Geo Factsheet

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BIOFUELS: An Environmental Option?

Views on the Increase in Biofuel Production:

"Biofuel policy is rushing ahead without understanding the implications"
Renton Righelato, The World Land Trust [a conservation charity]

"Biofuel production threatens to accelerate the destruction of some of the world's most precious habitats and wildlife. Without environmental standards, biofuels will be little more than a green con."
Mark Avery, Director of Conservation at the RSPB

"The Government's policy on biofuels is in danger of doing more harm than good. Without tough minimum standards, we risk escalating deforestation and even increasing our CO_2 emissions."
Adam Harrison, Food and Agriculture officer at WWF

"Biofuels are a false solution to climate change and are doing much more harm than good."
Friends of the Earth

Introduction

Biofuels are fossil fuel substitutes that can be made from a range of agri-crop materials including oilseeds, wheat, corn and sugar. They can be blended with petrol and diesel. In recent years, increasing amounts of cropland have been used to produce biofuels.

Biofuel technology has been available for some time, but concerns about fossil fuel scarcity, climate change and the desire to support rural economies has led to significant recent expansion. The argument has been that this is an environmentally friendly way of meeting the rising demand for energy. Biofuels became part of the 'climate change agenda' at the UN's Earth Summit in Rio de Janeiro in 1992, with the EU in particular taking up the biofuels mantle for this reason. In the USA production soared as farmers saw biofuels as a lucrative source of income. Initially, environmental groups such as Friends of the Earth and Greenpeace were very much in favour of biofuels, but as the damaging environmental consequences have become clear such environmental organisations were the first to demand a rethink of this energy strategy.

Different Types of Biofuel

The main methods of producing biofuels are:

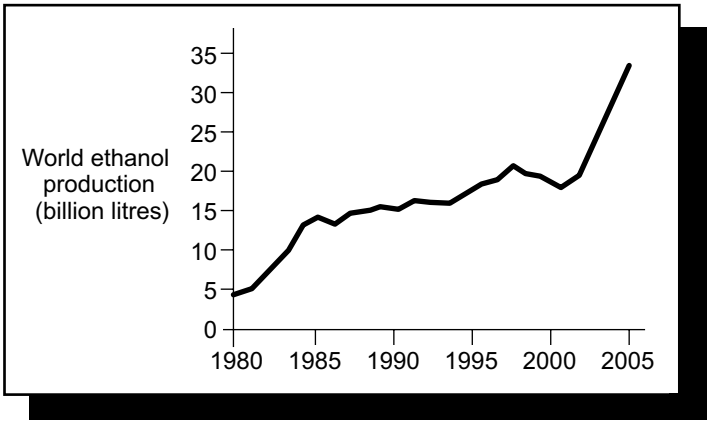
- Growing crops high in sugar (sugar cane, sugar beet, sweet sorghum) or starch (corn/maize). Then yeast fermentation is used to produce ethanol (ethyl alcohol).
- Growing plants containing high amounts of vegetable oil such as oil palm, soybean and jatropha. The oils are then heated to reduce their viscosity and they can be burned directly in a diesel engine, or chemically processed to produce fuels such as biodiesel.
- Wood can be converted into biofuels such as woodgas, methanol or ethanol fuel.
- Cellulosic ethanol can be produced from non-edible plant parts, but costs are not economical at present. This method is seen as the potential second generation of biofuels.

Biofuel technology is not new. In wartime Germany some vehicles were powered by a blend of gasoline with alcohol fermented from potatoes, called Monopolin. In Britain, grain alcohol was blended with petrol and marketed under the name Discol.

