

New Milford Farms and Organic Residue Recycling 1997

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ABSTRACT

Established in 1990, the New Milford Farms (NMF) composting facility serves as a low-cost means of disposal for various industrial residues from Nestle USA, a large international food company. The NMF facility takes in organic feedstocks ranging from spent coffee grounds and industrial wastewater sludge to leaves and brush from nearby residents, and combines them to create fertilizing compost useful for farms and gardens. Located in New Milford, Connecticut, the facility receives significant inputs from as far away as Fulton, New York and Freehold, New Jersey. The NMF business of industrial composting is growing within the larger framework of an emerging movement toward large-scale composting. A closer look at NMF reveals an array of the challenges, benefits, and potential areas for improvement in industrial composting. Environmental policy, markets for soil amendments, and the science of composting all form a critical backdrop for this rural Connecticut enterprise and hundreds like it in the U.S. and elsewhere.

NEW MILFORD FARMS

Operations

The primary incentive for Nestle to establish New Milford Farms (NMF) was the need for a cost-effective means to dispose of organic residues from its Food Ingredients Company (FIDCO), located across the river from the NMF site in New Milford. FIDCO also was searching for an economical way to dispose of a steady stream of wastewater sludge containing hydrolyzed vegetable protein waste (8% solids). Previously, FIDCO disposed of its residues in an onsite landfill at relatively nominal cost. As that landfill approached capacity, management feared the prospect of transporting the waste to a more remote site at much higher cost. Thus, Nestle undertook the development of a waste management center in the form of New Milford Farms.

Unfortunately, the organic residues are not readily compostable since the physical properties lead to a nutrient-poor amendment with offensive odors. Specifically, the FIDCO residue contains significant salt content and, as Dr. Walter Carey, president of New Milford Farms noted, "Salt in, salt out!" (Carey 1997). The NMF staff has found that in order to create desirable compost, the FIDCO residues must be kept to less than 20% of the total production feedstock. Thus, they must find large quantities of "bulking agents" to mix with the FIDCO residues.

For much of its bulking agent supplies, NMF has turned to other Nestle USA facilities in the Northeast. The plant in Freehold, New Jersey is a giant manufacturer of instant coffee and tea, where spent coffee grounds and tea leaves were traditionally burned to generate steam, and the remaining ashes disposed of in landfills. In 1995, its main boiler needed to be replaced at an estimated cost of ten million dollars. Nestle USA, with the assistance of NMF, decided that instead of purchasing a new boiler, Freehold could send the coffee grounds and tea leaves, as well as wastewater treatment sludge (40% solids), to New Milford Farms. The relationship saved the corporation millions of dollars in capital expenditures and promised to save millions more in disposal costs.

New Milford Farms established a similar arrangement with a Nestle chocolate-making facility in Fulton, New York. NMF receives cocoa bean cleanings and, frequently, the clean cocoa bean shells themselves. From a Nestle research and development facility in New Milford, NMF receives small quantities of various foodstuffs ranging from pasta and bread dough to water chestnuts. All of these feedstocks assist NMF in creating compost while also greatly lowering disposal costs for Nestle. Waste products from these various corporate facilities are augmented by yard waste from local residents, including brush, Christmas trees, and pallets.

The supply of these inputs varies greatly with differing production schedules and by season. This variability, in combination with minimal on-site storage capability, makes managing inputs an extremely challenging task. For example, when the Freehold plant is running, New Milford will receive literally tons of spent coffee grounds and tea leaves. The plant combines the shipments with other materials on hand, including yard waste from nearby residents and cocoa beans from New York, to create compost. When the Freehold production run ends and the plant shuts down for a week, shipments from other sources continue to arrive at NMF, forcing compost production to continue, even though the “recipe” is radically different.

An even more deleterious effect of the varied inputs is their tendency to create a compost of varying physical properties and quality, which is a challenge for sales and marketing efforts. NMF seeks greater consistency in its own end product in order to establish long-term contracts with consumers. More specifically, it would like to sell bulk compost to area farms, but the inconsistent nature of the product makes this difficult, since the farmers cannot rely on the product to provide the nutrients necessary for its specific crops and not to emit offensive odors. In short, the variation in properties and quality of the NMF compost make it almost non-marketable as a stand-alone product. The farm does have a large contract with Vermont Natural Agriculture, a maker of soil amendments and mulching products. However, Vermont Natural Agriculture utilizes NMF compost as an intermediate product, mixing it with either topsoil or cow manure to create a soil amendment for home gardeners.

In an effort to improve the consistency of its product, NMF is always on the lookout for alternative bulking agents to smooth the supply of inputs. Materials

The supply of these inputs varies greatly with differing production schedules and by season. This variability, in combination with minimal on-site storage capability, makes managing inputs an extremely challenging task. An even more deleterious effect of the varied inputs is their tendency to create a compost of varying physical properties and quality, which is a challenge for sales and marketing efforts.

that have been considered include corrugated cardboard, waxed cardboard, pre-consumer restaurant and supermarket wastes, fly-ash from coal-fired utilities, and wastes from paper manufacturing. None of these has yet proved to be a perfect solution to the supply difficulties. Physical properties of supplies, difficulties stemming from waste haulers, or problems with permitting from the Connecticut Department of Environmental Protection (see section on Policy) continue to hinder the operation.

