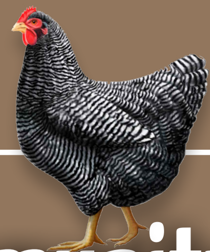

Feeding Community Food Scraps to Laying Hens in an Active Composting System

Black Dirt Farm

Acknowledgements

March 2017

This project was undertaken by Tom Gilbert of Black Dirt Farm in Stannard, Vermont, with operational support and leadership from John Smolinksy, also of Black Dirt Farm. Much of the inspiration for this work originates with the work of Karl Hammer at Vermont Compost Company, where he has been an innovator of this feeding strategy. Karl, his son Sid, and Vermont Compost Company have been important partners and collaborators in this project. Many thanks go to our technical advisor, Dr. Michael Darre, Poultry Specialist for the University of Connecticut for helping us establish the trial design, and sort through data and challenges along the way. Dr. Jarra Jagne, Poultry Pathologist for Cornell University, was critical to sorting through potential pathogens of concern and overseeing pathogen testing. Retired University of Vermont Professor of Poultry Science, Lyn Carew, dove in and helped us clarify our egg nutrition testing goals and interpret our results. Thanks also to James McSweeney of Compost Technical Services for his research on this topic and camradery. The Northeast Sustainable Agriculture and Education staff were incredibly supportive and professional in their oversight of this project. Graphic design and layout were provided by Brian P Graphics.

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Introduction

Renewed excitement about regenerative farming and food systems globally is, in part, driven by the increasing appreciation that, as a human species, we find ourselves in an unprecedented moment in history in which the ecological rules have not actually changed, but we have exhausted the buffers that have afforded us the ability to remain ignorant of them. Additionally, farming and food systems provide meaningful opportunities to address social issues of food access and nutrition, community economic development, and community vitality. Be it depleting stocks of oil or phosphorous (both being finite resources) or the increasingly thin margins of the Earth's atmosphere to absorb carbon and other toxins, we have arrived in a moment of accountability. To mitigate the use of nonrenewable, mined, or toxic inputs, while also improving the nutritional and ecological services provided by production systems and their products, a re-evaluation of food production and distribution systems, as well as resource management, is needed. Throughout time major developments in human civilization have been initially driven by practitioners. Science has followed, clarifying and broadening the application of new knowledge. Ecological and social issues require every food producer to look for opportunities to not just balance profit and loss statements, but to disrupt patterns of poor resource use and explore opportunities to improve efficiency and mitigate ecological impacts.

Discarded food is abundant in our communities. In the contemporary, linear food system model in which nutrients flow from fertilizer factory to landfills (and water systems), the capture of nitrogen, phosphorous, carbon and other resources in these food materials isn't a consideration, largely because we have never accounted for their fate and we have always assumed that we will have ongoing, unencumbered access to them. Having recently crested the concentration of carbon in the atmosphere that the global scientific community has identified as impacting life on earth, and nearing the point of permanent damage, resource recycling opportunities that mitigate waste (source of pollution) and imported grain (energy intensive), while retaining economic and social value locally, is not just a promising opportunity for farm viability, but has broader social and ecological value. Certainly far more food is wasted than necessary, and every opportunity to reduce initial waste, and then capture as much of that 'waste' as possible for human consumption, should be exploited. However, even with good upstream food capture in place, a considerable amount of discarded food will continue to be available.

Increasingly many states and municipalities, especially in the Northeast and Western Coast of the United States, are passing bans on sending food scraps to the landfill and establishing well-primed markets for collection businesses. Given the significant cost that feed represents in the typical egg farm model, and the energy intensiveness of grain feeding in general, growers are increasingly interested in alternative, local sources of nutrition for their flocks. Food scraps represent an exciting opportunity both in their abundance, as well as for their potential to shift the feeding paradigm to one of year round foraging of a decomposer system, better reflecting the birds native habits.

How to Use this Manual

This manual has been developed based on a two-year research project funded by United States Department of Agriculture Sustainable Research and Education (USDA SARE), a year of observation, and many years of anecdotal experience accumulated through our own operation at Black Dirt Farm and our partners: Karl and Sid Hammer at Vermont Compost Company, University of Connecticut's Poultry Specialist, Dr. Micheal Darre, and Dr. Jarra Jange, a poultry pathologist at University of Cornell. This should not be read as a definitive prescription for Best Management Practices since the practice is actively evolving and would benefit from further research. Additionally, there are limitations to the data generated by our SARE project due to the size of the project, imperfect benchmarks, and external variables as discussed further later.

The manual is laid out in four major sections:

- **Background of the practice**
- **Our SARE Project and its outcomes**
- **Sourcing Food Scraps**
- **Feeding Food Scraps.**

1 Background

For as long as humans have domesticated chickens and their predecessors, chickens have likely been consuming their discards in some capacity. In fact, fowl scavenging food in human communities may have contributed to domestication, leading to a longtime coevolution. The practice continued and became more deliberate through the 1930s when a resource-mindful World War II-era US Government encouraged citizens to set aside food scraps from their trash for the purpose of feeding hens and pigs. In fact, the separation and collection of these materials was organized and government propaganda encouraged people to 'Save Kitchen Scraps for the Hens! Your local council will collect'. Since that time there have been documented cases of pathogen transmission from humans to food scraps to pigs, which have brought about health concerns associated with feeding pigs food scraps. More recently we have come to understand the pathogen pathways between pigs and humans, however there has never been any documentation of this same risk with chickens. Many states regulate feeding discarded food to pigs, some banning it outright. Some states have implemented similar measures for poultry, without precedent or scientific basis. As growers and communities throughout the world are looking for new models of agriculture and community resource management utilizing discarded food as poultry feeds is a practice attracting more interest in recent years. Further exploration of the practice will help ensure efficacy, safety and producer viability. This project has sought to contribute to that process for our own farm as we scale up our laying operation, and that of other growers.

Red Jungle Fowl are believed to be the species from which the modern chicken has descended. These jungle birds forage from the forest floor searching out bugs, fallen fruit, plant matter and seeds. Much of their diet is derived from the decomposer system. Biomimicry is the practice of attempting to replicate certain relationships and functions present in ecosystems in a constructed environment. In agriculture a wide variety of techniques have been developed and are under development to mitigate the impacts of disturbance by adopting systems that attempt to reflect native, or more ecological, systems. For instance, the use of rotated pasture systems, cover crops, beneficial insects, intercropping, and wildlife buffers all help growers improve farm operations as well as mitigate the impacts of disturbance caused by farming.

The compost-based feeding system is an attempt to realize the nutritional value from food scraps, the fallen fruit of the food system, while also mimicking the biological system of the forest floor (a decomposer system) and creating a year-round pasture environment for hens to forage. By doing so, bacteria and other microorganisms proliferate. It is believed that these organisms likely constitute an important component of the birds' diet, contributing protein and other nutrients, as is seen in other carion/

detritous-eating species. While the food scraps themselves provide feed for the hens, as fallen Oil Palm fruits do their ancestors, this food also becomes a medium for growing bacteria.

In the US the average individual disposes of roughly one pound of food each week. When averaged with disposal at businesses, industries and schools, communities typically dispose of roughly 500–750 pounds of food scraps per year per capita (based on statewide estimates for Vermont). Given these volumes a significant number of hens could be fed, and a significant number of eggs could be produced, either entirely without, or with a fraction of, the grain required for a standard grain ration, thereby mitigating energy inputs in the food system and increasing producer margins. In efforts to develop regenerative food and farming systems with balanced and internalized energy equations, local economies with maximized community-based value creation and farm viability, this is an attractive proposition.

Vermont Compost Company (VCC), owned and operated by composting leader Karl Hammer, is a composting operation specializing in compost-based potting soils in Montpelier Vermont that has pioneered this practice in the US. They have been feeding hens on food scraps and selling eggs in the community for over 15 years. They began collecting food scraps from local restaurants and schools in 1998, eventually handing off their collection program to the Central Vermont Solid Waste Management District (CVSWMD). In 2016, CVSWMD delivered over 1100 tons of food scraps to VCC. VCC has fed its flock of between 600–1400 chickens—which has fluctuated somewhat over the years—with no purchased grain. The chickens produce eggs year-round, with augmented light in the winter, and have not displayed any signs of a lack of nutrition or disease.

