MUNICIPAL SOLID WASTE COMPOSTING: DOES IT MAKE ECONOMIC SENSE?

by

Mitch Renkow
Department of Agricultural and Resource Economics
North Carolina State University
Raleigh, North Carolina

A. Robert Rubin
Department of Biological and Agricultural Engineering
North Carolina State University
Raleigh, North Carolina

INTRODUCTION

Municipal solid waste composting is an alternative to the disposal of garbage in sanitary landfills. Municipal solid waste (MSW) composting facilities are currently operational in more than a dozen locations throughout the United States, and many communities are currently exploring the possibility of incorporating MSW composting into their integrated solid waste management systems. The growing interest in MSW composting has been stimulated by a desire to minimize the amount of garbage entering landfills – either as a way meeting state waste diversion requirements or as a way of extending landfill life.

Communities contemplating establishment of an MSW composting facility need to weigh several factors, including the environmental consequences of landfills versus composting, the relative political and social costs of siting landfills and composting facilities, and the economic implications of the alternatives. In this factsheet, we present information on the costs of MSW composting and how those costs compare with the costs of land disposal in sanitary landfills. Following a brief overview of MSW composting technologies, we report the results of a survey of 19 MSW composting facilities around the United States. We then use the cost information collected in the survey and actual landfill cost data from one North Carolina county to compare the cost of MSW composting versus the cost of land disposal. This analysis indicates that even accounting for the beneficial effects of delaying construction of a new landfill, a solid waste management system that includes MSW composting costs significantly more than a solid waste management system without MSW composting.

MSW COMPOSTING TECHNOLOGIES

Composting is a controlled biological process that uses natural aerobic processes to increase the rate of biological decomposition of organic materials. It is carried out by successive microbial populations that break down organic materials into carbon dioxide, water, minerals, and stabilized organic matter. Carbon dioxide and water are released into the atmosphere, while minerals and organic matter are converted into a potentially reusable soil-like material called compost. The loss of water and carbon dioxide typically reduces the volume of remaining material by 25% to 60%; compost can be used as a soil amendment in a variety of agricultural, horticultural or landscaping applications.

Composting is most commonly confined to municipal yardwaste operations that use leaves, grass clippings, and other yard trimmings as a feedstock. The number of yardwaste composting facilities throughout the country has grown tremendously over the past five years as state regulations have increasingly banned yard trimmings from landfills. MSW composting processes <u>all</u> of the biodegradable components of the wastestream that decompose most readily – paper, food waste, and wood in addition to yard trimmings. On average, these materials account for 55%-70% (by weight) of a community's solid waste. The significant volume reductions associated with composting and the possible uses of compost make MSW composting attractive as a potential

means of diverting waste from landfills. On the other hand, MSW composting requires considerable pre-sorting of the incoming waste and screening of the finished product to remove uncompostable materials such as glass, metal, and plastic – activities that tend to be relatively costly.

The two basic processes used in large scale composting are windrow-based technologies and in-vessel technologies. In *windrow* systems, waste is brought to a central open air facility and formed into windrows that are three to five feet high.[1] The windrows are turned periodically to maintain a stable temperature and rate of decomposition, and water is added as needed to maintain an appropriate moisture content. After a desired level of decomposition is reached, the composted product is ready for assembly and distribution to end-users. A somewhat more sophisticated alternative to the simple *windrow* system is the *aerated windrow system*. Aerated windrow systems replace manual turning of windrows with a network of pipes that force air into the windrows.

In-vessel systems employ considerably more sophisticated proprietary technologies. These technologies offer a highly controlled, enclosed environment for effecting the biological decomposition needed to produce a high-quality product. In-vessel systems tend to be considerably more capital intensive than windrow technologies, though, requiring a larger initial investment. In addition, the greater technical complexity of these systems usually requires a workforce that is more highly trained (but fewer in number) for operating the composting facility.

COSTS OF MSW COMPOSTING FACILITIES

A telephone survey of MSW composting facilities operating in various parts of the country was conducted in the spring of 1995. Nineteen facilities were contacted, and facility managers were asked a number of questions regarding the specific composting technology employed (windrow, in-vessel, etc.); operational details (process time, percent volume reduction, annual throughput); costs (both debt service and operating/maintenance costs), disposition of the finished product (uses and users, revenues from sales, and quality control systems to assure product consistency). Respondents were also queried as to any problems that had been experienced since start-up and ways in which problems were dealt with. Of the nineteen facilities contacted, three have shut down. One facility (located in Escambia Co., FL) was closed due to liability and cost problems, one (located in New Castle, DE) was forced to shut down due to odor problems, and one (located in Pembroke Pines, FL) has shut down temporarily due to technological problems.