Benefits of Operation

At first, composting appears to be the perfect business opportunity: In what other business can one generate revenues for both inputs and outputs? Ideally, a composting facility collects payments for disposal of materials at the site, mixes up the residuals, lets them cure and then sells the compost to farmers and gardeners. Unfortunately, composting has not proven so simple or lucrative for New Milford Farms. The alchemy of transforming waste into money has been complicated by NMF's constraining relationship with Nestle.

As currently operated and accounted for by Nestle, New Milford Farms posts significant losses (Ruhl 1997). However, common measures of financial performance do not capture the benefits that accrue to Nestle from NMF. For example, the annual financial statements for NMF do not include the disposal cost savings from the composting efforts. Dr. Carey has calculated that, after accounting for disposal costs savings, NMF does indeed turn a slight profit (Carey and Ruhl 1996).

Many other hard to measure benefits undoubtedly accrue to Nestle from operating New Milford Farms. For example, by not sending waste to landfills and other disposal facilities, Nestle lowers its risks of becoming involved in a Superfund site and generally reduces environmental liability. By going above and beyond compliance with environmental regulations, Nestle also enhances its relationships with state departments of environmental protection and the U.S. EPA, which may facilitate requests for new permits and encourage greater regulatory flexibility in the future. In addition, Nestle operations may benefit from improved public relations associated with a strong environmental reputation.

Currently, Dr. Carey must justify the benefits of operating NMF, since they are not readily apparent on paper. Hopefully in the future, firms will recognize both the tangible and intangible benefits of utilizing process residues and will make some effort to account for those benefits.

ORGANICS RECYCLING – A BRIEF HISTORY

Although large-scale composting NMF-style is referred to above as “an emerging movement,” the idea of recycling organic residues has actually been around for a long time. Since antiquity, manure has been spread on fields. Yet in North America, early European settlers felt that fertile soil was unlimited and did not take the same care to replenish it as farmers had done in Europe. By the early 1800s, soil fertility was decreasing, and in searching for improvement, American farmers developed many of the ideas to which we are now returning.

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In 1859 the New York State Agricultural Society encouraged farmers to follow the “universal law of compensation,” wasting nothing by returning all of the organic and inorganic matter used by crops to the soil. In seeking a way to do this, New York City and Long Island developed a symbiotic relationship whereby agricultural products were delivered to the city from the island and, in return, residues from street cleaning (mostly manure from cart-horses), manure from stables and dairy processors, bone meal and dried blood from slaughter houses, ash from soap factories, and night soil were shipped back to the farmers. (Night soil was the euphemism for human sewage, processed into a fertilizer called “poudrette” by a French technique of composting with peat moss.)

In 1842, a contributor to the *American Agriculturalist* calculated that “manure” from the 350,000 residents of greater New York contained enough nutrients to produce four million bushels of wheat, and another city entrepreneur figured that New York urine could be worth \$350,000 annually. Another estimate stated that by not using its night soil, the U.S. was losing \$50 million annually, a figure nearly equal to the entire federal budget at that time (Wines 1985).

As the search for better fertilizers and the pressures for increased yields intensified, agriculturalists developed synthetic fertilizers that were easier to handle. This led to the booming fertilizer industry and commercial agriculture so familiar to us today. Somewhere along the way the cyclical nature of the “universal law of compensation” was forgotten. Anthropogenic nitrogen fixation (by fertilizer production and the planting of leguminous crops) is currently equal to naturally occurring nitrogen fixation; similarly, human induced nitrogen run-off is equal in magnitude to natural levels (Ayres *et al.* 1994). It takes eleven barrels of oil to make one ton of nitrogen fertilizer, so this is an energy intensive process (Beers and Getz 1992).

Meanwhile, our waste stream includes large amounts of organic residues that are either burned or landfilled. Municipal solid waste (including paper) is 60-70% organic (Harrison and Richard 1992). Livestock manure, if not properly reused, leads to leaching of nitrogen compounds (nitrates and ammonium ions) into drinking water and lakes, rivers, and oceans. It also emits gaseous ammonia and methane. Nitrates are both harmful to humans and damaging to ecosystems because they encourage eutrophication (proliferation of algae). Our current use of fertilizer and disposal of organic waste in landfills exemplifies a linear pattern of resource use. Growing evidence of its adverse impacts is prompting an ideological shift toward the kind of cyclical resource use suggested by the industrial ecology paradigm. Currently, operations such as New Milford Farms are returning to older concepts and attempting to bring our organic residues back into the cycle.

Theoretically, all organic residues can be recycled into some further productive use, even if that use is nothing more than returning the elements contained in the residues back to the cycles of which they were part (Grogan 1997). Some residues, such as cardboard and paper wastes, can be returned

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directly to the same production processes. It is most efficient for them to be a source of fiber that is re-pulped and used for new paper or cardboard. Other residues, such as manure, sewer sludge, or wood chips, can be applied directly to land areas so that the carbon and nutrients in the residues are ultimately available for reuse by microorganisms and plants. A drawback here is that, as the residues are broken down by decay organisms, many of the nutrients represented by the residues are tied up for a period of time by microorganisms and are not available to support the growth of preferred crops. The way around this drawback and the way to turn virtually all residues into desirable forms for reuse is to compost them.

The composting process breaks down the more complex structures within the organic residues, reducing the material to fundamental components that are useful as inputs to subsequent organic processes. The composter must mix inputs carefully to achieve the proper moisture content, carbon to nitrogen ratio, porosity, and dilution of less desirable elements (e.g. salt and oil). As composting is essentially “human guidance of decomposition by bacteria” (Harrison and Richard 1992), everything must be done to provide an optimal environment for the microscopic workers. Plenty of oxygen must be provided. Temperature must be regulated so as to be high enough to kill pathogens and low enough not to kill important bacteria or to create odors.

