Highest	Least	Little

When considering which system to pursue, the most relevant factors for the organization will be the required setbacks for approved facilities, the presence of infrastructure (outbuildings, concrete, turning equipment), and the presence of initial capital outlay vs. time to invest.

Act 148 and Solid Waste Regulations

In order to process enough food scraps to achieve significant diversion rates in Rutland County, a certified facility is needed, because they can compost significantly more per year. For instance, without a certified compost facility there would have to be hundreds of facilities in Rutland County to achieve the capacity to satisfy Act 148. Facilities that do not acquire a permit can only process 100 cubic yards of material per year, which can be 20 tons of food scraps at most.[3]

According to Solid Waste Management Regulations, "composting facilities shall be managed to properly compost materials, destroy pathogens, not create a threat to public health or the environment, and not create objectionable odors, noise, vectors or other nuisance conditions" (11-7). The following regulations can also affect the financial and/or operational viability of a compost facility:

- *Zoning setbacks for compost facilities require attention to buildings and water sources.*

A certified compost facility must not be sited in a floodplain, 100 feet from surface water, where a three-foot depth contacts seasonally high water or bedrock, or within 300 feet from a private building (11-6).These rules protect rivers and lakes from exceeding the total maximum daily load of nutrients which may cause algal blooms or eutrophication.

[3] 800lbs/Yd^3 (average bulk density of food scraps) * 100 Yd^3 / 2000lbs/ton = Maximum 40 tons / year

- *Institutions and businesses producing over 18 tons of food scraps per year are required to send them to a certified compost facility within twenty road miles (in effect July 1, 2017).*[4]

A compost facility that starts near Rutland will not have to search for places to collect food scraps. The outreach to those businesses would be done by the Solid Waste District which has the resources and history of doing so. Additionally, *transfer stations are required to collect food scraps separately by the same date*. Based on my calculations, the Gleason Road (Rutland City) transfer station may have sent nearly 100 tons of food scraps to the landfill in 2016.[5]

- *The recipe for a compost blend is between 20:1 and 40:1 of Carbon to Nitrogen ratios.*[6]

Food scraps can have a C:N ratio of 15:1 or even less. This can require a matched or greater volume of carbon-rich feedstocks. Some would be leaves (54:1) and yard debris, horse manure (30:1) and paper mill sludge (54:1) (Rynk 106), all of which can be found in varying quantities around Rutland County. Disposal of food scraps is currently paid for by commercial entities, and haulers are contracted to bring materials to the landfill or recycling facilities. Composters can earn revenue by charging fees for haulers dumping. Leaf and yard wastes and manures can be valued by different businesses (farmers, landscapers) nearby, which would cause a facility to incur costs. This study has examined one composter in Vermont that obtains paper sludge from a mill in the Albany area. Since composting food scraps can be more costly than landfilling them, further research would be helpful to understand what can make it worth it for different organizations to give away or pay for the disposal of materials that composters need.

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[4] "Vermont's Universal Recycling Law"

[5] Based on estimated 28% of waste stream is food scraps from State of Vermont Waste Composition study.

[6] Solid Waste Management Regulations 11-8

The consideration of environmental impacts can be influenced greatly by putting a higher tax on landfill fees.

- *A temperature of 131° F is reached for at least 3 days for aerated static piles, and 13-16 days for windrows* (Solid Waste Management Regulations 11-10).

Temperatures must be recorded daily by a certified compost facility operator at regular intervals along a pile. Turning of piles may occur multiple times per week, which can take several hours or more for a 300-foot pile depending on the skill of the tractor driver, unless a specialized windrow turner is purchased. This exemplifies the lower maintenance required for forced aeration, but it is important to keep in mind the much higher startup costs.

- *Compost to be sold must be cured, meaning its temperatures are stable below 100° F.* [7]

The curing period can cause the entire process from raw material to compost to take up to two months before it is sold. The seasonal demand for compost can be a challenge for compost facilities without much storage space, because farmers can't apply soil or compost to fields during winter months up to April, due to the runoff caused by melt and spring rains. Food scraps are produced all year, however.

- *Compost and high-carbon materials sold in bulk are exempt from sales tax in Vermont.* [8]

This makes compost more competitive with other substitutes such as chemical fertilizer. It also prevents the increase in cost of carbon sources, such as wood chips, if they were to be bought by a compost facility. Any market study done for the potential for selling compost must take this into consideration.