Table 1 provides an overview of 17 of the MSW composting facilities surveyed.[2] Of the seventeen facilities listed, ten are publicly owned and operated, five are privately owned and operated, and two are publicly owned operated by private firms. About 40% use in-vessel technologies, with the balance relying on less sophisticated windrow systems. Annual throughput varies considerably, although publicly operated facilities tend to handle smaller volumes of waste. With one exception, process time ranges from one to four months and volume reduction ranges from 25% to 70%.

Table 2 indicates the uses of finished product from the facilities surveyed. Over half the facilities listed farmers and/or landscapers as the primary users of the compost that is produced. Six facilities contract with nurseries for disposal of some of their compost, and in five cases compost is used as landfill cover. Somewhat surprisingly, only two facilities provide compost for use as roadside fill dirt. In general, most compost was given away at no charge.

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[1]Windrow formation may be preceded by shredding the incoming product to reduce particle size at the outset of the composting process.

[2]We include information for the Pembroke Pines facility, even though it is not currently operating.

Table 1. Overview of MSW composting facilities surveyed

Location	Type of system	Age (years)	Volume (tons/day)	Process Time (months)	Volume reduction
Publicly owned and operated facilities					
Columbia Co., WI	in-vessel	2	67-80	2.5	40%
Lakeside, AZ	in-vessel	4	10-12	3.0	n/a
Martin/Fairbault Co., MN	in-vessel	4	100	3.0	50%
Mackinac Island, MI	aerated windrow	3	200-400	2.0	45%
Portage, WI	aerated windrow	9	16	3.0	50%
Sumter Co., FL	aerated windrow	7	50-55	2.0	n/a
Wright Co., MN	aerated windrow	n/a	175	4.0	60%
Buena Vista, IA	windrow	5	35-40	4.0	25-50%
Fillmore Co., MN	windrow	8	11	3.0	70%
Lake of the Woods, MN	windrow	6	1.5	1.0	50%
Publicly owned and privately operated facilities					
Sevier Co., TN	in-vessel	3	150	1.5	60%
Mora, MN	windrow	4	200-250	6.0[a]	50%[a]
Privately owned and privately operated facilities					
Baltimore, MD	in-vessel	2	500-600	1.5	n/a
St. Cloud, MN	in-vessel	7	65	2.0	60%
Whatcom Co., WA	in-vessel	4	100	2.0	50%
Pembroke Pines, FL[b]	aerated windrow	4	550	1.5	50%
Montgomery Co., KS	windrow	9	50-60	2.0	60%

a. The Mora facility also processes some compost for 12 months with volume reduction of 60%.

b. The Pembroke Pines facility is not currently operational.

Table 2. Disposition of final product at MSW composting facilities surveyed

Location	How product is used
Publicly owned and operated facilities	
Columbia Co., WI	Agriculture
Lakeside, AZ	Landscaping
Martin/Fairbault Co., MN	Agriculture, landscaping, nurseries
Mackinac Island, MI	Landscaping, landfill cover
Portage, WI	Agriculture, landscaping
Sumter Co., FL	Landscaping, roadside fill dirt
Wright Co., MN	Agriculture, landscaping, roads, nurseries, landfill cover
Buena Vista, IA	Landfill cover
Fillmore Co., MN	Agriculture, landscaping
Lake of the Woods, MN	Soil conditioner for closed landfill
Publicly owned and privately operated facilities	
Sevier Co., TN	Agriculture, landscaping, nurseries
Mora, MN	Landscaping, nurseries
Privately owned and privately operated facilities	
Baltimore, MD	Agriculture
St. Cloud, MN	Agriculture
Whatcom Co., WA	Nurseries
Pembroke Pines, FL	Agriculture, nurseries
Montgomery Co., KS	Landfill cover

Only nine of the facilities contacted were able to provide sufficient cost information to allow computation of average costs on a per-ton basis. In the case of privately-operated facilities, most firms informed us that this was proprietary information that they were reluctant to divulge. Public composting facilities were considerably more forthright about their costs; however, in several cases the requisite data (particularly data on operating and maintenance costs) was simply unknown by the facility manager.

