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Although single-use plastics are essential for certain experiments, some scientists are striving to reduce such waste.

DIY APPROACHES TO SUSTAINABLE SCIENCE

Research labs are huge producers of plastic waste, but scientists are becoming increasingly aware of their environmental footprint. **By Jyoti Madhusoodanan**

As a postdoctoral researcher, Cristina Azevedo went through single-use plastic tubes by the hundreds. The University College London biochemist was culturing yeast in Falcon tubes, and the thought of all that plastic waste was like an itch she couldn't scratch — especially when she recalled her PhD research, in which she grew bacteria in reusable glass flasks. "My own work was bothering me, and all around I could see the amount of plastic just being thrown out because of the need for sterility," she says.

She's not alone. Scientists are increasingly aware of the disproportionate environmental footprint of their research. Academic research facilities consume three to six times as much energy as commercial buildings, much of that due to refrigeration and ventilation systems. These facilities are also outsized producers of plastic waste — an issue that has become particularly acute since 2017, when China stopped accepting several types of plastic for recycling from the United States and Europe, causing more recyclable waste to be piled into local landfills.

At the institutional level, many facilities are stepping up, implementing better waste-management practices and seeking out greener energy sources. University College London, for example, is striving to be rid of single-use plastics by 2024 and to be carbon-neutral by 2030. Not all of these efforts will translate easily to individual laboratories, where ultracold freezers and single-use plastic pipette tips remain necessary for certain sensitive experiments. But when it comes to most standard bench science, little changes can go a long way.

Leeba Ann Chacko, junior research fellow at the Indian Institute of Science in Bengaluru, is another yeast researcher who reduced her plastic consumption by switching to glass Petri dishes to grow her microbes. Instead of a large bag of waste each week, she now generates only a few hundred grams. "Starting out, I was worried about contamination and the expense," Chacko says. "But it was a quick transition and left me wondering why we hadn't done this earlier."

Beyond reducing researchers' environmental impact, such efforts can help to make their funding go further. And there are more intangible benefits, including greater reproducibility and career perks. Azevedo's sustainability work helped her CV to stand out when she applied for her current position as director of the private non-profit association InnovPlantProtect in Elvas, Portugal, for instance.

Plus, sustainability is simply responsible

science, these researchers say. "We're being funded by public money," Azevedo says. "We have a social responsibility to think about the environment and the planet's future when using that money."

Starting small

Mechanical engineer Dan Preston of Rice University in Houston, Texas, was drawn into lab energy savings during his undergraduate years, thanks to a part-time job with the Alabama Industrial Assessment Center in Tuscaloosa, where he worked with researchers who offered energy-saving recommendations to local factories.

As a postdoctoral researcher at the Massachusetts Institute of Technology (MIT) in Cambridge, he got the chance to put that knowledge into action. Preston's research relied heavily on handling chemicals in a fume cupboard. He noticed that the sash window on the cupboard was frequently left open, which wasted energy by leaving the ventilation running, and wondered if he could engineer a simple solution. He and his colleagues entered a competition sponsored by MIT Green Labs, a programme in the environmental health and safety office that helps departments and labs across campus to operate in sustainable ways. They won around US$5,000 to develop a simple, unobtrusive sensor, which they named the motion and sash height (MASH) alarm, that alerts users if a sash is left open. He and his team also set up the Lab Energy Assessment Center (LEAC) to evaluate labs and offer energy-saving recommendations.

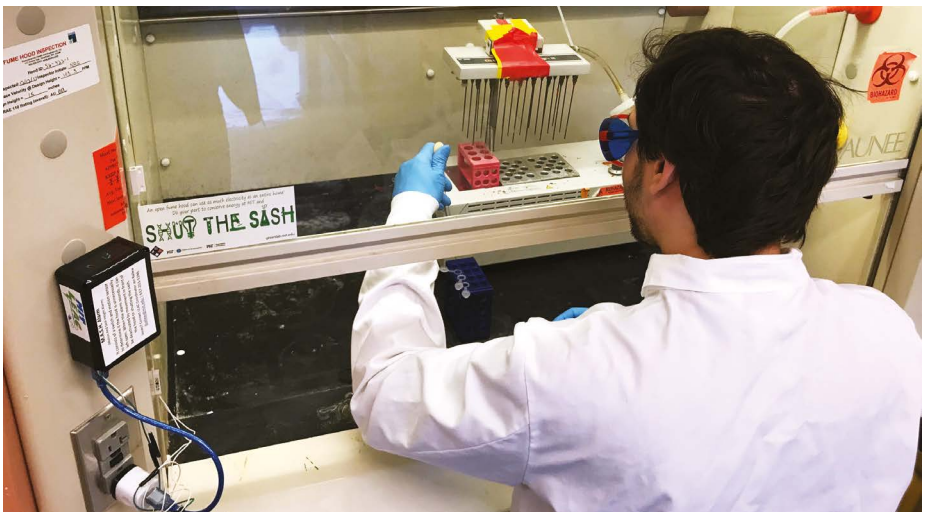
One MIT lab, for instance, was spending about $30,000 on electricity and releasing 163 tonnes of carbon dioxide per year, the LEAC team estimated. By increasing freezer temperatures from −80 to −70 °C, replacing overhead lights with LED bulbs and turning off one fume cupboard, the lab could reduce energy usage by 8% and save around 13 tonnes of CO_2 and $2,500 annually. "Many were surprised by the impact of these small changes," Preston says.