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[7] Solid Waste Management Regulations 11-8
[8] Sales and Use Tax -- Compost Policy

These Solid Waste management regulations present some challenges for allowing a compost facility, but some present opportunities for creating a marketing study and strategies. They do have forethought into how to prevent compost facilities from causing unintended environmental harm, but time can still be put into determining regulations that could make facilities financially attractive (such as higher landfill taxes).

Composter Interviews

Anecdotal evidence is provided below from interviews with compost facility operators and managers to help conclude which composting methods and business models show the most promise for entrepreneurs to begin a compost facility in Rutland County. Challenges are prevalent in the world of food scrap composting (and solid waste management in general). The following paraphrased details of different compost facilities in Vermont and single out the most successful models and practices. They are presented in order from those processing the most food scraps to the least.

The largest compost facility in Vermont processes 4,500 tons of food scraps every year (equivalent to over 85 tons per week) (“Encouraging Compost”). That is Green Mountain Compost in Williston, near Burlington, which is part of the Chittenden Solid Waste District. This facility started in 2010 with roots back to 1987 where composting started in The Intervale, a region of fertile area in Burlington (“Our Roots”). On 12.5 acres, the management and processing of the many different feedstocks that enter this facility every day is done by three full-time staff and many seasonal and part-time employees (“Encouraging Compost”). Green Mountain Compost uses up to 6 very large bays for aerated static piles to process incoming

materials, which are then formed into windrows for further processing and curing. The revenues of this facility come from both tipping fees (charging haulers for dropping off materials) as well as the sale of compost and other soil products. They are not great enough alone to keep the operation afloat, however. The general manager, Dan Goossen, states that "[Green Mountain Compost has] carried an operational subsidy since our construction/relocation in 2010." The subsidies have "been as much as $500K and as low as <$200K per year" ("Encouraging Compost"). High subsidies were required during the time that persistent herbicides contaminated the finished compost, which even killed some customers' plants. Contamination of chemicals is a large concern along with the more obvious plastics showing up in compost piles. Green Mountain Compost played the main role in increasing the composting of food scraps by 10-15% in Chittenden County since the Universal Recycling Law was enacted (Universal Recycling 15).

Vermont Compost is a well-known facility in Montpelier, Vermont, which is owned and operated by Karl Hammer and at least 13 other staff that manage a productive farm besides the soil company. This is the most successful compost facility that was interviewed for this study. Accepting many agricultural wastes along with food scraps for a tipping fee, this company creates multiple specialized blends that are sold (and renowned) across many states in the U.S. First, the food scraps are fed to chickens that help turn and fertilize the scraps, and then produce eggs for sale. Then the feedstocks are blended into specific recipes that are formed into windrows inside high tunnels, which prevents snow from accumulating on the piles during the Winter. Hammer has been experimenting with commercial composting since the 1980's, and has a lot of knowledge of the science. He shared that it took him many failures to get his companies to this point, and that "compost is not a way to start making money from scratch". He also

mentions that Vermont Compost is specifically successful because of large revenues from sales to farms in the midwest ("Vermont Compost").

TAM Waste Management is a materials hauling company in Bennington, Vermont that started a compost facility at the Shaftsbury transfer station. Along with drop-off food scrap collection from the transfer station, the company picks up food scraps in its own trucks, and charges the organizations that use the service. One full-time staff member and a recent additional part-time employee process over 600 tons of food scraps in a year ("TAM Compost"). A large challenge is that it is hard to sell most of the finished compost until a large contract for a field or highway comes in. In 2016, there were 800 cubic yards of finished compost that wasn't sold (nearly ⅓ of what they produced). In addition to food waste, TAM composts paper sludge from a money-printing mill near Albany. The compost sales are made up from 90% bulk sales at a relatively low price, while the other sales are smaller purchases from individuals. Trevor Mance, the facility and company manager, says the revenues from the paper sludge is what helps them break even with the costs of operating the facility. Mance also warned that compost facilities relying on food scraps for the nitrogen-rich feedstock in a recipe are at risk of losing that feedstock quickly. He related that from one week to the next, a pickup of food scraps from Price Chopper went from 20 barrels to 5 due to the variability of produce that had gone bad or passed the labeled date. Mance strongly urged during the interview that different composting or materials management facilities are in competition to secure certain feedstocks, and that there need to be new markets developed in order to provide enough materials at low or no cost for compost facilities to make money ("TAM Compost"). This could mean making a deal with

farmers to use manure, or even following through with the required collection of food scraps at transfer stations.