Annual debt service costs were, in most cases, provided by survey respondents. Where debt service information was unavailable, these costs were computed as 10% of initial capital investment (comparable to principal and interest payments on a bond financed at 8% over a 20-year period). In the case of the Sevier County facility, the reported initial capital cost of $6.5 million included a significant subsidy on the part of the vendor of the composting technology (Bedminster Corp.). Presently, a comparable system would cost twice that amount, and hence we computed the "unsubsidized" annual debt payments based on the price that a prospective purchaser would have to pay for establishing a similar facility. Finally, annual debt service costs and annual operation and maintenance (O&M) costs were divided by the number of tons of annual throughput to arrive at a cost per ton.

Table 3. Costs of selected MSW composting facilities

Location	Type of system[a]	Average Volume (ton/day)	Debt service ($/ton)	O&M costs ($/ton)	Revenue ($/ton)	Net cost ($/ton)
Sevier Co., TN						
- reported	I-V	150	$13	$23	$1	$35
- unsubsidized[b]	I-V	150	$26	$23	$1	$48
Columbia Co., WI	I-V	74	$14	$29	none	$43
Baltimore, MD	I-V	550	$27	$24	none	$51
Martin/Fairbault Co., MN	I-V	100	$28	$51	none	$79
Portage, WI	AW	16	$26	$24	none	$50
Wright Co., MN	AW	175	$28	$23	none	$51
Sumter Co., FL	AW	53	$22	$52	$20	$54
Fillmore Co., MN	W	11	$41	$240	none	$281
Lake of the Woods, MN	W	1.5	$176	$1,795	none	$1,971
Weighted average[c]			***$26***	***$28***	***$1***	***$53***

a. I-V = in-vessel; AW = aerated windrow; W = windrow

b. "Unsubsidized" estimate assumes an initial capital cost of $13 million (as opposed to the reported value of $6.5 million).

c. These are mean costs (weighted by tons processed), excluding the Fillmore County and Lake of the Woods facilities, and using the unsubsidized estimate for the Sevier County facility.

Table 3 lists the per-ton costs for the nine facilities that supplied cost information. There it will be observed that for six of the nine facilities, net costs lie clustered around $50 per ton (ranging from $43 to $54). One facility cost $79 per ton, and two other facilities – both of which handle relatively small amounts of material annually – had extremely large per-ton costs. In only one case were significant revenues from compost sales reported.

Respondents generally reported being pleased with how well their facilities were operating. Two problems – odor and residual plastics in the final product – were identified by a number of individuals questioned. Three respondents cited odor as a continuing problem, and an additional four had had odor problems that were remedied by installation of bio-filters. Residual plastics were cited as problematic at seven facilities. In most of these cases, this has led to greater emphasis on pre-sorting of feed stock prior to composting.

In summary, our survey indicates that MSW composting facilities generally involve costs around of $50 per ton, although we did uncover some cases of extremely large operating costs for a couple of facilities handling relatively small amounts of trash. The great bulk of facilities contacted receive no revenues for the compost they produce; rather, they generally give the finished product away to farmers, landscapers, nurseries, and landfills. We found little evidence of any particular cost advantage related to public versus private operation. Respondents generally appeared to be satisfied with the operational aspects of their facilities. Odor and residual plastics were identified as the primary areas of concern, but most operations had developed mechanisms for dealing with these problems.

MSW COMPOSTING VERSUS LANDFILLS

The survey results presented above indicate that communities contemplating MSW composting as part of their integrated solid waste management system should expect composting to cost in the area of $50 per ton. In North Carolina, this is above what it costs nearly all municipalities and counties to dispose of waste in sanitary landfills. However, as mentioned in the introduction, one of the benefits of municipal solid waste composting is that it extends the life of landfills by diverting waste. A key economic question that arises in assessing the desirability of establishing a MSW composting facility, then, is whether or not the economic benefits of extending landfill life exceed the additional cost of processing waste through composting.

To address this question, Table 4 compares the cost of landfilling all waste generated within the county with a hypothetical scenario in which 50% of a county's waste is landfilled and 50% is processed at a MSW composting facility. To do so, we utilize 1995 landfill cost data from Rowan County, North Carolina. Rowan County owns and operates a sanitary landfill that currently handles approximately 100,000 tons of garbage per year at a cost of just under $24.00 per ton. Total costs are made up of three roughly equal components: (a) Operating and maintenance (O&M) costs; (b) debt service on the capital outlay for construction; and (c) contributions to a reserve fund for environmental monitoring. Note that contributions to the reserve fund are fixed costs that accrue regardless of the amount of waste handled; a reduction in the amount landfilled therefore increases the *per ton* cost of this cost item. Debt service is also a fixed cost; however, extending the life of the landfill effectively draws out the period of time over which initial capital outlays are paid off and hence will lower the size of the total annual principle and interest payment (although not necessarily on a per ton basis). Finally, variable costs will fall in direct proportion to the reduction in waste landfilled and so remains constant on a per ton basis.

