



The Future of Clemson Organics Recovery



Table of Contents

I.	Introduction	3
II.	Education	4
III.	Innovation	5
IV.	Sustainability	8
V.	Future Opportunities.....	12
VI.	Conclusion	13



I. Introduction

Clemson Organics Recovery's dedication to education, innovation, and sustainability has made it a leading compost program in the southeast. Clemson's program began as a student initiative and has expanded into a multi-departmental effort to capture organic waste from dining halls, sports arenas, academic buildings, and student housing. The program offers valuable industry-level learning opportunities to students and other community members and is a resource for colleges and universities looking to start or improve their yard and food waste recycling program. Education, innovation, and sustainability are core values of Clemson's program and are vital to its continued success.

Clemson's composting facility, Cherry Crossing Research Center, is both a test bed for new ideas and an established facility that is defining best practices for university composting. The scale and management structure of universities, like Clemson, can control the type of materials collected and the way they are processed, which offers a unique opportunity to capture and repurpose large amounts of organic waste.

During the fall semester of 2019, Clemson University collected and composted approximately 635,000 pounds of compostable products such as food waste, paper towels, and compostable wares. Diverting organic waste from landfill reduces Clemson's environmental footprint while providing economic and social benefits to the university and surrounding community.

Clemson Organics Recovery is seeking partnerships with industry, universities, and faculty or student research projects to expedite the expansion and advancement of Clemson's program into a new facility that can accommodate post-consumer collections and provide a broader range of outreach and education services. Partners would have an opportunity to collaborate with Clemson's composting team and utilize Cherry Crossing's resources to test new ideas and technology.



II. Education

Clemson Organics Recovery's emphasis on education and student involvement is an extension of its roots as a student-based research initiative. Clemson's composting program began in 2010-2011 as a multi-departmental Creative Inquiry (CI) involving graduate and undergraduate students that sought to practice composting firsthand. That CI and many similar projects have grown the program into what it is today. CIs remain an important part of Clemson's program as students research and develop projects like biodiesel, black soldier fly larvae, food waste reduction and recovery, and more. In addition to CIs, Organics Recovery partners with career services on campus to employ student interns. These interns come away from their internship with industry-level experience in compost program development and operations, and they become advocates of the program within the student body. Interns help connect the community to composting in their time as a student and beyond.

The composting program is integrated with student organizations on campus, including EcoReps in residence halls, Tigers for Green Innovation, Solid Green Club, and Undergraduate Student Government. Students from these groups promote composting and sustainability to the students at Clemson and run pilots and programs that expand Organics Recovery's reach at the university.

Clemson Organics Recovery engages the student body, faculty, staff, and the greater community through outreach initiatives and by participating in organizations, webinars, and conferences. Members of the Clemson team are part of the Green Sports Alliance, the College and University Recycling Coalition (CURC), the Carolina Recycling Association (CRA) and the US Composting Council and have presented at affiliated conferences. The composting team is always eager to share their lessons learned to help others succeed. Clemson Organics Recovery sets an example that other universities can follow.



