FINANCIAL FEASIBILITY ASSESSMENT:

Composting at Glamour View Farm, Frederick County

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Background

The Maryland Department of Agriculture's Animal Waste Technology Fund (AWTF) provides grants for on-farm demonstration projects of innovative technologies for managing animal manure. These technologies are expected to better manage on-farm waste, improve water quality, and create new revenue streams for farmers in the form of cost savings and marketable byproducts.

Figure 1. Green Mountain Technology's composting system at Glamour View Farm is housed within a permanent structure. Figure 2. The Earth Flow composting system features automated mixing and aeration equipment. Photo credits: David Kann.

Glamour View Farm, located in Frederick County, Maryland, is a 146-acre dairy operation home to 180 Holstein and Jersey cows. The farm has embraced innovative technology as a core element of its operations, using robots to milk cows and distribute feed, installing solar panels on two barn roofs to provide electricity for farm operations, and re-using purified rain water to bathe and water cows.[1]

In 2015, Green Mountain Technologies (GMT), a firm that designs commercial-scale composting systems, received an AWTF grant to install a site-built composting system at Glamour View. The patent-pending Earth Flow (EF) composting system automates mixing, aeration and moisture addition, making it more efficient and effective than manual composting. The composter at Glamour View Farm is expected to process at least 500 tons of manure per year.

Expected Benefits

Glamour View's new composting system is designed to treat manure (animal waste plus bedding material) from the heifer segment of the dairy operation, which includes about 60 cows. These animals produce approximately 500 tons of manure each year, which will be treated in the composter and then used on the farm as bedding material or fertilizer, or sold as a soil amendment. In the absence of the Earth Flow composter, this manure would either be stored in a farm field (field-stacked) or diverted to a manure lagoon for treatment, when it could then be applied on the farm as a fertilizer or sold to another farm.

The new composter improves on these default management alternatives. Field-stacking raw manure is problematic in that nutrient runoff can impair nearby streams and/or reduce productivity of cropland near the storage site. Further, new Maryland regulations limit field-stack storage of manure during the winter months, allowing it only if the material has a moisture content of 65% or less, which may necessitate the construction of additional covered storage facilities. Composting alleviates this issue by converting the media to a dryer, more stable media and reducing its overall volume, which has the dual benefit of making it eligible for field stacking as well as making it possible to store a greater amount in limited covered facilities.

Glamour View's composter also makes the management of wet manure more efficient by decreasing the volume of material put into the farm's manure lagoon, reducing electricity needs as well as wear-and-tear on lagoon components. In addition, finished compost has a good market value, comparable to or better than what Glamour View would receive for raw manure. Overall, the composter gives the farm more options for managing and storing manure while producing a consistent, easily transportable, marketable, and environmentally benign byproduct.

Results: Financial Feasibility Assessment

The Environmental Finance Center developed a full cost balance assessment for the GMT composter project at Glamour View Farm. This assessment contrasts pre- and post-technology expenses and revenues across various modules including labor, operations and maintenance, materials and services, energy, capital costs, monetized environmental costs, and byproducts. EFC developed this assessment through desktop research and interviews with the vendor and other specialists familiar with the technology and with Glamour View Farm.

Table 1. *Cost assessment results for base scenario (see inputs and assumptions below)*

	Pre-Technology	**Post-Technology**	**Balance *(positive indicates cost savings or revenue)***
Labor costs ($)	2,167	633	1,533
O&M, material, and services costs ($)	2,005	3,511	-1,506
Energy costs ($)	7,216	6,274	941
Byproduct revenue ($)	0	2,000	2,000
Sub-total	*$11,388*	*$8,418*	*$2,970*
Monetized environmental costs*	$6,000	$0	$6,000
			Summary
Capital costs			$219,106
Annual cost savings + revenue			$8,968
Simple payback on investment			24 years

* Monetized environmental costs associated with field stacking or land-applying dairy manure have not been estimated in any scientifically rigorous manner. The analysis above identifies the avoided environmental cost that would be necessary to arrive at a cost-effective project defined as the simple payback equaling the useful life of the technology.