Yet, within the constraints of the process, different residues can be used as inputs in order to produce composts best suited to the desired use. Animal manures, as an example, are high in nitrogen after composting, but relatively low in carbon. They are best suited for use as a fertilizer that is applied to existing growing media. Combining the manure with yard wastes, sawdust or other materials high in carbon produces a compost that is more balanced in its final carbon to nitrogen ratio and therefore better suited to standing alone as a growing medium. Some of the resulting nutrients in compost are in a form immediately available to plants, and some require further breakdown time to be ready. This means that compost is essentially a slow release fertilizer, which reduces the quantity of excess nutrient run-off.

In addition to providing nutrients, composted organic residues have other benefits for agriculture. Compost can retain more water than the inorganic components of soil; therefore, if it is spread over fields as a mulch it reduces the amount of water required for irrigation (Grobe 1994). By retaining water it also slows leaching of nutrients and contaminants such as heavy metals and pesticides from the soil. The organic molecules in compost also directly bind to heavy metals and nutrients, thus holding them in place (Harrison and Richard 1992). This quality has led to the suggestion that compost be used as a filter for city stormwater to absorb grease, oil, heavy metals, and insoluble chemicals (Rogalski and Charlton 1996).

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fungicides present in compost are beneficial to plants that might otherwise suffer from fungal infection (Harrison and Richard 1992). Processors are further developing ways to inoculate compost mixes so as to increase what is already a naturally derived capacity for suppressing disease through the action of desirable microbes (Segall 1995). This replaces the need to use what have been large amounts of fungicides to prevent the establishment and spread of several damaging diseases.

Composting can take place in backyards, in household worm bins (where worms rather than bacteria decompose the organic scraps), and in large facilities. Large facilities can use piles, or windrows, or in-vessel composters. New Milford uses a combination of the latter two. Mechanized turning speeds up the process and reduces odors by providing aeration. In-vessel composting units allow for some anaerobic composting, from which methane can be harvested as a power source.

Large-scale composting requires some safeguards. It is important that large composting facilities have a means of collecting the odorous gases generated, and that they be designed to prevent runoff of liquid from the compost. They also must take care to protect their workers from exposure to pathogens and allergens that may be present during the composting process. Initial heat-generating composting can take from a week to a month, depending on the techniques used, whereas curing (the slower process that brings the compost to maturity) requires from one to six months (Harrison and Richard 1992). Large scale composting facilities must be carefully designed to take all of this into account, and there is a fast growing industry of compost machinery manufacturers and compost research labs to facilitate design and implementation.

An interesting question arises here: if all possible organic residues were harnessed for composting, would that generate enough organic fertilizer to replace commercial fertilizers? Just looking at nitrogen, Figure 1 proposes a technique for answering this question. Beginning with “plants” in the upper right corner, if we know the total mass of plants harvested for human and livestock consumption per year and the average nitrogen content of these plants, we can assume that this is the amount of nitrogen entering the human realm. Unlike carbon, which is used up for energy and released to the atmosphere as carbon dioxide, nitrogen tends to remain behind, i.e. the amount of plant-derived nitrogen consumed by an animal will either become part of that animal or be excreted as urine or manure. Any nitrogen that does not go into yearly growth of livestock and humans will be passed on into the compost stream along with plant residues from agriculture, food processing, and institutions or households.

The wood and paper industry and the fiber industry also have organic inputs and outputs. These tend to have lower nitrogen content, as it is the green parts of the plants that have higher nitrogen content, but residues could still be composted. During the composting process, nitrogen is used by microorganisms for growth and carbon is used for energy. As mentioned above, this means