III. Innovation

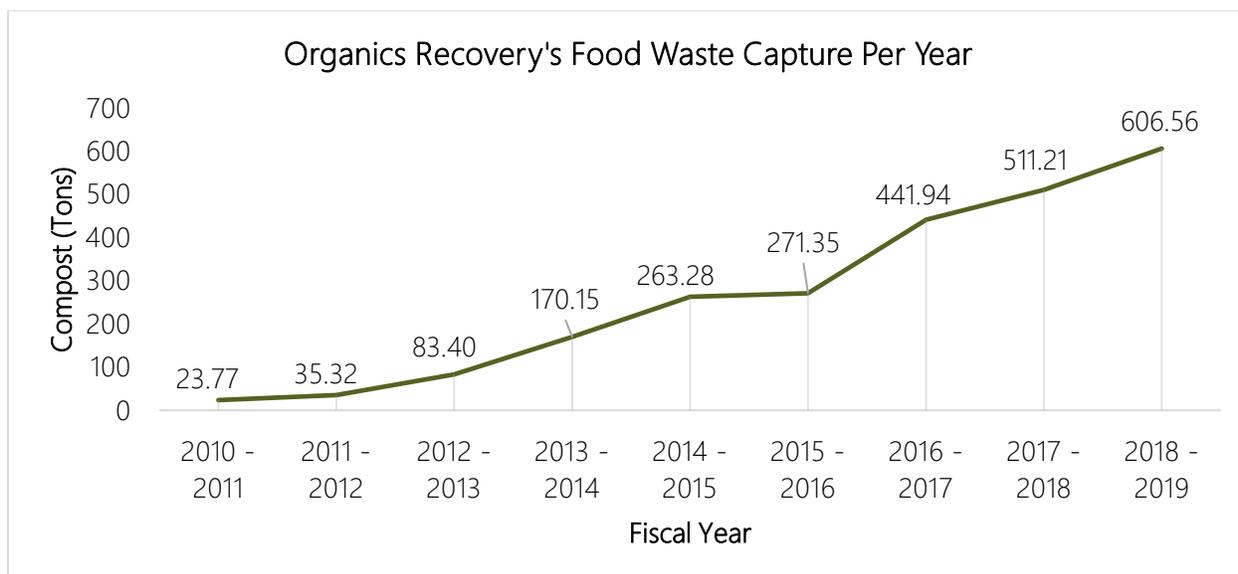
The evolution of Clemson Composting's operations reflects the composting team's resourcefulness and innovation. Clemson's composting team, including Creative Inquiry and internship students, has created a program from the ground up with limited resources by using knowledge gathered through research, trial, and lessons learned from successful composting operations.

The 2010-2011 CI team received a grant from the S.C. Department of Health and Environmental Control and used it to fund an in-vessel composter. An in-vessel composter is a large, barrel-shaped container that automatically rotates to aerate organic material and facilitate its decomposition into compost. The in-vessel method was chosen because regulating variables like temperature, moisture, and oxygen was easy, and the composting process required minimal management. The in-vessel composter's 3 yard per day capacity worked well initially, but as the participation outpaced processing capabilities in 2012-2013 the composting team realized a new method was needed and introduced the turned windrow method.

Clemson's team applied what they learned about composting using the in-vessel to the new methodology. In the turned windrow method, large piles of nitrogen and carbon rich feedstocks are mixed and allowed to decompose. The piles are separated by stages of the decomposition process and are turned periodically using a skid-steer to maintain oxygen and moisture levels. Cherry Crossing transitioned operations to a concrete pad large enough to house and turn the piles, and the program doubled its output over the next two years as a result of the added capacity and expanded collections to include more dining areas such as retail locations and coffee shops (see Figure 1).



Figure 1: Clemson Organics Recovery's Food Waste Capture Per Year (Tons)



Cherry Crossing Research Center is an established composting facility that is defining best practices for university composting. The program now collects back of house organics from all the campus dining halls, paper towels in select academic and housing buildings, and food waste from football and other events. Approximately 606 tons of compostable products were collected and composted between July 2018 and June 2019.

Being a university has given Clemson's program the flexibility to experiment and adapt. The scale and management structure of the composting program within the university makes it possible to consider the full life cycle of the organics and compostable products from purchasing through to the finished product. The compost collection and processing can be closely monitored. The team can fully understand the waste streams and contamination levels and where the material is coming from, and that information can be relayed back to other team members and upstream parties like dining services. This communication is invaluable because it closes the loop, increases transparency, and allows stakeholders to understand the impact of changes on the system.