The closest certified compost facility to Rutland City is owned and operated by Middlebury College. Kim Bickham is the manager of the college recycling and composting facilities. The operation has served the college since 1993, but their permit does not allow the collection of food scraps or use of compost off-campus ("Middlebury Compost"). That makes the financials simple, as there is no sale or charge to other entities. The operation is successful, still, as it processes over 300 tons of food scraps every year from multiple dining halls and dorms. Generally, there will be three, 150-foot long windrows at a time that are cooking the compost, and they are turned every couple days with a loader. A concrete pad over an acre in area hosts the piles, making turning a relatively easy process. Recipes containing manure, wood chips, and food scraps are blended and added to the newest end of a pile before turning. The facility does accept compostable plates, cups, and utensils, as they normally break down inconsistently in facilities that aren't reaching thermophilic temperatures. There is still some contamination of small plastics, which are screened out of cured piles once a year by the nearby Vermont Natural Agricultural Products, another compost facility ("Middlebury Compost"). Academic institutions can be great testing grounds for innovative practices, and once they are adopted, they remain consistent.

These composters all have many tips for those interested in starting a new facility, and they are very generous with their time. An entrepreneur that is considering starting a compost facility would do well to learn from the experts. There are many other compost facilities and models in Vermont, such as Brattleboro Compost operated by the governmental solid waste

district. There are also many small operations occurring on farms throughout Vermont, but they do not often accept food scraps due to many different risks and challenges associated with doing so, which will be addressed in the next section. In order to find out which barriers to composting prevent the acceptance of food scraps on farms, interviews were conducted with several farmers that produce diverse products to understand a wide variety of influences.

Farmer Interviews

Farmers are sometimes overlooked in decisions by municipalities to divert organic materials from the landfill, because they may not be directly impacted by the decision, unless a compost facility is operating on a farm. This study includes the perspective of farmers because of three main reasons:

1. Composting is a form of recycling. Food comes from the soil, and excess nutrients are restored to it through the process. Growing food from compost is therefore the highest and best use of the product, and the closer compost is to the farm, the easier that is to do.
2. Farmers have a wealth of knowledge and experience in altering their soil for as long as they are in business. That understanding is extremely useful in the creation of compost.
3. Farms have the resources. Open land that goes unused between seasons, equipment that can collect and process food scraps, and carbon feedstocks (manure) are some of them.

Other reasons will be examined below, along with the challenges that farmers face. These anecdotes from farmers outline the challenges that different types of farms consider greatest:

1. The Larson Farm in Wells, VT solely produces organic-certified beef and dairy for sale with their cows. They have a long history of treating their cows with utmost respect and care,

and that is their priority when producing compost that is used for their bedding. They compost the manure, urine and added wood shavings from used bedding to turn it back into clean material where the cows can rest inside. Leftover compost is spread on the pastures to return nutrients to the grass that the cows eat, but that is not the priority in the process. When asked if they would consider accepting food scraps to compost with, Cynthia Larson responded that the greatest concerns would be of the quality of the product to be used as bedding, and whether it would meet organic certification standards. They have a business that is working well for them, and adding on a new product (compost) would complicate it, and questions of whether it would be profitable are also prominent ("Encouraging Farms").

2. The Slate Hill Farm in Poultney has a wider variety of products, such as beef, eggs, chickens, and hay. Terry Williams composts the manure and bedding from the animals in combination with hay and sawdust. This comes out to be around 50 cubic yards every week or more. Some chicken carcasses are also composted. Williams brings eggs to restaurants in Poultney, and in turn, collects food scraps that are given to the chickens to reduce their reliance on purchased food. He is interested in beginning to compost food scraps as well, if it can generate more revenue. He is mostly worried about the risk of contaminants when he doesn't have a relationship with the food scrap generator, as he does currently. When asked what would encourage other farmers to compost on their property, he responded "what's in it for them?" ("Slate Hill Farm"). If it is proven to be a profitable endeavor, farmers will consider composting food scraps much more than currently.