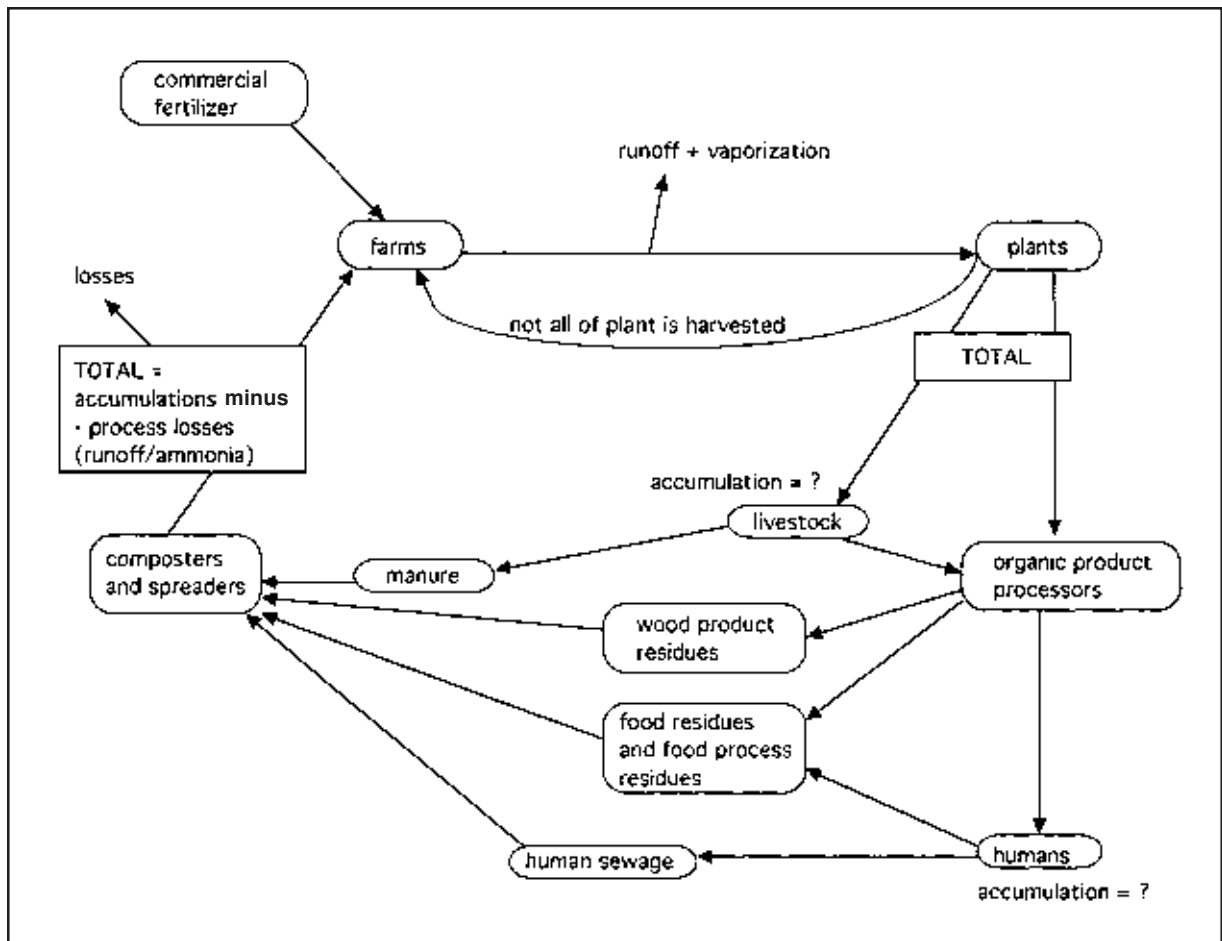


Figure 1 The Anthropogenic Nitrogen Cycle

that the carbon is released to the atmosphere, while the nitrogen remains present in the compost within the microbes (which break down over time). Some nitrogen is removed to the atmosphere by denitrifying bacteria, but during the compost process the Carbon:Nitrogen (C:N) ratio tends to drop from 30:1 to 10:1, so the majority of the nitrogen remains (NRAES 1992).

In 1994, world use of nitrogenous fertilizers was 73.6 million metric tons. The form of nitrogen referred to in this figure was not specified. It probably was not elemental nitrogen, but rather nitrate or ammonia. So the total weight of elemental nitrogen used may well be substantially less than 73.6 million metric tons (if the figure refers to nitrates, then the weight of nitrogen alone is about 22 million metric tons, so we can estimate world nitrogen use to be 22-74 million metric tons). A rough estimate of world agricultural production for 1994 is 5 billion metric tons (FAO 1996). This is the sum of world production of primary crops and includes animal feed, and supposedly pasture as well. It may not include parts of the plant that are not harvested (such as cornstalks), but this plant matter is generally returned to the soil in current practice.

Assuming that the average dry nitrogen content of this organic matter is roughly 2% and that the average moisture content is 30% (because grains make up a large portion of this total and are relatively dry), this would mean that the amount of plant matter above would contain 60 million metric tons of nitrogen (NRAES 1992).

Certainly not all 60 million metric tons could be recycled because some would become part of people and some would become part of animals and some would be lost on the way to run-off and ammonia gas. By one estimation, 5-20% is assimilated and 23 million tons of ammonia are emitted by manure from domestic animals, though this amount might go down if more of the manure were composted. So perhaps 33 million metric tons of nitrogen could be cycled back through (60 million metric tons of nitrogen, minus 20% assimilation and an estimated 15 million metric tons lost to the atmosphere as ammonia). This is a very rough estimate, yet gives a sense of the magnitude – 33 million tons is a large fraction of the 73 million tons of fertilizers used. It certainly would require the incorporation of human and animal manure to achieve this result, since this amount of nitrogen cannot be sequestered from vegetable residues alone.

It also makes sense to look at countries individually, since it is unclear, in the long run, if residues generated in one country would be shipped to another for use. Some imbalances will arise in the case of countries that import much of their food or export much of their agricultural production. An important note is that while organics recycling could not entirely replace the use of synthetic fertilizers, the additional beneficial effects of compost (decreasing run-off, increasing plant absorption of nutrients) improve the outlook. We probably do not need all of that fertilizer since much of it ends up as run-off. Currently in developed countries, fertilizer use is decreasing, as there is increased use of leguminous crop cycles to increase nitrogen content of the soil. Certainly it is a worthwhile effort to capture as much organic material as we can for recycling.

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ORGANICS RECYCLING – THE LOGISTICS

Closing the Loop on Organic Residues

Regardless of the type of residue, compost, or potential application, these various materials can find a place on the closed loop of organic recycling represented by Figure 2. Organic residues are generated by a wide range of private, commercial, and public activities. Currently if the residues cannot effectively be used at the site where they are created, they are likely to end up in landfills or incinerators. Although the theory and technology exists for effective composting, the logistics of actually gathering the material and setting up profitable composting facilities are still tricky (as New Milford Farms has found). Compost processors can choose how they want to work – with a limited number of residue inputs generating an output useful for specific types of applications, or with a wider variety of inputs to create outputs that have a

broader array of possible applications. What the processors turn out as product is influenced by opportunities to find a demand among a variety of customers for alternative types of compost. These customers, in turn, are often generators of residues that feed additional composting activity.