As homesteaders we have also utilized this practice for over 10 years with success. Upon establishing Black Dirt Farm in 2014 we were eager to bring this model to scale, but had no data. Our desired flock size was 2,000 hens. We applied for a USDA SARE Farmer Grant to better understand the practice before of scaling up. The practice fits our operation for a variety of reasons. Black Dirt's farm model is designed to increase value within the farm system through process integration that will mitigate input costs, such as hen feed or heat for the greenhouse, reducing pressure to increase revenues. By stacking functions and dovetailing value from one enterprise into the next, we aim to keep the scale of each enterprise as contained as possible, limiting the need for growth.

Our core enterprises follow the decomposer cycle, beginning off the farm when we collect food scraps. We currently collect roughly 200 containers per week from 60 entities, mostly within a 30-mile radius, but extending as much as 50 miles in some cases. We deliver roughly 15 tons a week to a partnering farm, Tamarlane Farm, for making compost, and bring 7–10 tons to our own farm each week. Food scraps arrive at the farm at a net profit and reduce our need for purchased feed, immediately lowering operating costs and the scale at which we must operate to be profitable. After food scraps have been blended into a compost mix and fed, they are removed from the hens for making compost. We are in the process of establishing an Aerated Static Pile system to harvest heat from the composting process to heat our 30'x100' greenhouse and reduce composting labor. The composting process yields a pre-conditioned feed for worms, from which we make worm castings, and compost. Our farm sits at 1500' on Stannard Mountain in the Northeast Kingdom of Vermont in a USDA Zone 3b climate, where we also undertake a variety of farm enterprises and homestead functions not covered here.

Project Overview

Project Summary From Grant Proposal

'In general, small egg operations (less than 5,000 birds) are economically challenging given the high cost of feed within current production models. Feed costs can represent as much as 70% of total production costs and 30% of the retail value of the egg. Our communities generate substantial volumes of discarded food. Our farm and a small group of other farms in our region have raised laying hens on a diet of discarded food for over ten years, however no quantitative assessment on food scraps as a feed has been conducted, and there are concerns with the transmission of salmonella. This project will assess the opportunities and risks associated with feeding food scraps to laying hens. Specifically, we will assess nutritional value and pathogenic risks associated with food scraps as a feed, and the economic viability of this practice for small-scale commercial production (50–2500 hens). With a thorough assessment of food scraps, we will develop feed ration recommendations and pathogen management protocols that can be used on our farm and others to ensure healthy birds and consumers. We will collaborate with the University of Connecticut to conduct the study. We will collaborate with the Highfields Center for Composting and the Agricultural Service Providers in Applied Poultry Science network (funded through NESARE Professional Development Grant) to disseminate information.'

Project Objectives

- **Objective 1:** Evaluate nutrient content of food scraps*.
- **Objective 2:** Assess food scraps for Salmonella enteritidis.
- **Objective 3:** Assess eggs for Salmonella enteritidis and nutrient composition. Assess egg quality through egg weight, egg cracking and conformation, and yoke color**.
- **Objective 4:** Assess poultry housing for Salmonella enteritidis.
- **Objective 5:** Assess economics of food scraps as poultry feed and monitor egg production.
- **Objective 6:** Produce ration recommendations and Best Management Practices for optimizing use of food scraps as poultry feed, and mitigating pathogen risks, and disseminate information.

  * This objective was discontinued after year one.
  ** These additional metrics were added to this objective in year two.

Changes in Project Objectives

Year 1 – We proposed and implemented an approach of assessing the ration potential of food scraps, as well as potential presence of Salmonella enteritidis. Evaluating the food scraps as a ration in a meaningful way was difficult. We began by sampling and analyzing the fresh food scraps for nutritional value. Upon review against typical ration recommendations, our Technical Advisor, Dr. Michael Darre of the University of Connecticut, advised that food scraps should not account for more than 7% of the hens' diet. While we anticipated there might be dietary gaps we would need to fill, this recommendation seemed at odds with the observations and other data we were accumulating from the split flocks. If nothing else, our egg production numbers were similar for the two groups. We decided that our sampling technique was not reflecting the hen's grazing strategies and habits, nor the feed value of microbial populations cultured during composting.

Year 2 – In Year 2 we decided to simplify our approach to analysis and focus on the outcomes from the two feeding strategies as the starting point for comparison, rather than establishing specific ration recommendations. Our initial scope had included measures like total egg production and lay rate, however we added other metrics to the list to fill out our picture of how the feeding system affected egg quality. We shifted our feed testing budget to testing the nutritional content of the eggs. Additionally, we took egg weights, assessed egg conformation and evaluated yoke color.

Challenges and Limitations of this project and its data

1. **Old Flock, small numbers and poor historical records –** The greatest limitation to this project has been its size, a lack of baseline information, and poor historical records on hen ages within the existing flock. At the outset of the project we had a 50-hen flock with widely mixed ages (1–4 years) and breeds, and no record of age by group. We raised an additional 50 pullets for the project. In order to establish two 50-bird flocks, we split the existing flock as evenly as possible between age (guesses) and breed (visual identification), and divided the pullets evenly between the two groups. The lack of clarity regarding the core flock's age and breed distribution between the two flocks inherently compromises the data collected, but our attempts to establish commonality between the two groups should be adequate to validate this project as a reference point for those interested in this practice and future investigations.
2. **Sampling Methods and Analysis –** As was discussed earlier, evaluating the food scraps as a ration component was challenging and we determined our methods were too imprecise. Once we shifted our testing budget toward an evaluation of egg quality, we had limited time left in the project. This was further complicated by equipment challenges that interrupted our capacity to manage the compost-

ing system effectively in January and February of 2015 (see below). Therefore the first half of the egg nutrition testing reflects values from the two flocks, while the last half of the data reflects a hybridized approach we implemented after integrating the flocks when the year of split flock operations was over. In sampling hybrid-strategy eggs, we compared these values to the published USDA values. Additionally, at the same time we needed to change the battery of tests we were doing to a schedule of tests more relevant to nutritionists. As a result, a number of our egg-nutrition measures changed during the sampling and testing period. Similar to the issues that emerge out of working with hens of various, undocumented ages, these changes in the management systems and the testing parameters reduced our overall sample sizes to evaluate, and therefore made our outcomes less definitive. That said, they still provide a base level of insight into the practice that remains useful and will help inform future study.

3. **Operational Challenges –** January and February of 2015 were historically and unseasonably cold with frequent nighttime temperatures between –15°F to –35°F, and daytime temperatures often just cresting 0°F. During that time we had a series of problems with our tractor (required for managing the feeding system), as well as our collection equipment, which consumed unending amounts of time and attention. We temporarily stopped the project to ensure hen health, and put both flocks onto a full grain ration until mid-March. We disregarded data from these months in our analysis.

Summary of Findings

> **"In summary, I support the concept of using food waste for feeding of poultry. The project seemed to work well for the laying hens."**
>
> *– Dr. Michael Darre, UConn Poultry Specialist*

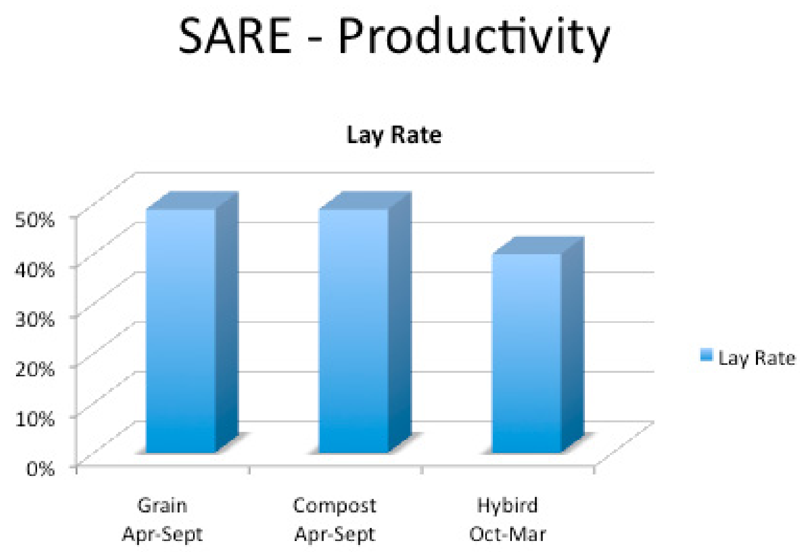
Despite the circumstantial limitations in this project, we were able to produce meaningful experiential evidence that feeding hens on a food scrap based composting system is a feeding strategy worthy of consideration, and further evaluation and development. In addition to the data presented in the tables to follow, this project ultimately found:

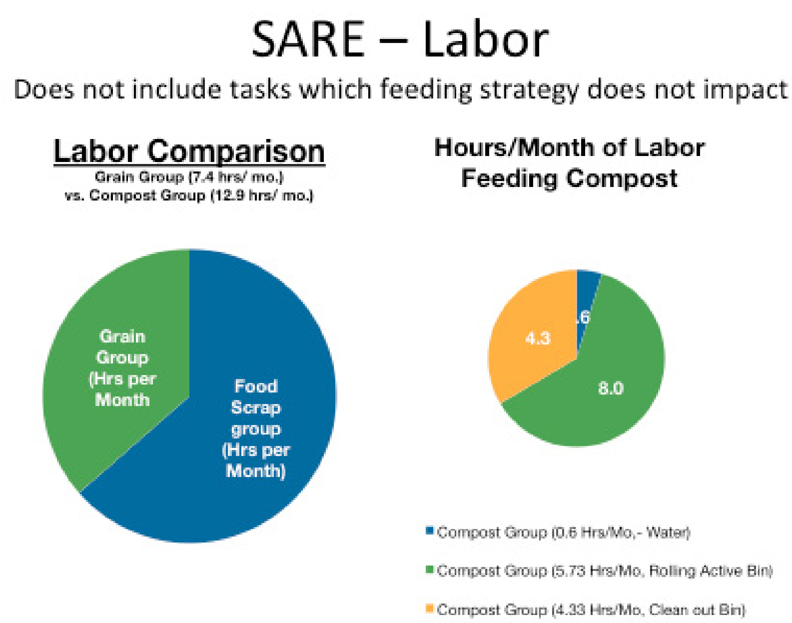
1. **Pathogens –** No samples of food scraps, eggs, or manure showed evidence of Salmonella enteritidis
2. **Egg Production –** largely even between the groups with the Grain Group producing roughly 2% more eggs over the year (excluding the two coldest months of the year). During certain times of the year the Compost Group produced as much as 10% more. Not only does this suggest that a completely compost-based diet is possible, but that there are environmental and management considerations that we can better understand to improve outcomes.
3. **Egg Nutrition –** There were few major differences between the two groups in overall egg nutrition, however the specific differences would be worth exploring further. The increased content of Luceine, an essential amino acid, in the com-

post group eggs is interesting since its creation is, in part, associated with micro-organisms. Elevated trans fat content of compost group eggs is worth further inquiry. It is possible that pre-composting could improve this. See Table.

4. **Egg Weights –** Eggs from the Grain Group were 4% heavier.
5. **Egg Conformation –** While records did not reflect any difference in egg conformation or the rate of cracking, operator observation would suggest the Compost Group's eggs were slightly more fragile.
6. **Yoke Color –** the Grain Group had an average yoke color of 5 on the International Yoke Color Fan and the Compost Group averaged a 12 (1 = palest yellow, 15 = darkest orange, nearly red).
7. **Labor –** Grain Group required 57% the amount of management time over one month as the Compost Group did. Labor in the Compost Group can scale however (ex. labor for 300 birds is same as 50), unlike the grain fed option in which your feed cost per bird will parallel your flock growth for the most part.
8. **Water –** the Grain Group consumed nearly two times the amount of water that the compost group consumed. While consuming less, the salt content of the food scraps means that access to clean water is equally important for compost-fed hens.
9. **Expenses –**
    a. **Operating –** Despite increased labor costs, the cost-savings on feed and the secondary, value-added compost product in the Compost Group considerably improved gross and net revenues. The grain group operated at a loss with the cost of feed representing over 87% of the value of the egg sales.
    b. **Capital –** The cost of setting up for feeding hens on compost is greater than that of grain feeding. Both systems require the same basic housing, pasture, watering and grain feeding systems, however the Compost Group also required the setup of a Feeding Bin for receiving, managing and feeding food scraps. The cost for this system, which has since been able to increase the number of birds it feeds by six times, was roughly $3,000. Additionally, this system requires a tractor or some other form of hydraulic power to manage the material.

Data Presentation



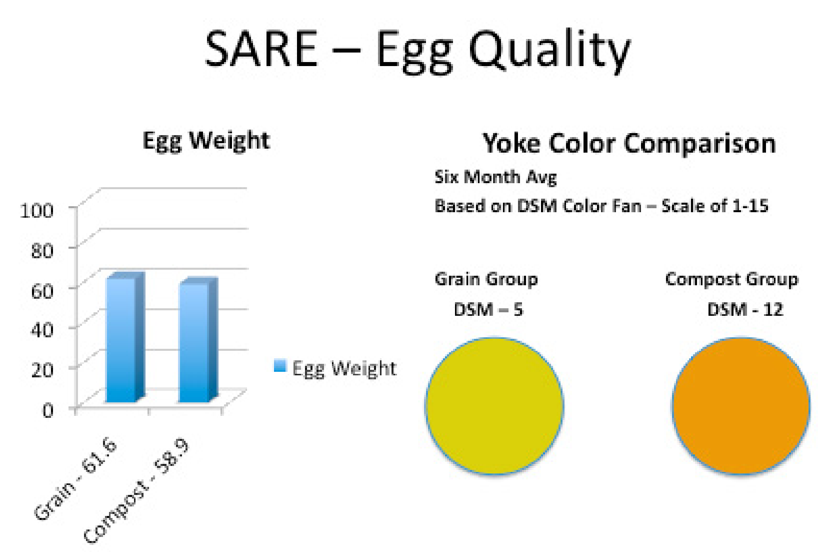


Cost Comparison for Various Feeding Scenarios and Scales

Income

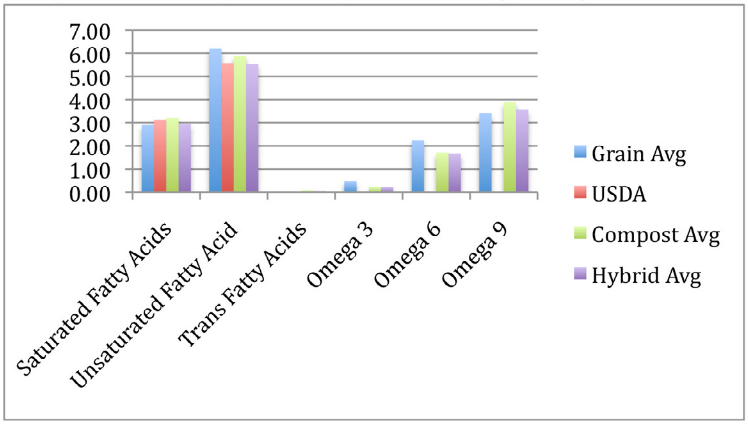
Description	Compost 50 birds	Grain 50 birds	Hybrid 300 birds	Hybrid 2000 birds
Income				
Egg Sales	$2,307	$2,431	$24,638	$177,938
Compost - Farm Use	$2,000	$200	$3,000	$7,500
Compost - Sale	$2,500	$0	$9,000	$45,000
Tipping Fees	$9,100	$0	$9,100	$26,000
Egg Delivery			$1,460	$10,544
Soup Birds			$1,000	$10,000
Total	**$15,907**	**$2,631**	**$48,198**	**$276,982**
Expenses				
Labor - loaded rate	$3,870	$2,226	$15,699	$100,000
Truck O&M	$0	$309	$967	
Equipment O&M	$3,009	$0	$3,360	$12,000
Grain	$0	$1,701	$4,385	$21,312
Packaging			$1,898	$13,744
Egg Delivery			$1,095	$7,908
Culling			$350	$3,500
Replacement Birds			$800	$8,000
Bedding, Wood Chips				$3,248
WoodChip/ co-composting mtls				$8,198
Buildings & Equipment				$23,500
Admin & Overhead				$20,000
Total	**$6,879**	**$4,236**	**$28,554**	**$221,411**
Net Income	**$9,028**	**-$1,605**	**$19,643**	**$55,571**

Notes:
1. Compost = compost only diet; Grain = grain only diet; Hybrid = Compost/Grain Diet
2. All scenarios only account for egg and compost production income & expenses, and DO NOT include costs/revenues from hauling, worm castings, heat or other products.
3. 50 bird scenarios are actual costs. 300 bird scenarios are actual costs with adjustments to reflect changes in our system that records do not account for. 2000 bird scenario is a projection.
4. Labor & Expenses for 50 bird scenarios do not include tasks which feeding practice does not effect, including egg collection, coop clean out, washing and packing eggs, bedding, labels, etc
5. Labor for Compost Group can scale. Same amount of labor is required for 300 hens (current scale) as 50 hens, while grain cost will increase proportionately to flock size.
300 & 2000 bird scenarios includes total labor whereas 50 bird scenarios are feeding exclusively.