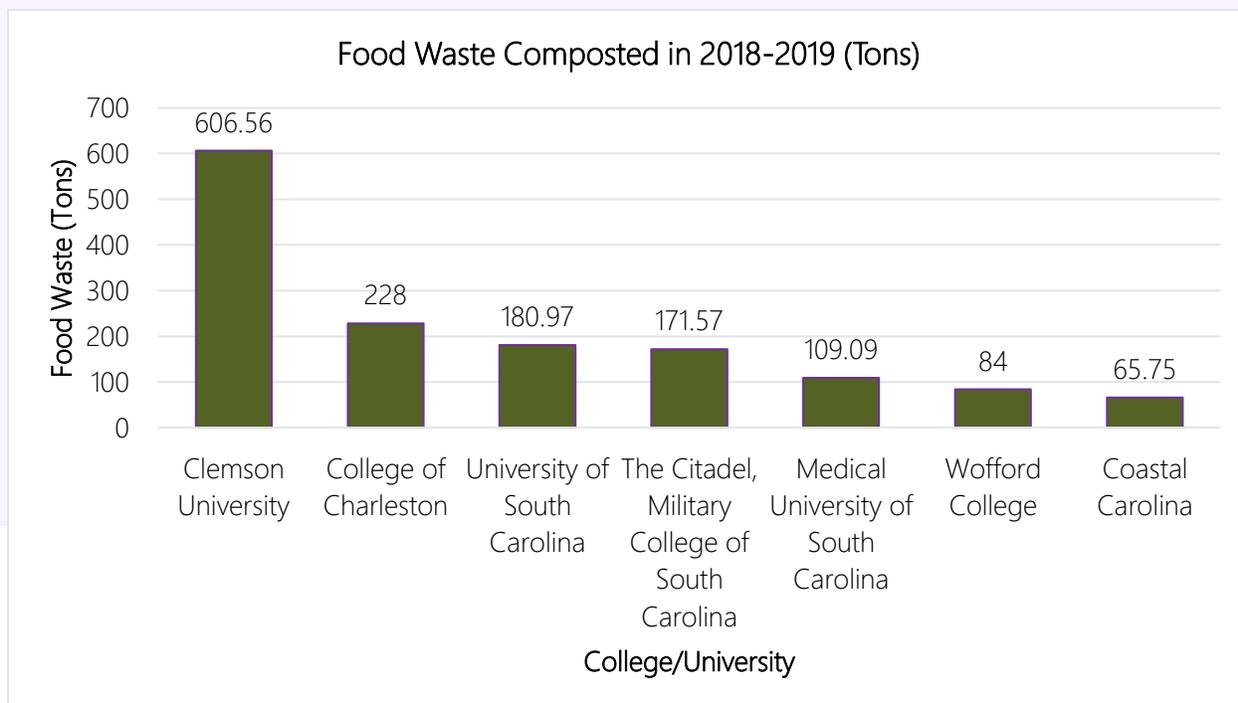
Clemson's program is willing to accommodate feedstock with a greater contamination rate than commercial composters and adjust processing accordingly. The team can hand-sort material as it comes in, which allows the program to run pilots and test compostable materials with minimal consequence. The turned static pile process is one of several methods used for



composting at Cherry Crossing. Other methods include in-vessel, vermicomposting, black soldier fly larvae, and aerated static pile. These methods are used for special use cases and educational demonstration. For example, Clemson was able to handle contaminated material from a zero-waste picnic without losing compost value by processing the picnic waste separately from the everyday compost streams by using the in-vessel and black soldier fly larvae.

Systems understanding and communication have largely contributed to Clemson Organics Recovery's success, and Clemson has become an established leader in composting in the Southeast. As shown in Figure 2, Clemson composts more than the next three universities and colleges in South Carolina combined. Pickens County, the home of the university, ranks number three in food waste recycling in South Carolina without any commercial composters because of Clemson's contribution. Clemson Organics Recovery is proud of what it has accomplished so far and will continue to explore new avenues for education, innovation, and sustainability moving forward.

Figure 2: Food Waste Composted in FY 2018-2019 (Tons)



