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Culture of Microalgae in Outdoor Raceways Using Flue Gas Carbon Dioxide

A project is starting at the Texas AgriLife Research Mariculture Laboratory in Corpus Christi to demonstrate the feasibility of growing marine microalgae in outdoor raceways using carbon dioxide from power-plant flue gas to produce biofuel and high-value coproducts in Texas.

This research is designed to establish and optimize a cost-effective prototype system for high-density culture of oil-rich microalgae in open raceways using seawater and carbon dioxide supplemented from the natural-gas-fired Barney Davis Power Plant, which is the home of the Mariculture Lab. Renewable biofuel production systems offer great economic opportunities leading toward energy independence from foreign oil while not competing with traditional agriculture for freshwater and productive cropland. Large-scale microalgae culture systems annexed to power-generating plants can recycle or capture, and therefore reduce, part of the 2.8 billion tons of carbon dioxide released annually into the atmosphere by United States power plants while producing a range of high-value products.

At current consumption rates, Department of Energy statistics suggest that the U.S. would need about 140 billion gallons of biodiesel to satisfy its annual land transportation fuel requirements. Terrestrial food staples—such as corn, soy, canola, and other traditional food crops—are not a realistic option for providing a significant fraction of the nation's transport fuel needs and, more importantly, would make productive cropland unavailable for food production. Microalgae farms could theoretically yield enough biodiesel to entirely replace petroleum as a transportation fuel in the U.S. in an area equivalent to as little as 1% to 3% of the one billion acres of available farmland. Moreover, the type of land envisioned for algae biomass production need not displace traditional agriculture, thereby avoiding any impact on U.S. grain production.

The initial phase of the study will include growing of Nannochloropsis and Phaeodactylum in twelve 3-square-meter and six 10-square-meter outdoor raceways. A series of trials will optimize delivery, retention, and uptake efficiency of flue gas carbon dioxide to evaluate the effects of different nutrient concentrations, fertilization rates and frequencies, and the potential use of sewage from water treatment plants for salinity control and as a partial source of nutrients. Related studies include collection of year-round algae samples and water quality data from the adjacent Laguna Madre to isolate and identify local strains that show promise for algae biomass production. The next phase of the study will involve integrating results from the first phase and conducting tests in 50- and 250-square-meter raceways for further optimizing the use efficiency of the flue gas carbon dioxide, nutrients, and overall growing conditions in scaled-up systems.

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