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Cost Estimates for Producing *Sargassum* spp. Compost[1]

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Objective Statement

The objective of this study was to provide insights to municipalities and small businesses who are considering starting composting operations using *Sargassum* as a feedstock.

Introduction

Sargassum spp. is one of the dominant forms of brown macroalgae (seaweed) found on beaches throughout Florida. The algae is pelagic—that is, free floating near the ocean surface—and naturally found floating in the ocean. When in mats in the ocean, it serves as habitat for fish and turtles and is protected. Accumulations of *Sargassum* spp. naturally wash up on the shores of Florida beaches. *Sargassum* spp. originates from two sources, the Sargasso Sea in the Northern Atlantic Ocean near Bermuda, and the great Atlantic Sargassum Belt (GASB). The growth of the large mats of *Sargassum* spp. is believed to be fueled by the global flow of nutrients with some pointing to the release of nutrients from the deforestation of the Amazon Rainforest as one cause for the sudden increase in *Sargassum* within the Caribbean (Wang et al. 2019). Recently, there have been large quantities of *Sargassum* spp. reported in the central Atlantic Ocean and the Caribbean Sea. During the summer of 2018 and 2019, record amounts of *Sargassum* spp. were documented along Florida beaches, resulting in local authorities hauling this seaweed to the nearest landfill (Parks, Recreation and Open Spaces 2021). Scientists believe that the amount of *Sargassum* spp. will increase as global temperatures continue to rise (United Nations 2020).

Figure 1. *Sargassum* spp.
Credits: Afeefa A. Abdool-Ghany, UF/IFAS

The Sargasso Sea, with its large mats of free-floating *Sargassum* spp., is a thriving ecosystem and provides a vital habit and food source for many marine species. Turtles use *Sargassum* spp. mats as a source of shelter and food since shrimp, crab, and fish are found in the floating algae. *Sargassum* spp. deposits on beaches are important in maintaining ecological balance. When excessive, however, the local ecology suffers and the aesthetics of the beach decline. In extreme conditions (when seaweed mats are too thick), turtles and dolphins are unable to surface and therefore drown (Atkin 2018). The thick mats also block sunlight from reaching seagrasses in shallow coastal waters. Once these thick mats make their way on shore, they begin to decompose and release hydrogen sulfide, which causes a foul odor (Atkin 2018; Langin 2018). Huge heaps of *Sargassum* spp. on the sand contribute to a decline in the aesthetic quality of Florida beaches and ultimately impact the tourism industry (CAST 2015). *Sargassum* spp. also attracts insects, such as sand flies, as it decomposes further

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degrading the aesthetic quality of beaches (Swinscoe et al. 2018).

One city in south Florida has successfully reduced the impacts from large amounts of *Sargassum* spp. on the beach by implementing a unique and sustainable practice of composting. Ft. Lauderdale, located in Broward County, has been composting *Sargassum* spp. for the past 15 years. They have fine-tuned the collection process to optimize beach ecology and aesthetics. It uses a beach raker pulled behind a tractor to first clean the beach (Figure 2, left and middle). The *Sargassum* spp. is then transported to a city park where it is dried and placed into a compost pile (Figure 2, right). Once dried, the *Sargassum* spp. is then passed through a shaker to remove any debris before it is used as compost by the city or given away to city residents.

Figure 2. Left, *Sargassum* spp. collection on Miami Beach, Florida with a surf rake; middle, *Sargassum* spp. collection at Key Biscayne; right, *Sargassum* spp. compost at the Ft. Lauderdale compost facility. Credits: Left: Trent Blare; middle and right: Afeefa A. Abdool-Ghany

This publication examines the costs that the city of Ft. Lauderdale incurred to establish their *Sargassum* compost facility. The objective of this analysis was to provide insights to municipalities and small businesses considering starting composting operations with the expectation that *Sargassum* composting will provide them with more space in their landfills while maintaining their beaches' tourist appeal. The data for this analysis was collected through interviews in 2021 with several individuals in municipalities and small businesses, which use a wide range of *Sargassum* management strategies. This publication is intended only as a guide to estimate the financial aspects of starting and operating a *Sargassum* composting operation.

