Turning algae into biofuels

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Bird's-eye view of algae- producing raceways and harvest barn at the Texas A&M AgriLife Research Station at Pecos. Credit: Texas A&M AgriLife Communications

Pecos is usually egg-frying hot, bone dry and much of the groundwater is brackish, but Texas A&M AgriLife Research personnel know the area is prime real estate for conducting algae research, something they've been doing successfully since 2007.

They're good at it too, so good that they've recently been asked to share

an $8 million Department of Energy grant with three other research institutions, officials said.

Shay Simpson, the associate program director of corporate relations for AgriLife Research at College Station who helped orchestrate the Texas grant portion, said the agency's algae program at the Pecos Station has grown from its start when drop-in fuels– those that are interchangeable with conventional fuels– were the focus to 2009. After that, animal feeds took center stage and today, biomass production, along with chemical and nutraceutical or health-related products, are the prime interests.

The University of Arizona leads the partnership funded by the grant called the Regional Algal Feedstock Testbed or RAFT. The other partners are the Pacific Northwest National Laboratory, a Department of Energy research facility at Richland, Wash., and New Mexico State University at Las Cruces. These research partners are tasked with finding better ways to turn algae into biofuels, bioproducts and feed by optimizing growth systems to produce more biomass and lipids from the algae. They also are developing water recycling systems and testing new, more efficient species of algae.

The Texas team is headed by Dr. Jaroy Moore, AgriLife Research resident director at Lubbock who administers the Pecos project, and Lou Brown, AgriLife Research project manager responsible for the daily AgriLife Research conducted at the Pecos Station.

"My one thought since the inception of our algae growing project several years ago is that we've continued to make progress and many of our peer institutions and peer researchers continue to look to us for algae production," Moore said. "So far we continue to be funded and funding is directly based on demonstrated performance."

Simpson said the accomplishments to date at Pecos funded by previous

grants include evaluating and selecting 38 algae species with high biomass or oil-producing capacity; developing, testing and demonstrating advanced algae production systems, and evaluating and fine-tuning the lipid separation techniques necessary to produce fuel.

"They've also successfully developed improved production scale-up techniques, evaluated potential uses for algae co-products for livestock feed and tested and optimized different algal separation techniques," she said.

Brown whose expertise centers on his ability to find algae species with the best commercial potential, said the RAFT project will allow the Pecos Station to take their previous work to the next level.

"We are going to do some really in-depth studies on the top three to five algae species from among the 38 we've already tested," he said. "We're after those that have consistently shown the most promise for larger scale growth," Brown said. "We want to determine the benefits and pitfalls associated with a particular algae or production system."

One algae species in particular from the genus chlorella, which was a late-comer in previous studies, has consistently made high marks prompting researchers to ask Brown to study it further.

"It does show a lot of potential and several of us are growing it at different sites and we all have different traits we're trying to streamline on that particular species," he said. "Another top contender is kirchneriella, a strain we isolated in Pecos that grows well in the wintertime and could potentially be used in an off-season crop rotation strategy very similar to a mainstream agricultural cropping system."

Brown said the algae will be tested using different variables, exposing it to marginal water, for instance waste-water, water too high in salinity for

other crops or water used in the oil industry's fracking process.

Feeding or fertilizing algae for maximum production is another of Brown's research areas. He said algae takes up nitrogen, phosphorus, potassium and carbon similar to conventional crops.

"My team has adjusted the different chemicals in the mix and switched them out for cheaper alternatives or done away with them. We've also taken the site-specific water chemistry and used what's already available in the water in place of things we have to add that cost money."

Brown added that their current focus on creating biomass has changed their production systems somewhat, much like a farmer switching from an annual to a perennial crop.

"We're more on a continuous culture methodology now from a cultivation standpoint," Brown said. "Which means we are currently producing biomass for as long as we can, as fast as we can. Unlike our previous research, the lipid is not our primary goal; now it's the biomass.

"Before, we could get a culture or 'crop' out there, move it through the system and get it out. Now we've got to keep a culture out there as long as we can and harvest off of it as often as we can while still maintaining good growth, keeping the contamination out and keeping the water quality correct.

"I think in the end we'll create a product that's more acceptable to a broader range of technologies. So, I think that area of research has got a lot of potential."

Marine algae species are another area being explored, and Brown likes growing them out in the desert. They fight off all the "native" freshwater algae brought in by rain, wind and dust that can contaminate a

"cultivated' freshwater algae crop.

"Our well water runs from 3,500-4,500 parts per million salt," Brown said. "I actually increase the dissolved salts closer to 28,000 parts per million to essentially make it seawater. Luckily, salt is reuseable and we're going to continue work on recycling our water. I think we can get close to reclaiming 90 percent of all the water we use except for the evaporation make-up water which is our biggest loss."

Simpson said Texas A&M's algae effort has included 30-plus AgriLife Research scientists and engineers in multiple locations across Texas. The Pecos facility, an arid production scenario with its impaired groundwater, supports the other researchers around the state.

The Pecos algae facility includes eight 50-gallon raceways for initial outdoor testing, two 1,000 gallon, four 2,000 gallon and three 6,000 gallon raceways for large-scale production. Simpson said the outdoor facility is supported by two indoor laboratories where algae seed are grown and production samples are tested for nutrient and lipid content and general health of the algae. An on-site harvest barn allows collaborators to set up equipment for pilot-scale research.

So, given the recent project funding and continued interest in the crop, what's the future for algae production on a commercial basis in the Pecos area?

Brown feels it will come down to the amount of water available for production, so groundwater availability and recharge rates will have to be closely scrutinized before any large scale operations are launched.

"Once you start going to a really large scale you are going to use a lot of water," Brown said. "Now, you can recycle a lot of that, but the more acres you put into production, the more evaporative water you've got to

keep adding.

"We're going to have modelers address the economical size for a commercial farm as part of this project, that's why my priority is to provide data on growth parameters and the inputs needed, so later down the road at the end of the two-year project those questions might be better answered."

Moore said success may also hinge on getting the right algae crop, one for the summer and others for the different seasons.

"There is future potential at Pecos for commercial algae production simply because the water that's used is not competing with municipalities or conventional agriculture," he said. "The land itself is relatively inexpensive and there's plenty of sunlight and available carbon dioxide. All those factors have always been sought after when talking about algae production. But the coast is probably going to be the first choice especially if salt water species are produced simply because you don't have to do anything to the water nor do you have to lift that water very much.

"So, if somebody from Pecos, a producer maybe, might ask if we are still working with algae out there, I'd say 'yes, but don't start getting ready to change your conventional farming operation just yet,'" Moore said. "We continue to make steady progress, and so algae production is going to be continued to be looked at. One of these days it'll work and become a viable crop on the producer level. But right now, I don't know when."

Provided by Texas A&M University

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