Greg Cox is the owner of Boardman Hill Farm in West Rutland, and he sells a diverse array of vegetables, chicken, and pork. He has helped create the organic standard through the

Northeast Organic Farming Association, and had the first certified organic farm in Vermont. His emphasis is that "it's not about [the farmer], it's about the plants!" He currently accepts food scraps at no charge from the BROC food shelf in Rutland, as well as from the workers at Vermont Electric Power Company. He combines food scraps with feedstocks from his farm, such as offal (animal carcasses and parts) and the animal bedding. Cox's composting method is a passive pile, and is not required to have a permit due to the low quantity of food scraps. The compost pile requires little maintenance, but he does turn it, and uses all of it on his own fields. Cox expressed interest in becoming a certified collection site for Rutland City, but the largest barrier he faces is the time and logistics needed to collect food scraps. His current collection sites are only happening because of his relationship with the organizations where he drops Community-Supported Agriculture shares off at the same time he picks up food scraps. Secondarily, he is greatly concerned about potential contamination of plastics and other inorganic materials. He stated that "source-separation is a must," meaning collection of food scraps must be paired with adequate education so that users put the materials where they are supposed to go ("Boardman Hill Farm"). If collection and separation systems are in place, it makes the composters job much easier.

These different farmers are exemplary models of businesses taking advantage of natural systems of nutrient recycling. They speak from decades of experience with growing food, and handling nutrients and water. Their perspective is of utmost importance to consider, especially since they are willing to work with organizations to compost food scraps. The only farm interviewed that wasn't interested in accepting food scraps was the Larson dairy and beef farm, but they are proponents of doing so where appropriate. Cynthia Larson suggested that permit

regulations on composters can be too restraining, as they will prevent the operation from growing. Cox also pointed out the setbacks from private property lines would prevent many small farms from hosting a certified compost facility. To reiterate, the most prominent barriers to farmers accepting food scraps are the time and coordination necessary to do so, the threat of contamination in the feedstock, and the constraints of requirements for accepting large amounts of food scraps. An incentive that can make composting large amounts of food scraps more desirable is the potential for revenue from selling the material to earn more revenue for the farm.

In some cases it is possible for certain organizations, neighborhoods, or individuals to compost some or all of their food scraps on-site. This results in the benefit of less burden on a food scrap collector, as well as the understanding of what actually composts, and what to avoid throwing in the collection bins. While certified compost facilities will be necessary to gather a large portion of the food scraps entering the landfill, small operations can have a great role to play in avoiding reliance on a single facility or person to take care of all the food scraps.

The role of Community and Backyard Composting

Many people are familiar with the EPA food waste recovery hierarchy, portrayed as an upside-down triangle to show which steps in diverting food scraps from the landfill should have the highest priority to gain the most environmental and economic benefit; composting is relatively low: just above landfilling food ("Sustainable Management"). The Highfields Center for Composting and the Institute for Local Self-Reliance (ILSR) partnered in a study titled *Growing Local Fertility: A Guide to Community Composting*. They outline a Hierarchy of Food Scrap Recovery which puts residential backyard composting, small-scale, decentralized and

locally based composting, and centralized, far-away composting in that order of having the most benefits (Platt 6). One reason for starting with the smallest scale and moving towards larger compost facilities follows: “in community composting programs, resources are recognized and managed as community assets. These programs are typically characterized by local control and community access but not necessarily community ownership” (Platt 7). Compared to the conventional waste disposal industry which dumps regional materials on already burdened areas, this model promotes the cycling of resources within small communities, which keeps the economic and environmental benefit local as well. Additionally, it raises awareness for youth and adults alike of the importance of separating food scraps from trash and recycling.

There is a surprising amount of material that can be composted in a small site when enough people and resources are invested in the project. One example of a community operated compost program in an urban area is BK Rot. In Brooklyn, NY this group of seven youth and two organizers manage a community garden and several compost systems, including vermicompost and thermophilic (passing 131° F for extended periods) bins. All the mixing and turning is done by hand, and collection from 97 different households and commercial entities is done by bicycle. In total, BK Rot composted nearly 38,000 pounds of food scraps in 2016, which is nearly ⅓ ton per week (what a small restaurant generates). The outstanding fact is that the garden and compost area is on less than a quarter of an acre in a very crowded Brooklyn neighborhood (“BK Rot”).

It is estimated in Rutland County that 28 tons of food scraps per week are composted in residential backyards, while there are around 114 tons per week generated by residents (*Rutland Regional*). If 60% of the residents in Rutland County were to participate with composting

services, the rate would increase to nearly 70 tons per week recycled, with 47 tons per week that will be composted in backyards by 2020. Community composting efforts could handle some of the residential food scraps, but also some of the commercial generation. If community composting can be done in urban areas of Brooklyn, NY and the District of Columbia, then it can surely be done in Rutland and the surrounding food scrap dense towns.