<u>Key finding</u>: When considering only labor, energy, materials and services, and revenue from the sale of byproducts, the GMT composter as applied on the Glamour View Farm will result in annual cost savings of less than $3,000. This calculation assumes the pre-technology manure management practice has zero value as a saleable product (because Glamour View produces more than enough

manure for its own fertilizer needs, and because the market for raw manure in Frederick County is weak), and it assumes costs associated with field stacking and lagoon wear-and-tear. However, to the extent the market or the State values decreased nutrient runoff from field applied manure (e.g., via nutrient credit trading, public subsidy, etc.), and the farm can generate additional revenue, the project financial balance will improve drastically. Solving for conditions whereby the simple payback of the project is equal to the useful life of the technology (i.e., 25 years), then the project could be considered cost effective if the value of preventing raw manure from being field-applied were $12/ton or greater. Under these conditions, the total annual cost savings (internal and external costs) would be $8,968 (see Table 1).

Table 2. *Critical inputs, value, and corresponding notes for base scenario*

Input Name	Value	Note
Animal waste + bedding input per year (tons)	500	Per the vendor, Earth Flow can process as much as 1,300 tons/year, but Glamour View plans to process only approximately 500.
Pre-technology manure allocation ratio (field apply : sale)	1:0	Pre-technology, 100% of manure is field stacked and 0% of manure is sold.
Compost sale price ($/ton)	10	Conservative estimate per conversation with nutrient management expert (who suggested $12-18/ton).[2]
Post-technology revenue from compost sale ($)	1,000	Based on 200 tons of compost (40 percent efficiency of composter; 500 tons input) sold at $10/ton.
Post-technology labor commitment (hrs/year)	26.6	Accounts for labor required to load system (2 minutes per ton) compared to labor required to field stack (10 minutes per ton).
Post-technology operation and maintenance costs associated with EF system ($)	2,097	Based on 3 percent of Earth Flow equipment cost of $69,900.
Useful life of site-built EF composting system (years)	25	Per vendor.
Value per ton avoided for land-applied manure ($/ton)*	12	Set to simple payback equal to the useful life of system or 25 years based on other given inputs.
Field stacking pre-technology internalized cost per year ($)*	6,000	Based on 500 tons of manure land applied at an internalized cost of $12/ton (minimum value in order for the project's simple payback to equal the useful life of the technology; see discussion above).

* Inputs highlighted in gray are hypothetical (see discussion above).

<u>Critical model inputs and assumptions</u>: The results presented above are sensitive to key inputs and assumptions. In order of relative importance, the most important inputs include: (1) the default costs and benefits of alternative uses for manure – in this case the sale of raw manure or field storage and application – for the farmer and/or the public, (2) the amount of manure loaded in the composter per year (with higher amounts yielding greater cost savings), and (3) the price at which compost is able to be sold, as well the price differential with the sale of raw manure.

<u>Scenario analysis findings</u>: The base scenario outlined employs inputs that represent EFC's best understanding of operations at Glamour View Farm. However, some of the assumptions may not be

applicable to other farms, and even within the Glamour View Farm operation, if the farmer elects to change operations in the future. For example, the base scenario assumes that 500 tons of manure are loaded into the composter yearly, but GMT estimates that the system could process significantly more, as much 1,300 tons per year. Likewise, the base scenario assumes that the farmer does not sell the diverted manure or need it as fertilizer, that compost is valued at $10/ton, and that compost *isn't* used for bedding at Glamour View Farm, which it may very well be at some point in the future.

The scenario analysis findings (see Table 3 below) demonstrate the impact on project feasibility associated with the change of a few key inputs. Namely, higher input capacity for the composter (the upper range of GMT's estimate) and higher dollar value for finished compost (upper end of the range estimated by Glamour View's nutrient management consultant) yield a better payback (Scenarios A + B). Additionally, if the farmer were interested in using the compost as a bedding substitute, there is significant savings potential (Scenario C), as the current cost of bedding is around $.9 cubic foot for shaved wood. If the farmer had previously been using raw manure as fertilizer and substituted finished compost for manure, however, annual cost savings decrease and the project's simple payback period may exceed its useful life (Scenario D). Similarly, if the farmer had been extracting value from raw manure via sale to other farmers, financial feasibility of the composting project decreases (Scenario E).