University funding can provide another avenue to support sustainability. David Waterman and Brenda Lemos were molecular and cell biology graduate students at Brandeis University in Waltham, Massachusetts, in 2017, when China announced it would no longer accept plastic waste from the United States and Europe. The two put together a business proposal for a recycling firm and defended it in front of a panel of venture capitalists as part of a programme called SPROUT, a university award to support student entrepreneurs. The resulting financial support and mentorship allowed the team to launch GreenLabs Recycling, a company that recycles the plastic boxes used to store single-use pipette tips.

Defending a proposal to launch a business felt like the opposite of a thesis defence, "where you're the world's expert on the research material", Waterman recalls. "I found it much more stressful, but you do leverage the soft skills of a PhD, such as how to convincingly tell a story."

GreenLabs Recycling now has 16 customers in the Boston area, and receives roughly 1,400 kilograms of plastic pipette-tip boxes per week. Researchers often ask how they can use the company's services, but Lemos explains that researchers and firms first need to interact with their facilities managers to address the issue. "Although we as scientists are aware of the lack of recycling in science, facilities managers are less familiar with the problem," Lemos says. "So there's an initial disconnect when you're trying to get people to pay for recycling."

Preston and his colleagues, supported by MIT's environmental health and safety office, expanded LEAC to increase the number of labs it evaluated. The team also made MASH assembly instructions open-access, so anyone can build their own alarm system for about $50. Working with undergraduate students is a big part of LEAC's efforts, Preston says. "We think of it as saving energy, but also as inspiring and educating the next generation of energy-conscious researchers."



MIT ENVIRONMENT, HEALTH & SAFETY OFFICE

An energy-saving alarm (shown left) signals when a fume cupboard is left open.

> **"Sustainability is simply responsible science."**

Every step counts

Even researchers without the support or funding needed for such large-scale efforts can make a difference to their own lab's energy footprint, according to Kathryn Ramirez-Aguilar, programme manager for the green labs scheme at the University of Colorado Boulder. One simple way is to share equipment.

At her university, departments and groups of researchers began that process informally, with each lab sharing an under-utilized instrument. Some have formalized these arrangements by hiring managers to maintain shared instruments, and creating memoranda of understanding for users. The arrangements conserve research dollars and help users to share expertise on making the most of various instruments, which are housed in individual labs or a common area. They also conserve lab space, which tends to be the most expensive, energy-intensive space on campuses. "Can you imagine the impact if we didn't have to build a whole other lab building, simply because we were using our space more efficiently?" Ramirez-Aguilar says.

That impact could extend to scientific reproducibility and efficiency by reducing the need to repeat failed experiments, argues Martin Farley, University College London's sustainable-labs adviser. "Research requires an immense investment of energy and materials, and the data generated represents an investment of those materials," he says. "Any way that we can promote better use of the data, or techniques that reduce error and repetition, are going to be more sustainable."

Plus, shared instruments are likely to be better maintained than equipment in an individual lab, Farley adds. Researchers with these facilities "get better support around experimental design, and they understand better what the equipment can actually do", he says.

The bottom line is: when it comes to sustainability, individual researchers can make a difference. And every little bit helps. "Whether you choose to champion sustainability in your own lab or whether you want to work with many different labs through something like LEAC, it takes both to implement real change," Preston says. "You can have a huge impact either way."

Jyoti Madhusoodanan is a science writer based in Portland, Oregon.

Correction

This Technology Feature gave the wrong current affiliation for Cristina Azevedo. She is director of the biopesticides department at the private non-profit association InnovPlantProtect in Elvas, Portugal.