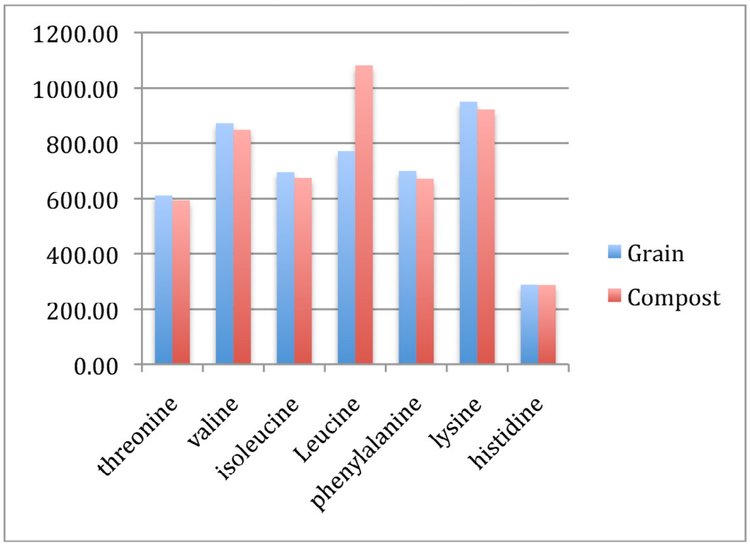


Egg Nutrition Data

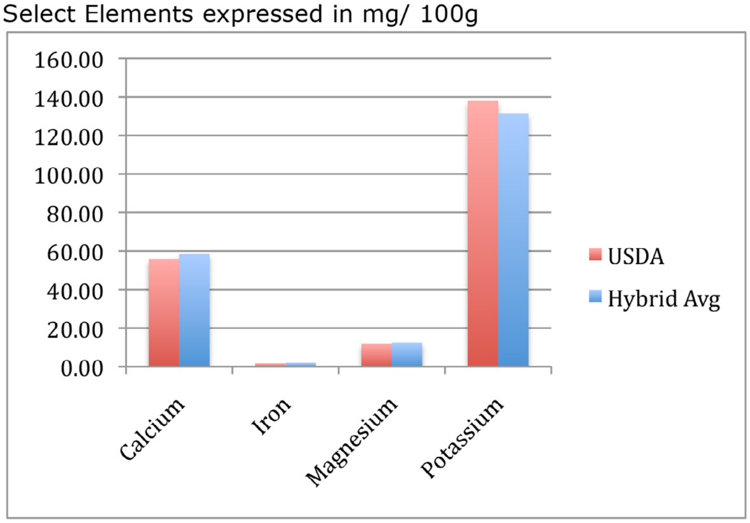
Comparison of Fatty Acids expressed as mg/ 100g



Select Amino Acids expressed as mg/100g



Select Elements expressed in mg/ 100g



Lessons Learned *(further discussion of practice in the Best Practices section)*

1. **Optimizing the Strategy**

   a. **Managing the mix**

      i. **Food Scrap Ration –** While an individual hen may only consume a couple of pounds of food scraps each day, a larger quantity needs to be used in the mix because the pile itself must achieve a certain volume to support desired microbial activity, and the hens can only access feed that is in the top two inches of the pile. Ultimately, we arrived at a ratio of 15–20 pounds of food scraps per hen.

      ii. **Daily Agitation –** To support hen access to fresh feed each day, the pile must be agitated on a daily basis.

      iii. **Biological Activity –** Managing the food scraps in a composting system and growing the microbial population in the media is important to increasing the nutrients available to the hens from this system.

      iv. **Inoculating the mix –** One limitation to the specific feeding bin system we are utilizing is that the residence time for materials in the bin is 3–4 weeks, meaning that it is hard to get all of the mix as biologically active as we would desire while the hens have access to it, and the hens are limited in their access to compost in its various stages of activity. To improve microbial growth and expose the hens to the various microbial communities associated with different stages of composting, the mix is inoculated with active compost throughout the week. We have also played with applying worm castings tea to the mix to stimulate activity. Extending the period of active composting activity the hens can forage is important.

      v. **Excluding precipitation –** food scraps arrive with a lot of moisture in their own regard, and in our setup they contain wash water from container washing. Rain and snow only create more moisture to manage. In all seasons this will depress biological activity, especially in winter. Covering the feeding bin is therefore important in temperate climates.

      vi. **Diversifying Feed –** Maximizing diversity of feed sources will provide a diversity of benefits to the hens. We provide hens with either pasture or second cut hay during most of the year. Other products, such as Okara (the pulp that results from making soy milk) or whey, would be good additions to our mix.

b. Effective infrastructure

i. **Access –** Our feeding bin is currently roughly 50 feet from the barn. The hens foraging compost therefore need to travel through the elements, such as rain and snow, to get to the bin and had to work harder to earn their breakfast. In our northern, USDA Zone 3B climate, this can be a real challenge for the hens. Constructing feeding bins or piles contiguous with hen housing would eliminate this issue.

ii. **Covered Feeding Bin –** A roof over the feeding bin helps exclude moisture and encourages the hens to forage, even in inclement weather.

iii. **Rodent Mitigation –** Eliminating rodent access points and identifying management opportunities at all stages and parts of your infrastructure will be important to a successful, ongoing rodent control strategy. This is important because rodent populations can increase amazingly quickly and can become a potential vector for disease.

c. Hybridized, Seasonal Rations –

By the end of the study we felt that a hybridized approach was most effective. Our greatest concern was ensuring that adequate protein, energy and calcium were available to the hens. While these could potentially be provided through materials other than grain (such as whey, second cut hay, and other feeds), we decided to use purchased grain to supplement the composting system. We do this year round, increasing the ration during the winter months when energy in particular is a limiting factor, and staying warm in our climate is extremely challenging. While we are still in the process of determining the best ration, we currently feed 0.15 pounds of grain per hen per day in the winter (60% of a standard ration), and 0.03 pounds of grain per bird per day in the summer (12% of standard ration). When feeding grain in this scenario, it is important to ensure all hens can eat at the same time so that some hens do not consume a full ration and others eat none at all. Having enough feeding trough space for every hen to stand at simultaneously is therefore critical. We allow 6″ per bird of linear trough space. Troughs can be accessed from both sides.

d. Moisture

i. Overall this kind of feeding system results in the need for greater moisture management because you are literally importing moisture, and your birds will routinely spend time in a damp environment. This can result in dirtier birds, dirtier eggs, and excess moisture from the compost mix that needs to be managed. It is important to set your bin up to discharge and treat free moisture. This keeps the bin much drier, improves handling and bird cleanliness. Liquids should be drained into a treatment system.

ii. In terms of bird cleanliness, we find it is important to pay close attention to the mix in the bin and keep it as dry as possible. We also find it important to bed heavily in the coop so that the birds can clean themselves frequently. Strategically, its good to make sure your coop layout provides a good area for the birds to clean off before they reach the nesting boxes.

2. Challenges

a. Ration Development in a Chaotic System – this is an inherently chaotic feeding system and the hens' uptake of food, and therefore nutrition, is unpredictable. For instance, individual hens may have differing food preferences, which will result in different birds consuming differing levels of nutrients, rather than in a grain system where the ration is balanced, calibrated and consistent.

b. Rodents – All farms typically experience rodents, however this feeding system is prime for growing your rodent population without controls in place at the outset of the practice. Managing rodents, especially rats, can be very challenging once populations are established. Other operators have experienced challenges with crows.

c. Materials handling and bin system – Given our current bin set up – only one bin with tractor access from one end – we are limited in our ability to agitate material in the back of the bin. To keep the back of the bin active and part of the feeding regime, we often fork the material over by hand, though admittedly this is relatively inefficient.

