

# Health

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## GE Foods and Human Health Safety Assessments

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Genetically engineered (GE) versions of soybean, canola, corn, potato, sugarbeet and cotton have been approved for sale in Australia. They are widely present in breads, pastries, snack foods, baked products, oils, fried foods, confectionary, soft drinks and small goods casings.

GE foods are a recent phenomenon as a result of new gene techniques that permit DNA sequences to be removed from plants, bacteria, viruses or animals, joined with other DNA sequences and placed into plants. However, the techniques employed, eg coating tiny balls of gold or tungsten with the desired DNA and shooting it at a single thickness of the tissue-cultured plant, provides for the insertion of one or more pieces of DNA into the plant in a random fashion. As a result, the insert may be placed in an active gene and could turn-off or change the function of one or more of the plant's genes. In addition, other partial copies may be present in the plant. For example, seven years after the release of Roundup Ready soy, Monsanto has found two segments of DNA present in that GE plant that they were previously unaware were present<sup>1</sup>.

Consequently, concerns have been raised not only about the production of substances genetically engineered to appear, such as Bt toxins, but about the production of unexpected, novel substances in these plants and their potential health consequences. Already, a tobacco plant, genetically engineered to produce gammalinoleic acid also unexpectedly produced octodecatetraenoic acid, a substance never before seen in tobacco plants.

Of any novel substance that may be produced, novel proteins are of specific concern. Proteins have the ability to cross the gut wall into bodily tissues to create toxicological and other health problems, as evidenced by food intolerances (eg to peanuts), and variant Creutzfeldt-Jakob disease associated with eating beef from cattle with bovine spongiform encephalopathy (BSE).

Other concerns relate to a risk of novel DNA being incorporated into gut bacteria or crossing the gut into the tissues of the body. Recent, as-yet-to-be-published work by Professor Hans-Hinrich Kaatz, University of Jena, Germany, has shown that the gene conferring resistance to glufosinate in GE canola had transferred to some bacteria and yeast in the gut of bees. A recent study, reported in the Guardian,<sup>2</sup> on seven people who had previously had their lower intestine removed and consequently use colostomy bags, found that "a relatively large proportion of genetically modified DNA survived the passage through the small bowel" after a meal of a burger containing GM soy and a milkshake. Furthermore, in three of seven colostomy bag samples, bacteria had taken-up the herbicide-resistant gene from the GM food at a very low level.

Moreover, results from Schubbert et al (1997)<sup>3</sup> indicate that foreign DNA ingested by mice can reach peripheral leukocytes, spleen and liver via the intestinal wall mucosa

and can be found covalently linked to mouse DNA. Other work by Einspanier et al (2001)<sup>4</sup> from feeding corn to cows and chickens has indicated that short DNA fragments from plant chloroplasts can be found in the lymphocytes of cows, and possibly in their milk, while muscle, liver, spleen, and kidney tissues from chickens were found not only to contain, but to amplify, certain gene fragments. Moreover, the recent sequencing of the human genome has indicated that perhaps half of our DNA originally came from bacteria and viruses during our evolution. All of these results indicate that DNA from outside sources can enter the human body and become incorporated into human DNA.

In science, the results of new experimental work is published in peer-reviewed scientific and medical journals, so that others can repeat and extend the experiments and hence build-up a picture of the area. However, a recent literature search of the safety assessments of the GE foods currently available in Australia yielded only some safety assessments of one food, Roundup Ready soy, written by Monsanto-paid scientists. It is therefore very difficult for a scientist to assess the safety of the GE foods currently eaten in Australia. In particular, the accuracy and veracity of the results of the company that developed the food cannot be checked and there is a complete lack of independent safety assessments. The only effective way to assess data on the issue is to review documents that are written by our food authority when it is asked by an applicant company to approve a GE food for consumption in Australia and New Zealand.

This food authority used to be called Australia New Zealand Food Authority (ANZFA) but is now called Food Standards Australia New Zealand (FSANZ). This organisation has produced a document called "GM foods and the consumer. ANZFA's safety assessment process for genetically modified foods". In it, ANZFA/FSANZ describes its guidelines for assessing the safety of GM foods, which are best described as: safe until proven harmful. This is the opposite of the precautionary principle.

Whenever ANZFA/FSANZ reviews that safety of a GE food or group of foods, it reviews the information available to it and generates a report of approx 70 pages per GE food application. However, as stated above, essentially none of this evidence has been peer reviewed and none of the information has been obtained from independent scientists. Therefore, the information about GE food safety assessments, below, has been obtained by reviewing 12 such reports written by ANZFA/FSANZ covering the following 28 GE crops: 4 soy, 3 corn, 10 potatoes, 8 canola, 1 sugarbeet and 2 cotton.