Ethanol

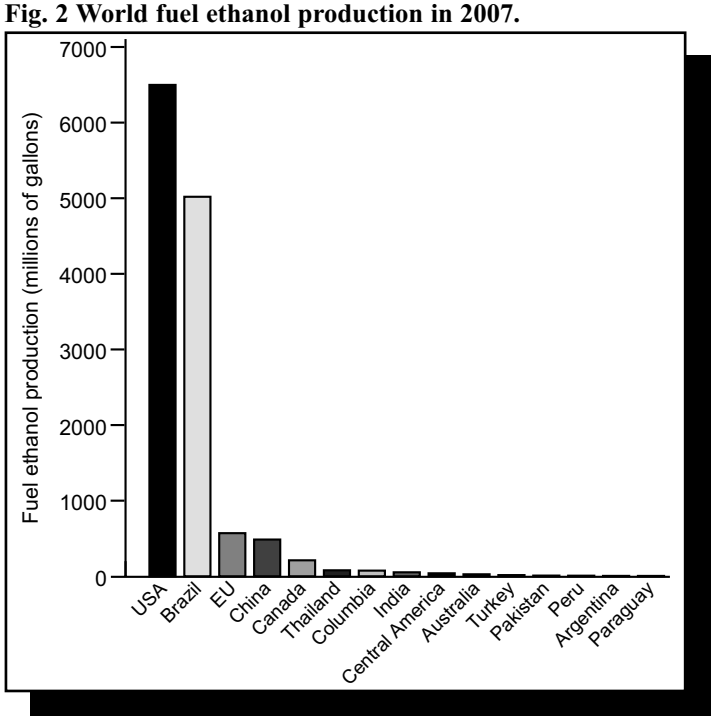
Ethanol is the most common biofuel globally, particularly in Brazil and the USA. It accounts for over 90% of total biofuel production. Ethanol can be used in petrol engines when mixed with gasoline. Most existing petrol engines can run on blends of up to 15% ethanol. Global production of ethanol has risen rapidly in recent decades *(Fig. 1)*. For example, in the USA the amount of maize turned into ethanol increased from 15m tonnes in 2000 to 85 million tonnes in 2007. This amounts to about one-third of US maize production.

Fig. 1 World ethanol production, 1980-2005.



Source: *The Times 07/03/08*

Fig. 2 World fuel ethanol production in 2007.



Source: *www.ethanolrfa.org/industry/statistics*

Fig. 2 shows that the USA and Brazil are by far the largest producers of ethanol in the world. Together, these two countries produce 87.9% of the world total. However, production in the European Union and China is growing significantly.

In contrast to the USA, Brazil uses sugar cane to produce ethanol. More than half of Brazil's sugar cane crop is now used for this purpose. Sugarcane-based ethanol can be produced in Brazil at about half the cost of maize-based ethanol in the USA. This difference is due to:

- Climatic factors
- Land availability
- The greater efficiency of sugar in converting the sun's energy into ethanol.

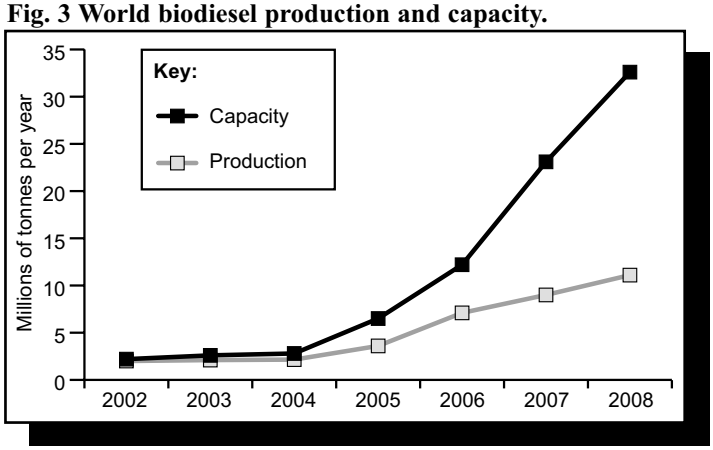
Some car manufacturers are now producing flexible-fuel vehicles (FFV's) that can run on any combination of bioethanol and petrol, up to 100% bioethanol.