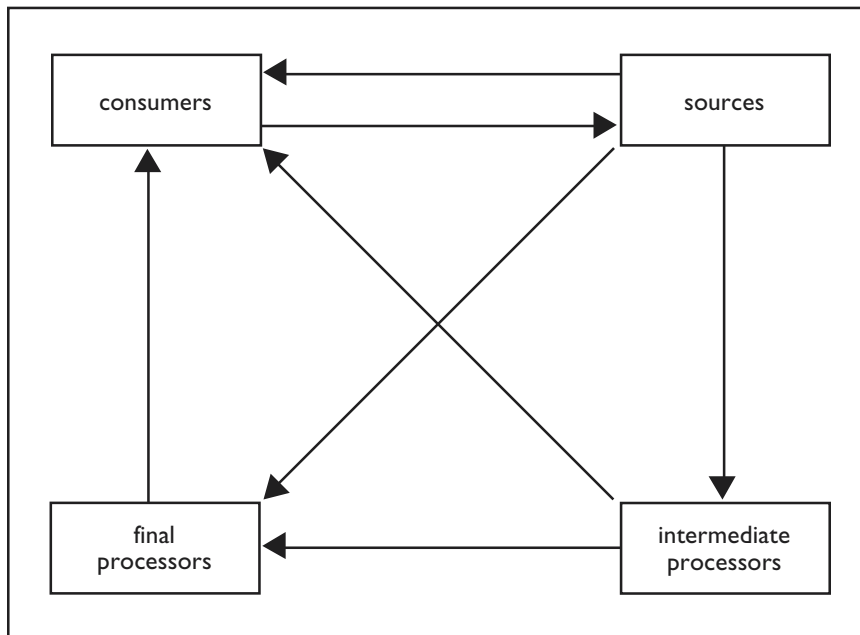


Figure 2 Closing the Loop on Organics

Demand for Compost

In considering the components of this loop more closely, we find that the consumers are the ones driving much of the activity. As opportunities and limitations associated with the use of compost are understood by more and more people, interest and demand continues to grow. Concerns about pathogens threatening humans are addressed by practices that properly subject compost to temperatures high enough to kill all pathogens. Increased awareness of what plants need for good growth, as well as what goes into developing a soil that supports maximum growth, leads to a better appreciation of the benefits of compost.

Home gardeners are attracted to compost as a potting mix, a medium for raised beds, or an amendment for garden soils. In the first two instances, a compost made from a blend of inputs can produce a finished product that is, by itself, sufficient as a planting medium. For soil amendments, manure or sludge-based composts can be good nutrient sources, while yard waste, leaves, or woody residues make compost good for soil conditioning. Professional landscapers and municipal groundskeepers are increasingly finding compost sufficient to fulfill these needs.

Commercial nurseries and greenhouses can meet almost all of their planting media needs with carefully blended composts. Given the highly mechanized and automated systems used commercially to fill containers and apply

water and nutrients, it is essential that the compost be uniform and consistent. This is certainly possible, but does require that the compost processor exercise tight constraints regarding inputs and composting methods.

Farmers are under increasing pressures and regulatory requirements to control the use of nutrients on the farm. Farmers need to test soil carefully to determine kinds and amounts of nutrients needed to grow a particular crop (Bellows 1997). If they spread manure from their own operation, they are required to test the manure to determine the level of nutrients it represents. In the past, manures and crop residues or cover crops have been incorporated into the soil to help improve the soil structure and water handling characteristics. Organic farmers, but increasingly all farmers, are looking at appropriate composts as sources of most of the nutrient requirements for their crops. Not only can the compost supply all of the necessary nutrients, but they become available to the crop gradually rather than all at once. This is more coordinated with the requirements of the plants and reduces the potential that excess nutrients will be carried away by overland flow or groundwater. Compost from different types of inputs can work well for farmers, as long as the nutrient content is known and factored into the site and crop requirements. Widespread use of compost by farmers has the potential to increase demand dramatically over what it has been.

An important requirement if this potential demand is to actually develop is that adequate amounts and types of compost be available for farmers at reasonably competitive prices (Humphries 1997). While nutrient needs may be met presently by having inorganic fertilizer spread by a commercial applicator for a total cost of approximately \$20 per acre, fulfilling those same nutrient requirements with manure costs closer to \$50 per acre (Humphries 1997). Inorganic fertilizers can be made more expensive through input taxes, but it may take some type of cost incentive on the other end of the scale to shift the emphasis to organic sources of nutrients (Runge 1996).

Sources of Organic Residues

Increased demand for a variety of composts would create economically attractive opportunities for recycling many organic residues. Large volume generators such as sewage treatment plants, larger confined animal feeding facilities, industrial operations, and forestry or wood products operations have been coming under increased pressure and costs to dispose of organic waste streams in ways that do not add to the landfill burdens or incineration loads. Moving these materials to composters already can be a lower cost option. The major constraint is often the cost of transporting bulky, often liquid, material over any distance that exceeds five to ten miles.