Rowan County is currently planning to develop a new cell (at a cost of $3 million) that will take 7 years to fill up at current waste generation rates. The first column in Table 4 provides the costs for the "landfill everything" scenario. These cost figures assume that (a) the $3 million capital outlay is financed over the seven years it will take to fill the cell up, at an interest rate of 5%; (b) the current amount set aside annually for environmental monitoring remains constant; and (c) current per-ton variable costs remains constant. Given these assumptions, the total annual cost of solid waste management would be $2.2 million (or $21.28 per ton of waste handled).

The remaining columns of Table 4 present the costs of solid waste management assuming that half of the waste generated within the county is landfilled and half is processed at a MSW composting facility. Here, we take the variable and fixed costs of MSW composting to be equal to the averages derived from the results of our survey of composting facilities presented earlier ($30 and $20 per ton, respectively).

Table 4. Comparison of annual waste management costs with and without MSW composting

	Landfill Only	Landfill + MSW Composting		
		Landfill Cost	Compost Cost	Total Cost
Fixed Cost[a]	$1,357,213	$1,141,826	$1,053,670	$2,195,496
Variable Cost[b]	$885,465	$442,733	$1,580,505	$2,023,238
Total Cost	$2,242,678	$1,584,558	$2,634,175	$4,218,733
Tons of garbage	105,367	52,684	52,684	105,367
Fixed cost per ton	$12.88	$21.67	$20.00	$20.84
Variable cost per ton	$8.40	$8.40	$30.00	$19.20
Total cost per ton	$21.28	$30.08	$50.00	$40.04

a. Fixed cost for the landfill includes contribution to a reserve fund for environmental monitoring. Fixed costs for the landfill are computed assuming a $3 million loan at 5% interest paid out over 7 years in the "Landfill Only" scenario, and over 14 years in the "Landfill + MSW Composting" scenario. Fixed costs for MSW composting are assumed to be $20 per ton of waste handled.

b. Variable costs for the landfill are assumed to be $8.40 per ton of waste handled. Variable costs for MSW composting are assumed to be $30 per ton handled.

Diverting half of the county's waste to a MSW composting facility entails processing half the county's waste steam at a per ton cost that is more than twice the cost of landfilling. There is some cost saving in extending the life of the landfill by lengthening the period over which debt needs to be paid off. This cost saving only partially offsets the greater cost involved in composting, however.[3] The overall impact of diverting half of the county's waste to a MSW composting facility is an 88% increase in the county's annual solid waste management bill – from $2.2 million ($21.28 per ton) to $4.2 million ($40.04 per ton).

From a financial perspective, it is clearly not possible to justify construction of a MSW composting facility for the specific case of Rowan County, even when the value of extending a landfill's life is taken into account.

[3]In fact, the per ton cost of landfilling actually *rises*, due to the fact that while fixed costs drop by 15% the amount of trash over which these fixed costs are spread falls by 50%.

Further analysis indicates that only if landfill costs were more than double those of Rowan County ($59.00 per ton) would processing waste at a MSW composting facility become economically feasible. Disposal costs are currently much lower than this at most, if not all, landfills in North Carolina. We conclude that only if landfill costs were to rise considerably – or markets for compost were to develop such that revenues from compost sales grew enough to substantially offset the higher costs of composting – would MSW composting become an economical component of a community's integrated solid waste management strategy.

DOES MSW COMPOSTING MAKE SENSE?

From an economic perspective, communities contemplating MSW composting as a component of their overall solid waste management system should proceed with great caution. It is clear that at present MSW composting cannot be justified on financial grounds where landfill costs are relatively low (as in North Carolina). It is conceivable that there are other factors that might justify the larger costs of MSW composting in some communities. One such factor is the strength of state- mandated waste diversion requirements. Where these mandates are binding – and to the extent that other, cheaper alternatives such as yard waste composting do not divert sufficiently large volumes from landfills – MSW might be rendered more attractive (although no less costly).

A second possible reason sometimes offered as to why some communities might want to explore MSW composting has to do with the difficulty of siting a new landfill. According to this argument, if a community perceives MSW composting to be more environmentally "friendly" and/or to be less damaging to local property values than land disposal, it may be easier to site an MSW composting facility than a new landfill. This contention is probably no longer true for most if not all communities, however, given recent well-publicized negative public reaction to MSW composting facilities in various locations across the country due to odor problems and cost overruns.