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Algae Farming Technology Yields Renewable Fuel, Uses Waste as Fertilizer

WOOSTER, Ohio -- Right next to a commercial nursery and greenhouse operation on the outskirts of Wooster, paddlewheels keep water constantly moving in four 30-by-200-foot ponds shaped like automotive raceway circuits. The water is deep green and murky.

That's just how Phil Lane likes it.

Lane is a program manager for Touchstone Research Laboratory, a West Virginia-based company that operates this unusual facility on a stretch of farmland where the remnants of corn and soybean fields are now buried under snow.

And the stuff making the ponds green is another type of crop that could one day grow alongside the more traditional fare occupying Ohio fields: algae.

"Algae can be grown just about anywhere, so we are not competing with farmland for growing food crops," said Lane, who manages the Wooster algae pilot facility. "Algae can add value to marginal lands, generating a crop that can be turned into biofuel and a variety of bioproducts."

Algae farming is expanding across the United States and around the world, showing great promise as a fast-growing and efficient source of natural oil for renewable transportation fuel, bio-plastics, food supplements and many other products.

Growing algae in places like Ohio may sound like a strange proposition, especially in the middle of winter. After all, most large-scale algae operations are found in warmer climates with lots of sunshine, as these conditions allow for year-round production. However, the project in Wooster is seeking to

OARDC's Yebo Li (left) and Touchstone's Doug Amie check a water sample from one of the indoor ponds growing algae in Wooster. (Photo by Ken Chamberlain)

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change that.

Built in late 2011 at Cedar Lane Farms, the two indoor and two outdoor raceway ponds host collaborative research between Touchstone and Ohio State University's Ohio Agricultural Research and Development Center (OARDC), whose Wooster campus is located just a few miles from this site.

OARDC is the research arm of Ohio State's College of Food, Agricultural, and Environmental Sciences.

Funded by close to $7 million in grants from the U.S. Department of Energy and the Ohio Coal Development Office, this research involves testing of three innovative technologies that seek to make algae farming viable, more cost-effective and sustainable in a wider variety of climates and locations.

The first technology, previously developed by Touchstone exclusively for algae production, is a phase-changing material that covers a majority of the pond surface. This material regulates daily temperature, helping the algae grow during colder periods; controls the infiltration of invasive species; and reduces water evaporation, which is a big problem with open-pond algae systems.

"We are testing this technology at both the indoor and outdoor ponds," Lane explained. "For each pair, one pond will be covered by the phase-change material while the other pond will have no protection and serve as the control.

"We are seeing up to 90 percent reduction in evaporation with this material. We are also looking at the impact of this material on other variables, for example, if algae growth increases, if lipid (oil) content goes up."

The second technology serves an environmental purpose. It involves pumping carbon dioxide from Cedar Lane Farms' advanced coal-burning system into the ponds. Like all plants, algae needs CO2 to grow. And since algae grows very fast -- doubling its mass in 24-48 hours depending on the type -- it can use a lot of the greenhouse gas.

How much? Lane said the goal for the four ponds at Cedar Lane Farms is to keep up to 60 percent flue gas CO2 generated by the facility's coal-burning system from being released into the environment.

The third technology involves research conducted by OARDC biosystems engineer Yebo Li. As an alternative to using commercial fertilizers to feed the algae, Li is testing a liquid waste (called "effluent") that comes out of anaerobic digesters -- systems that produce biogas from organic matter.

"The effluent is rich in nitrogen and phosphorous, two nutrients that algae needs to grow," said Li, who obtains this effluent

from quasar energy group, an OARDC research partner that operates an anaerobic digester on the Wooster campus.

This algae grown in Yebo Li's lab serves as the seed for algae production in Touchstone's research ponds. (Photo by Ken Chamberlain)

In an effort to make this algae-growing system as sustainable as possible, Li is using the biomass left over after extracting oil from algae as a feedstock for anaerobic digesters. Doing this takes care of the algae biomass and also helps produce more clean energy, which in turn leads to more effluent fertilizer available. In other words, it's an integrated system in which nothing is wasted.

"Algae biomass is rich in proteins and carbohydrates and works very well for anaerobic digestion," Li said. "Algae contains about 40 percent lipids and 60 percent biomass, so future large-scale algae farming would generate a lot of biomass residues that can be used as a fertilizer or for making energy."

Li's laboratory also tests and grows the seed algae that is later added to the ponds to multiply. With these three technologies combined, the four ponds at Cedar Lane Farms can produce some 2,000 gallons of oil per year -- approximately 10 times more oil than what soybeans could yield on the same area of land.

"Tests at his pilot plant will help us determine the operating costs and yields from this technology," Lane said. "We hope the pilot plant will attract investors to license this technology to others in the algae industry and that the production process will be adopted to provide energy savings and to reduce water usage.

"Ultimately, the aim is to reduce costs enough to make the algae industry competitive with petroleum fuels."

Brian Joseph, president of Touchstone, said Ohio is a good place for algae farming because it has a high water table that makes it easy to set up ponds, as well as a large supply of waste heat available. The opportunity to work with Ohio State is another important asset.

"Having Ohio State as a partner is great," Joseph said. "They have great depth of expertise in every part of the biological spectrum that you can think of."

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