The USA has set a target of increasing the use of biofuels to 35 billion gallons by 2017. This is about five times the current level. The objective is to replace approximately 15% of imported oil with domestically produced ethanol. Subsidies are an important element in encouraging biofuel production. In 2006, US tax credits for maize-based ethanol production amounted to around $2.5 billion. This sum is expected to increase with rising production.

Biodiesel

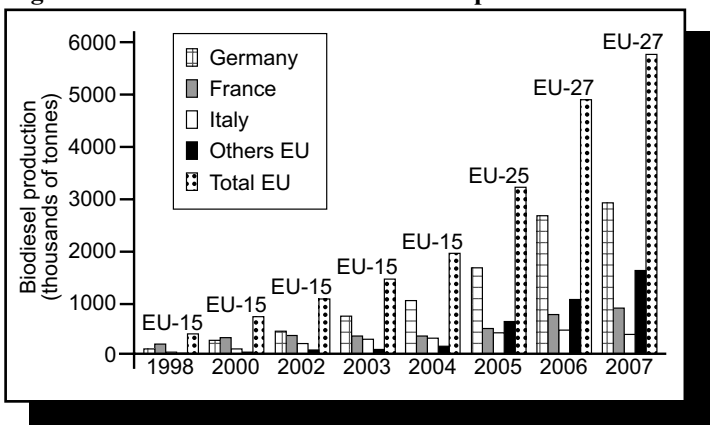
Global biodiesel production and capacity have risen significantly in recent years *(Fig. 3)*. Biodiesel is the most common biofuel produced in Europe, with the continent accounting for over 63% of global production. Germany and France are the leading producers within Europe *(Fig. 4)*. Biodiesel can be used in any diesel engine when mixed with mineral diesel, usually up to a limit of 15% biodiesel. Rapeseed oil is the major source of Europe's biodiesel. After the EU, the USA is the second most important producer of biodiesel. In the latter, soybean oil is the main source for production. Several Asian countries, including Malaysia and Indonesia use palm oil as the source for their biodiesel plants. The expansion of palm oil estates has been at the expense of considerable deforestation and violation of human rights of indigenous people. Between 1999 and 2007 EU imports of palm oil have more than doubled to 4.5 million tonnes

Fig. 3 World biodiesel production and capacity.



Source: *Biodiesel 2020: A Global Market Survey, 2nd Ed.*

Fig. 4 EU amd Member States' biodiesel production.



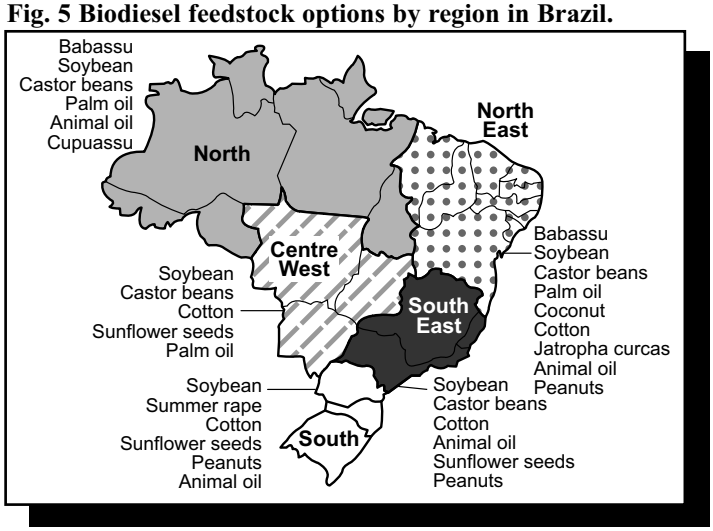
Source: *www.ebb-eu.org/stats.php*

However, in a number of world regions a transition to non-food (alternative) feedstocks is taking place.

