Biofuels: still in bloom or cause for gloom?

Demand for biofuels has increased amid growing energy needs, rising oil costs, concern about climate change, and a desire to boost farm incomes in developed countries. Scepticism about the environmental benefits has also increased, along with concerns about trade-offs with land tenure and food security in developing countries. Can bioenergy benefit agricultural growth, poor people, and the planet?

Interest in renewable energy has grown over the past decade, with demand driven not only by rising energy needs and costs but also by concern about climate change mitigation and a desire to boost agricultural income. Industrialised countries, in particular, have enacted policies in the hope that biofuels would reduce dependence on imported fossil fuels, increase farm revenues, and reduce greenhouse gas emissions from the transport sector. In turn, the need for crops – such as maize and oilseeds – to be used as feedstocks for first-generation biofuels has increased dramatically. This has had a significant impact on global food systems and the volatility of key commodity prices – with strong implications for poor people, who spend a large share of their incomes on food. Debate has ensued over trade-offs and synergies between food, feed, and fuels. The rise of crop-based biofuels has been felt through the reduction of exports from key agricultural producers and the increase in market prices. In addition, several studies have raised concern about negative environmental consequences such as the release of carbon emissions when forests are cleared for biofuel production.

Such concerns notwithstanding, scenarios generated by the Intergovernmental Panel on Climate Change show renewable fuels such as biofuels playing an important role in stabilising atmospheric carbon levels as part of the global energy mix to 2030 and beyond. The challenge will be to design the most beneficial, truly carbon-saving biofuel programmes.

Impact on food and poverty

Poor people are disproportionately vulnerable to the effects of food price volatility because food dominates their spending. The rapid increase in demand for and production of biofuels, particularly bioethanol from maize, has affected the dynamics of grain markets and exports from key regions. Expanded production of ethanol from maize, in particular, has increased total demand for maize and reduced maize exports, driving up the prices that importers must pay. Rising prices, in turn, have had an impact on the demand side, causing food consumers to shift their diets towards other grains – rice, wheat, or even coarse grains such as millet and sorghum – which still comprise a significant portion of staple food intake in much of the developing world. According to an IFPRI model that projects long-term impact on food supply, demand, and prices, the acceleration of biofuel production accounted for roughly 30 percent of the rise in real cereal prices during the period 2000–07. The greatest impact was on maize prices. According to IFPRI's analysis, ethanol production was a significant contributor to the 2007–08 food-price crisis.

Siwa Msangi
Senior Research Fellow
International Food Policy Research Institute (IFPRI)
Washington, DC, USA
s.msangi@cgiar.org

In theory, the higher prices for commodities resulting from biofuel feedstock production can mean higher incomes for some farmers in developing countries and better agricultural wages for labourers although the distribution among winners and losers depends upon the nature of land holdings and whether household farms are net producers or consumers of the crop. In practice, trade protectionism, such as high tariffs against imports of ethanol into the United States, represents a loss in benefits to sugar producers in countries such as Brazil while accruing benefits to US maize producers.

Likewise, subsidies in industrialised countries have constrained the competitiveness of biofuel production in the developing world even as they have pushed up food prices, thus reducing consumption and nutritional well-being for net buyers. In its push to increase biofuels, the US government subsidises the output of ethanol, paying blenders for each gallon of blended fuel produced. Most US ethanol comes from maize and, according to some estimates, almost a quarter of this year's US maize crop will be diverted to fuel. The production of biodiesel made mostly from soybean oil is also expanding, although the volume of biodiesel produced within the European Union still dominates by a large margin. Many commodities analysts and economists have identified this demand as a primary factor pushing up wholesale food prices, including in grain-based food chains such as meat, dairy, and poultry. Many analysts also regard the diversion of the US maize crop from food and feed exports to domestic biofuel production as the most significant source of demand-driven pressure on prices. The use of maize for ethanol grew especially rapidly from 2004 to 2007, with ethanol using 70 percent of the increase in global maize production.

