Biofuels: Are They Still Relevant?

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With the race to find new gas deposits and develop production of other carbon-based fuels, such as shale oil in the USA, Argentina, Russia and Algeria, the development of the tar sands in Canada and the return to coal in some countries, biofuels might appear irrelevant. But this ignores the high cost, both financially and in terms of water use, impact on local habitats and the longer-term consequences for climate change that result from exploiting both the old and these new sources of oil and gas (Crooks, 2013; Lattanzio, 2013). Such exploitation undercuts efforts towards an energy transition in which clean transport technologies, such as biofuels, could be important. Some options that biofuels are already providing in developing countries are briefly examined and factors that contributed to their positive impact on inclusive development are discussed.

Link to agriculture

A key link between clean and sustainable energy in the transport sector and inclusive development is to agriculture, for both biodiesel, made from the seeds of oil-rich plants, and ethanol, a product of fermentation using plants such as sugarcane or maize[1]. However, biofuels have been both praised as a means to provide energy and reduce greenhouse gas emissions, and criticised for contributing to the destruction of tropical forests and competing with food crops for agricultural land. These negative effects need not always result.

Jatropha, for example, has been regarded as an important feedstock for biodiesel because it can grow on marginal land and in arid environments unsuitable for food crops (UNEP, 2009). It is also a good candidate for smallholder production. Yet, it has not worked out well everywhere. The case of Garalo in Mali is an exception.

In 2007, rather than rely on imported diesel fuel for a future off-grid generator, the villagers of Garalo chose to plant Jatropha on 440 hectares (ha) of their land as part of a multi-goal project to stimulate rural development by providing electricity for lighting, refrigeration, welding and agricultural processing machinery for use by businesses, workshops, health services and schools. It would supply the electricity to reduce the costs of the village water-pumping system, replacing the diesel genset then in use with electricity from a local mini-grid they planned to build. That grid now has over 230 clients, of which 198 are households (ACCESS SARL, 2010; Burrell, 2008). The long time to maturity of Jatropha seed, however, has meant that in 2011 Jatropha oil accounted for only 5-10% of the fuel used, the remainder coming from diesel fuel.

[1] More recently, second-generation biofuels made from wheat or rice straw, bagasse and other decomposable agricultural and waste products have begun to expand these options and the commercial production of biofuels made from algae is moving second-generation biofuels even further ahead.

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Nonetheless, the project has produced some very positive results. Many came from the role that local farmers played in the project design and in the decision to plant Jatropha. Of the 440 ha planted with Jatropha, 2 ha were prepared as a nursery and 95% of the fields were planted by individual farmers. A survey after two years showed that many farmers[2] had chosen to intercrop Jatropha and local food crops such as maize, sorghum, millet, peanut, sesame and beans, indicating that an either-or choice between using land for food or fuel is not essential.

Farmers in Garalo have also developed and sustained close links to research institutions relatively nearby. This has led to considerable follow-up experimentation and local learning as well as improved methods of inter-cropping (Mytelka *et al*., 2012). Such learning processes and linkages offer the flexibility that smallholders need to adapt as prices and competitive conditions change. The experience of a women's group in Gbimsi, a town in Northern Ghana, moreover, illustrates the importance of creating such linkages in the early phase of project development. Previously, the lack of a locally available energy supply meant that it took the woman of Gbimsi two weeks to process 25 kg of shea butter, their major commercial crop. With the support of Ghana's Ghana Regional Appropriate Technology Industrial Service (GRATIS) Foundation[3] and UNDP-GEF (Global Environmental Facility) they grew Jatropha on a 4-ha farm, using cuttings and seeds grown in the field. With equipment designed by the GRATIS Foundation they extracted oil and mixed it with traditional diesel fuel (70% Jatropha)[4] to run the shea butter extraction and processing equipment. Within a few years they were able to deliver one metric ton of shea butter in a month, earning two million Ghana cedis (around US$ 1 million) in profit. Subsequently, however, increased production of shea butter in the area and insufficient markets for the product locally made a rethink necessary. Through the GRATIS network, the women, who have full control and ownership of the project, began to explore additional options such as palm oil extraction and the production of diesel fuel for stand-alone generators.

Most Jatropha projects have not put farmers in the driver's seat, nor adopted the kind of multi-goal approach that strengthens smallholder farmer communities. This is particularly true when Jatropa oil is conceptualised from the outset as an export commodity. Several factors help to explain the unexpected, often negative impact that this can have on inclusive development.