The cost of materials for constructing bins for community composting is very low, as they can easily be built from reclaimed wood and metal. The greater challenge than funding is encouraging active volunteer participation so that most of the work does not fall on one person. The Neighborhood Soil Rebuilders program in D.C. is a training program by the Institute for Local Self-Reliance that helps volunteers learn the science and procedure of composting in communal bins. Once trained, volunteers can drop off their food scraps at the bins, and contribute at least one hour per month to turning or mixing the compost. The only cost for that program is paying the garden/farm managers that coordinate the trainings and volunteers ("Neighborhood Soil"). This could be worked into some of the non-profits in the Rutland area, such as Marble Valley Grows (Rutland, VT), Vermont Community Garden Network, and Smokey House Center (Danby, VT).

While little equipment is needed for community composting, the volunteers may be trickier to come by. The role of education in implementing Act 148 has been embraced and encouraged by legislators and enforcers of the law. Training programs for compost facility operators are already offered, but community compost training is an opportunity for partnerships between non-profit organizations and governmental bodies. People are learning the importance of disposing of materials differently, so the culture of wanting to do something about wasted

materials is also becoming more prominent. Many citizens just need the confidence to jump into an area of uncertainty, and there are plenty of resources of knowledge available.

CASE STUDY: COMPOST FACILITY FEASIBILITY

In order to understand many of the realities of starting a compost facility, it is very useful to go through the steps of site and financial analysis that offer a basic estimate of how financially attractive a compost facility may be. Amy Gilbert has been interested in starting a compost facility since purchasing land in Wallingford, VT. The opportunity to do an analysis of a real project provided me insight into what many composters go through to implement a project. Some characteristics are less than ideal, such as the site being located less than 300 feet upslope from the river, or neighbors being within sight, but it serves well to gain a basic understanding of the permitting and planning process.

Permit application is done through an online platform on the VT Department of Environmental Conservation (DEC) website. Applicants are required to enter general information about the location, a full management plan, an estimation of the types and quantities of feedstocks, and provide written approval from the landowner and local solid waste district. The management plan may be the most lengthy writing required, but would be necessary for any facility manager to consider all the operational procedures. Before starting the permitting process, there is technical assistance provided by the DEC and Compost Technical Services (CTS) to anyone interested in starting a compost facility. This is through a contract between the DEC and Compost Technical Services, which jointly provide the required compost facility operator training.

The site under consideration in this study is located on over 150 acres of land ten miles south of Rutland City. Most of the property is forested, but there are fields used for growing hay and caring for sheep, dogs and a horse. The most likely business model for this facility would be owned and operated by a single, very motivated individual or a partnership. The quantity of materials composted annually would be similar to that which TAM Waste Management processes, which is operated by one full-time worker, and managed by the owner of TAM. The lower field is a potential site of the compost facility, with a reasonable slope that could benefit from grading to an even surface. There are adequate access roads, but an old bridge may require some reinforcement to handle trucks carrying heavy loads of feedstocks. There are nearby residences and surface water that limit the potential area of the facility, but there is still adequate area for compost processing and curing. The main potential issue is of the depth from the surface of the site to bedrock or seasonally high waters, which requires a test pit to be dug for proper analysis. Before investing in a project of this size, however, it makes sense to consider the initial and operational costs of the business, as well as the potential revenues.

The major costs that may be required to be able to even accept feedstocks for composting at this site include the turning equipment, source-separated organics collection infrastructure, gravel for grading and drainage, and bridge reinforcement. Costs may vary by location, dealer, and circumstance, so actual costs are not discussed. Estimates and descriptions of why the cost is necessary are the main focus of this paragraph. The cost likely to be the highest would be turning equipment. The cheapest option that would still be effective could be a tractor with a bucket loader implement. The collection infrastructure could consist of bins that are picked up by hand and transported by a truck. Partnering with a hauling company, such as Casella, could make the

most sense, rather than purchasing new equipment, as there are many different trucks that can contain and transport food scraps. Setting up the separation of organics in transfer stations and commercial entities is necessary as well, and partnering with the local solid waste districts can help educate and consult on setting up and maintaining source separation. Gravel is relatively cheap, but hiring a contractor to grade and level the surface can be a much higher cost. A proper site surface is important to avoid pooling of leachate (liquid high in nutrients from compost), which can make operations much more difficult, and reflects poorly on the perception of the business. Finally, the bridge reinforcement would only require metal decking to replace the wooden boards, which would be the cheapest investment, and will allow trucks with large amounts of food scraps to access the composting area.

