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FULL OF ENERGY: Ceres CEO Richard Hamilton in a switchgrass greenhouse. The biotech firm is developing methods of converting plant fiber into cellulosic ethanol.

Seedlings of a Fuel Industry

The effort to turn plant waste into a new form of ethanol is attracting ingenuity and investors.

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TIMES STAFF WRITER

Near a cluster of purple petunias in a Thousand Oaks greenhouse sprouts a key weapon in the nation's ambitious push into biofuels.

The plants don't look like much. They're just tall, spiky shoots of prairie grass. But these

stalks are souped-up samples of switchgrass, part of an urgent drive toward a new kind of ethanol using plant fibers instead of corn kernels or sugar cane.

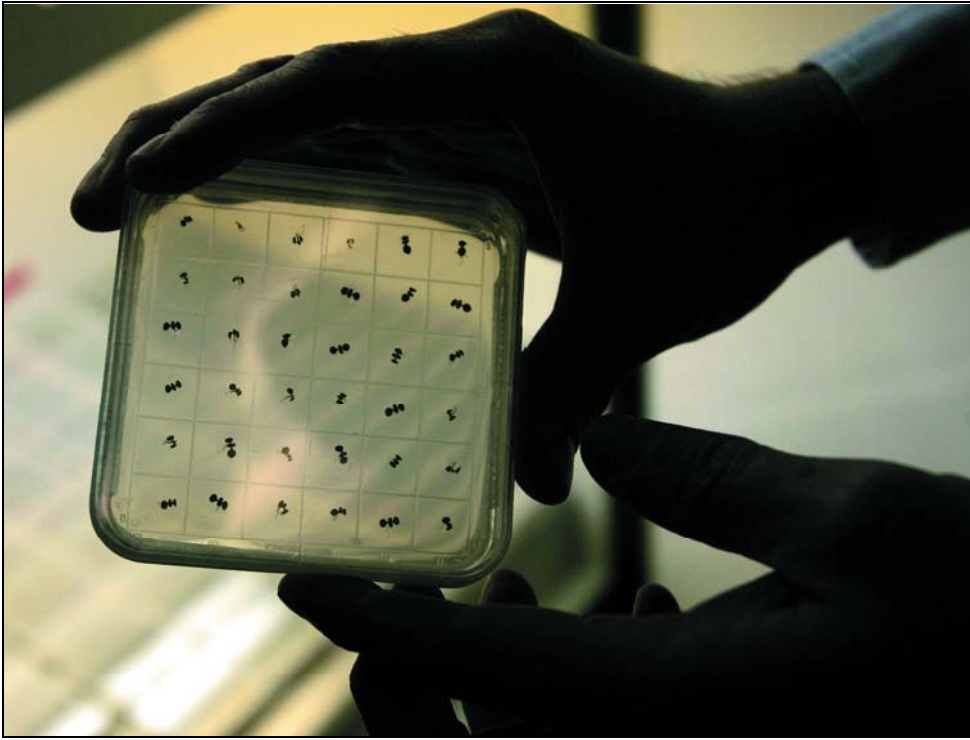
Ceres Inc., the biotechnology company nurturing this batch of switchgrass, is betting that the plant has a big future as an energy crop. It's a strong candidate because it can be grown year-round in poor soil, then harvested and converted to fuel ethanol without displacing traditional food crops.

Researchers at Ceres and labs around the world are experimenting with various crops and forms of plant waste and conjuring up enzyme

cocktails that would lower the cost of teasing energy out of the cell walls of plants.

Such work, once conducted in relative quiet, is now in the spotlight. The federal government has stepped up ethanol research funding, and last week the Energy Department announced grants worth up to \$385 million to jump-start construction of six small operations to refine ethanol from a wider variety of plants. It marks the nation's first major foray into the production of so-called cellulosic ethanol.

Ethanol will be on the agenda Friday, when President Bush travels to Brazil to meet with President Luiz Inacio Lula da Silva. The two



NURTURING AN IDEA: Ceres will use these seedlings in tests of plant fiber as the raw material of cellulosic ethanol.

countries are expected to announce a partnership to boost production of biofuels such as ethanol, which Brazil makes from sugar cane. The U.S. and Brazil already make 70% of the world's ethanol.

