

## FEATURE-Can fungi trim the U.S. gasoline habit?

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By Timothy Gardner

NEW YORK, Feb 24 (Reuters) - Souped-up microscopic fungi could help cut the U.S. gasoline habit by converting a billion tons of agricultural waste into domestic fuel, while also slashing greenhouse gas emissions.

As if that isn't enough, the concept has the blessing of the president -- an ex-oilman.

On a tour of the Midwest this week, President George W. Bush reiterated that he wants to wean the United States off its "addiction" to imported oil, partly by funding research into new methods of producing ethanol -- a fuel currently made in North America mostly from corn kernels and in Brazil from sugar cane juice.

Filamentous fungi and other microbes can be bred to break down an array of feedstocks, including wood chips, corn stalks and switch grass, that require no fertilizer and less input than traditional sources of the fuel.

James Woolsey, former CIA director under Bill Clinton, compared the state of the science for the new ethanol to the quick rise of the aero industry after the first flight.

"The Wright Brothers have flown," said Woolsey, who is now a consultant at Booz Allen Hamilton.

Woolsey and other experts say the biggest factors supporting the growth of an ethanol derived from native grasses and crop waste is that the science to make it is already within reach, and cars that burn it are already on the road.

To make cellulosic ethanol, enzymes spewed from fungi convert cellulose from the fibrous parts of plants, such as stalks, into sugar that then is fermented. In traditional ethanol, yeast breaks down sugar from the starchy parts of plants, such as corn kernels.

Scientists bioengineer fungi -- such as "jungle rot" that chewed through tents of the U.S. Army during World War Two in Guam -- to make the best enzymes for different fibrous plants.

"Fungi are the scavengers in nature that break down cellulose anyway, so we're not trying to turn an elephant into a mouse," said Mark Emalfarb, president and chief executive of Florida-based Dyadic International Inc. <DILA>

Emalfarb said fungi Dyadic uses to soften and lighten blue jeans can break down corn stalks, sugar cane waste and rice straw into fuel.

It's a step beyond making conventional ethanol in which yeast breaks down easier-to-process plant starch.

### COSTS

The current price is high, about \$2 to \$3 per gallon, compared with about \$1.07 a gallon for conventional ethanol, according to Glenn Nedwin, president of Danish enzymes company Novozymes <NZYMB.CO>.

But as the first commercial plants open and processing is perfected, costs should quickly fall, Woolsey said.

Feedstock abounds. The U.S. government estimates that more than 1 billion tons of crop and forest waste are available. Potentially, that amount of waste could make 80 billion gallons a year of ethanol -- about a third of U.S. gasoline demand.

And native crop switchgrass and other low-input feedstocks can be grown far away from the current Gulf of Mexico and Midwest oil refining centers. That would allow the fuel to be produced nationwide and could cut the need to transport fuels thousands of miles.

What's more, the fuel can cut carbon dioxide emissions. At least one big energy company under mandate by the European Union to cut greenhouse emissions is investing. Royal Dutch Shell <RDSA.L> has invested \$40 million in logen, which has been operating a pilot plant making the fuel in Canada for two years.

### FOLLOWING BRAZIL'S LEAD?

Brazil has slashed imports of Middle Eastern oil by expanding its conventional ethanol program. If fungi or bacteria can be engineered to break down sugar cane waste, it could even cut its dependence on its own oil, experts say.

President Bush hopes to reduce oil imports from violence-torn countries, in part by making cellulosic ethanol competitive in six years.

That could give a headache to the Organization of the Petroleum Exporting Countries, whose slice of the world's oil production is growing as output elsewhere wanes. OPEC currently produces 40 percent of the world's oil and is expected to produce 60 percent of world oil in 2030.

U.S. conventional ethanol output grew 17 percent last year, according to the Renewable Fuels Association. That could lay the groundwork for growth in cellulosic ethanol.

"Corn is a transitional technology, it's creating infrastructure and demand, but ultimately we're going to be growing specialized energy crops," said Chris Somerville, a researcher at Stanford University's Global Climate and Energy Project.

Already, 37 states have stations that pump E85, a blend of conventional ethanol with gasoline. The total number of pumps is small, but ethanol is closer to reality than hydrogen fuel cells, the government's other big transportation fuel push.

And the few hydrogen fuel cell cars in existence cost about \$1 million. But more than 5 million U.S. cars can burn E85.

Energy experts are cautiously optimistic. "The infrastructure is there or the technology to create it is there," said Aaron Brady, an analyst at Cambridge Energy Research Associates in Massachusetts. "I don't see any huge hurdle to getting this stuff to the pump," he said.

He said the fuel could become a big part of an alternative fuel program that eventually cuts oil dependence by including solar, wind and nuclear power.

The first commercial cellulosic ethanol plant is slated to open this year in Spain, owned by SunOpta Inc. <STKL.O> Logen plans to build a \$350 million commercial plant in the Midwest or Canada next year, though it hasn't secured financing yet.

Earlier this week, U.S. Energy Secretary Sam Bodman announced that Washington is offering \$160 million to build up to three industry-government funded cellulosic ethanol refineries.

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