Based on data provided by SC DHEC



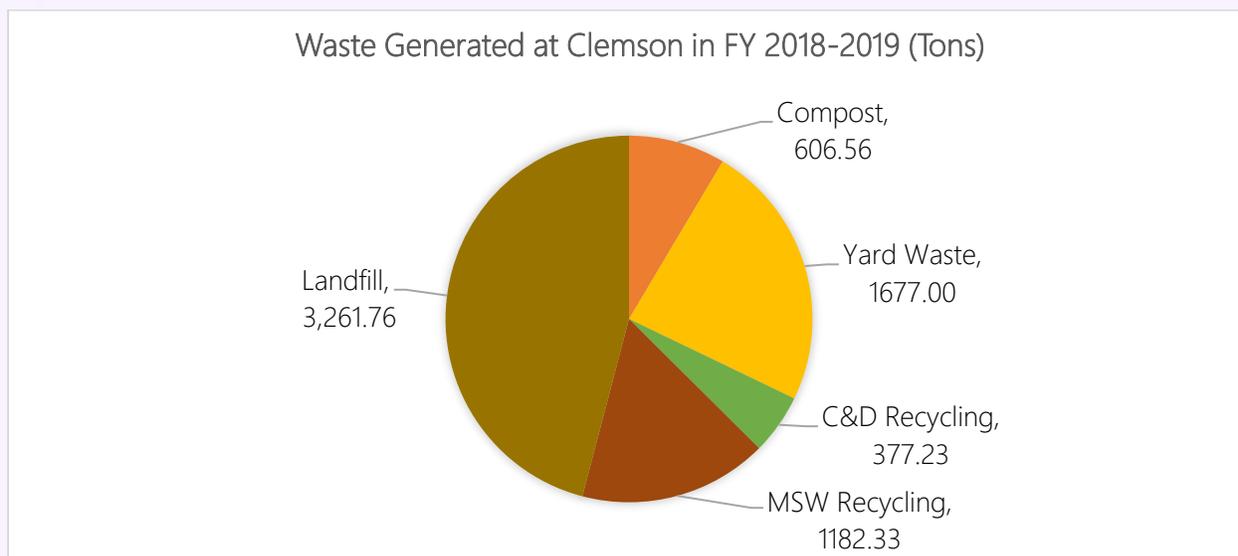
IV. Sustainability

Clemson evaluates the environmental, economic, and social aspects of sustainability when designing programs and maintaining operations. Composting at Clemson has triple bottom line benefits for the university and the greater Clemson community.

Environmental benefits

Composting is an excellent alternative to reduce landfill volumes (United Nations, 2019). In South Carolina, food and yard trimming waste represent about 30% of landfill (South Carolina DHEC, 2019). At Clemson, food waste and yard trimmings totaled 35% of the municipal solid waste produced in 2018-2019, which equated to 607 tons of food waste and 1677 tons of yard waste diverted from landfill (Figure 3).

Figure 3: Waste Generated at Clemson in FY 2018-2019 (Tons)



Compost usage reduces the need for fertilizer, pesticides, and water (South Carolina DHEC, 2019) through replenishing organic material and nutrients, as well as promoting healthy microbial growth. Clemson affiliated groups use Clemson compost for soil amendment in a variety of ways, ranging from ornamental and lawn care to crop or orchard production (see Figure 4).



Figure 4: Chart of Compost Usage by Campus Entities FY 2018-2019

<i>Clemson Department/Organization</i>	<i>Approximate Yards of Compost Used</i>
CU Facilities and Landscaping	100
Student Organic Farm	60
Musser Fruit Research Farm	40
SC Botanical Garden	20
Local Community	150
Donation for projects or research	100
<i>Total</i>	<i>470</i>

Economic benefits

The process of composting takes organic waste normally destined for a landfill and transforms it into a value-added product which can then be sold or used for cost avoidance. Clemson compost is sold to the local public by the yard, the majority of whom are staff or faculty utilizing it for their own personal garden plots. The revenue helps offset some of the cost of maintaining the program. There is potential for growth in this aspect of the program – selling by the yard limits the customer base because many people do not require that volume of compost for their landscaping.

Diverting organic waste to Clemson’s composting program provides a valuable cost savings by avoiding landfill costs. The cost to landfill municipal solid waste for Clemson University averages between \$115-125 per ton over the last 3 years. The cost includes labor, transportation, and tipping fees. In 2018-2019, the 610 tons of compostable material diverted from landfill equated to a cost savings of up to \$76,000 for the year (does not include landscaping debris). From 2010-2019, the total food waste diverted was 2,362 tons, approximately \$272,000.

Composting is also a cost avoidance for landscaping and other groups who do not have to pay to dispose of yard waste, and who use compost as soil amendment in place of purchasing fertilizer. In 2018-2019, 1677 tons of yard waste were diverted from landfill, which was a savings of up to \$209,600 for the year.