Variable costs of operating the facility will include the carbon source, fuel and maintenance for equipment, the leasing of land, and labor. Income and sales taxes are also important to consider, but bulk sales of compost are exempt from tax. The first cost examined was the source of carbon, which is usually leaf and yard debris, sawdust, hay, or manure. Leaf and yard debris from the Rutland City transfer station is valued at $23.50 per ton, which is readily available. In that the quantity of carbon source needed is calculable, the next paragraph examines the quantities of each feedstock processed, and the associated revenues and costs. Fuel and maintenance costs are very uncertain, as the speed and frequency of turning piles is reliant on the experience of the operator, and can even range from 20 to 70 cubic yards flipped every hour (Rynk 26). The cost of leasing the land depends on the landowner's needs, and what she exchanges in return for allowing a compost facility. An agreement may be made to have a share

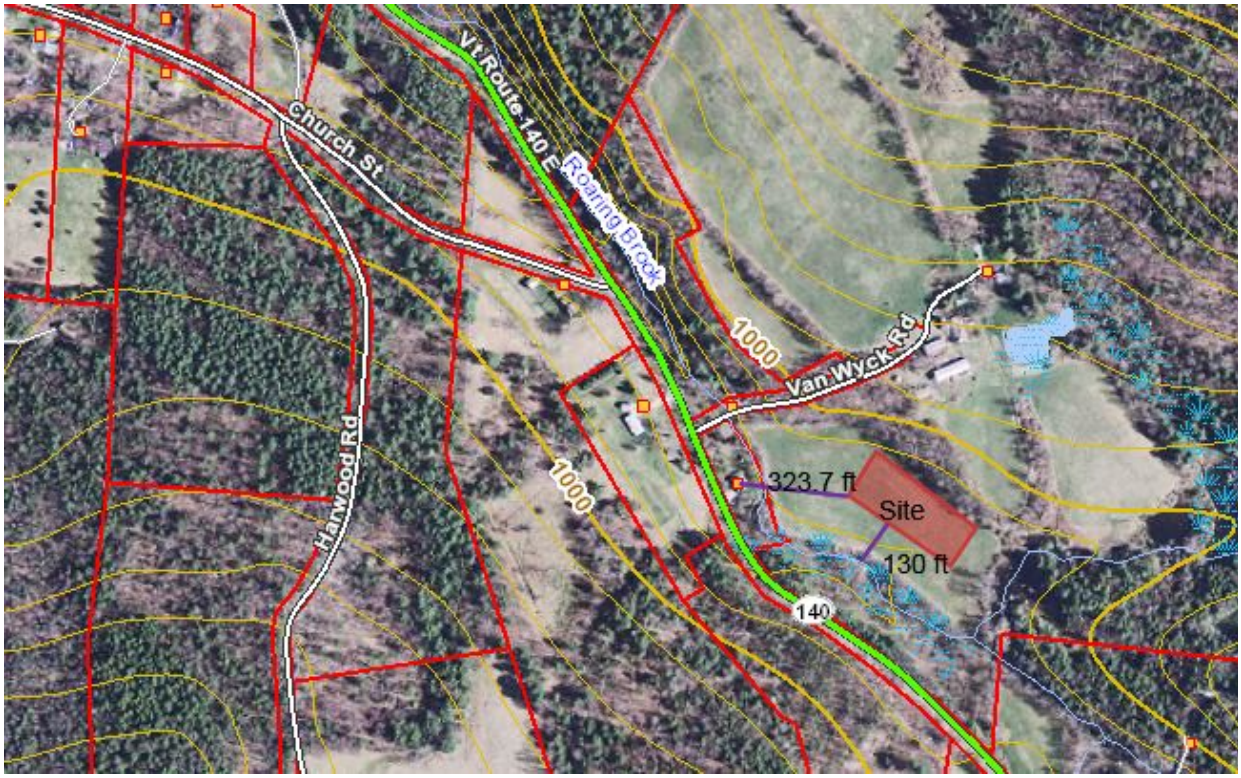
of the profits returned to the landowner in exchange for a cheaper lease. The cost of labor is also difficult to calculate, as the amount of hours worked also depends on the operator's experience.