Of significance, there appear to be no feeding trials on people for these foods. In addition, one of these foods (a corn) had not been tested on animals at all. Foods for 9 potatoes, 1 corn, 4 canola, 2 cotton and 1 sugarbeet were only tested as a single oral gavage (a type of forced-feeding), with observation for 7-14 days, of the substance that had been genetically engineered to appear, not the whole food. Such testing assumes that the only new substance that will appear in the food is the one genetically engineered to appear, that the GE plant-produced substance will act in the same manner as the tested substance that was obtained from another source, and that the substance will create disease within a few days. All of these are untested hypotheses.

For the foods where the whole food was given to animals to eat, sample sizes were

often very low (eg 5 to 6 cows per group for Roundup Ready soy<sup>5</sup>) and they were fed for only 4 weeks. Moreover, some of these experiments used some very unusual animal models, such as chickens, cows and trout. Some of the measurements taken from these animals are also unusual, such as measuring abdominal fat pad weight and total de-boned breast meat yield. These are unusual measures of human health by anybody's standard. So it would appear that many of these tests have not been set-up to measure human health at all, but rather to reassure primary producers that GM feed will still permit farm animals to grow sufficiently to get a reasonable price at market.

Often the only results given from these experiments was the death of experimental animals. If any other information was given, it was usually only body weights, with possibly some organ weights. If 'gross pathology' was done, no description was given of what was involved. Certainly, biochemistry, immunology, tissue pathology, and gut, liver and kidney function and microscopy results were not given, and were therefore probably not done. In addition, animals were not fed for long enough for cancer studies or studies into the effect of offspring to be done. Even so, some adverse effects were found. For example, rats fed canola meal from GE canola GT73 had increased liver weights of approximately 12-16%<sup>6</sup>. However, rather than investigate these results further, these results were simply attributed to a higher level of glufosinolates in the GE canola compared to controls, when the level of glufosinolates was only about one third of the official level of concern as measured by Codex<sup>6</sup>. This indicates that this substance may be innocent of these adverse effects. Consequently, a different substance may have caused the adverse events, and if it is oil-soluble, this substance may be in the oil fraction that is fed to people. However, there appear to be no feeding studies on canola oil to check this possibility.

In another example, in addition to their normal diet, one group of rats was fed control potatoes while another was fed GE potato line BT-06. After a month, "a number of" abnormal findings were noted, such as enlarged lymph nodes, hydronephrosis and enlarged adrenal glands<sup>7</sup>. However, because at least some of these results were also found in the control rats, no statistical difference was found between the two groups, and so the GE potatoes were regarded as safe for eating! However, control rats are supposed to remain healthy, indicating that either rats are an inappropriate animal model for safety testing of potatoes, or that something unusual was happening with the rats. For example, a virus may have infected all the rats, masking any effect of the GE food, or the controls may have been inadvertently fed the GE food. To put it into perspective, consider a hypothetical clinical trial to determine the effects of a new aspirin. In this situation, one group of people would take the new aspirin and another group would take a sugar pill placebo for comparison purposes. After several weeks in this hypothetical trial, the manufacturing company followed-up its trial volunteers and found a high proportion of those taking the new aspirin had been hospitalised. However, the manufacturing company argued that because some volunteers taking the sugar pill had also been hospitalised, the new aspirin was safe. The regulatory authority agreed and released it for sale, without anyone asking: how can a sugar pill hospitalise a high proportion of those who take it? Put quite simply, the experiment should have been repeated and expanded to determine what was occurring and why, before the food was considered to be safe.

This is particularly important because of work from Fares and El-Sayed (1998)<sup>8</sup>. They

used a different potato genetically engineered to produce a Bt toxin approved for human consumption in some countries and also used potatoes treated with the  $\delta$ -endotoxin believed to have the insecticidal properties of that GE potato. Both of these potatoes caused damage to the microscopic structure of the ileum (part of the small intestine) of mice. Mice fed the  $\delta$ -endotoxin had hyperplasia and other changes often considered to be precursors to cancer. As a result, the authors recommended thorough testing of all possible consequences of all transgenic crops before release to the market.

In work on compositional analyses of the GE foods, often only the compositions of amino acids (the building-blocks of proteins) were given in the ANZFA reports, and not even the fatty acids (the components of fat). Moreover, when a scientific journal would normally require most of the number, mean, standard deviation, 95% confidence interval of the mean, nature of the statistical test (eg t-test) and a p-value, never more of these than the number and mean were given for any analyses, thereby preventing others from reviewing the data and doing sample size calculations<sup>9</sup>.