3. Future Investigation – this practice is worthy of further investigation. Relevant future work should consider:

a. Pathogens – Further testing of Salmonella enteritidis is necessary. Additionally, an expanded list of foodborne pathogens of concern should be explored.

b. Productivity – Additional productivity comparisons should be made.

c. Feed ration – What is the role of microbial value in the ration? What other locally-available byproducts could be used to supplement a compost ration? What is the baseline grain requirement, if any, required to meet production and cost goals?

d. Egg Quality – Continue evaluation of differences in egg nutrition.

Food scraps are relatively abundant in most communities. In fact, it is estimated that 30–40% of a communities' waste stream is organic material. Sending these materials to the landfill reflects a loss of nutrients from the food system, that in turn, without being fed back into the system, creates pollution. Typically the challenge in sourcing materials is their collection, rather then their availability. Farmers interested in utilizing food scraps can typically obtain them one of three ways:

1. Residents and/or commercial generators self-haul to the farm
2. Commercial haulers deliver to the farm
3. Farm-operated collection service

If you have a local hauler that currently provides food scrap collection services or would be interested in doing so, you will be able to largely focus on how you will manage these materials once they land on the farm. If no such infrastructure currently exists in your community, your strategy for sourcing food scraps will likely require you to collect them yourself. Drop off locations for residents and business to 'self haul' to are effective but limited in the volume they can typically yield. Further information about setting up collection programs can be found in the Resources section of the Appendix.

Finding the right means of obtaining materials will likely depend mostly on three factors – flock size (how much material do you require), types of local food scrap generators, and existing collection infrastructure and operators. Relying entirely on food scraps being delivered to the farm by residents is likely only suitable for very small flocks, or for providing modest portion of the total feed with food scraps. Partnering with a commercial hauler who will tip food scraps at your farm is a suitable, and in some cases, preferable scenario, however it requires very clear expectations and roles be established since the hauler is the intermediary with the food scrap generator, and will determine how well trash is source-separated from the discarded food. A grower who assumes their own hauling operations will benefit from controlling some part of the market, owning the contamination prevention strategy, and the vertical integration of their business and associated revenues, while also being burdened with additional equipment to maintain, additional staffing, collection schedules, capital costs to start the business and an additional system to learn and manage. Collection operations have a decent profit margin, are economically viable, and can compete in many markets with trash disposal.

Sources

Food scraps come from a wide variety of generators, including: residents, schools and colleges, restaurants, grocery stores, hospitals, nursing homes, prisons, food processors, gas stations, work place cafeterias, and a variety of other businesses and institutions. Each establishment's food scraps reflect the nature of their business. The hens eat a wide diversity of foods, but cannot subsist on materials like coffee grounds, so picking up your local coffee shops' discards might still be useful for amassing composting material, but it likely won't contribute to the hens' diet. In circumstances where food is cooked, the food will putrefy and attract maggots much more quickly, while also being much heavier. A diversity of food materials is most likely to yield the most balanced diet for the hens.

Product quality & source separation

The three greatest challenges food scraps pose is their weight, their putrefiability and their potential to be contaminated. Food scraps are heavy because of their moisture content. While there are ways to collect food scraps without mechanical assistance, they are limited by the volume one could effectively handle without some form of mechanical advantage. Additionally, the moisture content does limit the feed value of the material – with more moisture, the hens are likely to feel full faster than they potentially consume the necessary amount of nutrients. Dehydrating food scraps at their point of generation could reduce the collection challenge and improve the feed value, and it is technically feasible, however the costs are considerable and would generally not be viable in this scenario. Additionally, the moisture content can provide collection challenges in northern climates where temperatures below 10F will cause the food scraps to freeze into solid 'totesicles'. This can make emptying the containers a challenge.

Contamination of food scraps is a preventable problem. When it occurs, operators risk feeding nonfood materials to hens, spreading trash on their farm, selling compost with trash in it, and potential health risks associated with microplastics in a low-pH, high temperature and moisture environment. Effective source separation of trash from food scraps will depend on the type and quality of education and enforcement implemented to support it. We see these challenges as an exciting opportunity to build greater literacy across our community about how to steward resources and organize ourselves in more effective community-scale systems.

We train all of the staff and students at every generator we collect from, provide refresher trainings, provide immediate feedback to generators when contamination is identified, and bill them in cases of excess or routine contamination. When all employees and/or students at a generator are effectively educated in why local food systems and food scrap recycling programs are important to the local economy and environmental sustainability, and how they can effectively incorporate it into their tasks, they can successfully prevent contamination. When this education is lacking or insufficient (including only focusing education on the 'hows' and not the 'whys'), contamination is likely. Source separation is genuinely a cultural undertaking and requires authentic buy-in at all levels of an organization. Participants must genuinely believe

in the value of the resource they are stewarding,, understand the larger system which they are a part of and appreciate what happens to the material after it leaves their location. Educational measures are best supported with clearly stated protocols and penalties for handling contamination when it arises. Black Dirt Farm screens each container we tip and tracks contamination by the generator. If a generator is found to have contamination we try to work with them to prevent further contamination in a short time frame. If the problem reoccurs the entity is 'fined' at a rate of 100% of the cost of each contaminated container (two times the usual container price).

The rotting potential of food scraps is not insignificant, presenting itself mostly during the warmest months of the year. We believe washing containers after emptying them is an important odor prevention strategy, and communicates to our customers that we take the program seriously, which in turn improves source separation. Our observation of many programs throughout the US suggests that the better the hauler is at providing a very clean, professional service, the better the generator is about providing clean food scraps. With our weekly collection schedule food scraps can grow maggots in prepared food and raw meat in the summer months, which we mitigate by supplying generators with sawdust for capping containers with – providing a barrier to fly entry and a filter to absorb odors. Additionally, the moisture in food scraps can cause them to freeze solid during the winter months, creating challenges emptying containers. We use a combination of strategically applied hot water and brute force (see picture) to address this, which can require as much as 30–50% more time per container.

Equipment

The equipment required for collecting and handling food scraps will vary significantly based on the volume and characteristics of the food scraps an operator is collecting.

1. **Containers –** At the very least every operation will require containers that can hold food scraps. Containers must be strong enough for the weight and density of food scraps, watertight, easily handled by the operator when full in poor weather and site conditions, and sized suitably for the application. All containers should have lids and containers over 10 gallons should have wheels. Depending on the generator type and size, a wide variety of container sizes are available for collection, ranging from 5–96 gallon 'totes' to specialized, ventilated 40 yard roll-off containers. We prefer containers with a somewhat flexible plastic (to absorb impact), wide wheelbase, large (6") wheels, and the capacity to be stacked. Black Dirt Farm uses Toter International 48-gallon totes.
2. **Collection Vehicles –** The vehicle used to collect materials must correspond to the type of container, as well as the total volume and weight of material being collected, and the density of material available in your given geography. A wide

range of collection vehicles can be used for collecting food scraps, ranging from bicycles with trailers capable of handling several hundred pounds at a time to ton trucks with dump trailers capable of handling 5 tons at a time to large single bodied vehicles capable of hauling 20 tons in one pull and roll-off trucks. Black Dirt Farm operates a F350 Super Duty, diesel but would likely upgrade to a 550 in the future. We pull a 10 yard Down Easter dump trailer with the truck. A table of vehicle options are in the Appendix.

a. **Lifters –** A variety of lifters are available for lifting totes. These break into three basic groups: Human power, lifters that raise the load into storage area (lift gate), and those that lift, tip and empty the containers into the vehicle. Human power is limited to 50–100 pounds. Containers larger than 24 gallons may prove challenging over time. We lifted 32 and 48-gallon containers for years, and both eventually strain the operator and will likely inspire spills and frustration at some point. Lifters that simply raise loads include lift gates and truck cranes. Both systems require the operator manually tip each container on the farm. In most cases, operators with lifting systems like these will use a tote exchange system – replacing full, collected totes with clean empty totes each week. This can require 50–100% more containers than required by generators. Lifters that can tip materials (typically semi-automated), dramatically improve operator efficiency, volume capacity and operator wellbeing. Black Dirt Farm uses a Leclerc Industrial Lifters 'candy-cane' style lifter that picks containers up and tips them over the edge of our trailer.

b. **Container Washing –** Containers used for food scrap collection require regular and frequent cleaning to prevent odor and fat residues from accumulating in and on the plastic. A variety of systems can be developed, however a typical system includes a large water reservoir of 150+ gallons of water, and a pressurized washing system. Although most containers can be cleaned relatively well with cold water under pressure, hot water pressure washers are more effective overall, handle grease effectively and help to manage frozen containers during northern winters. In northern climates, preventing water from freezing in this part of the system is a challenge. We have invested significantly in closing in and heating the back of our truck to keep the pressure washer and pump working during our six months of winter.