- China has recently set aside an area the size of England to produce jatropha and other non-food plants for biodiesel
- India intends to replace 20% of diesel fuels with biodiesel from jatropha
- In Brazil and Africa schemes are underway to produce biodiesel from jatropha and castor. *Fig. 5* shows biodiesel feedstock options by region in Brazil. Each region has a wide range of possible sources.

Increasing investment is taking place in research and development of the so-called 'second generation' biodiesel projects including algae and cellulosic diesel. Other important trends in the industry are a transition to larger plants and consolidation among smaller producers.

Fig. 5 Biodiesel feedstock options by region in Brazil.



Source: *www.emerging-markets.com/biodiesel/default.asp*

The Fuel V Food Debate

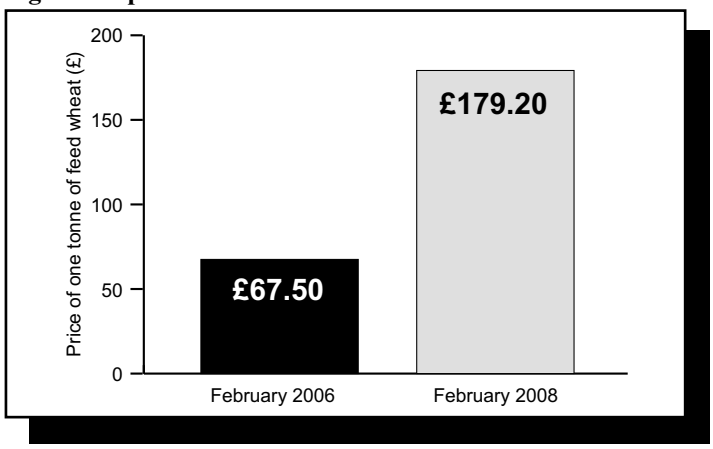
The impact of turning over increasing areas of farmland to biofuels on much-needed food production has been significant on a global scale and devastating in particular parts of the world. The world's poorest people simply cannot afford such a large increase in food prices, resulting in protests in a significant number of countries:

- 'Tortilla riots' in Mexico in January 2007 over a fourfold rise in the cost of maize to make tortilla.
- 'Pasta strike' in Italy in September 2007 over a 20% price increase caused by the rising cost of durum wheat.
- Riots in Senegal, Morocco, Mauritania and Burkina Faso between November 2007 and February 2008 over government increases in staple food prices.
- In Germany beer prices have risen to their highest level ever because of the increasing cost of wheat.
- In the Philippines the government called on Vietnam to guarantee rice exports amid increasing concerns about future food shortages in Asia.

The demand for both fuel and food is increasing significantly. Global population is projected to rise from 6 billion in 2000 to 9 billion by 2050. Energy demand is projected to increase by 50% by 2030. A similar increase is projected for the demand for food.

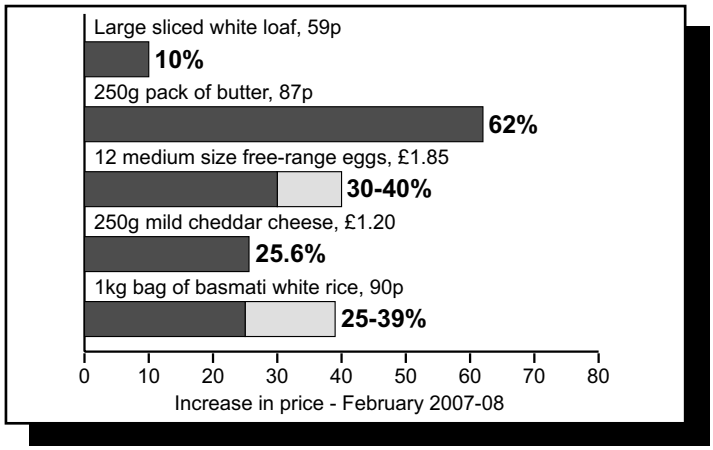
The pressure placed on global food supply by the diversion of crops to energy has been reflected in rapidly rising food prices. For example, the price of a tonne of feed wheat increased from £67.50p in February 2006 to £179.20p in February 2008 *(Fig. 6)*. *Fig. 7* shows how the costs of some basic foods in the UK have risen in price between 2007 and 2008. According to Don Mitchell, chief economist at the World Bank, three-quarters of the 140% rise in world food prices between 2002 and 2008 has been due to biofuels.