The prospect of increased demand brings with it the prospect of many more processors finding opportunities to start operations closer to larger sources and larger customers. More facilities operating throughout a region decreases the cost of moving residues from generator to processor. Private haulers who find

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it expensive to keep material separated while transporting it over longer distances are able to offer the service at more reasonable prices over the short haul. This in combination with lower tipping fees for recyclables, compared to general trash, makes separating organics more attractive for most generators. This is especially important for food wastes (created at institutions, restaurants, stores, and even homes) that have not been economically feasible to work into the compost process, primarily due to transportation costs (Pizzimenti 1997). There has also been experimentation with composting of mixed municipal wastes, where the facility separates the organic materials from the waste stream, but this can lead to high levels of heavy-metal contamination. Research shows that source-separated collection is much safer and more effective (Harrison and Richard 1992).

While it may be possible for private, commercial, retail, or public facilities to separate and ship their organic residues to compost facilities, some may choose not to send it away. Homeowners may find it desirable and cost effective to compost material in the back yard and use it around the house or garden. Some institutions such as prisons and schools have set up compost operations on site to handle food wastes and other organics. In such cases, the compost is usually used on site. Farmers generating large amounts of manure or crop residues have experimented with composting on site, then reusing the material on the farm or selling it. They may look to supplement their inputs by taking in domestic or municipally collected yard wastes and leaves. Few of these have developed into profitable additions to the farm operation (Ruhf 1997) so it is likely that as separate commercial facilities become available nearby, these farm-based operations will shut down and the waste will be shipped to the local processor.

Processors

The processors become the facilitators of moving organic residues from the generators to customers while transforming it into a useful material. Increasing and varied demand for compost from farmers, commercial growers, and others will combine with increased desire from generators to find cost effective disposal options to make it possible for processors to set up numerous facilities, broadly distributed and focused on matching local demands with local supplies. Often, these facilities will focus on processing large volumes of certain specific types of residues generated in an area to go to a small list of customers who have particular applications for the outputs produced. New Milford Farms is a current example of that type of operation.

Alternatively, the processor may focus on generating complete, finished compost for a more broad market of private and commercial growers. These processors will have to set up in locations where they not only can find suitable markets, but also where they can line up the appropriate inputs to create the product needed. Some processors may be involved in more than one type of production at the same time. Flexibility becomes an important component of responding to local demand and supply opportunities. Being able to move

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these materials within local areas is an important part of keeping costs down and increasing the likelihood that most organic residues will find their way into some type of recycling.

Hurdles to Realizing the Possibilities

Interest in recycling organics through composting has grown as concerns about landfills have increased (Sellew 1996a). Many regions were developing conceptual plans targeted to moving most organic waste into composting, but, simultaneously, many of these same areas were exploring and going forward with improved incineration technology as an alternative means of disposal (Jeffrey 1997). Municipalities have made commitments to regional incinerators that essentially preclude considering composting alternatives and even reduce the incentive to separate recyclables at the source (Sellew 1996b). Leaves and yard wastes have been an exception in that more and more municipalities and private composters (often farmers adding the material to manure) are finding it cost effective to compost this material for local use (Sellew 1996a).

Overall, the current state of regulations and disposal alternatives leaves composting lower on the list. Large regional landfills are operating at low enough costs with enough land area available to be the lowest cost disposal option for the foreseeable future. Collection and transport of unseparated wastes costs less than handling separate materials and adds to the attraction of landfilling (Sellew 1996b). Until space limitations or safety concerns raise the cost of landfilling significantly, it is likely to be the disposal option of choice for financially stressed municipalities and bottom line oriented businesses and institutions.

A LOOK AT COMPOSTING TODAY

Despite limitations, in the last ten years many new composting facilities have been initiated, putting us on the path toward realizing the possibilities described above. In California, the Good Humus Man (John Guzik) composts leaf cuttings from a lettuce packaging plant owned by Dole Corporation. The leaf cuttings used to be used as livestock feed, but now they are produced in such volume that Guzik saw the opportunity to cycle them right back onto Dole's fields rather than trucking them to livestock-producing areas. He mixes the lettuce with wood fines, cardboard, and manures. Dole has given him space and funding to develop his on-site composting facility, and the resulting compost is applied directly back to the farmland. Dole already has been using the water from cleaning the lettuce as irrigation water with some organic content (Grobe 1994).

Anheuser-Busch composts waste from a brewery in New York State, mixing sawdust as a bulking agent with cakes of high nitrogen content brewery sludge. In three years it processed 11,600 dry tons of sludge. The company markets its compost to All Gro, which is a mixer of soil products. The facility is similar in many ways to New Milford, except that it has simpler inputs and more control over them (Beers and Getz 1992).

The German company Herhof has 45 composting plants. One of them takes 21,000 tons per year of yard waste and household organics, another takes 27,000 tons. It stores excess summer woody material to be added as bulking agents in the winter when yard waste is less available. Its front loaders use bio-diesel fuels and one facility gets all its power from methane gas from a nearby landfill. It uses a 7-10 day in-vessel process and then lets the compost mature outside for 12 weeks and makes 12 different product mixes, in addition to selling cheap carloads of unmaturing compost to farmers.

Europe is on the forefront of the composting movement. In the Netherlands, household organic waste separation is mandatory. England has a profitable facility that collects household organics and sells the compost to gardeners. All together, home composting in England takes care of 2% of the country's total domestic waste, which comes to 400,000 tons diverted per year.

Spain has two mixed municipal waste compost facilities, one processing 108,000 tons and the other 87,000 tons. Glass, paperboard, plastics, and metal are also separated on site and sold for recycling. There are plans to use the compost for strawberry production (Rogalski and Charlton 1996).