Along with being a necessary part of the permit application, estimating the quantity and type of feedstocks processed for a compost facility will help generate annual revenue predictions. Since money is earned by accepting food scraps and from the sale of compost, the estimates of quantity will inform both sides. Given a specific site with constraints to the size of compost processing, the estimates were created by estimating the maximum amount of materials being processed at any given point in a year. The detailed resource from the Agency of Natural Resources called *Sizing Your Compost Pad* was used for calculations and constants . Even though it takes around 8 months for the full composting process (McSweeney), this estimate does not include the other four months when food scraps could still be accepted and sales delivered. This conservative estimate of revenues predicts that operations will not always proceed at maximum capacity, and that all of the finished compost will not be sold immediately or in the first year.

The maximum area of compost processing available at this site is 60,000 feet^2 (1.38 acres) due to previously mentioned constraints, with dimensions of 400 feet by 150 feet. 16% (9,600 feet^2) of this area is allocated to curing compost and work area, as the recommendations for pile sizes and management are not as strict after active composting has completed. The area for blending and dropping off feedstocks is 40 feet by 60 feet to allow adequate turning radius for trucks and work space for equipment. The rest of the active composting site allows for six windrows that are 130 feet long and two that are 100 feet long at any given time of year. These windrows will result in a total quantity of finished compost of up to 1,725 cubic yards in an eight

month period. Factoring in the densification of piles that occurs in the process, food scraps would make up 1,000 cubic yards of the raw feedstock inputs, along with 578 cubic yards of horse manure and leaf/yard debris each. Using the Compost Recipe Calculator prepared by Compost Technical Services and the Agency of Natural Resources, this blend of feedstocks creates an ideal carbon to nitrogen ratio, bulk density, and moisture content. Additionally, they are all readily available in the area, though horse manure may be difficult to find in large quantities.

Figure 2: Wallingford Compost Facility Case Study Site Map



With the estimates of quantities of feedstocks processed and finished compost produce, revenues were calculated using the same fees and prices that TAM Waste Management uses. The following chart shows the calculations and results:

COMPOST SALES	*VALUE ($/yd³)*	*AMOUNT (yd³)*	*REVENUE*
Wholesale bulk	$38.00	1650	$62,700.00
Residential bulk	$55.00	75	$4,125.00
TIPPING FEES	***VALUE ($/ton)***	***AMOUNT (tons)***	***REVENUE***
Food Scraps	$40.00	500	$20,000.00
Yard Debris	-$23.50	145	-$3,407.50
Horse Manure	?	?	
		TOTAL REVENUE:	***$83,417.50***

These calculations determine a large portion of how the facility would be managed, and show that it could very likely be financially feasible. It does seem, however, that it would not be financially attractive to someone or multiple people that put in much more than 40 hours of work in a week to manage all the moving parts. Additionally, financing the compost facility may be difficult, as there is a long delay from when food scraps are accepted to the time that finished compost can be sold. In order to make the initial purchases, one must consider the different financing structures (through loans or investors) that would maximize profits and minimize liability. This decision would benefit from hiring a tax attorney and/or an accountant to determine the best financing agreement.

The main concerns with this case study are the availability of different feedstocks, as well as the issue of permitting in a potentially prohibited location. Additionally, being that the business would rely on over 70% of revenues from the sale of finished compost, a study on the current market demand for compost would be extremely useful in predicting the success of the

facility. It would certainly be worth paying someone to dig a test pit and analyze the layers of soil. In general, this facility could process up to 10 tons per week of food scraps from Rutland County, which would satisfy a tenth of the expected needed capacity in 2020. Multiple other small facilities could also step in to make money on the endeavors, so a market demand study would encourage other entrepreneurs to look into other sites for a compost facility business. This is precisely the kind of action and partnership that the Department of Environmental Conservation has been looking for to help implement the requirements of Act 148 by 2020.

CONCLUSION

Diverting food scraps from the landfill is important for environmental conservation and financial health of society, and will be a legal requirement by 2020. Rutland County is a prime location to implement composting, which can divert food scraps from the landfill quickly. More research and development of different plans for facilities is needed, though. The county also has the food scraps and resources to implement compost facilities, but support is needed from governmental bodies as well as non-profits and haulers in the area. The successes and challenges for other composters in Vermont provides a great opportunity to learn and move forwards as a state. Farmers are a key group of stakeholders that should be contacted for determining availability of feedstocks, and asking their interest in accepting food scraps for their current or planned compost operations. Contacting them will even help find ways to get food scraps to animals. They do face many challenges to starting a facility as well, however, greatest of which are the time and logistics necessary to coordinating collection of food scraps and processing them properly.