Sufficient information to calculate these was requested of ANZFA by the Public Health Association of Australia (PHAA) in late October 2000, but the data have still not been received by the Association. Moreover, the sample sizes are very small indeed, usually about five to seven and reaching as low as two for GE canola line GT73. Consequently, the applicant company often reports that no statistical difference could be found between the composition of the GE food and its control, when the sample sizes make that result almost a foregone conclusion, regardless of what may occur in nature<sup>9</sup>. However, statistically significant differences were still found with some foods (eg eight of the eighteen amino acids measured in corn line MON 810 were significantly different to the control corn<sup>10</sup>) but were then ascribed to natural variation and were not investigated further, even though such significant amino acid differences could also signal the production of potentially harmful novel proteins. Adding weight to this possibility is that the amino acid differences could not be explained by the production of the proteins that were genetically engineered to appear, for any of these foods.

Results such as these have led the Royal Society of Canada to describe substantial equivalence as "scientifically unjustifiable and inconsistent with precautionary regulation of the technology"<sup>11</sup>, the American National Academy of Sciences to describe human health safety testing procedures to be 'woefully inadequate' and the Royal Society in London to describe the current system of safety screening, developed in the USA, as flawed and subjective. The Royal Society also called for better tests, saying that current safety tests on GE foods are inadequate and that manufacturers' tests on such foods should be tightened and opened to independent scrutiny<sup>12</sup>.

I believe that it is essential that independent safety testing be done on these foods before they are permitted for sale, and that governments should set-aside specific funding to enable this to happen. The tests should closely resemble the procedures established by the pharmaceutical industry to test new drugs - the clinical trial. That is, comprehensive animals testing should be first be undertaken. Here, it would be important to feed animals the GE food under investigation for long enough to determine any cancer risk, and the foods should be fed to pregnant animals to determine any effect in new-born animals. Biochemistry, immunology, tissue

pathology, microscopy, and gut, liver and kidney function should be measured at a minimum. If the food passes these tests, then small numbers of human volunteers should be fed the food to determine if there are any health effects. If it passes this test, then hundreds of volunteers should be randomly assigned to one of two groups - those receiving the GE food and those receiving the non-GE equivalent control. Volunteers should be fed the foods for several months and the resultant data should be analysed to determine any ill health effects. However, even studies such as these do not determine the long-term health effects of these foods on humans. To do this, long-term cohort studies are required, where people's current self-selected exposure to various GE foods can be measured and subsequently linked to any disease states in future years. In addition, specific surveillance systems are required to pick-up any ill-health effects in the general population.

It is vitally important to do the types of safety assessments outlined here as virtually every Australian is currently exposed to these foods, with more on the way. Simply on the basis of the numbers exposed, if health effects are found later, the consequences could be dire.

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# GE Food: Safe to Eat?

**M**ost genetically engineered (GE) crops are processed into food for humans and animals - but are they safe to eat? Genetic engineering can have unexpected and unintended effects because the process is imprecise and random. Inserted genes may disrupt natural genes, be unstable in their new environment, or function differently than expected. But what does this mean for food safety?

There are two ways in which genetic engineering may affect food safety:

- gene disruption or instability may lead to new toxins being produced;
- the new protein produced by the foreign gene may cause allergies or toxicity.

There is scientific agreement that the potential for such risks does exist and in many countries regulations are in place to examine the safety of GE foods. But how good is the testing system? This briefing examines the regulatory system and the way in which it operates. Disturbingly, it reveals that regulatory authorities use the concept of 'substantial equivalence' even though it has been severely criticised by some of the most respected scientific bodies.

## How are GE foods tested?

Although the regulation of GE foodstuffs differs from country to country, the concept of 'substantial equivalence' forms the basis of regulatory assessments worldwide. Essentially, the chemical composition of the GE food is compared to an equivalent non-GE variety – GE soybean would be compared to conventional non-GE soybean, for example. If there is no significant difference detected between the two, the GE variety is pronounced safe. This sounds sensible, but a

closer look at the system reveals some serious shortcomings.

The first problem concerns what is actually compared between the GE and non-GE food. The levels of some major and minor nutrients, known toxins and other anti-nutritional factors are measured. In potato, for example, the major nutrients include carbohydrate and protein, the minor nutrients are any vitamins, and known toxins would include solanine (the compound in green potatoes that can cause illness). However, there is no standard list of what must be measured and there is no process to look for unexpected or unintended changes – one of the most important concerns over GE food safety.