Main Assumptions

Land

The cash overhead costs (e.g., insurance and taxes) of a *Sargassum* spp. composting operation were computed to be $200 per acre, based upon City of Ft. Lauderdale estimates. Non-cash overhead costs (e.g., land rent) are estimated to be about $500 per acre, estimated on the rental rate for farmland in southeast Florida (Blare et al. 2022). The cost to purchase farmland in Broward County is estimated to $3,360/acre (Land and Farm 2021). Thus, total fixed costs are estimated to be $700/acre. These values will change based on the location that is chosen for the *Sargassum* composting site.

Equipment

Operational Hours – The time that the city employees dedicate to cleaning the *Sargassum* on the beach (using a tractor to pull the surf rake and an 8 yd^3 truck) is 5 hours a day for a total of 1,825 hours per year (5 hours x 365 days). The bulldozer used to spread and turn the *Sargassum* at the composting site is used one hour a week or 4 hours a month.

Diesel Fuel Costs – The US Energy Information Administration (2021) estimated that the average cost of diesel from January 2021 to October 2021 was $3.20/gallon. Average fuel consumption (in gallons/hour) for farm tractors on a year-round basis without reference to any specific implement can also be estimated using the following equation (Edwards 2015):

0.044 × *Maximum PTO horspower*

We used this equation to estimate the average fuel consumption for the tractor, 8 yd^3 truck, and a bulldozer. We estimated that the tractor gas tank size was 50.2 gallons with a PTO of 92 hp (Easterlund 2016). We estimated the tank size for the 8 yd^3 truck to be 50 gallons with a gross horsepower of 300 (Ritchie Bros. 2018). The tank size for the bulldozer was assumed to be 69 gallons and net power of 130 horsepower (Caterpillar 2021). Once the fuel consumption was calculated, it was multiplied by the average price of diesel to get the per-hour fuel cost. Then, to determine the annual fuel cost, we multiplied the operational hours to per-hour fuel cost.

Equipment Costs – Two 8 yd^3 trucks are used by the city, but since half of the use was for *Sargassum* composting, while the other half was used for other projects around the city, one truck was used for the annual cost calculations. One bulldozer is used in the city to maintain the *Sargassum* pile for one hour a week. There are three tractors and surf rakes that are used in the collection of *Sargassum* off the beach. Three are used in case one breaks down and needs maintenance, or in case it's a heavy season. At most, there can be a total of two tractors and surf rakes used at a time to clean the beach, which would require a total of two people to operate. One shaker is used only when the compost produced is needed for a project. It allows for a more uniform product and removes larger debris pieces.

Table 1 breaks down the costs that are associated with the equipment used in the composting facility.

Maintenance Costs – The maintenance cost of the equipment in use is about 1% of the equipment cost (Edwards 2015).

Personnel

An employee earns an annual salary of $60,000. Employees collecting the *Sargassum* off the beach work from 6 AM to 11 AM, for a total of 5 hours each morning. As collection is done 7 days a week, a total of 35 hours a week are spent on *Sargassum* removal. There is one person who is tasked with maintaining the compost pile one day a week. They operate the bulldozer a maximum of one hour a week on the pile. *Sargassum* collection can be broken into peak (3 months/year or 12 weeks) and off-peak seasons (9 months/year or 36 weeks). Peak season for *Sargassum* takes place in May, June, and July, while off peak season takes place from January to April and August to December. When there is a modest to heavy amount of *Sargassum* on the shore, about four people work on the beach (two people operate tractors on the beach; two people driving trucks). The total person hours for the peak season would then be 1,680 hours (4 people × 12 weeks × 35 hours/week). During the off season, two people work on the beach (one operating the tractor and one driving the truck. The total person hours for the off season would be 2,520 hours (2 people × 36 weeks × 35 hours/week). Seaweed is collected seven days a week.

Cost Analysis

Table 2 shows the total value for each of the major cost categories of a *Sargassum* composting facility. The total annual cost to clean the beach and manage the *Sargassum* compost pile is $386,872. Figure 3 illustrates the share of each of the costs by category. Machinery costs (surf rake, tractor, 8 yd^3 truck, bulldozer, and shaker) are estimated to be 77% of the total cost, followed by personnel costs accounting for 23% of the total cost, and finally land costs which constitutes 0.18% of the total cost.