Other than certified compost facilities, community gardens, green spaces, and individual backyards have the capacity to process many more tons per week than they are currently doing, which would help educate the participants to reduce contamination of larger loads for facilities. This requires initiative from neighbors and community members, which can be spurred on with workshops or trainings and consulting assistance. Source reduction of food that is overproduced, and recovery of food for donating to those in need are also high priorities, and further outreach on those topics is highly encouraged.

In order to ensure clarity on where resources can be best allocated, the remaining section makes specific recommendations to different stakeholders, and prioritizes the areas of interest.

RECOMMENDATIONS

Many of these recommendations overlap, or require partnerships to execute fully and effectively. Reading through all of them will provide the next stepping stones for diverting food scraps in Rutland County.

- **To the Department of Environmental Conservation**

Priority: Compile resources from Highfields Center for Composting, ANR materials, and national resources into a compost business startup toolkit as extensive as the one provided at facility operator trainings.

Distributing information is a strength of government bodies, and structured toolkits often succeed in achieving their goals. If even one entrepreneur in Rutland County uses the toolkit to look into starting a compost facility, it will be a success. Renewing the contract with Compost Technical Services to provide technical assistance and host operator trainings for composters was

a smart move. Continuing to provided resources and assistance to solid waste districts for outreach to food scrap generators is also necessary, but encouraging outreach to farmers is also of importance.

Taxes on landfill fees will cause the fees charged by composters more attractive, or will allow them to raise tipping fees as well. Consider that raising the tax on landfill fees may be a main economic driver for increasing rates of recycling and composting statewide. Finally, notifying solid waste districts of funding and financing opportunities for compost facilities is key for them to pass information along to entrepreneurs.

- **To the Rutland County Solid Waste District and Solid Waste Alliance Communities**

Priority: Contact farmers with an initial survey to determine who is currently collecting food scraps, and what the main barriers are for those that aren't.

A survey will identify what projects can be done immediately to best encourage farms to accept food scraps for feeding animals and composting, as well as to better understand how many food scraps are being diverted from the landfill already. Collection infrastructure and source-separation of organics seems to be a priority according to the research in this study. Continuing outreach to food scrap generators about ways to divert food scraps will further that initiative, and implementing separation at the transfer stations will also provide opportunities for picking up food scraps. Partnering with another organization (perhaps a non-profit or academic institution) to conduct a market survey of compost and soil products would inform entrepreneurs of the target organizations where the potential for selling finished compost is. Connecting with Master Composters and Master Gardeners will provide them with volunteer hours, and relieve some of the burden from employees.

- **To the Farmers**

Priority: Reaching out to employees at the Department of Environmental Conservation and solid waste districts to express interest in accepting food scraps will go a long way to finding resources and connections to help save money on animal feed and soil nutrients.

Researching compost facilities resources, and attending a compost facility operator training will result in more confidence to accept food scraps.

- **To the Academic Institutions**

Priority: Furthering research on several different study suggestions in this report.

Those include compost market demand, barriers to farmers accepting food scraps, and barriers to backyard or community composting.

- **To the Rutland Area Farm and Food Link**

Priority: Aiding the solid waste districts with outreach to farmers.

Continuing all the current programs such as gleaning is a fantastic way to prevent food from being wasted in the first place. While contacting farmers for being part of the Locally Grown Guide or gleaning programs, planting a seed in their minds of the cost savings and revenue that food scraps and composting could provide would be a first step in promoting those endeavors.

- **To the Vermont Community Garden Network**

Priority: Create a training guide for composting at community gardens, such as the Neighborhood Soil Rebuilders program in the District of Columbia.

Events like Day in the Dirt and community compost forums are very effective at engaging communities state-wide, and have the potential to encourage projects such as composting to save money and provide nutrients for the garden. We can all benefit from having more materials remain in and come from local communities, as resilience to the changing climate will only come from doing so.

- **To Individuals**

Priority: Get engaged and stay connected with the many organizations listed above.

Composting in your backyard will save you money and increase the positive impact you have on the environment. Through websites, social media, or talking to your neighbors, these are ways we can make positive collective impact on greenhouse gas emissions, food systems change, and even our own health.

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