Agrofuels and the use of Genetic Modification

GeneWatch UK

Briefing
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In the last few years, rising concern about climate change and the security of oil supplies has led to interest in the production of energy and fuels from biomass. At present, the major feedstocks for liquid biomass fuels are food crops such as soybean, maize and sugar cane. Production is often on a large scale, using chemical-intensive agricultural practices and often includes GM crops.

As countries have started to set targets for the use of liquid biomass fuel, concerns over their sustainability have increasingly been raised. One response from industry and government has been to invest in the development of so-called 'second generation' biomass fuels claiming they will not only increase output, but allow a broader range of plant based materials to be used as feedstocks.

In July 2009 the UK government published both its Renewable Energy Strategy (1) and the Carbon Reduction Strategy for Transport (2). Both these documents reaffirm the governments commitment to increasing biofuel use and investing in research into 'advanced' biofuels which are perceived as being able to overcome the problems associated with current biofuels by increasing the types of feedstock used and so reducing competition with food crops.

Earlier in the year the BBSRC (Biotechnology and Biological research council) launched its £27m Sustainable Bioenergy Centre which will focus on widening the range of raw materials, and altering crops to be more useful for bioenergy production including biofuels. They also say the centre will analyse 'the complete economic and environmental life cycle of potential sources of bioenergy'.

GeneWatch has produced a report which investigates how the genetic modification of crops is being used in both first and second generation industrial-scale biofuels (often called agrofuels)

GM and 'first-generation' agrofuels

There is no legal requirement to identify agrofuels produced from GM organisms at the point of sale, or to publish information about their use during production. As a result, there is very little information in the public domain about the use of GM organisms in agrofuel production, and the industry provides little or no public information on the subject. However, the evidence suggests that a significant proportion of biodiesel and bioethanol currently on sale is likely to be derived from GM feedstocks: for example, GM herbicide tolerant soya or oilseed rape for biodiesel or GM insect resistant maize for bioethanol. Given that GM foods are viewed unfavourably by consumers in many parts of the world, it could be argued that agrofuels provide a useful outlet for an unpopular product.

The boom in ethanol production in the United States has aided the fortunes of GM seed companies. However, GM seeds being sold to farmers supplying the ethanol market are modified with existing GM traits, such as insect resistance or herbicide tolerance. Agrofuels are providing a useful opportunity for biotechnology companies to increase market share of their existing GM crops. Only one company, Syngenta, has so far produced a GM maize specifically intended for ethanol production, but this is not yet commercially available.

At present, there is no commercial production of GM sugar cane anywhere in the world, because of concerns from the sugar industry about public resistance to GM sugar. However, the agrofuel rush could change this situation and appears to be spurring on the development of GM varieties. In the last few years, companies from Brazil, the United States, Europe and Australia have all started developing GM sugar cane, and it appears these crops are being aimed at the ethanol market. While it remains to be seen whether they will gain commercial approval, some of the companies are claiming their GM sugar cane will be launched by the end of the decade.

GM companies are also claiming that they will soon be launching crops with improved yield or suited to drought prone regions. However, once again there is little evidence available, so these claims cannot be verified. Historically, GM industry claims for such crops have not come to a great deal, and modifications that seemed successful in the laboratory have not transferred well to field conditions.

GM organisms for 'second-generation' agrofuels

A number of companies are working to develop cellulose enzymes for ethanol production. The ultimate aim is to develop micro-organisms that can digest cellulose and produce ethanol. While many companies and research groups are making claims to have done so, their work is often so tightly bound by commercial secrecy that little detailed information escapes into the public domain. Approaches include the genetic modification of fungi (for example, yeast), as well as bio-prospecting for genes and/or micro-organisms from a range of environments. Projected yields from cellulosic ethanol are dependent, at least in part, upon the abilities of the GM micro-organisms (GMMs) to produce ethanol. So far, the GMMs appear to be struggling to produce the high yields obtained from ethanol production using sugar or grain crops.

Little funding appears to have been allocated for examination of the environmental or plant health issues connected to the development of GM micro-organisms that contain potentially harmful traits. Nor is there any research into whether these traits could be passed on to naturally occurring micro-organisms, or whether they could be released into the environment. Horizontal gene transfer of GM traits is a possibility because the use of feedstocks such as straws or timber will import naturally occurring micro-organisms into the fermentation process. Measures to prevent such gene transfer, or to prevent the escape of GMMs used in cellulosic ethanol production, have not been made public by the industry.

Over millions of years, plants have evolved numerous mechanisms to defend themselves against attack from micro-organisms. These mechanisms act to hinder the breakdown of biomass to sugars. Genetic modification of food crops, trees and energy crops is being proposed as a solution to this problem. However, apart from GM trees, which were already in development for other reasons, the research is still at an early stage. Of the work that has been done, published studies have shown that unexpected impacts are commonplace, including variations in growth rate, survival and decomposition.

The use of GM trees as feedstocks for cellulosic ethanol would pose particular risks of gene escape, because tree pollen and seeds can move long distances. Many species of poplar are also capable of prolific and widespread vegetative (asexual) reproduction. As trees are essentially undomesticated, the spread of GM traits into wild populations is much more of a risk than for crop plants. Lignin modifications have the potential to change the ecological balance of receiving tree populations.

Lignin modifications also have the potential to impact on decomposition rates and carbon cycling in the soil. Results of published studies into this issue are contradictory, but as it is the stated aim of agrofuel production to reduce carbon emissions, further research is required to establish whether such GM crops would reduce carbon sequestration in soil, as has been suggested by some studies.