Table 3. *Base scenario financial results plus five alternative scenarios with modified inputs**

	Scenario A 1,300 tons/year input, $10/ton compost sold	**Scenario B** 500 tons/year input, $18/ton compost sold	**Scenario C** 500 tons/year input, compost used to offset bedding*	**Base Scenario** See inputs above**	**Scenario D** 500 tons/year input, compost used on farm as fertilizer***	**Scenario E** 500 tons/year input, pre-technology manure sales****
Annual cost savings + revenue ($)	26,002	10,568	18,903	8,968	6,219	7,219
Simple payback (years)	8.1 < 25 year useful life	20.7 < 25 year useful life	11.8 < 25 year useful life	24.4 < 25 year useful life	35.2 > 25 year useful life	29.3 > 25 year useful life

* Assumes zero sales of compost, which instead goes to offset bedding costs. Assumes composter produces 12,705 cubic feet of compost material per year, which is used to offset fresh shavings valued at .9 $/cubic feet; ** All scenarios assume $12/ton for monetized environmental cost of avoiding land applied manure, the minimum value needed in order for the technology's simple payback to equal its useful life, as discussed above. *** Assumes that finished compost is substituted for raw manure as on-farm fertilizer; due to conversion of manure to compost at 40% efficiency, farmer must purchase 300 tons/year of manure at $2.5/ton. ****Assumes pre-technology sale of raw manure at $2.5/ton, and implies that after conversion to compost, operation takes a loss by selling compost instead of raw manure.

Discussion: Transferability and Policy Considerations

The analysis above pertains specifically to Glamour View Farm. As discussed below, a number of factors affect whether these findings are transferable to other farms in the state, and whether investment in this composting technology will be feasible on a given farm.

<u>Default manure management costs:</u> The greatest determinant of whether composting is a cost-effective alternative is the farm's default manure management options. If a farm is able to regularly sell raw manure at a high price, and the cost of shipping it is not prohibitive, it will be more

challenging for composting to demonstrate cost effectiveness. Likewise, if a farm can use manure to fertilize its own cropland (while complying with nutrient management regulations), there is a reduced financial incentive to invest in composting technology. On the other hand, if the farm cannot use or does not need manure to fertilize its own crops, or if there is a weak local market for manure, composting will be a more financially compelling option, especially if there is a strong market for finished compost.

For all these reasons, manure composting technology is more likely to be cost effective for dairy and horse farms than for poultry operations. Poultry litter is relatively dry, light and easy to ship, and it has ready buyers. Dairy manure, on the other hand, does not enjoy as strong demand and it is more expensive to transport, even when there is demand. While farms can get cost share assistance via the state's Manure Transport Program, it still is not typically cost-effective to ship dairy manure long distances. Horse manure has low nutritive value and thus isn't in demand as fertilizer. For farms in areas with soils that are over-enriched with phosphorous (and thus subject to new, more rigorous state phosphorous regulations), composting might be especially cost effective, as it reduces manure's volume (meaning more can be stored in limited storage facilities) as well as its moisture content and weight (meaning it can be shipped at lower cost). In these cases, a composting system may prove more profitable than the next-best alternative of building additional manure storage facilities, which can cost $200,000 or more and still present manure management complications.[3]

Value of byproducts: Closely related to the previous factor is the price at which a farm is able to sell raw manure or compost. This varies by location and across nutrient compositions. In general, finished compost is more valuable than manure (selling for $10-18/ton compared to $2.50/ton),[4] because it is stable, pathogen-free, familiar to consumers, and has broader markets than raw manure, including landscaping and plant nursery applications. Further, as discussed above, compost is drier than raw manure and thus easier and cheaper to ship. However, the process of converting organic material into compost results in a 30 to 50 percent reduction in volume, so even though compost commands more per-pound, farmers would have a greater quantity to sell if the product was raw manure versus finished compost.

Capital costs and other sources of revenue: The capital cost of Glamour View's composting system was $69,900. Design, permitting, site prep and installation were an additional $134,099. As they are location-dependent, site prep costs may vary greatly depending on the available space and necessary infrastructure installation. Design and permit costs may vary as well, meaning that total capital expenditures to begin operations may be higher or lower. Further, a farmer's share of capital costs for a similar composting system could be reduced if this technology were to become eligible for financial assistance through the Maryland Agricultural Water Quality Cost Share Program, which subsidizes best management practices for water quality management on farms. There are currently about 30 approved BMPs through this program, including practices such as planting streamside buffers and installing waste treatment lagoons. Eligible farms can receive grants to cover up to 87.5% of the cost to install such conservation measures, with a total cap of $150,000 for non-manure BMPs and up to $450,000 if manure management BMPs are included.[5] Adding composting as an approved BMP under this program could defray installation costs and incentivize farmers to pursue this technology.