An organic farm in Costa Rica uses a mixture called Bocachi, developed in Japan, as fertilizer. This is a combination of rice hulls, coffee bean shells, chicken manure, and cheese whey, and composts very quickly.

Canada composts 11% of its 6.2 million ton per year organic waste stream with 161 facilities, 50 of which are private and 111 municipally owned (Rogalski and Charlton 1996).

In 1995 in the United States, 500,000 tons of food scraps were composted out of 14.1 million possible. This means that 4,000 tons of nitrogen were recovered out of a possible 110,000 tons, which is still only 1% of U.S. nitrogenous fertilizer use, so the U.S. would have to compost materials beyond food scraps to make a big dent in fertilizer use. Some universities are beginning to compost their food wastes in addition to trimmings from grounds maintenance. Organic farmers use on-farm composting of seafood residues (high in nitrogen) as a source of fertilizer in Maine (Kunzler and Farrell 1996).

The government is beginning to take a role in promoting composting. The Iowa Department of Natural Resources Waste Management Assistance Division is developing a database of organic residues to improve on existing management procedures by aiding development of composting facilities (Hay 1997). This is along the lines of a vision for a public/private partnership in the building of composting facilities where the government would provide the land for the facility and take care of the permitting and collection procedures, and private companies would manage the actual composting and marketing.

This review of current composting practices shows that there is a lot happening, but it is not on the scale it could be, and certainly not enough for composting to approach closing the loop and reducing the demands for commercial fertilizers. Part of the hold up is the current regulatory climate.

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Real concerns mixed with irrational fears combine to make us hesitant in this modern day and age to spread composted sewage sludge on fields. It is important to make sure that compost is safe and that the process is not a nuisance to nearby inhabitants. Regulatory variations from place to place lead to variations in the extent of composting. Europe has spent more time than the U.S. developing a regulatory environment that is conducive to composting. California, Texas, and Washington have drawn up regulations for specific source separated organics (Kunzler and Farrel 1996). This facilitates the initiation of new projects. It is important to consider how social policy influences the growth of the composting industry.

Social Policy Framework

The Resource Conservation and Recovery Act (RCRA) of 1976 is the federal statute that covers the handling of solid wastes, including garbage, sludges, and other discarded materials. Subtitle D of RCRA regulates solids not considered hazardous (the vast majority of solids, by far), including agricultural and manufacturing wastes of the kind we are considering here.

Among the many issues surrounding RCRA's Title D is the question of pollution prevention and recycling. According to an Office of Technology Assessment (OTA) Background Paper (1992):

RCRA's stated goal is to encourage the prevention of waste generation and the recycling or recovery of waste materials when possible. The Nation's experience with hazardous waste indicates that incentives to reduce waste generation and increase materials recovery have grown as the liabilities and direct costs of waste disposal and as right-to-know reporting...have increased. To date, however, EPA has not strongly promoted prevention and recycling of Subtitle D wastes, which may reflect the general lack of resources and lower priorities given over the years to Subtitle D compared to Subtitle C wastes. In addition, EPA is unable under RCRA to regulate production processes in terms of their later impacts on risks associated with the management of Subtitle D wastes...

The organic waste streams of interest to our group for this project – those from industry, municipal sewage treatment, post-consumer sources, and households – suffer from the regulatory neglect of Subtitle D wastes. The science of recycling organics creates opportunities that are captured by the spirit of RCRA, but neglected in practice. Opportunities are lost also because of state-by-state inconsistencies in the implementation of RCRA and state standards, as well as corporate disincentives to re-process organics. New Milford Farms operates in the state of Connecticut within 50 miles of both New York (upstate) and Massachusetts; NMF currently imports wastes from New York and New Jersey. And as noted above, Nestle USA operates NMF as a waste disposal alternative, not as a proactive organics recycler.

This review of current composting practices shows that there is a lot happening, but it is not on the scale it could be, and certainly not enough for composting to approach closing the loop and reducing the demands for commercial fertilizers.

The same OTA background paper suggests the following as strategies for enhancing overall pollution prevention efforts:

- Increasing technical and financial assistance to businesses and states;
- Increasing the use of market-based incentives...to encourage innovative technologies and practices...;
- Removing existing regulatory disincentives to prevention and recycling; and
- Increasing public disclosure of emissions.

What is the regulatory environment for NMF in Connecticut? The Connecticut Department of Environmental Protection (DEP) permits NMF as a “volume-reduction” facility allowing up to 2,000 pounds of yard waste materials per day to be shredded or compressed in a process of composting. The State’s dual purposes are to track the kinds and amounts of materials handled at the site, and to collect fees for same (Faryniarz 1997). While the Solid Waste Section of DEP handles the permitting process, the Bureaus of Water Management, Air Management, and Natural Resources must also ratify permits of the type held by NMF. Final permits are issued under site-related guidelines related to features of the site itself, access to utilities and transportation, and residential proximity.

The general framework of the permit allows certain specified substances to be handled, allows for demonstrations of expediency for new substances, and allows for flexible mixing ratios within parameters of safety (Faryniarz 1997). But Connecticut imposes some severe constraints, chief among them the requirement that all composting except leaf piles must be done indoors. Neighboring New York and Massachusetts do not require this.