Firstly, the assumption that Jatropha is a low-cost, low-input crop that grows virtually by itself is problematic in the context of scaling up. Research in India shows that the export price of Jatropha depends on increasing the yields, which in turn requires costly inputs in improved seeds, water and fertiliser (Altenburg *et al*., 2008). This puts Jatropha into direct competition with food crops. It also increases the upfront investment costs over the years during which the Jatropha plants are maturing. Such large projects are thus frequently undertaken by foreign investors and many involve the purchase of land owned by local farmers, or long-term leasing arrangements. Failure to reach anticipated yield levels in a reasonable timeframe and changes in global pricing for fuels have led to the abandonment of

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[2] 71.2% of the 118 hectares sampled in the field study.

The GRATIS Foundation offers business development services, provides training in food processing and textile industries, manufactures machinery and equipment for rural farmers and maintains a network of rural service centers and support groups.

[4] The extraction of Jatropha oil is a much simpler process than making biofuel.

many such ventures in India (Cotula *et al*., 2008), Ghana (Dogbevi, 2009ab) and Tanzania (Pohl, 2010; Carrington & Valentino, 2011). This includes the fall of Sun Biofuels Tanzania LTM, a UK-based company that purchased 9,000 ha of land from local farmers in 2005 as the first stage in a project to plant Jatropha for export and provided 1000 local jobs, and the uncertain future of London-based D1 Oils when BP withdrew from their Jatropha joint venture in Ghana.

Secondly, a movement towards mass market and export activities requires a quite different management, and often ownership, model that increases uncertainties associated with global pricing trends and limits the role that Jatropha can play as a driver of local development, especially for smallholders.

Jatropha is only one of a broad range of agricultural-plant-based inputs that can be used to produce diesel fuel. Of importance when deciding between different possible plants is the amount of oil that can be extracted from the seeds. Sunflower seeds and rapeseed oil, for example, are high in extractable oil (43% and 40%, respectively). This increases their energy efficiency in biodiesel engines. Soyabeans have an oil content of only 20%.[5]

In transitioning to clean and renewable energy, the pros and cons of each option need to be considered on their own merits in its local context. In 2008, Michael Mwakilasa, a Tanzanian national, established Mafuta Sasa Biodiesel with a friend, which positioned itself to replace 2% of the diesel market in Dar es Salaam with biodiesel from used cooking oil that has been chemically transformed into biodiesel suitable for use in diesel engines or generators. At that time Tanzania consumed over two million litres of petroleum diesel daily, all imported. Matatu (privately owned mini-buses) owners, the company's principal customers, can now purchase biodiesel at a price 20% lower than that of imported petroleum diesel (Mafuta Sasa, 2011).

A similar reliance on imported oil stimulated Brazil's long-term research process that led to the development of ethanol from sugarcane that could compete with imported oil for dominance in the automobile sector. Brazil became the world's second largest producer of ethanol and by 2010, over 90% of the new car registrations in Brazil were flexfuel vehicles[6] able to shift between ethanol, gasoline and a variety of blends as prices changes. Today, Brazil is a world-class producer of research on sugarcane and second-generation biofuels such as cellulosic ethanol.

In 2009, the Organisation for Economic Co-operation and Development (OECD) drew attention to the emergence of the 'bioeconomy' (OECD, 2009) and its potential importance for developing countries. In the not-too-distant past, the very notion of building a bioeconomy in a developing country would have seemed unrealistic. Currently, however, the development of biofuels from sugarcane and second-generation cellulosic ethanol and diesel in Brazil and the ongoing research on enzymes to decompose wastes in South Africa and make diesel fuel from algae, suggest that this is no longer the case.

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[5] Over the next few years, it is expected that further research will enable the price for biodiesel made from algae to decline. Algae do not compete with food crops and can use CO_2 as a nutrient.

[6] Data are from ANFAVEA, the Brazilian Automobile Association.

What are needed now, however, are efforts to further strengthen local research capacities, and encourage participation in collaborative research and development (R&D) projects by potential users of the output. There are some indications of greater focus on the development of collaborative research projects such as these in the European Union's new Horizon 2020 programme and the Climate Technology Network set up in Copenhagen as part of the United Nations Framework Convention on Climate Change (UNFCC) and its Green Climate Fund. For this to be effective, however, governments in developing countries must focus on the coordination of policies across government ministries, thus laying the foundation for the long-term development of a bioeconomy and the multiple options it will offer in the future.

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