Bioenergy potential of reviving abandoned agricultural land

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Across the globe, hundreds of millions of acres of once-productive agricultural land lie abandoned, according to a new report from researchers at Stanford University and the Carnegie Institution for Science. If this land was used to grow crops for conversion into biofuel, it could help ease the energy crunch without worsening the world food shortage or contributing to global warming.

Critics blame biofuel production for contributing to recent global food shortages, which have spawned riots. Although much of the current supply of biofuels comes from crops that could be used for food, biofuels need not be a villain taking food from the mouths of the hungry, the researchers say. Neither, however, are biofuels likely to be the magic bullet that slays the dinosaur of our dependence on fossil fuels.

"Our results showed that if you used all these abandoned agricultural lands, you might obtain up to 8 percent of current energy needs," said Elliott Campbell, a postdoctoral fellow in biology at Stanford University and lead author of the report scheduled to be published June 25 in the online edition of *Environmental Science and Technology*. "So this result is basically showing us that biofuels could be a meaningful, but a small portion of our total energy future."

Perhaps the biggest limiting factor with biofuel production is finding land to grow the biomass needed to produce the energy. Taking cropland out of food production clearly is not a good long-term answer. Nor is clearing forestland.

"Basically, what happens when you cut down forest is that all the carbon that was stored in those trees is released to the atmosphere," said Chris Field, a professor of biology and environmental earth system science at Stanford and a co-author of the paper. "If you put biomass energy in locations that previously had agriculture but don't now, you can avoid those problems."

Between 1- and 1.2-billion acres of abandoned agricultural land is lying fallow, according to the researchers.

"Just to put that in context, global cropland is around 3.8 billion acres. So this is not a small number; it's something like a quarter of the total amount of cropland globally," said Field, who is also director of the Carnegie Institution's Department of Global Ecology at Stanford.

To determine how much fallow cropland there is around the world, they used a combination of satellite imagery and historical maps of agriculture.

Then, they estimated the amount of land that had either been lost to urbanization or had gone back to forest, and reduced the total of available land accordingly.

Land has fallen out of agricultural production for a variety of reasons. In some instances, new technologies or infrastructure made land with better soil available, as when farmers in the eastern United States left their farms for the richer prairie soils of the Midwest.

In other areas, soil erosion may have triggered the abandonment, or soil nutrients may have been depleted through poor farming practices but might still be sufficient to support grasses.

Field said there are three broad categories of crops that have potential

for bioenergy: food crops, local native plants and special bioenergy crops such as switchgrass or elephant grass, both of which are hardy enough to grow well on marginal agricultural land.

"These abandoned agricultural lands are distributed throughout the world, in places with a variety of different climates," Campbell said. "So the type of plant species that might give you the most biomass per year would probably depend on the local climate."

Corn is not necessarily the crop of choice for the abandoned lands because some of these areas are prone to erosion, and corn needs intense cultivation and tilling, Campbell said.

"Perennials, crops that don't need as much tilling or cultivation would probably be more advantageous, so you would have less runoff, less pollution in the water and you would be able to sustain your soils better," he said.

Brazil, China, India, the southern republics of the former Soviet Union, Australia and the United States all have large areas of land with significant potential for growing bioenergy crops.

"The ability of biomass energy to be a significant fraction of a country's energy demands is actually greatest in the countries that have a combination of significant amounts of productive land and relatively low energy consumption," Field said. "That is mainly countries in the middle part of Africa, Mongolia, areas that are at the very early stage of developing an energy infrastructure and are really poised to take advantage of the bioenergy resources that are available to them."

Crops can be converted to bioenergy in a number of ways, Field said. "At the low-tech extreme, biomass can be burned in indigenous stoves. At the high tech extreme, it can be fed into energy-efficient power plants

or it can be converted into liquid transportation fuels."

A regular coal power plant can have up to about 5 percent biomass mixed in without experiencing any significant loss in efficiency, Field said. The net effect on carbon in the atmosphere is nil, because the carbon released during burning has been pulled by the plant from the atmosphere during photosynthesis.

"If you do that in situations where the coal power plant has carbon capture and storage, you are actually having a net path moving CO_2 out of the atmosphere into the plant and then into long-term underground storage," Field said. "So this is one of the ways you could potentially think about actively decreasing the CO_2 concentration in the atmosphere."

"I think that is very attractive - maybe not for 2010, but I hope by 2020 we have some systems doing that," he said.

In the big picture, limitations on the prospects for sustainable biomass energy come into focus when considering the recent growth in the global energy system. With worldwide energy demand increasing by several percent a year, the potential energy content of this sustainable biomass - which in total would amount to about 8 percent of the world's current energy demand - could be offset in only three or four years of continued growth in global energy consumption.

"Hopefully this kind of energy can be one of many pieces of a puzzle that leads us to the energy system that is going to be non-fossil based," Field said.

"Our real bottom line is that we would like this to be the first step toward a map of sustainable biomass energy, but we also want to raise the caution that it would be unwise to think about a future that was

developed primarily with bio-energy replacing fossil energy, because there just isn't enough potential for sustainable bio-energy."

Source: Stanford University