Other legal forms of composting in Connecticut provide potential input streams for large-scale composting facilities like NMF which may turn out product ready-to-mix for active use. These include sewage sludge composting (which currently may not be used for anything other than landfill cover), manure composting, and clean wood chipping. At least one Connecticut official, Joe Faryniarz, sees a bright future for composting in Connecticut. An alternative to landfilling, composting also provides a vehicle for processing waste currently located in landfills as the latter are “mined” and revamped to hold the next generation of new opportunities to discover re-processing.

Connecticut also has a legislative mandate to produce a State Plan for solid waste management every two years. At this writing, the 1991 plan has not yet been replaced and it allows for recycling programs to include composting only if the material is actually re-used; objectives for composting on a large scale have not yet been addressed in a State Plan (Alexander 1997).

A major unmanaged stream of waste is from the commercial and institutional sector’s organic fraction. It is not being separated at the source, but significantly, is being excluded from the tonnages required by towns to go to waste-burning power plants. DEP Compost Specialist K.C. Alexander sees a

variety of possibilities for this stream: on-site composting supervised at first on a pilot basis by the state (projects are underway), expansion of existing sewage sludge treatment facilities to process food organics in separate bays, addition to farm-based manure composting, and entrepreneurial, source-separated facilities located along major state routes (Alexander 1997).

There is much to be done in Connecticut. Neighboring states (especially Massachusetts) are more actively promoting composting. A major educational effort must precede composting on a massive scale; the public would have to undertake this form of recycling with the same vigor now expended on collecting newspapers and cans. More difficult is the prospect of bringing the public around to accepting the usefulness of human sewage sludge in large-scale composting.

New Milford Farms and Industrial Ecology

We now can better place New Milford Farms into the context of the organics recycling movement and evaluate how it is doing and how it could improve. NMF successfully complements Nestle USA operations by converting significant waste quantities into useful, environmentally friendly end-products. New Milford Farms' mission is simultaneously its greatest strength and greatest weakness: as a subsidiary of a much larger corporation, NMF operates to serve the larger divisions which are its "customers." Its success is not measured based on efficiency of converting the most industrial waste into a useful end-product, or even on profitability. Thus, management cannot operate like an independent composting facility, limiting flexibility and total capability. For example, the farm is required to use waste residues from the FIDCO facility even though they lead to significantly worse compost. In addition, the production schedules of other divisions (made without regard to the needs of NMF) lead to compost of varying grades and physical characteristics, which is also not ideal for running an efficient composting facility.

NMF demonstrates the potential of regarding industrial waste as feedstock for alternative operations. The facility also illustrates how a large manufacturer developed a creative, environmentally-friendly solution to waste disposal issues. On the other hand, New Milford Farms also has its shortcomings. Using the matrix tool from stream-lined life cycle assessment, New Milford Farms received a score of 86 points out of a possible 100 (Graedel *et al.* 1995). The following table highlights the strengths and weaknesses of the facility.

As shown in Table 1, New Milford Farms achieves high marks – after all, it converts waste that otherwise would be landfilled or incinerated into a rich, environmentally friendly compost. Not surprisingly, the facility scores high marks for product use and refurbishment, recycling, and disposal. One interesting source of strength is gaseous residues during product manufacture – gaseous residues are normally high during composting. NMF reduced emissions by channeling the vapors underground, providing heat and nutrients to its lawn and flower garden.

Table I New Milford Farms Product Matrix

Life Stage	Materials Choice	Energy Use	Solid Residues	Liquid Residues	Gaseous Residues	TOTAL
Pre-Manufacture	3	3	3	3	3	15/20
Product Manufacture	3	2	4	4	4	17/20
Product Delivery	3	2	4	4	3	16/20
Product Use	4	3	4	4	3	18/20
Refurbishment, Recycling, Disposal	4	4	4	4	4	20/20
TOTAL	17/20	14/20	19/20	19/20	17/20	86/100

Note: Areas were rated on a scale of 1-4, with 1 being the lowest and 4 being the highest.

On the other hand, New Milford Farms suffers some low marks primarily because it lacks the autonomy to run its operations optimally. Energy usage during production is extremely high due to the long distances to its main suppliers. The coffee grounds, tea leaves, and wastewater sludge from New Jersey travel over 150 miles to New Milford, and the cocoa beans from New York travel over 250 miles. In 1995, NMF received over 60 truckloads from Fulton and nearly 700 truckloads from Freehold. Assuming that trucks travel at ten miles per gallon, transport of those inputs alone consumed nearly 24,000 gallons of fuel. New Milford Farms can improve the performance by “double-loading,” but the fact remains that transportation of materials is not minimized. Product delivery also saw a couple of lower marks, primarily because the compost must often undergo further processing before usage.

The low marks result largely from lack of autonomy and regulatory freedom. Thus, they could be remedied if the facility operated independently and established high, constant levels of local supply and demand.

There is also a role for regulation in the composting movement. We see a future for regulation of nitrogen levels with state and federal monitoring sites; such an approach allows for planning the recycling of organic material in tandem with the reduction of commercial fertilizer applications. We see potential for community-based consensus models to expand the flexibility of solid flows to composting facilities, mediated by computerized databases of information on inputs and outputs. We also see potential for niche industries to act as intermediate processors of local organics which are fed into larger, more remote final processors.

Our vision includes the prospect of federally funded, regional pilot projects to plan feasible organics recycling systems that meet nitrogen standards at strategically identified check points. States can play a substantial role in setting appropriate costs for industry, institutions, and municipalities which fail to meet more stringent nitrogen management goals. In short, we see a future for public as well as private entrepreneurship in the field of organics recycling.

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