The United States accounts for about one-third of global maize production and two-thirds of global exports, so changes in production easily affect international prices. By comparison, European biofuel production is concentrated in biodiesels and uses about 7 percent of global vegetable oil supplies, amounting to about one-third of the increase in vegetable oil consumption in 2004–07. Biofuel production in the rest of the world is either relatively small or uses crops (such as sugarcane, in the case of Brazil) which have not experienced price surges.

Environmental consequences

While transportation and industry dominate the profile of global greenhouse gas emissions, agriculture has also contributed towards the global climate change problem. As a sector, it contributes about 13.5 percent of annual greenhouse gas emissions (with forestry contributing an additional 19 percent), compared with 13.1 percent from transportation. However, agriculture also offers promising opportunities to mitigate emissions through enhanced carbon sequestration with improved soil and land use management practices, and the production of biomass for renewable energy.

The expansion of biofuels production, however, raises the prospect of increased pressure on the limited natural resources upon which poor farmers depend and for which they compete. The rise of large commercialised agribusiness ventures – whether geared towards biofuels or

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not – could lead to the exclusion of smallholders from productive agricultural land, if not adjudicated properly, and water supplies could be placed under greater strain.

Already there is concern that the land-use consequences – primarily, the loss of natural cover such as shrubland and forest – could be undoing some of the potential carbon benefits of switching from fossil-based transportation fuels to biofuels. Were sugarcane production for bioethanol to be scaled up in India, limited water availability could prove to be a major barrier to expansion since most of the country's crop is irrigated from strained surface and groundwater resources. Similar environmental constraints would confront Senegal and Mozambique, although the barriers facing biofuels in these countries are mainly economic. Brazil, by contrast, has an experienced and vibrant biofuels sector whose main feedstock, sugarcane, is almost entirely rain-fed and very high-yielding.

Whether for food, feed or fuel, increased crop production will rely on a combination of more extensive and intensive farm-level feedstock production in order to meet growing demands to 2030 and beyond. Where production becomes more extensive, cultivation will spread and we will see more sweeping loss of natural land cover, including forests. This could be minimised through the intensification of production on existing acreage but, we would then see a rise in the environmental burden of pesticides and fertiliser, in addition to an increase in water consumption. Greater dependence on fertilisers also could amplify the farm sector's sensitivity to oil prices, since most fertilisers are made from energy products. Energy can account for up to 90 percent of the price of fertiliser production.

Managing trade-offs

Despite the technological and economic challenges confronting them, a number of developing countries are joining the biofuels rush in a desire to reduce dependence on expensive oil imports and attract investment to their nascent agribusiness sectors. In Mozambique, a food-insecure country that is increasing export-oriented production, some research has already demonstrated a potential for poverty alleviation and perhaps for greater food security if biofuel production provides technological and other types of beneficial spillovers into food production, particularly of staple crops. And if production of the feedstock – in this case, jatropha and perhaps sugarcane – relies on outgrower schemes, which are decentralised rather than concentrating production on one or a few big plantations, then the potential for poverty alleviation through employment is even greater. In Mozambique, however, there are key trade-offs to consider between the growth of biofuels and other labour-intensive export-oriented sectors since land is abundant and labour is relatively scarce.

By contrast, recent research on biofuels growth in Tanzania carried out by the Food and Agriculture Organization of the United Nations in conjunction with IFPRI has shown that expanding biofuels production can potentially free up labour that would otherwise be involved in labour-intensive export crops such as cashews and, in so doing, even help boost food production. However, Tanzania and Mozambique need to address the challenge of providing infrastructure that is adequate to attract investment and ensure the viability of a biofuels sector. Poor infrastructure prevents any agribusiness venture – whether based on biofuels or not – from taking off and thriving.

IFPRI modelling suggests that, given technology spillovers to the food sector, a mix of ethanol from plantation-based sugarcane and jatropha biodiesel from outgrowers could allow Mozambique's total national income (GDP) to grow by an additional 0.7 percent, while the growth of value added in the

agriculture and manufacturing sectors would be 2.4 percent and 1.5 percent, respectively. If configured in this way and implemented properly, biofuels could account for up to 5 percent of the country's GDP by 2015, although some of this growth might come at the expense of growth in other export crop sectors due to crowding out of labour and other resources. All in all, the simulated growth in biofuels production could bring about a 5.9 percent reduction in the national poverty rate, which translates to a decrease of 6.4 percent in rural poverty and 4.9 percent in urban poverty.