Another approach to GM crop development is the idea of creating crops that produce cellulase enzymes. There appears to have been little research into the impact on plant metabolism and disease resistance of such modifications. Production of cellulase within plant cells could potentially affect decomposition rates and nutrient cycling in the soil, or important agronomic characteristics such as disease resistance.

At least two US biotechnology companies have now started breeding programmes and genetic modification of energy crops such as miscanthus and switchgrass. These plants naturally display traits that make them good candidates for developing into invasive species, and so genetic modification of such crops needs to be treated with increased caution. Almost no research has been conducted into the potential for these crops to become invasive in the different parts of the world where they could be grown. Until this basic research has been conducted, even preliminary assessments of the environmental impact of GM varieties will not be possible.

Environmental impacts

Both current practice and future proposals for the production of agrofuels raise a wide range of important issues. Potential impacts are as wide ranging as the agriculture (and, in the future, forestry) upon which this new industry is based.

Powerful vested interests from the oil, car-manufacturing, agricultural and finance sectors are all involved in the current rush to develop agrofuel production. Environmental groups, aid agencies and community groups in affected areas are also trying to influence the course of its development. Policy makers are being required to make decisions on whether agrofuels really do reduce carbon emissions, whether they are fuelling habitat destruction, whether they are a viable route of development for developing countries, and whether they are distracting attention from other, more valuable, technologies.

Against this background, the use of genetic modification in agrofuel production is only one technology amongst many. However, a clear understanding of the various technologies, their potential and their limitations should be central to assessing energy options and making policy decisions. Assessing the pros and cons of agrofuels depends on a number of key issues:

1) Impact on reducing carbon emissions. The first generation of agrofuels has been widely criticised for making over-optimistic assumptions about the claimed benefits for mitigating climate change. Recent assessments suggest that burning some existing agrofuels, in some circumstances, may even be worse than burning oil. Although second-generation agrofuels are intended to address this problem, there is little evidence that any serious attempt has been made to thoroughly assess the likely climate impacts.

2) Impact on biodiversity. Industrial-scale production of agrofuels, whether GM or not, may have serious negative environmental impacts, associated with the use of intensive agriculture and monocultures. The use of a new generation of GM crops and micro-organisms raises new areas of concern, including the likely introduction of invasive traits; impacts on sensitive ecosystems on marginal land; the contamination of non-GM plants and micro-organisms and the potential spread of undesirable traits. The possible survival and spread in the environment of genetically modified micro-organisms designed to break down plant material is of particular concern.

3) The production of first-generation agrofuels is having significant effects on land use and food prices, with serious negative consequences for many people. Although second-generation agrofuels are intended to increase the use of non-food crops (such as grasses and trees) and agricultural waste (such as corn stalks), both these practices could still have major impacts on land use. Some GM plants grown for agrofuels could also cross-contaminate food crops, introducing new traits into the food chain with unknown consequences for human health.

4) Technical feasibility, costs and impact on alternatives. The use of agrofuels in general raises issues about whether this approach will undermine alternatives, such as better transport policies and planning and more efficient use of fuel. There are major technical limitations to producing second-generation agrofuels, and the likelihood that they will be developed in time to make a significant impact on climate change appears slim. The cost-effectiveness of these technologies is another issue, raising questions about whether money invested in research and development is being wisely spent.

A significant amount of research funding, both public and private, is being put into GM methods to develop agrofuel, particularly cellulosic ethanol. At the same time, almost no funding is being put towards an evaluation of the safety of these methods or their environmental impact.

The push for the GM route to agrofuel production is largely coming from the United States, but governments around the world are also succumbing to the appealing prospect being presented for cellulosic ethanol. Virtually every development in cellulosic ethanol is being patented, not least those relating to GM organisms.

Combined with the accepted practice of allowing companies to prevent publication of details of their technology on the grounds of commercial confidentiality, this means that the large quantities of research funding going into GM developments for agrofuels has produced only a trickle of publicly available data. In the absence of evidence, policy makers are largely reliant upon statements and projections made by the industry.

Claims are made for the ability of GM micro-organisms to efficiently convert biomass to ethanol; or that GM crops will increase yields of oil crops; or that GM biomass crops can be developed that will be easy to process into ethanol. Very little hard evidence is provided in support of these claims. Yet they feed into projections by the agrofuel industry for future production and the lead time required for commercialisation of second-generation agrofuels. In turn, these projections are used to determine policy and shift economies in the direction of agrofuel use.

GeneWatch UK recommends that;

The development of GM agrofuels raises serious questions in two important areas: whether research money is being wisely spent, and whether potential environmental impacts are being thoroughly considered. GeneWatch UK believes that:

1. A more realistic and independent appraisal of the potential impact of second-general GM agrofuels is needed to inform policy decisions. This should include an assessment of the likely performance against key criteria, including: impact on climate, biodiversity, food supply and land use, and technical feasibility. It should be open about uncertainties, economic interests and how different social values (such as how people value biodiversity and impacts on food supplies in poorer countries) are likely to affect policy decisions.

2. Important gaps in research and regulation should be addressed. These include:

- research on environmental impacts, including invasiveness, energy balance and the impact of factory-scale waste streams containing genetically modified microorganisms;

-consideration of major gaps in regulation, including regulation of waste streams containing genetically modified micro-organisms, and how the possible contamination of food crops with new traits from GM agrofuels will be addressed. In general, more public involvement and debate is also needed to ensure that policy decisions, including research funding decisions, are not driven by a narrow range of vested interests.

For more details see **Agrofuels and the use of genetic modification** (August 2009) www.genewatch.org

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