Social benefits

Organics Recovery helps support a sustainable Clemson area community. The composting program is part of the local material cycle - it provides a service that diverts waste from the local landfill. This decreases the negative impacts on adjacent communities and generates a useful product to positively affect the wellbeing of the local area.

Clemson University's compost facility is an education platform for Clemson affiliates and the local community to learn about composting and agriculture. Students can get involved through classes, volunteering programs, and internships. Students are involved with the compost program in their day-to-day lives when they put their plates on the dish line at the dining hall and when they collect their food waste and bring it to the recycling center. Community members can tour Cherry Crossing and participate in programs like the Organic Farm's crop share. Organics Recovery is part of the community functionally and educationally.

Clemson's current partnerships with on campus entities, like Aramark dining services, and off campus entities, like Atlas Organics, play a crucial role in the program's integration into the campus and community.

Aramark – Clemson Dining

Aramark manages the food services for Clemson University. Aramark uses compostable items where possible for to-go services and coordinates with Organics Recovery for collections of compostable items and food scraps at dining halls, events, and athletic facilities. In the 2019-2020 school year, over 333 tons of food was captured and composted from the dining halls on campus.

Student Organic Farm

Clemson University has an organic farm which is an educational small-scale platform for students. At the farm, Clemson compost is used for soil amendment instead of traditional synthetic fertilizers and pesticides.



Musser Fruit Research Farm

Clemson's Musser Fruit Research Farm composts their fruit waste through Clemson's composting program, and in turn receives compost for the farm usage and long-term efficacy experimentation.

SC Botanical Gardens

The South Carolina Botanical Garden is a diverse 295-acre garden. The Gardens use Clemson compost as potting soil amendment or ornamental garden soil amendment, and partner on community outreach projects.

Clemson Landscaping

Clemson composting's primary source of carbon feedstock comes from campus landscaping. Coupling organic recovery with landscaping services has been crucial to the success of both programs in terms of cost savings and a secure and consistent carbon feedstock needed for organic waste processing.

Atlas Organics

Atlas Organics, a commercial composter founded by a Clemson alumnus, leases the trommel (used to sift finished compost) from the University. Atlas helped Clemson innovate the aerated static pile method, which served as a proof of concept for Atlas Organics to receive approval from Greenville County to begin their commercial processes on a larger scale.

Sonoco FRESH

The mission of Sonoco FRESH is to have a major impact on the reduction of food waste and examine the concepts of safe, secure, and sustainable packaging. FRESH looks at the food lifecycle holistically and identifies opportunities to reimagine processes, sciences, technologies, and behaviors for the greater good of society. Sonoco FRESH is a large part of the food waste reduction Creative Inquiry, and the sustainable packaging Creative Inquiry that will begin fall 2020.



V. Future Opportunities

Clemson is continuously looking to collaborate with new partners and is open to all opportunities. Clemson Organic Recovery is committed to maintaining its excellence in service to the operational needs of the university as the university grows, and partnerships will ease and expedite the process.

The vision for the future of the program is to procure a new site and develop a larger, more efficient facility with data integration. Improved data collection and controls will open doors for greater technical research opportunities and more precise operational management. A larger, more efficient facility would allow the university to process more material as it grows and expand capture into front of house or post-consumer collections.

Increased volumes of material will require a more comprehensive solution for the finished compost; using the compost in landscaping and selling it by the yard to local community members will not be enough to move the volume of compost that will be created. One possible solution is to use a soil bagging system to create bags of compost in volumes that are more accessible to the general public than bulk yard purchasing.

Regarding education and outreach, the program is planning to host tours, workshops, and trainings at the composting facility and grow its on campus educational presence through digital media and participation at in person events.

If you are interested in partnering with Clemson Organics Recovery on these or other projects, please contact recycle@clermson.edu.



VI. Conclusion

The Clemson Organics Recovery program is centered around education, innovation, and sustainability and will continue operating with those values for future endeavors. The program is an integral part of the university and surrounding community; it offers environmental, economic, and social benefits through waste and cost diversion, education, and contributing to local agriculture and ecology. Current and new partnerships are vital to growing the program, conducting research, and expanding into new territory.