Equipment Costs– The breakdown of the major machines (Figure 4) involved in the composting operations are the 8 yd^3 truck (31%), tractor (29%), surf rake and bulldozer (each 18%), and shaker (4%).

Land Costs– Land costs account for 0.18% of the total cost.

Personnel Costs– Includes all the costs that are associated with labor and personnel that are needed to run the composting facility and represents 23% of the total cost.

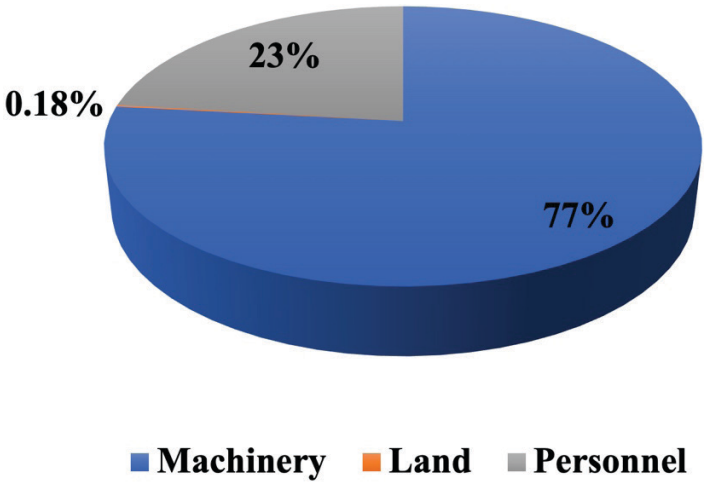

Figure 3. Division of annual costs associated with managing a *Sargassum* composting facility.
Credits: UF/IFAS

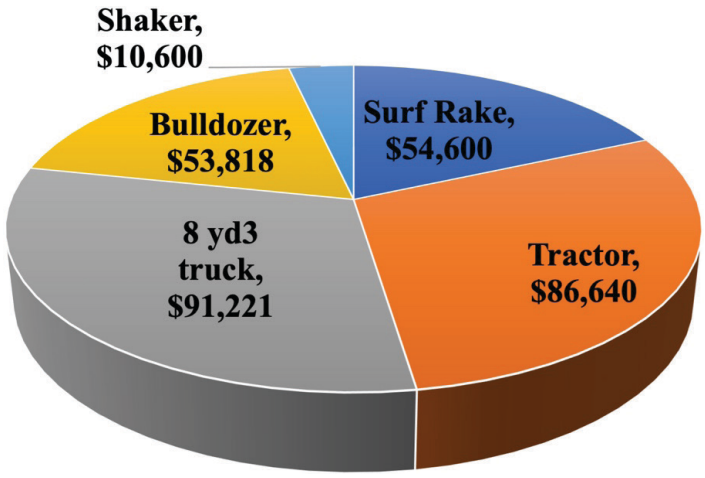

Figure 4. Division of annual cost to operate machinery at a *Sargassum* composting facility.
Credits: UF/IFAS

Conclusions

Because of the growing concern of *Sargassum* accumulation on the beaches of Florida, composting of this seaweed appears to be an attractive option for city and county governments that are tasked with keeping Florida's beaches in pristine condition. We estimated that the city of Ft. Lauderdale spends $386,872 annually to clean its beaches of *Sargassum* and maintain its compost pile. Equipment is the major investment to start a compost facility. Although the land allocation only accounts for 0.18% of the total cost to operate a *Sargassum* composting facility, according to three local governmental officials who were interviewed as part of this study, the availability and access to land, especially in increasingly urbanized southeast Florida, are the main constraints (University of Miami 2022). The land rental value used in this study was based on land zoned for agricultural purposes in southeast Florida and may not represent the value of land in heavily urbanized areas. Additional costs may need to be considered for local governments looking

to create a composting facility, such as the additional cost to transport *Sargassum* to an area farther away than the city of Ft. Lauderdale to access site-specific space for a compost pile. This budget is only meant to be a reference for city and county governments or other entities that are considering composting *Sargassum* to take into consideration when creating their own program.