Wall Street and private investors have joined the search for new kinds of ethanol, putting unprecedented amounts of money behind companies with promising technologies. Oil giants have rushed in as well, striking deals with universities and firms involved in biofuels.

"People are working feverishly on innovations.... Everyone's racing," said Nathanael Greene, clean energy policy analyst at the Natural Resources Defense Council. "There are many more companies now working on many different variations."

Among the motivators: Bush's goal of displacing 20% of the nation's gasoline with alternative fuels and improved fuel economy by 2017. Although biodiesel, hybrid cars, natural-gas-powered buses and other energy advances will be part of the mix, most experts believe Bush's benchmark can't be met without a substantial contribution from next-generation ethanol.

"It's a big technology bet that cellulosic will be a primary contributor," said Alexander Karsner, assistant secretary for the Energy Department's energy efficiency and renewables group. Apart from outright cuts in energy use, he added, such next-generation ethanol "is perhaps the best hope we have in the transportation sector for minimizing the human impacts on global climate change."

Today, ethanol made from corn kernels is the most pervasive renewable fuel in the United States, blended into about 46% of the nation's

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Alexander Karsner
Energy Department

gasoline. Using a process similar to brewing beer, ethanol refineries isolate starch from corn and convert it to sugars that are fermented and distilled to get the finished product.

Corn-based ethanol remains this country's cheapest, easiest and quickest way to displace gasoline in the short term, but it has substantial drawbacks. It is laden with corn-state politics, clashes with food supply needs and lowers fuel-efficiency. In some formulations, it can increase certain pollutants even as it reduces others by replacing gasoline.

"It's good for going forward, but there are a lot of issues that come up" with corn ethanol, said Ron Pernick, co-founder of Clean Edge, which tracks venture capital funding. "We need to move to next-generation biofuels, including cellulosic ethanol, and to next-generation biorefineries."

Cellulosic ethanol is already a proven concept, with production processes that work, said Mark Emalfarb, chief executive of Dyadic International Inc., one of several biotechnology companies that are isolating and patenting microbes used in making the fuel. "It's now a

matter of making it work on a large enough scale and at a low enough cost."

The National Renewable Energy Laboratory estimates the production cost of noncorn ethanol at \$2.25 a gallon, or about double what it costs to make corn ethanol. BlueFire Ethanol Inc., an Irvine company that plans to make ethanol from landfill plant waste, said it expected its process to cost \$1 a gallon.

"I describe a cellulosic biorefinery as the ultimate flat-screen TV," said Richard Hamilton, chief executive of Ceres, the Thousand Oaks company using genetics to improve switchgrass and other potential energy crops. "The first few are going to be very expensive, but the key part is getting those first few built so we can ride the cost curves down."

Iogen Corp. of Canada was the first to take cellulosic ethanol out of the lab, opening a pilot plant in 2004 that has been making the fuel from wheat straw at a rate of 260,000 gallons a year. Using an Energy Department grant, the firm will launch U.S. production in Idaho Falls, Idaho.

Last month, Massachusetts-based ethanol maker Celunol Corp. launched production at the first U.S. test refinery for cellulosic ethanol, located in Jennings, La., and has started construction of a larger facility. The bigger project would produce as many as 1.4 million gallons a year of ethanol made from crushed sugar-cane stalks.

The cellulosic approach can pull energy out of nearly any plant material, but the process is difficult because it must draw sugars from tough substances inside plants. Some processes draw out the sugars using heat and chemicals; others employ specialty enzymes.

"Of the initial plants...not all of them will work perfectly," said Karsner of the Energy Department, who expects cellulosic refineries to be commercially viable by 2012. "They will be the training wheels, where we get the kinks out of the systems and understand how to process large-scale biomass."

Greene, of the Natural Resources Defense Council, is optimistic. Cellulosic ethanol is easier on the environment than corn-based ethanol, once fertilizer and tractor fuel are factored in, and it could put a meaningful dent in U.S. petroleum use, he said, "so it's worth struggling to figure out how to get there."

Back in Thousand Oaks, Ceres is gearing up for a cellulosic future that CEO Hamilton believes will include lots of switchgrass. When that future arrives, he said, "we want to be there with the best seeds."

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