



T.O. firm's gene work aims to boost use of ethanol

The seeds of fuel

By Allison Bruce
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Standing in a room full of clear plastic boxes stacked on shelves, Richard Hamilton reaches into one of the boxes and pulls out a small, clear vial of seeds with a label on the side.

Each of the seed samples has been altered slightly to see if a little tweak to a gene will make it produce a plant that does better in various conditions — perhaps make it more tolerant to a drought or better able to withstand cold.

These seeds at Ceres Inc. in Thousand Oaks are the foundation for a new generation of plants that can be used for future fuel needs.

Hamilton, president and chief executive of Ceres, said the company uses advanced technology — applied to such efforts as the Human Genome Project — to guide plant development. Ceres, which started out discovering genes and developing traits in row crops, is now nearing the release of its first "energy crop," a bioengineered switchgrass that can be processed into ethanol.

"We've been using genes to improve plants the last 10,000 years," Hamilton said, referring to the long process of breeding plants for certain traits. "Now we can do it a lot more quickly."

Ceres, which employs about 130 people, is a privately held company that recently raised \$75 million in financing through a private offering of convertible preferred stock. The money will finance research and product development of several energy crops.



Researcher Lina Anusausaiene cuts dried plant material for analysis at Ceres, which is working on new and more efficient ethanol sources.

Ceres is a leading developer of a new kind of biofuel that is drawing a wave of interest: cellulosic ethanol. It's so named because it uses cellulose and hemicellulose found in stems, stalks and leaves of plants to make ethanol.

Corn is used to produce most of the ethanol in the United States, but rising corn prices have increased interest in other approaches.



Photos by Dana Rene Bowler / Star staff

Edgar Sanchez, a Ceres lab assistant, examines samples of Arabidopsis.

"In the longer term, we really have to move beyond products for food production for fuels," said Gary Schmitz, spokesman for the National Renewable Energy Laboratory in Colorado. The research — and money to fund it — is going toward cellulosic ethanol these days.

It is estimated that corn ethanol production could reach about 15 billion gallons a year, a small dent when compared with the 140 billion gallons of gasoline consumed annually in the U.S., said Virginia Lacy, an analyst with the energy and resources team at the independent Rocky Mountain Institute. The gap is even greater than at first glance because a gallon of ethanol has about two-thirds the energy of a gallon of gasoline.

Much larger potential

However, cellulosic ethanol yields could potentially reach about 100 billion gallons a year, which could provide a sizeable replacement for gasoline, Lacy said, citing Department of Energy information. Cellulosic ethanol can come from a variety of sources, including plant material left over from a corn harvest, wood chips or "energy crops," like the kind being developed by Ceres.

Perhaps one of the biggest benefits of cellulosic ethanol is the variety of sources that can be used. Each state could rely on waste material or energy crops that are common to their areas.

Schmitz said energy crops are some of the most promising sources.

"Those will have a great role in the future for providing fuel for the country," he said.

Lacy added that energy crops tend to have a higher yield per acre than corn, which means more feedstock at less cost. A crop such as switchgrass requires less fertilizer and irrigation, plus it grows in areas where corn doesn't.

Ceres' switchgrass is made to become a biofuel. It matures late, so it continues to grow, producing more grass — or biomass — per acre. This "yield density," plus drought tolerance and efficient use of nitrogen, creates a promising crop.

"Yield density for energy crops is probably the single biggest enabler for a biofuels industry," Hamilton said.

There are several challenges to the widespread use of cellulosic ethanol, but successful strides have been made. One main obstacle is the production cost.

Because of a longer and more involved process, it costs more to produce cellulosic ethanol — about double what it takes to make ethanol from corn.

The higher production cost stems from a technological challenge. Getting starch to make ethanol out of corn is fairly easy and straightforward, but the material needed for cellulosic ethanol is bound to other molecules inside the plant and harder to extract.



Arabidopsis, in the mustard plant family, is easily studied to identify genes and their functions and improve desired qualities.

Lacy borrows an analogy sometimes used to describe the difference: A piece of bread left out in the rain would break apart quickly to its sugary components, but a two-by-four piece of wood set beside it would take years to break down.

Plants have spent millions of years building up their cell walls, so getting at the cellulose requires going through a lot of tough stuff, she said.

"The science is there, it's just a matter of improving some of the steps in the process," Lacy said.

The goal is to get the cost down in the next six to 10 years so it is competitive with corn ethanol and gasoline.

Two possible approaches

There are two ways to go. One is developing better technology for breaking down plant material. Schmitz said enzymes are being developed that are less costly and more effective for the job.

The other possibility is creating a feedstock that is easier to break down, which is where Ceres comes in. Hamilton refers to the objective as an "energy crop that melts in your mouth."

He offers this analogy: "Cellulose is like a package of uncooked spaghetti. You have to blow it apart so the enzymes can get in and break down the spaghetti strands."

Ceres' technology makes it easier to blow that spaghetti apart — though how it does that is proprietary information.

Hamilton said Ceres is working with different biorefinery leaders to develop crops that best work with their approaches to breaking down crops to make ethanol or other biofuels.

Schmitz said the first commercial cellulosic biorefinery plants should be up and running in about five or six years. The concrete for the foundations is being poured this year for some of those biorefineries.

People also should keep in mind that the introduction of cellulosic ethanol is just part of the push to reduce fossil fuel use, Lacy noted.

There are two elements to the equation: supply and demand.

A lot of the talk these days is about supply — renewable energy, biodiesel, ethanol — but there also needs to be discussion about demand, Lacy said.

More efficient fuel use means there would not be a need for as much supply, which has financial and environmental benefits, she said.

Hamilton noted that there is a need to look beyond ethanol. Biomass crops don't have to be fermented into ethanol — they also could be used to create other biofuels, he said.

He predicts Ceres will continue to make research advances and develop new feedstocks. The company recently formed a partnership with Texas A&M's Texas Agricultural Experiment Station to work on a sorghum energy crop, which could be commercialized by 2010.

In the company's greenhouse, flowering plants are designed to produce a plastic precursor that can be removed from the plants before being converted into a biofuel and used to make a plastic, Hamilton said. The research is partly funded by a Department of Energy grant.

Hamilton is standing in the greenhouse surrounded by plants grown from seeds, like those stored in vials in clear plastic boxes inside. Some plants stretch up toward the glass roof, while others yellow or turn brown. Scientists keep an eye on how the plants respond and grow, and they collect the seeds.

It's a long process, watching plants go from the lab to commercialization, but it already is starting to happen at Ceres. Hamilton predicts energy crops will become the feedstock of choice for future biofuels.

On the Net:

www.ceres.net



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