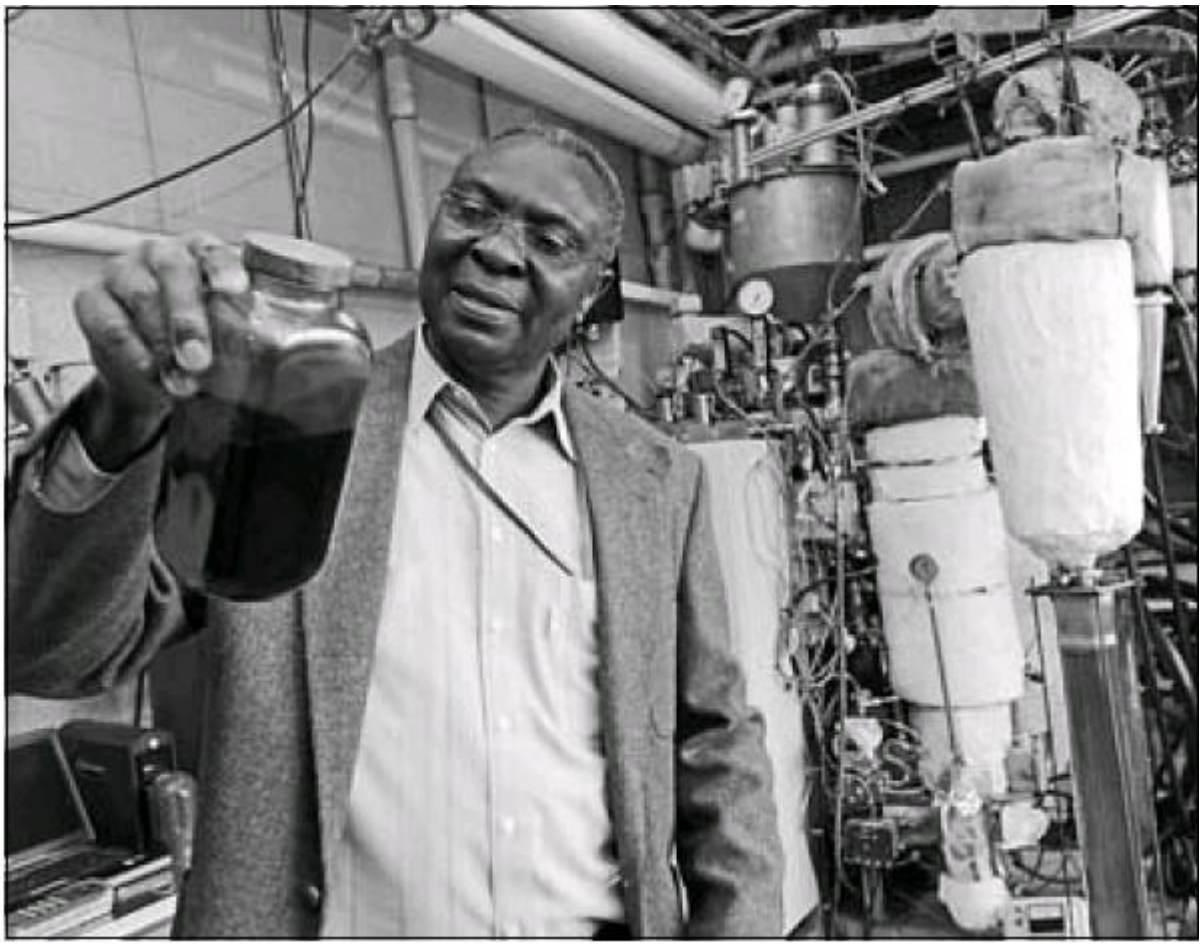
Turning agriculture into oil, bio oil, that is

The process dates to ancient Egypt. Now, it's being studied here by the USDA as a way to fuel farms.

Pour a few handfuls of chopped- up corn stalks or switchgrass into a hopper. Heat rapidly. Funnel the resulting mixture through an intricate network of metal pipes and canisters.



APRIL SAUL / Staff Photographer **Chemical engineer Akwasi A. Boateng holds up a sample of oil produced by the process called fast pyrolysis.**

Out the other end — drip, drip — comes a thick brown liquid that looks an awful lot like oil.

Called bio oil, it is not quite the same as what comes out of a well. But it is close enough that government scientists think the process, called fast pyrolysis, is a promising way for farmers to enhance energy security.