3. **Sawdust for capping containers –** In rural areas it may be economically challenging to service a customer more than once per week. Certain generators produce food scraps that will create odors or attract flies and begin to grow maggots during the summer months. We have found 'capping' the food scraps with several inches of sawdust to be an effective method of filtering odors and preventing flies from accessing the food scraps. We deliver sawdust to customers in 48-gallon totes upon request for a fee. We source our sawdust from two cabinet

shops and a furniture factory, and require roughly 250–430 gallons per week for our roughly 60 customers in the summer months.

The Black Dirt Farm collection set up for handling 15-30 tons per week:

Truck – One-ton Ford Super Duty V8 diesel

Modified 10-yard Down Easter dump trailer

Leclerc Industrial Lifters tote lifter

Enclosed washing system inside of truck canopy

Totes by loading dock at Hannafords

Tote washing

Tote shelf for transporting sawdust or empty totes

Truck in shed

The following discussion focuses largely on our own experience with the practice at Black Dirt Farm. As we explore this practice, we appreciate that it is still very much emerging and yet to be clearly defined in many ways. We see other approaches that have their own benefits, drawbacks and unique contexts (climate, composting activity: hen ratio, pasture). While we would love to capture all of these, it is not within the scope of this project. That said we feel that it is worth conveying some of the specific differences with Vermont Compost Company's (VCC) operations. Our system will shift as we scale it up, which we attempt to describe in the discussion.

The aspect of the VCC model that is most distinct from ours is its integration into a large composting operation, providing VCC with a large ratio of total composting activity to number of hens. This creates a variety of benefits –more total feed and greater overall variation in the compost life cycle represented. Additionally, VCC runs its hens entirely, as Karl affectionately refers to it, 'free to leave.' VCC's birds have the run of the entire yard, extending their access to the entire life cycle of the decomposer system, as well as a highly varied habitat with other foraging opportunities. VCC's model likely optimizes the microbial feed potential of this model.

VCC aggregates their food scraps into a pre-feeding blend of roughly 25% food with 65% blend of cow manure and bedding, spoiled silage, rotting hay, horse manure bedded on hardwood shavings, and 10% finished compost. This blend then sits for 1–5 days before it is piled up in the chicken feeding area. This short "pickle" prior to feeding allows the blend to start generating heat and vigorous microbial activity. It also allows for some of the moisture to drain off prior to feeding. As the feed piles grow, they are tracked for temperature, turned, rolled, and eventually when the pile is large enough, the older half is moved from the feeding zone into a compost maturation area, where the piles are managed for 5–8 months before they reach full maturity and are blended or sold.

The chickens have access to fields in the summer, and can be seen eating grass and insects in the surrounding fields.

The Black Dirt Farm system is further described below. From the 30,000 foot perspective, our process looks like this:

Collect Food Scraps (weekly) ➔ Tip at Farm (2 loads, once weekly) ➔ Blend Food Scraps with Co-Composting Materials (daily, over 1 wk) ➔ Feed Hens (daily) ➔ Empty Feeding Bin (monthly) ➔ Make Compost ➔ [Extract Heat for Greenhouse – under construction] ➔ Make worm castings ➔ Grow crops ➔ Sell eggs, compost, worm castings, and crops.

Infrastructure

1. **Access –** Good year-round access to the various components of your system is critical. This means having both good functional sites and systems for managing material, but it also includes accessing these with good, reliable roads. Access points that must be functional include roads for incoming vehicles, tipping dock, bin clean out access, and post-foraging composting. Applying 1.25″ washed gravel or Stay-Mat to roads and tipping dock will improve traction and drainage. Ideally the tipping dock will enable the tipping vehicle to be level when tipping its load. For optimum chicken access, the feeding bin will be covered and contiguous with housing.

2. **Feeding Bin –** At Black Dirt Farm we have developed a receiving, blending and feeding area that are cross-functional (i.e. they all happen in the same place). At some operations, no feeding bin is used and compost blends are fed to free range hens in piles in an open yard. While there may be some advantages of an open pile (access to all sides of the material, greater surface area for foraging, improved passive aeration), we have chosen to use a bin system and would likely continue the practice because it provides containment for operation within a more confined space and offers a control point for us to be able to manage the material and birds separately (we can exclude the birds from the bin during tipping and clean out).

In general, if you are using a feeding bin you want it to be both contained and accessible for tipping, feeding and clean out. Our bin consists of a concrete slab, walls made of 2′x2′x6′ locking concrete blocks, and a roof. The block wall on one side provides the 'dock' from which we tip our loads of incoming food scraps. Due to the design of our dump trailer, it is advantageous to be elevated by at least two feet to tip the load (otherwise the operator needs to move the trailer forward in mid-tip to empty it completely). The bin has three access points – the tipping dock previously described (delivery), the tractor gate (daily blending and monthly clean out), and a small chicken door connecting the bin to the pasture, that can be closed when we want to exclude the hens. Our bin can only be managed with the tractor bucket from one end; access from both ends of bin would improve operations and allow for better management of the material.

Our feeding bin is pretty much the simplest, cheapest system we felt would be functional. It cost roughly $3,000 in materials and contractor fees to construct (this includes excavator work for leachate treatment system). While we are happy with the basic functionality, in the future (with a bigger flock to justify the expense and a better location) we would use formed concrete walls rather than concrete blocks (which shift in the winter and allow rodent access), construct multiple bins to allow for greater foraging access over the composting lifecycle (i.e. more overall retention time with chicken access), a roof with better solar exposure (ours is 50% metal), have it contiguous with hen housing to ensure easy, year-round access regardless of weather, and use bins to aerate piles and capture heat.

3. **Feeding Bin Leachate Treatment –** While you are seeking to minimize free moisture in general, you will likely have some, unless you pick up very dry materials and do not handle your wash water with the food scraps. Assuming you do have some free moisture to manage, it is important to recognize that it may contain nutrients, volatile organic acids, and salts that could impact surface or ground water if directly discharged without treatment.

   We have set up a three-phase leachate treatment system. The slab in your feeding bin should be on a 1–2% grade toward the leachate system. The moisture passes into a landfill-linear lined pit filled with wood chip for phase one treatment. Here solids are trapped, some evaporation occurs and a basic level of microbial activity develops and initiates the breakdown process. Liquids leaving phase one into phase two spill over a leveling lip to distribute the effluent as evenly and thinly as possible through a six inch layer of 50:50 blend of compost and wood chip. This section is planted to perennial shrubs, including blueberries, which are tolerant of slightly acidic conditions, and is designed for nutrient and moisture uptake. The last section is a 70:30 soil-compost blend planted to grasses and legumes. In most cases effluent would likely never arrive here (because we are oversized), but if it does, this is the final stage of infiltration and nutrient trapping. This final phase has a fail-safe overflow designed to divert any overflow that might occur away from surface water and into the chicken paddock.

4. **Post-Feeding Composting Area –** Depending on the scale and configuration of your operations and its components, you most likely would have a secondary composting pad where the mix is composted after the grazing period. While we would encourage other operators to maximize the duration of the hens' access to the compost mix, to meet Organic Standards and possibly State laws, you are likely to want to remove the material from chicken access at some point during your heating phase, which will then require that you have a separate composting area to finish the composting process.

   This site should meet State and Federal Laws for setbacks from surface water, wells, neighbors, and roads, as well as separation distances to ground water and ledge in order to protect water quality. While it may be possible and legal to compost on your soil surface, functionally you will likely want to install a proper pad of some sort – earthen (gravel, lime-hardened clay, Sure-Pak) or concrete. Having a firm surface on which to op-

erate will improve your ability to manage windrows, keep a tidy site, and provide a quality product to customer if you sell any (i.e. no incorporated soil and stone). At present we have not installed an improved pad because we are planning to scale up our operations and reorganize the site in the next two years and the investment would not be worth it, however there are times of the year when soil moisture makes pile management slower, less productive, messy and frustrating. If you have not managed composting in windrows before, use a site planning and sizing tool to help you design and size it properly. Assume you will need roughly twice as much space for work area as you require for windrows. You may be eligible for state agriculture or USDA cost-share funding to develop your pad.