Recommendations

How, then, to maximise the benefits that biofuels could bring to the agricultural economies of aspiring producer nations and minimise the possible environmental and economic trade-offs? The effects of global biofuel development and growth, especially on poor rural households, are likely to be mixed and specific to each farming system and the socio-economic context of each country. For this reason, a single appropriate template for policymaking or programme design is unlikely to emerge. Nevertheless, research by IFPRI and others supports the following broad recommendations:

- Choose the most efficient and high-yielding feedstock. Production of ethanol from Brazilian sugarcane, for example, has minimal effects on the food market (due to the flexible, dual-use nature of Brazilian sugar and ethanol processing facilities) and on water use and deforestation (because most of the sugar is not grown in Amazonia and is rain-fed). Brazilian sugarcane is also the lowest-cost source of ethanol, especially when compared to US maize ethanol, which is largely competitive due to the significant subsidies and trade protection provided to producers and processors. The poor-yielding varieties of jatropha that are being tried in Senegal, India, Mozambique, Tanzania and other parts of the developing world, however, offer little promise of being competitive for large-scale biodiesel production unless significant improvements are made to the feedstock crop and to its value chains.

- Develop production processes for liquid biofuels that bring a wider array of benefits to poor people. Production systems should integrate rural households, where possible, by allowing the non-farm addition of value rather than just extracting raw biomass. Some mixed configuration of centralised plantations producing feedstocks combined with some outgrower-based production coming from smallholders could be possible in many places.

- Diversify beyond just the production of biofuels for the transportation sector – which for most countries in sub-Saharan Africa is relatively small, compared to the export demand going to the EU and other OECD countries, and doesn't take into account the energy demands of poorer people. In many developing countries, there is much need for renewable and cleaner sources of energy for cooking, heating, and lighting, compared to the traditional woody biomass that is used. This will have different implications for women's and men's domestic air quality, health, and time use that should also be considered.

- Reduce subsidies and trade protectionism and periodically review and revise biofuel blending mandates from OECD countries. This would enhance the in-country economic benefits and global environmental gains by making it easier to get lower-cost, sugar-based ethanol from developing countries to advanced markets. IFPRI research has shown that although trade liberalisation could lead to slightly greater conversion of land for production in Brazil and elsewhere outside Europe, this effect would be outweighed by the reduction in direct greenhouse gas emissions.

In summary, biofuel production could yield substantial benefits for people in developing countries but bringing about the conditions necessary for success will involve significant investments and improvements in efficiency along the entire value chain and among rich and poor countries.

Zusammenfassung

Viele Entwicklungsländer streben einen Ausbau ihrer Biokraftstoffproduktion an, um die Abhängigkeit von teuren Ölimporten zu verringern und ihre aufstrebenden Agrarwirtschaften zu fördern. Die Folgen der weltweiten Entwicklung bei Biokraftstoffen, insbesondere für arme Haushalte in ländlichen Regionen, werden voraussichtlich sehr unterschiedlich sein und von den Agrarstrukturen und dem sozioökonomischen Hintergrund jedes Landes abhängen. Daher wird es sicherlich auch in Zukunft kein Patentrezept für geeignete politische Richtlinien oder Programmentwürfe geben. Aus Forschungsarbeiten können jedoch verschiedene Empfehlungen für angehende Erzeuger und bereits entwickelte Märkte abgeleitet werden.

Resumen

Los países en desarrollo están buscando expandir su producción de insumos para biocombustibles, a fin de reducir su dependencia frente a las costosas importaciones de petróleo y dar un impulso a sus incipientes sectores de agro-negocios. Los efectos del desarrollo y la expansión de los biocombustibles a nivel mundial sin duda serán mixtos – especialmente para los hogares pobres – y quedarán determinados por las especificidades de los sistemas agrícolas y el contexto socioeconómico de cada país. Por lo tanto, es poco probable que se pueda contar con un único patrón correcto para la definición de políticas o el diseño de programas. No obstante, la investigación ha dado como resultado un conjunto de recomendaciones generales para productores en ciernes y mercados avanzados.