The room-size network of pipes and canisters is a pilotscale reactor in Wyndmoor, at the eastern regional research center of the U.S. Department of Agriculture. Scientists there are confident that,

with some tweaking, they can turn any "biomass" — even manure — into oil that can be refined into gasoline or diesel fuel.

"We want to engineer this for the farm," said Akwasi A. Boateng, the chemical engineer who is leading the effort for the Agricultural Research Service.

Agriculture has long been touted as a source of automotive fuel, the prime example being ethanol, to the tune of billions of gallons each year. But most U.S. ethanol is made from corn, grown through an energy-intense process that typically uses a lot of fertilizer. Critics also knock the use of corn for fuel because of the potential for raising food prices. And ethanol, no matter the source, is not fully compatible with the infrastructure for petroleum.

The goal of Boateng and his colleagues is to make oil, and ultimately gasoline, that is interchangeable with the traditional kind. And they would make it from nonfood crops such as switchgrass, which can be grown on lower-value land. Or from the inedible part of corn — the stalks and other residue called stover.

Farmers use stover to build up carbon in the soil, but that is not a very effective use of the material, said Robert C. Brown, director of the Bioeconomy Institute at Iowa State University.

Brown, who is familiar with the USDA research, said pyrolysis was potentially a much better use for stover and other agricultural by-products.

"Dr. Boateng's work is producing the equivalent of an oil well," Brown said.

The private sector is getting into the pyrolysis act as well, with several efforts toward commercialization under way.

One is Envergent, a joint venture between Honeywell-owned UOP and Ensyn, a Canadian company, that has built a demonstration plant in Hawaii.

Pyrolysis means heating something in the absence of oxygen so that it does not burn but decomposes, yielding a mixture of charcoal, gas, and oily liquid. It has been around at least since ancient Egypt, when it was used to make tar for sealing boats. But the ancients were performing slow pyrolysis, heating the material slowly in an enclosed pit — a process that does not yield much oil.

In the 1980s, scientists learned they could increase the yield of oily liquid by applying heat rapidly, hence the name fast pyrolysis. Yet, unlike oil from a well, pyrolysis oil contains oxygen, and thus cannot be readily processed in a traditional refinery.

Boateng is working with research chemist Charles Mullen, mechanical engineer Neil Goldberg, and others on refinements, such as using a catalyst, that would remove oxygen from the oil.

Boateng, a native of Ghana whose nickname is Kwesi, jokingly refers to the pilot plant as the Kwesinator, which can process about 10 pounds of material per hour. With a new $6.8 million USDA grant, the team is building a much bigger reactor that can be moved from farm to farm on a trailer.

That device would handle two tons a day, yielding about 300 gallons of oil, Boateng said. Someday he wants to build a fullscale reactor that would make 100 times that much oil, by taking in raw material from multiple farms in a 25-mile radius.

The material is heated rapidly by feeding it through a "fluidized bed," a mix of gas and hot sand.

"The gas and the sand are behaving like a boiling liquid," Boateng said.

Kevin Hicks, who oversees all biofuels research at the Wyndmoor research center, said bringing the reactor to the farm is key. It is much easier to make oil on site rather than trucking the grasses or corn stalks a long distance, as these raw materials are not very dense.

"The cost for transporting a ton of that stuff gets really high, so it just destroys the economics," Hicks said.

Economics, after all, are what will determine if this process catches on in a big way. Boateng's analysis suggests that pyrolysis oil can be cost-competitive with the traditional variety, though a lot depends on what raw feedstocks are available. And once there is demand, the cost of the materials goes up.

Helping the equation are the two other products of pyrolysis — the gas and the charcoal, more commonly called biochar. The Kwesinator runs on electricity, but the gas and charcoal could be burned to power the reactor — with an estimated energy efficiency of about 60 percent. And any leftover charcoal can be used to improve soil quality, much as the ancients did.

The team is working with more than a dozen academic and private-sector partners on the project, including the University of Delaware, Drexel University, Villanova University, the University of the Sciences, and Swarthmore College, where Boateng once taught engineering.

One goal of getting fuel from plants is to achieve carbon neutrality. The idea is that burning fuel does not result in a net gain of heat-trapping carbon in the atmosphere, because growing more plants will absorb it again.

But since some of the biochar would be returned to the soil, where it would remain for long periods, the USDA scientists argue that their process could be better than neutral.

"We like to think we're carbon negative," said Goldberg, the engineer.

A negative that could be a big positive.