Farm Equipment

Once you have the food scraps tipped on your site, you will need an effective way of handling and managing the material. The scale at which human power is effective and economically viable is subjective but from our experience here at Black Dirt Farm and previous composting and chicken feeding efforts, we believe managing materials with a 4- or 5-tine D-handle manure fork, a wheelbarrow, and your own strength can be effectively done up to 25 birds, or 350 pounds per week, but you would preferably have more material for even this small group of birds, potentially up to a ton per week, in which case while you might be able handle the daily functions manually (with extremely well-thought-out systems), it could quickly become cumbersome to manage the material over time (50 tons per year) without hydraulic assistance. Whatever system you are planning to use, take the long view – you need a system that isn't just possible, but one with staying power that you can execute with every day as needed, and for years to come.

Once you start managing more than 500 pounds per week, mechanical lifting is recommended. On most farms this will be a tractor with a bucket, however skid steers, small loaders, and excavators can also be effectively used. Excavators can be used for pile management but are limited in their capacity to move materials around a site, so an operator would require some sort of bucket loader in addition to an excavator. At Black Dirt we use a Kubota M5200 with a bucket for all of our materials handling. The scale we operate at puts more demand on the tractor front end than it is probably designed to handle over time. In our future setup, with multiple bins side-by-side, an excavator would probably be an ideal tool and would improve efficiency because of its ability to move material laterally without moving the equipment itself. If you only have one machine in your set up, a tractor or small loader is the most versatile tool for the variety of tasks required.

Other equipment that could be useful might include a wood chipper to process wood chip on-site and a trommel screen for screening oversized materials out of finished compost. The use of fans in an Aerated Static Pile (ASP) can be beneficial in many cases, regardless of scale, and for smaller operators can help mitigate the need for a tractor. In all cases, ASP systems are the first step toward a heat recovery system.

Co-Composting Materials

The feeding strategy described here emphasizes feeding food scraps to hens in a compost blend and fostering the composting process. Ultimately, the desired blend characteristics are the same as for making compost – 20–30:1 Carbon to Nitrogen, 50–70% moisture, and adequate porosity to maintain passive aeration – however this is a bit fungible and an area where we are devoting continued attention in developing more prescribed practices. Essentially, in order to make more food available to the hens and account for the material they will consume and reject, we leave the food scrap portion of the recipe high to begin with. While we would typically keep the food scrap component of a composting mix about 20–25% of the total mix, in the chicken feeding system it represents roughly 40% at the outset, of which some portion is eaten and removed from the equation. By the time we are emptying the feeding bin the food scrap portion of the mix is roughly 25–30%, and the blend is complete, requiring no further additions of material, except a base layer of wood chip onto which the windrow of removed compost is initially built on the pad. We tend to run on the dry side during composting (our manures are very high in bedding content), so we err on the side of greater food scrap density in our mix. We are likely to continue to adjust this part of our process. We like feeding a complete and active composting mix, but with our present space constraints this sequential blending approach seems to work pretty well.

To achieve this blend, as well as to support good microbiological diversity, we use a variety of different materials possessing different qualities. Our food scraps contain several carbon materials that contribute to our mix, and may or may not be present for other operators. In addition to discarded food, we collect nitre (diatomaceous earth with minerals and sugar from maple syrup filtering), thick paper filters (used in syrup and spirits filtering), brown paper (towels and seed-germination papers), and sawdust used to cap containers (especially in summer). These materials do not mitigate the need to introduce additional carbon and dry matter (the nitre in fact is very moist and dense), but they are accounted for in our recipe and contribute to the diversity of carbon sources we supply to the biology we're trying to grow in the feeding system. The use of at least two, and preferably four or more of the following materials will support proper recipe development. Ideally at least one of these materials will be livestock manure.

1. Wood chips
2. Hay and/or straw
3. Sawdust/ wood shavings/ saw chip
4. Paper products – paper towels, newsprint, white paper, kraft paper, 100% fiber filters, or cardboard (NOT ACCEPTABLE – magazines, plastic lined paper products, freezer cardboard, or glossy printed boxboard)
5. Horse Manure (Be aware of potential pathway for herbicides)
6. Well-bedded ruminant manures
7. Active Compost

It should be noted that herbicides and other contaminants can find their way into your operation if you are importing inputs. Hay grown with persistent herbicides, and manure from animals fed crops grown with these, have been found to concentrate the active ingredients in compost and cause crop damage. Feed product labels do NOT indicate that these substances are present in the feed, and clarifying what non-Organic products contain these is often challenging. See Appendix for Vermont Agency of Agriculture recommendations. It is important to better understand potential contaminants in order to mitigate them.

To determine the proper ratio of other materials to your food scraps, seek out a composting calculator online, a technical service provider, or refer to the NRAES On-Farm Composting Handbook for calculations. The Black Dirt Farm weekly mix is as follows:

	Initial Mix		**After Foraging**	
Material	Volume (CY)	% of Mix	Volume (CY)	% of Mix
Food Scraps	14	41.5%	8	29%
Paper Towels	2.5	7.3%	2.5	9%
Paper Filters	1	2.9%	1	3.6%
Nitre	1	2.9%	1	3.6%
Sawdust	0.5	1.5%	0.5	1.8%
Active Compost	3	8.8%	3	10.7%
Wood Chip	2	5.9%	2	7.2%
Mulch Hay	3	8.8%	3	10.7%
Bedded Horse Manure	2	5.9%	2	7.2%
Bedded Chicken Manure	4	11.7%	4	14.0%
Bedded Beef Manure	1	2.9%	1	3.7%
Total	**34**	**100%**	**28**	**100%**

Management Practices

1. **Receiving & Blending –** When receiving food scraps, the load can either be tipped in a blending area separate from where the hens feed, where it can be blended, or tipped directly into a feeding bin or the open pad where you will be feeding. When tipping onto a separate pad for receiving and blending, the operator can incubate the mix in order to feed it out 'hot' (once microbial activity has been activated and mesophilic temperatures (80–120°F) are detectable. Alternatively, food scraps can be tipped directly into a feeding bin (or pad) and blended within it. Regardless, an absorbent bed of dry blend materials will typically be placed on the ground onto which the load of food scraps will be tipped. We typically bed the bin with 4–6 yards of some combination of bedded manure, wood chips, active compost and mulch hay.

Receiving in the feeding bin can be managed in multiple ways. The blend can be achieved upon receiving and then agitated daily, or managed and blended sequentially over a period of time (in our case 1 week) before the next incoming load arrives.

If food scraps are delivered to the site in containers, and the containers are not needed immediately, the operator can tip containers on a daily basis. Doing this in daily layers, covering food scraps with dry materials each night works well for small operators. Unless there is a secondary composting system the hens also get to forage, this method will not deliver the same microbial mass to the hens as an actively blended mix.

2. **Feed Management –** While our efforts to quantify the food scraps consumed daily by each hen suggest the average hen eats 1.2–1.5 pounds of food scraps per day, and we recommend budgeting at least three pounds per hen per day to account for refused feed, far more material than this is required to establish successful conditions as far as we have observed. In order to ensure adequate food diversity, total pile mass for building and maintaining biological activity, and ensuring hens have adequate feed on the surface of the pile to forage (hens can only scratch the top 1–2 inches of material), we have found having 15–20 pounds per hen per day is a functional ratio.

As the above ratios would reflect, not all food scraps are created equal. The operator needs to be thoughtful about the material they exposing for the hens as they blend. For instance, certain materials we collect add value to our overall composting blend but are either inedible (ex. nitre) or undesirable to the hens (ex. fermented juniper berries from gin distilling). A savvy collection operator can organize loads such that there is some level of discretion as to what food scraps are at the top of a fresh load. As the pile is being agitated the tractor operator can also express discretion and ensure that the hens have access to food scraps that will provide better feed value by leaving these materials exposed. Ideally we like to leave the hens with a good mix of whole foods that contain vegetables (especially leafy vegetables), fruits (can peck through apple and watermelon skins but not orange rinds), fresh meat, and grains. Additionally, when possible we supplement compost with 2nd cut hay (fine texture and high in protein) that we make on the farm. This is typically feed out directly in the feeding bin where the uneaten portions become part of the mix. Hens will eat considerable amounts of hay if the quality is adequate.