Although the budget for *Sargassum* clean up and composting may seem large, it represents a cost savings from the alternative of collecting the *Sargassum* and disposing of it. Our analysis of the Ft. Lauderdale *Sargassum* composting project considered the entire cost to collect the seaweed on the beach and run the compost facility. However, the cost to clean the beach would be undertaken whether the city decided to compost the *Sargassum* or not. This would be a sunk cost, or a cost that would be incurred regardless of the disposal option used. The additional annual cost to run the compost pile totaled $78,118. This value includes $53,818 for the bulldozer, $10,600 for the shaker, $13,000 in personnel costs, and $700 for land. This value represents only 20% of the cost that the city of Ft. Lauderdale spends on its beach cleaning and composting program. The other 80% is spent on cleaning the beach.

Before Ft. Lauderdale started composting *Sargassum* in 2010, they spent $200,000 annually on disposal costs, which included the tipping fees and additional transportation costs to take the *Sargassum* to the landfill located farther away than the composting facility. In 2020, there were about 3,500 yd^3 of *Sargassum* collected and disposed of in the Village of Key Biscayne alone. As a comparison, Ft. Lauderdale collected 4,721 yd^3 in 2019. The Key Biscayne Village manager mentioned that the Village spent about $300,000 to dispose of *Sargassum* in 2020, or about $1,710 per 20 yd^3. Using this updated disposal cost, Ft. Lauderdale would have had to spend nearly $404,000 to dispose of its *Sargassum* in 2019, meaning the city saved around $326,000 by using a compost facility, which was estimated to cost $78,118 to run, rather than disposing of the *Sargassum* in a landfill.

Composting not only allows these entities to save on the disposal costs but also permits them to create a useful product that has the potential to be used by these entities to offset landscaping costs by substituting *Sargassum* compost for soil. The city of Ft. Lauderdale estimates an additional savings between $2,000 and $3,000 per year in soil costs, as it uses the *Sargassum* compost for fill dirt in its parks and roadways. There is also potential to market the product to be used by local homeowners, landscaping providers, and growers. Future research in estimating the value of *Sargassum* compost based on its nutrient content compared to similar products on the market would provide insight into the potential to sell *Sargassum* compost to help offset some of the beach cleanup and composting costs. However, more research is needed to understand the safety of using *Sargassum* compost in orchards or vegetable gardens before such markets can be fully established, as the level of arsenic and other heavy metals in this compost is unknown. Before starting a *Sargassum* composting facility, businesses and municipalities should check local permit requirements. *Sargassum* quality should be checked to confirm that it meets local regulatory guidelines, inclusive of levels of heavy metals, in particular arsenic.

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Table 1. Equipment costs associated with a *Sargassum* composting facility.

Item	Number of Units	Value of Equipment ($)	Useful Life (years)	Annual cost of Equipment ($)	Cost of Diesel ($/gal)	Average Diesel Fuel cost ($/hour)	Operation (hours)	Annual Fuel cost ($)	Maintenance Cost (per unit)	Total maintenance cost ($)	Total Annual Cost ($)
Surf rake [a]	3	70,000	4	52,500	N/A	N/A	N/A	N/A	700	2,100	54,600
Tractor [b]	3	100,000	5	60,000	3.20	12.95	1825	23,640	1,000	3,000	86,640
8 yd^3 truck [c]	1	80,000	6	13,333	3.20	42.24	1825	77,088	800	800	91,221
Bulldozer [d]	1	250,000	5	50,000	3.20	18.30	72	1,318	2,500	2,500	53,818
Shaker [e]	1	60,000	6	10,000	N/A	N/A	N/A	N/A	600	600	10,600

N/A- information was not available or was not used to compute the final cost.
Cost of insurance for each piece of equipment was not included since the government institutions are self-insured.
[a] Surf rake is maintained 2 times a year.
[b] Tractor is maintained every 100 hours.
[c] 8 yd3 truck is maintained 3 times a year.
[d] Bulldozer is maintained 3 times a year.
[e] Shaker is maintained one time a year.

Table 2. Annual cost structure for a *Sargassum* composting facility.

Item	Value ($)
Land	700
Machinery	296,880
Personnel	89,292
Total	386,872