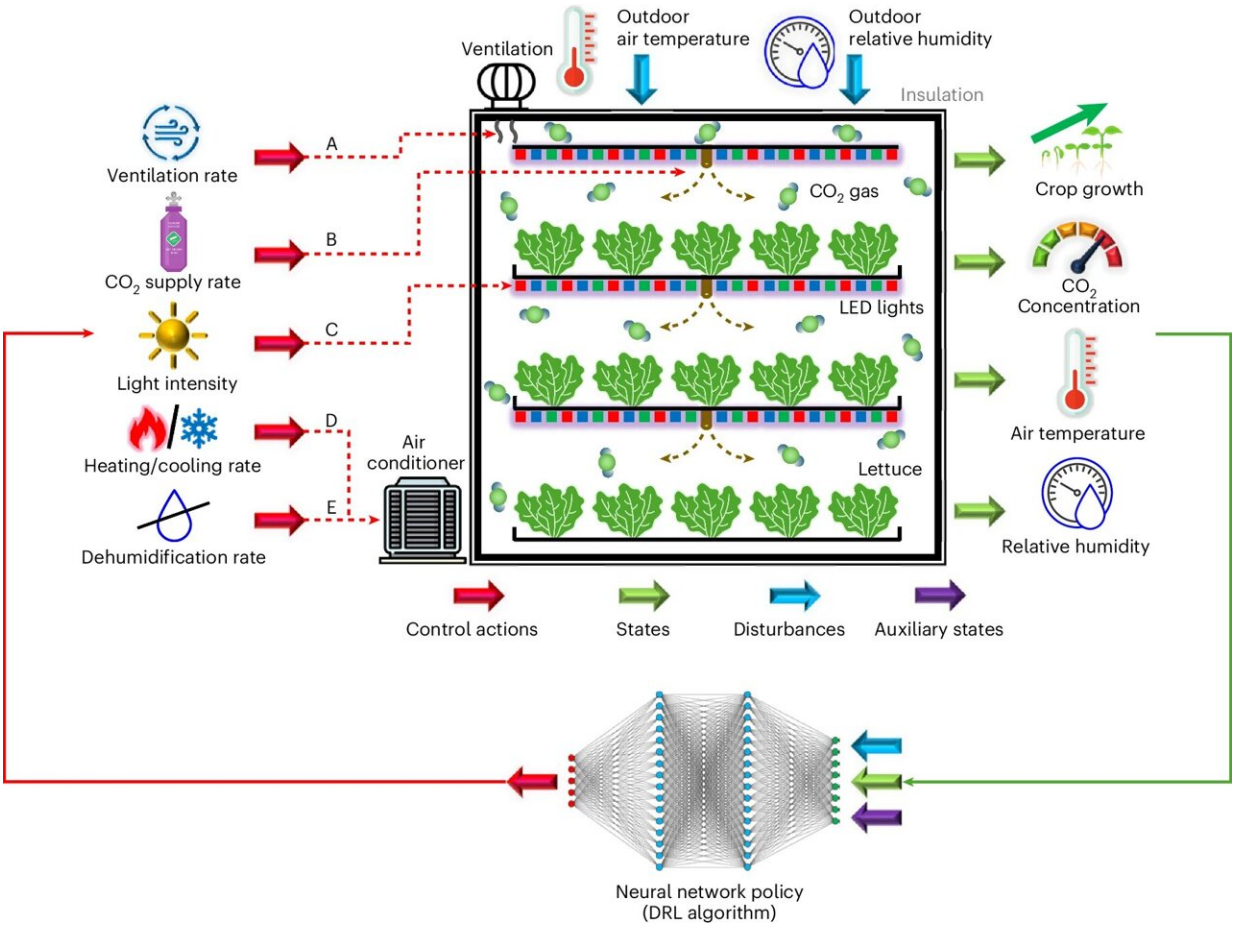
AI boosts indoor food production's energy sustainability

September 9 2024, by Blaine Friedlander



A schematic diagram of a PFAL with DRL for lettuce production. Credit: *Nature Food* (2024). DOI: 10.1038/s43016-024-01045-3

Integrating artificial intelligence into today's environmental control

systems could reduce energy consumption for indoor agriculture by 25%—potentially helping to feed the world as its population rises, Cornell engineers have found.

"If we incorporate AI into agricultural plant factories—large-scale indoor farms with complete lighting and climate control—all around the world, we can facilitate crop photosynthesis, transpiration and respiration in these buildings," said Benjamin Decardi-Nelson, a postdoctoral fellow in the laboratory of Fengqi You, the Roxanne E. and Michael J. Zak Professor in Energy Systems Engineering in Cornell Engineering. "We can expect to see substantial energy reduction while amplifying efficiency and a savings of precious resources."

Their research, "Artificial Intelligence Can Regulate Light and Climate Systems to Reduce Energy Use in Plant Factories and Support Sustainable Food Production," appears in *Nature Food*.

The world population is expected to grow to 9.7 billion people by 2050, according to the United Nations. This growth, combined with climate change and urbanization, requires fixes for the flaws in the world's current food production systems, the researchers said.

Indoor farming methods, such as plant factories with artificial lighting, are less vulnerable to climate change, but they're energy-intensive and require careful resource management to be sustainable.

"Existing environmental control systems are not smart enough," said You, who is the co-director of the Cornell Institute for Digital Agriculture and co-director of Cornell University AI for Science Institute.

Ventilation can reduce energy use, but complicates plant growth by affecting carbon dioxide levels and moisture balance. AI tools can help

regulation methods factor in this criteria.

"Artificial intelligence offers a promising solution by managing several complexities," Decardi-Nelson said.

By using AI techniques like deep reinforcement learning and computational optimization, the scientists analyzed lettuce cultivated in indoor agricultural facilities within eight diverse locales throughout the U.S.—Los Angeles; Chicago; Miami; Seattle; Milwaukee; Phoenix; Fargo, North Dakota; and Ithaca, New York—as well as Reykjavík, Iceland and Dubai, United Arab Emirates.

AI reduces energy use by optimizing lighting and climate regulation systems. Energy use dropped to 6.42 kilowatt hours per kilogram fresh weight (energy needed or used to produce one kilogram of indoor-grown lettuce) from 9.5 kilowatt hours per kilogram fresh weight, in places that use non-AI technology. The researchers found that for warmer areas such as Dubai or southern U.S. climes, AI reduced energy usage to 7.26 kilowatt hours per kilogram fresh weight, down from 10.5 kilowatt hours per kilogram fresh weight.

Low ventilation during light periods (16 hours of simulated sunlight) and high ventilation during dark periods (eight hours that simulate night) provided an energy-efficient solution for optimal indoor carbon dioxide levels for photosynthesis, oxygen for respiration and plant growth, and balanced other ventilation requirements.

"This is a very similar concept to smart homes," You said. "We want to be comfortable at home while reducing energy use; so do crops. This work focuses on a smart system to make food production optimal, sustainable and lower the carbon footprint. That's what AI does very well. We can save quite a bit if we use AI to optimize the artificial lighting and other energy systems carefully."

By streamlining operations using AI to reduce energy consumption, indoor farms become viable, Decardi-Nelson said, even in regions with limited energy-saving opportunities.

"By strategically aligning environmental control system technology with plant biology," Decardi-Nelson said, "energy can be conserved using ventilation while minimizing carbon dioxide waste and maintaining ideal growing conditions."

More information: Benjamin Decardi-Nelson et al, Artificial intelligence can regulate light and climate systems to reduce energy use in plant factories and support sustainable food production, *Nature Food* (2024). DOI: 10.1038/s43016-024-01045-3

Provided by Cornell University