Clemson's program has come far since it began in 2010 – it is exciting to see what the next 10 years will bring.



Special Thanks to:

Adah Gorton, Office of Solid Waste Reduction & Recycling, SC DHEC

David 'Buddy' Haines, Composting Operations Manager 2016 – present, Clemson University

Tom Jones, Director of Lean Processes, Clemson University

Jacob Kiser, Recycling Supervisor, Clemson University

Matthew Lawrence, Organics Recovery Intern, Clemson University

Jared Montgomery, Organics Recovery Intern, Clemson University

Brittany Morra, Recycling Coordinator, Clemson University

Gary Nihart, Founder, Atlas Organics

Leah Powley, Aramark Sustainability Director, Clemson University

Ana Romero, Graduate Research Assistant, PhD Candidate, Sonoco FRESH

David Thornton, Composting Operations Manager 2010-2016, Clemson University

Dave VanDeventer, Solid Waste Manager, Clemson University

and all who contribute to Clemson Organics Recovery.



References

Chowdhury, A. K. M. M. B., Konstantinou, F., Damati, A., Akratos, C. S., Vlastos, D., Tekerlekopoulou, A. G., & Vayenas, D. V. (2015). Is physicochemical evaluation enough to characterize olive mill waste compost as soil amendment? The case of genotoxicity and cytotoxicity evaluation. *Journal of Cleaner Production*, 93, 94-102.

EPA (United States Environmental Protection Agency). (2019). Composting at home. <https://www.epa.gov/recycle/composting-home> Accessed June 11 2020.

Ghosh, P., Thakur, I. S., & Kaushik, A. (2017). Bioassays for toxicological risk assessment of landfill leachate: A review. *Ecotoxicology and Environmental Safety*, 141, 259-270.

Hermann, B. G., Debeer, L., De Wilde, B., Blok, K., & Patel, M. K. (2011). To compost or not to compost: Carbon and energy footprints of biodegradable materials' waste treatment. *Polymer Degradation and Stability*, 96(6), 1159-1171.

Meyer-Kohlstock, D., Hädrich, G., Bidlingmaier, W., & Kraft, E. (2013). The value of composting in Germany—Economy, ecology, and legislation. *Waste Management*, 33(3), 536-539.

Onwosi, C. O., Igbokwe, V. C., Odimba, J. N., Eke, I. E., Nwankwoala, M. O., Iroh, I. N., & Ezeogu, L. I. (2017). Composting technology in waste stabilization: on the methods, challenges and future prospects. *Journal of Environmental Management*, 190, 140-157.

South Carolina DHEC (South Carolina Department of Health and Environmental Control). (2019). Composting: Recycling Naturally <https://scdhec.gov/environment/recycling-waste-reduction/composting-recycling-naturally> Accessed June 11 2020

Traversa, A., Loffredo, E., Gattullo, C. E., & Senesi, N. (2010). Water-extractable organic matter of different composts: A comparative study of properties and allelochemical effects on horticultural plants. *Geoderma*, 156(3-4), 287-292.

United Nations. (2019). Waste Not, Want Not. <https://www.unenvironment.org/resources/report/waste-not-want-not-reducing-food-loss-and-waste-north-america-through-life-cycle> Accessed May 30 2020

University of Louisville (n.d.). Organics Recovery Program Development Tool for Colleges and Universities <https://louisville.edu/cepm/pdf-files/organics-development-tool> Accessed July 1 2020.

US Compost Council. (2016). A Guide to Workplace Composting. <https://www.compostingcouncil.org/general/custom.asp?page=WorkplaceComposting> Accessed June 25 2020.

USDA (United States Department of Agriculture (2019). Composting: Nature's Way of Recycling Organic Materials <https://www.ars.usda.gov/oc/br/compost/index/#:~:text=Why%20Compost%3F,%2C%20food%20waste%2C%20and%20manure.&text=For%20example%2C%20compost%20enhances%20rainfall,water%20runoff%20and%20soil%20erosion.> Accessed June 11 2020.