BIODIESEL PRODUCTION COSTS

Emission omissions

Can biodiesel help cut emissions in the Indian transport sector?

Diesel is a major fuel source in India, with 71 percent of the oil consumed in 2005 being diesel and 29 percent gasoline. Given that India's fuel consumption of 12 million tonnes per annum in the transport sector alone is expected to double by 2030, India and other developing countries are urgently seeking cheap and environmentally friendly alternatives to meet future energy demand.

A recent study by IIASA's Forestry Program, published in the journal *Applied Energy*, demonstrates that biodiesel, which produces significantly fewer emissions than regular diesel, can be produced cost-effectively in India from the plant *Jatropha Curcas*, a drought- and pest-resistant perennial that grows in tropical wastelands and produces seeds for up to 50 years. *Jatropha* could potentially produce 150,000 tonnes of cheap and renewable diesel for Indian vehicles per year.

Importantly, *Jatropha* does not compete with food crops for land; instead, it potentially offers opportunities to poorer Indian farmers to use wasteland to increase their income. By-products of biodiesel production, for example, oil cakes and glycerol, can also be used in the fertilizer and cosmetic industries, respectively.

Jatropha seeds have a 37 percent oil content that needs minimal refining before use. As *Jatropha* biodiesel is very similar to diesel itself, little modification to current engines is required. Vehicles can run on pure biodiesel or any bio/mineral diesel mix. Compared to mineral diesel, pure biodiesel cuts emissions of black carbon or "soot" by 60 percent, carbon monoxide and hydrocarbons by 50 percent, and greenhouse gases by 80 percent. Sulfur dioxide emissions are nil, given the vegetable origin of *Jatropha*; however, the combustion characteristics of the engine used could increase or decrease nitrous oxide emissions by up to 10 percent.

With Luleå University of Technology in Sweden, IIASA modeled 40 million hectares of Indian wasteland across 24 states to determine the number and locations of potential biodiesel production plants that would be optimal for fuel production. The analysis revealed that biomass cost was the most important factor affecting overall biodiesel production cost, followed by investment and transportation. One result of the emissions analysis was that poor *Jatropha* plant yield at any location could result in raw materials needing to be transported to the production plant, increasing financial costs and emission levels. While overall findings show that, based on the costs of production and the emissions released, an appropriate number and specific locations of biodiesel plants can be determined, further research is required on the economies of scale involved.

The use of *Jatropha* for biodiesel production, while significant, is limited to tropical countries. Previous FOR research has shown that methanol derived from poplar trees can be a viable biofuel alternative to gasoline in Austria, while ongoing research is looking at the potential for using a variety of other plant types (such as maize or canola) as biofuel production sources in other non-tropical regions. ■

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JATROPHA CURCAS Currently, the oil from *Jatropha Curcas* seeds is used to make biodiesel fuel in the Philippines and Brazil. In India a train powered by 15–20 percent *Jatropha* biodiesel connected two of its largest cities in 2007. In 2008 a Boeing 747 Air New Zealand carrier became the world's first successful test flight on *Jatropha* biofuel.

Further information Leduc S, Natarajan K, Dotzauer E, McCallum I, Obersteiner M (2009). Optimizing biodiesel production in India. *Applied Energy* 86(1):125–131.

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