Growing Food in the Future:

New MSU laboratory provides opportunity to explore vertical farming

BY HOLLY WHETSTONE, EDITOR

IT'S NEARLY IMPOSSIBLE TO WALK BY THE NEW CONTROLLED-ENVIRONMENT LIGHTING LABORATORY (CELL) IN THE PLANT AND SOIL SCIENCES BUILDING ON THE CAMPUS OF MICHIGAN STATE UNIVERSITY (MSU) WITHOUT PEEKING INSIDE. FLASHY STREAMS OF COLORFUL LIGHT BEAM INTO THE HALLWAY BECKONING PASSERSBY TO LOOK IN THROUGH THE WINDOWS ON WHAT COULD ARGUABLY BE THE MOST HEALTHY-LOOKING LETTUCE AND KALE AROUND.

Photos by Derrick Turner, MSU Communications and Brand Strategy

The unique space is the first of its kind allowing MSU faculty, staff and students an opportunity to study vertical farming – the practice of growing food and other specialty crops in vertically stacked layers or vertically inclined surfaces as well as integrating crop production in other structures.

Erik Runkle, professor in the MSU Department of Horticulture, developed CELL to:

- Conduct research on controlled-environment production of high-value specialty food crops, such as leafy greens and herbs, along with ornamental plants, such as seedlings and cuttings.
- Demonstrate indoor growing systems to inform growers and capture the interest of students and the public.
- Provide teaching applications for undergraduates enrolled in relevant horticulture production courses.

The laboratory consists of two independently controlled and refrigerated growth rooms filled with stacked shelves of plants grown hydroponically – meaning recirculated water, no soil. State-of-the-art light-emitting diodes (LEDs) developed in collaboration with OSRAM and OSRAM Opto Semiconductors allow for alterations of light quality and intensity.

Runkle said research conducted in CELL focuses on lighting to produce crops with desired traits such as leaf size, texture, thickness and color, as well as taste and nutritional content. Since vertical farming is a relatively new way of growing food crops and other plants indoors, Runkle said the setup of the lab where those in the hallway can look in on the plants has helped spark interest in the subject matter.

"Vertical farming is potentially suitable for crops that are produced quickly, have high value, are perishable, are small and have a large harvestable index," said Runkle. "This includes leafy greens (such as lettuce, arugula and kale) and herbs (such as basil and mint), as well as ornamental transplants for the floriculture industry and field transplants for the vegetable industry."

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"Indoor farming is not appropriate for agronomic crops, which are comparatively large, have long production cycles, have high light demands, and only a small part of the plant is typically harvested."

CELL is a place where Qingwu (William) Meng, one of Runkle's doctoral students, spends much time. A strong advocate for science communication, Meng said he believes that this lab layout – easily viewed and accessible – can help with the public's acceptance of new technologies and scientific advancements, such as vertical farming.

"Vertical farming has only recently started to scale up," he said. "It's a small fraction of agriculture in the U.S. and globally. As a result, it hasn't contributed a lot to the whole economy these days. But, we'll have to feed 2 billion more people in the next 30 years. We really need to think about alternative ways of growing food and providing food to people in need."

Vertical farming is a way to supplement food production, especially in large cities where land is limited and where some are willing to pay more for fresh, local produce all year round. The concept is not that new; it's been around for a few decades in Japan, where indoor farms are referred to as "plant factories." However, the industry is only beginning to emerge in the U.S., where people increasingly want locally sourced, healthy and fresh food.

"It's difficult to get fresh lettuce in Michigan during the winter," Meng said. "We're reliant on lettuce produced in California and Arizona so by the time the plant gets to us, it may have already spent several days in trucks. It's lost some of its visual appeal and nutritional value. It also doesn't taste as good anymore."

SHINING THE LIGHT ON RESEARCH

Runkle and Meng are researching the impact different LED colors and intensities have on plant growth, leaf shape and color, and nutritional benefits. Eventually, they will look at ways in which lighting can improve flavor.

"We know that by modulating the light spectrum we can influence plant growth and development," Meng said. "We can alter light quality and quantity to regulate both photosynthesis and secondary metabolism, the process where nutritional and flavor compounds are produced. These are some added benefits of growing crops indoors under LED lighting."

Specifically, the duo is looking at ways to change plant shape and promote growth by adding green and far-red light (which we can't see, but influences plants) to traditional blue and red light. Around four weeks after seed germination, plants will be measured for several growth attributes including yields and leaf size.

Both Runkle and Meng realize the uphill battle vertical farming faces. They say operating a vertical farming system is expensive. Although the LED lights are more efficient than traditional lights – such as fluorescents – they still consume considerable electricity and emit heat that needs to be pulled out of the room. As the largest operating cost, electricity for the lights and cooling system is generally the most intimidating to potential entrepreneurs. Capital costs for the lights is also quite high.

MSU doctoral student Qingwu (William) Meng works in the new Controlled-Environment Lighting Laboratory.

Although some have worked out viable business plans, many who make a go of it struggle despite advantages such as little to no pests or diseases, water conservation (some companies estimate over 90 percent less water is used compared to traditional field farming), the ability to produce locally all year round and much lower transportation costs to the market.

"If you can find a niche market and design your operation and business model properly, vertical farming can work," said Meng. "But it's also a risky business, and that's why some of the companies in this market – even some big ones – have gone bankrupt."

Runkle and Meng say their goal is to help steer research to help optimize the vertical farming system and make it more readily viable by producing higher quality crops with lower energy costs. They've personally witnessed an increased growth rate in vertical farming and believe that using abandoned buildings, where trays of plants can be stacked 10 to 15 layers deep, could prove to be extremely impactful.

"If you have some vacant warehouses or buildings, conceptually you can convert them to productive plant factories to feed people living there," said Meng. "Cities like Detroit have many food deserts. I think this might be a way to address some food crises."

"The truth is, through CELL, we're delivering the same photons from LEDs as you can get from sunlight," Meng said. "A lot of people will call these LEDs 'artificial lighting,' which is a term I tend to avoid. The photons, no matter whether from the LEDs or from sunlight, are the same physical matter. Unlike sunlight, the photos from LED aren't free, but with LEDs, we can tweak the light spectrum to get better control of plant traits, which may justify the added costs."

TRANSITIONING FROM ENGINEERING INTO VERTICAL FARMING

Meng wasn't always so interested in vertical farming. He spent his first 18 years of life in Lanzhou, in northwestern China, before moving to Beijing where he earned an undergraduate degree in agricultural engineering. He came to the U.S. five years ago to pursue his graduate degrees.

It was a thesis project during his last year of undergraduate studies that ignited his interest in plant biology. He evaluated different lighting fixtures to benefit plant growth. Afterwards, he came to MSU to study how different colors of light controlled flowering of greenhouse ornamental crops.

"Then I got more and more interested in vertical farming, still revolving around the theme of LED lighting in agriculture," he said. "I was thinking more about the food crises we are having or will be having in the future and how to solve those food production problems. As I was conducting horticultural lighting research, I realized how much potential it could have for future farming."

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