Regulatory drivers: Under Maryland's new Phosphorus Management Tool (PMT) regulations, farms with high soil phosphorous levels may be more strictly limited in applying manure to their land, and thus may have a stronger impetus to find alternative uses for the manure they produce. Most farms subject to this regulation are poultry producers in the Lower Eastern Shore counties of Somerset, Wicomico, and Worcester, where an estimated 30% of the land area is not required to use the PMT to manage phosphorous use, compared 79% for the state as a whole.[6] However, poultry litter is not ideal for composting because of its low moisture content, and further, composting only serves to *stabilize* phosphorus, not reduce its quantity, so it is unlikely that composting would be viable solution for such farms to comply with PMT (and, as mentioned above, strong demand for raw poultry litter means that poultry operations don't have a great incentive to pursue composting in the first place).

PMT might make a bigger difference for dairy farms that are subject to the regulations, or in regions where the new regulations apply to many farms because of widespread phosphorous over-enrichment. Restricted in how much manure can be field applied or sold to nearby farms (if they are also subject to PMT), these operations have two main alternatives: build more manure storage facilities and ship manure out of the region, or invest in alternative manure management systems such as composting system that changes the material's physical characteristics and may broaden available market uses.

Beyond PMT, farms statewide are subject to regulations that prohibit the application of any nutrient-containing material during winter months. MDA anticipates that more than 200 dairy farms across the state need additional manure storage capacity in order to comply with this rule; in total this will require more than $40 million in investments.[7] For farms that need additional storage, finding a way to reduce overall organic material volume – which composting does effectively – could be tremendously helpful.

A final policy driver affecting financial feasibility of composting projects on other Maryland farms is Maryland's Nutrient Trading Program and accompanying markets. If composting were to be designated an eligible generator of nutrient credits – and if the market were to start to see stepped-up trading activity – composting would represent a potential source of revenue for farmers.

<u>Private financing outlook:</u> Grant funding via the Animal Waste Technology Fund makes the Glamour View project financially feasible. If the farm had to take on a 25-year term private loan to finance the project with an interest rate above 1 percent, base scenario assumptions would not support the investment. Assuming the farm had sufficient cash on hand, and it did not need to acquire any debt to complete the project, the internal rate of return on the project (i.e., ~.012%) suggests the investment is not competitive with alternative investments the farm might make elsewhere in the economy. Moreover, for the farm to be cash positive for the duration of the project while taking on debt, it would need to secure a 25-year loan (assumed life of the system) for the entire cost of the system at an interest rate close to zero. Interest rates in the 1 – 1.5% range are currently available via MDA's Low Interest Loans for Agricultural Conservation program.

Yet it is important to note that even relatively small changes in assumptions – higher input to the composter, greater sale value for finished product, using compost to offset bedding – would make this project more realistic as a privately financed endeavor (see Scenarios A, B, and C, above). Similarly, lower capital costs – which could be achieved by constructing a simpler hoop house to contain the composter, for example – could improve the cost effectiveness of a similar project.

Conclusions

On-site manure composting reduces the volume of raw manure and stabilizes its nutrient content, producing a material that is easier and more cost effective to store, sell, and transport, and that typically commands a higher price than raw manure. For medium to large dairy operations facing significant manure management costs, and/or those subject to regulations limiting the application of raw manure, composting represents a potentially profitable alternative.

As applied on Glamour View Farm, however, the GMT compost project cannot be considered a cost-effective investment unless external costs are included. Namely, without the value-added to the farmer or to the public through the avoidance of field applying manure (the predominant alternative to composting), the simple payback on the investment is greater than the useful life of the technology.

Expanding the scope of analysis to consider broader transferability to other farms in the state, it appears the technology would be more feasible (not necessarily feasible) if: (1) The farm's default manure management strategy yields little revenue and/or incurs significant costs, as is likely to be the case for farms in areas with a weak or unstable manure market, such as horse farms statewide and dairy farms in areas subject to PMT regulations; (2) The finished compost can be sold as a soil amendment or used to offset bedding costs on the farm; (3) The farm is able to take advantage of subsidized interest rates via the Low Interest Loan for Agricultural Conservation to finance the project; or (4) The technology were to become eligible for cost share assistance via the Maryland Agricultural Water Quality Cost Share Program, or if it were to be designated an eligible generator of credits via the state's Nutrient Trading Program, which would compensate farmers for preventing raw manure from field application.

References

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[2] David Kann, Nutrient Consultant to Glamour View Farm. Interview with EFC, 7/1/16.

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