Fig. 6 The price of feed wheat in 2006 and 2008.



Source: *The Times 07/03/08*

Fig. 7 The cost of basics - UK prices.



Source: *The Times 07/03/08*

A 2006 report from the UN's Food and Agriculture Organisation suggested that for the EU to meet its 10% target from home-grown biofuels would require as much as 70% of arable land to be taken out of food production. One consequence would be a massive increase in EU food imports. The FAO believes that if biofuel production continues its present upward trend in the USA, nearly a third of US farmland could be used for biofuel production.

In early 2008 the UK Government's Chief Scientific Adviser, Professor John Beddington stated that the rapid increase in biofuel production was threatening food production and the lives of billions of people. It seems that without the increase in biofuels, world wheat and maize stocks would not have declined appreciably and price increases due to other factors would have been moderate.

The Environmental Debate

Supporters of biofuels argue that increasing this energy source will reduce greenhouse gas emissions. This view largely held sway in the 1990s and the first few years of the present century. However, in recent years this assertion has been increasingly challenged. Critics say that when all factors such as the use of fertilisers and pesticides are taken into account biofuels have a net negative impact on the environment. They also point to the loss of forested areas cleared for new areas of biofuel crops.

Friends of the Earth and other environmental organisations are vigorously opposing the EU target for biofuels to contribute 10% of road fuels by 2020. They say that this major increase in biofuel production will have a devastating impact on the world's poorest countries by:

- pushing up food prices
- damaging wildlife through deforestation and soil erosion
- destroying communities by clearing more land for crop production.

There is considerable debate about how to calculate the net environmental impact of biofuel production. Thus, it is not surprising that the conclusions of various studies vary widely.

A study by Cornell University (USA) in 2005 concluded that biofuel production from farm crops such as corn uses 29% more energy than is yielded by the fuel itself. However, critics of this study argued that the research assigned too little value to by-products, some of which can be fed to livestock. This displaces the need to grow some corn.

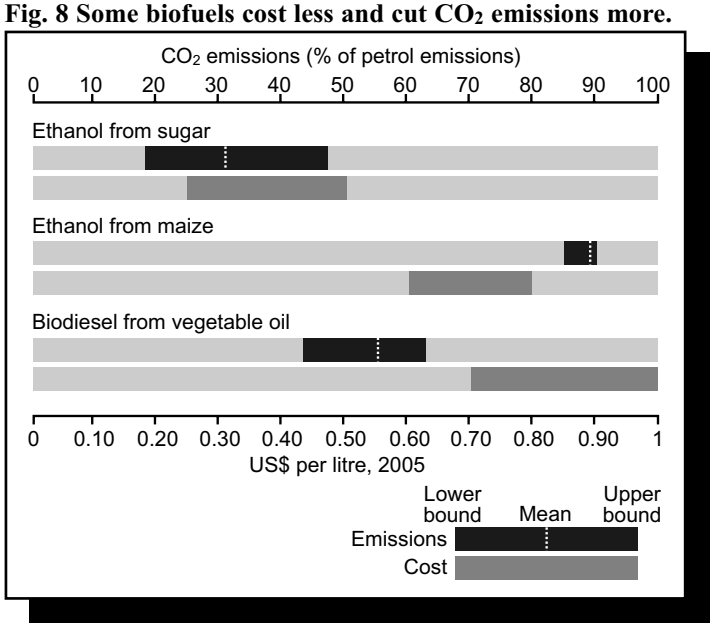
Another 2005 study by the American Institute of Biological Sciences found that corn-based ethanol yielded only about 10% more energy than was required to produce it. The study contrasted this with a 370% energy yield from sugarcane in Brazil.