We manage our material sequentially over the course of the week, between incoming loads. Our schedule looks something like the following (colors indicate dominant component in mix – green is food scraps brown is other materials):

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
1. Make Space for new load 2. Lay down bedding 3. Receive Load; no blending	1. Add active compost and hay 2. Roll food scrap – expose fresh material and encapsulate new compost and hay	1. Add hay 2. Add horse & beef manure 3. Roll pile	1. Add horse & beef manure 2. Roll Pile 3. Add active compost and hay	1. Add horse & beef manure 2. Roll Pile	1. Add horse and beef manure 2. Roll Pile 3. Add bedded chicken manure	1. Add horse & beef manure 2. Roll Pile

To support the feeding process, it is critical that you appreciate that you are managing a composting process. The basic principles of composting apply and should be followed. We've already established that your recipe is the basis for your composting process, fundamental above and beyond everything else. Next in line is your management of oxygen in the media. When feeding hens you will need to agitate material for the purpose of exposing fresh food material, in addition to incorporating oxygen into the pile. When a pile is being managed for fresh forage, the necessary agitation is likely to accomplish and exceed pile aeration requirements. A temperature probe is useful for assessing pile temperature, which corresponds with the level of microbial activity in the pile (the heat is mostly microbial body heat!). For further information on the mechanics and practices of composting, refer to the Composting section of the Appendix.

In the future we would design things differently, partly based on new understanding, and mostly based on what an increased scale of operation could afford us (space and cost). In constructing a dedicated layer barn we will design our feeding system to extend the life cycle of the composting process that the hens have access to forage. Instead of one bin that is emptied every 3–4 weeks, we would have 3–4 bins that would allow hen access to material for several months (in other words, they would be able to access compost at various stages of composting). Material would move sequentially through the series of bins. We would likely equip two or three of these bins with blowers that would help aerate them in place, increasing microbial activity, reducing pile turning labor and capturing heat for use elsewhere.

3. **Post Forage Handling –** When the feeding system is at capacity (bin or pad), the contents need to be removed or moved to make way for the next incoming load. What happens at this point will depend on your system. If you are not required to exclude the birds from the process to achieve Organic standards or other regulatory compliance, you may simply be stacking the compost to cure or even spreading it directly. If you are selling compost or trying to achieve regulatory compliance, you will likely need to remove it before it has completed its thermophilic stage in order to achieve the Process to Further Reduce Pathogens (it will need to heat above 131°F for 15 days with 3–5 turnings to achieve Organic Standards). In this case, the mix that is removed from the feeding system is piled in windrows and further composted and cured. During the composting process that will take place in windrows separated from chicken access, the operator will be using the traditional tools and skills of a composter to effectively manage the piles.

Routine monitoring of temperature, moisture and pile structure allow the operator to effectively manage the process, achieve regulatory compliance, and produce a quality product for use or sale. A 36-inch compost temperature probe and good record keeping will provide the operator with the necessary basic feedback in most cases. Consult composting resources for further discussion on pile monitoring and management practices. See Appendix for a list of resources.

Appendix

Useful Resources for Operators

Poultry

a. *Scaling Up Egg Production: Management, Markets, Regulations and Finances.* Intervale Center and University of Vermont Extension Report, 2015. http://blog.uvm.edu/farmvia/files/2013/03/FBRR013-2015-Scaling-Up-Egg-Production.pdf

b. ATTRA Poultry page (wide variety of husbandry topics) – https://attra.ncat.org/attra-pub/poultry/

c. Alltech Poultry Advantage – 20 Common Egg Shell Quality Problems

Feeding Poultry Food Scraps

a. *Food Scraps for Chicken Feed*, Highfields Center for Composting video. http://highfieldscomposting.org/news-resources/resource-library/video-food-scraps-for-chicken-feed

b. *Leftovers for Livestock: A Legal Guide to Using Food Scraps as Animal Feed.* Harvard University Food Law and Policy Clinic, Food Recovery Project of University of Arkansas, and University of Arkansas School of Law. 2016. http://www.chlpi.org/wp-content/uploads/2013/12/Leftovers-for-Livestock_A-Legal-Guide_August-2016.pdf

c. *Handbook of Poultry Feed from Waste Processing and Use*; El Boushy, A.H., van der Poel, A.F.B., Springer Science and Business Media Dordrecht. 2000.

Community Composting Programs & Food Scrap Collection

a. *Growing Local Fertility: A Guide to Community Composting.* Institute for Local Self Reliance and Highfields Center for Composting. 2015. https://ilsr.org/size-matters-report-shows-small-scale-community-based-composting/

b. *Biocycle* Magazine (composting trade magazine). JG Press.

c. *Composting in Restaurants and Schools*; a Municipal Tool-Kit – Center for Ecological Technology, Report. 2003. http://www.cetonline.org/wp-content/uploads/2013/03/Composting-in-Restaurants-and-Schools-CET.pdf

Composting and Vermi-Composting

a. Trade groups:

   Composting Association of Vermont http://compostingvermont.org

   US Composting Council http://compostingcouncil.org

   Canadian Composting Council http://www.compost.org/English/ENGLISH_INDEX.htm

b. *Biocycle* Magazine (composting trade magazine). JG Press https://www.biocycle.net/

c. Cornell Waste Management Institute – cwmi.css.cornell.edu

d. *On-Farm Composting Handbook*; NRAES. https://campus.extension.org/pluginfile.php/48384/course/section/7167/NRAES%20FarmCompost%20manual%20 1992.pdf

e. Modern Composting Technologies (process control and equipment)

f. Agrilab Technologies (compost heat recovery systems). http://agrilabtech.com/

g. *Vermiculture Technology*. Edited by Edwards, Arancon, and Sherman. CRC Press. 2011.

Livestock

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Collection Equipment Comparison

NOTE ON WEIGHT: All scenarios must properly pair the weight of the food scraps being transported with the manufacturers specified load and tow ratings, or you will risk injury or excessive vehicle wear. Many collection systems can carry more volume than they can weight. Additionally, operator safety is paramount and every scenario should be priced to accommodate safe working conditions. Food scraps are heavy!

Collection Vehicle	Cost	Weight per week	Considerations
Bicycle with Trailer	$750–$1,500	100–5,000 lbs/week	Requires farm within close vicinity to generators Limited container and generator size serviced Local winter conditions may limit application Container exchange — may require 50–100% more containers
¼–1-ton Pick Up Truck	$10–$30,000	50–15,500 lbs/week	Manual loading of containers can be very demanding physically without loading docks or small containers Container exchange — may require 50–100% more containers Requires manual tipping at farm
½–1-ton Truck with Lift Gate or Crane	$15–$40,000	1–18 tons/week	Requires manual tipping at farm Requires container exchange or customer washing Washing system can be portable or on-farm
½–1-ton Truck with Trailer	$10–$50,000	500 lbs–15 tons/week	Requires manually loading containers in truck or on trailer Requires manual tipping at farm with loading dock Requires container exchange or customer washing Washing system can be portable or on-farm Physically demanding
Box Truck with Lift Gate	$15–$40,000	1–20 tons/week	Requires manually loading containers Requires manually tipping containers Container exchange — requires 50–100% more containers Washing system can be portable or on-farm
1–2 Ton Truck with 5-ton (10-yard) Dump Trailer	$50–$75,000	10–40 tons/week	Requires mechanical lifter Requires on–board washing system for containers 3 foot+ tipping dock is preferable
Modified Single-axle Hook Truck with 12-yard Container	$90–$125,000	20–60 tons/week	Requires on-board washing system for containers Requires mechanical lifter Can be used for multiple containers (e.g., container at a horse farm collecting manure for monthly collection)
Modified Roll-off Truck with 20-yard Container	$125–$160,000	50–100 tons/week	Requires mechanical lifter Requires on-board washing system for containers Washing system can be portable or on-farm 3 foot+ tipping dock is preferable

Note regarding ramps: trailer and box truck scenarios with ramps may be attractive due to lower capital costs, and these systems have been used effectively over time, however they increase physical labor and effort, potential for injury, and require 6–10 feet more space at loading areas. During wet or wintery conditions ramps can be unsafe for operators.

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