Research by the World Land Trust, published in the Journal Science in 2007, calculated that increasing production of biofuels to combat climate change will release between two and nine times more carbon gases over the next 30 years than fossil fuels. The report highlighted the deforestation programmes taking place to supply the world biofuel market.

Environmental groups blame the expansion of palm oil output for biofuels for the destruction of rainforests in Southeast Asia. In Indonesia the survival of Borneo's orang-utans is in danger because of the clearance of rainforest for biofuel production. The clearing of rainforest to grow fuel crops has become of major concern in a number of tropical regions. Large areas of Brazil's rainforest have been cleared for biofuels.

Critics of biofuels argue that the net energy content value added and delivered to consumers is very small or even negative when the total energy consumed by the whole production process is taken into account. This includes energy used by farm equipment, fertilisers, pesticides, herbicides, irrigation systems, transport of feedstock to processing plants, fermentation, distillation, drying, transport to fuel terminals and retail pumps.

Fig. 8 Some biofuels cost less and cut CO_2 emissions more.



Source: *Human Development Report 2007/2008*

Fig. 8 compares three types of biofuel production in terms of cost and CO_2 emissions.

Adding to the cost of ethanol is the fact that it cannot be transported in pipelines like oil and gas. Pipelines are readily contaminated with water which can bind with ethanol ruining its fuel value.

Environmentalists argue that a more logical approach would be to double the fuel efficiency of new cars. They criticise motor manufacturers and politicians for not doing enough in this respect.

The UK and the EU

In early 2008 the European Commission set targets with regard to biofuel production. Within 12 years 10% of all fuel sold in the UK (and in other EU countries) must be derived from plants. At present there is a 20p per litre reduction in duty on biofuels compared to standards fuels to encourage demand. Subsidies are available to farmers who grow crops for energy. The government has also recently announced additional funding for research into biofuels. However, government ministers argued that a balanced approach was being taken to production levels of food and fuel.

A government review of biofuels published in July 2008 urged a slowdown in the move to biofuels and in August 2008 the UK's Renewable Fuels Agency admitted that less than 20% of biofuels are meeting basic environmental standards. The latter report highlighted that the amount of former rainforest and other wildlife habitat being destroyed to grow fuel crops is unknown.

Biofuels of the Future?

Supporters of biofuels argue that as biofuel technology improves, many of the disadvantages of biofuel production will be reduced. Second generation biofuels such as cellulosic biofuels can use a variety of non-food crops such as the stalks of wheat and corn and waste biomass. These processes do not divert food from animals or humans.

Cellulose forms the stalk of a corn plant, the straw of grains. It also forms the body of other plants not generally thought of as crops. The US Department of Agriculture has said that massive harvesting of cellulose across the country could produce enough ethanol to replace one-third of US oil consumption. The cellulose in corn can be viewed as very cheap as it takes very little extra work to harvest the stalk. Also, when the sugar is removed in processing the remaining material, lignin, burns well.

Conclusion

The optimism of only a few years ago about the green credentials of biofuels has largely faded as one organisation after another has voiced a variety of concerns. It now seems likely it will take the technological advances of the second generation of biofuels to satisfy at least some critics about the sustainability of this form of energy. The key areas to be addressed are:

[a] the use of non-food crops rather than food crops *and*

[b] the need to ensure that there is a clear net environmental benefit in the production and use of biofuels. Not all biofuels are the same. Investment should be concentrated on the most sustainable biofuels.

Further Research

Scientific American (January 2007)
'Growing Fuel' National Geographical Magazine (October 2007)
'Forests or fuel – special report' The Ecologist (January 2007)
'Still Hungry and Getting Worse' Geo Factsheet 228 (2008) Geopress
'Biofuels' Geographical Magazine (2007)

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