The second problem is that the systems to detect allergenicity or toxicity of the GE product have serious limitations. Allergies to proteins found in some foods such as peanuts are already well known. Genetic engineering is designed to produce new proteins not normally present in the plant and these may cause allergies. It may also result in unintended modifications to existing plant proteins, which could make them allergenic. However, it is not possible to predict whether a protein is a potential allergen with any certainty. Tests examining the protein's characteristics and comparing them with known allergens are not foolproof. The proteins may never have been part of humans' diet before so there may be no experience to go on. Questions have also been raised over some GE crops which have already been given safety approval. For example, it has recently been shown that a *Bt* protein, Cry1A - commonly present in GE insect resistant crops - may have induced allergenic-type responses in mice and the study recommended further safety tests<sup>1,2</sup>.

Another problem is that when any food safety testing is performed on GE crops, it is only

short-term - over days or a few weeks. There is no long-term testing or testing for chronic effects of toxicity or nutritional changes. Because of this, the French food safety authority, AFSSA, recently concluded that current safety testing is not sufficient to ensure the safety of GE foods<sup>3</sup>. Their report also stated that it was important to research into the possible gradual development of allergic reactions through prolonged exposure to GE foods. This echoes a scientist's comments in the scientific journal, *Nature*, about the long-term effects of GE food that: "*Under current monitoring conditions, any unanticipated health impact of such foods would need to be a 'monumental disaster' to be detectable*"<sup>4</sup>.

Because of problems like these, the use of substantial equivalence as a criterion in GE food safety testing has been severely criticised<sup>5</sup> by such respected institutions as The Royal Society of London<sup>6</sup> and Royal Society of Canada<sup>7</sup>.

### Cause for concern

The criticisms of substantial equivalence are of more than academic interest. There is evidence that unintended effects of genetic engineering are not uncommon, that potential allergens have entered the food chain because of inadequate controls, and that the scientific data supplied to regulatory authorities cannot be trusted.

### ***Unexpected and Unintended Effects***

Unexpected and unintended effects in GE crops can be produced in several different ways:

- **By the genetic engineering process itself:** Genetic engineering involves the insertion of a novel gene(s) at random into the DNA of an organism. It is a crude science and small segments of the plant's own DNA may become rearranged or deleted<sup>8,9</sup>. Multiple copies and extra fragments of gene inserts have been found in GE plants, including some commercial varieties of corn and soya<sup>10,11,12</sup>. For example, Monsanto's Roundup Ready soya contains two additional fragments of the inserted

gene<sup>10</sup> and a segment of 'unidentified' DNA<sup>9,13</sup>. This was not known at the time of the regulatory approvals for food use in several countries and the discoveries were only made after Roundup Ready soya had been on the market for several years.

- **By alteration of normal function:** A plant's normal metabolism may be affected by genetic engineering if the insertion of a gene disrupts its complex biochemical pathways. It is difficult to predict what the consequences would be and these could be affected by environmental conditions<sup>14</sup>.

Examples where genetic engineering has caused unexpected effects in plants and other organisms include:

- 1) Yeast which had been genetically engineered to improve alcohol fermentation unexpectedly had up to 30 times the concentration of methylglyoxal (a highly toxic compound) compared to the control non-GE strain<sup>15</sup>.
- 2) Researchers at Monsanto who were trying to increase the content of carotenoids (a chemical which is used to form vitamin A) in canola (canola) found that vitamin E and chlorophyll levels in the seeds were dramatically and inexplicably reduced<sup>16</sup>.
- 3) Other researchers trying to genetically engineer the carotenoid pathways in tomatoes found over-expression of the gene caused unexpected dwarfism in the plant<sup>17</sup>.
- 4) Monsanto's GE Roundup Ready soybeans have suffered unexpected crop losses in hot, dry weather due to stem splitting caused, most probably, by increased lignin<sup>18</sup>. The soybeans' phytoestrogen levels are also 12-14 % less than in conventional soybeans, which may mean that soy-based products derived from Roundup Ready soybeans would be less useful as sources of phytoestrogens<sup>19</sup>.
- 5) Levels of a potato toxin (glycoalkaloid) increased and decreased unexpectedly in separate genetic engineering experiments when engineered with different genetic

inserts that were not intended to alter the toxin content<sup>20</sup>.

### Allergies

Even if the allergenic potential of a GE crop is recognised by the regulatory authorities, it can still end up in human food. Aventis' StarLink was a type of insect resistant GE corn grown in the USA from 1998, which produced the *Bt* protein, Cry9C. It was only approved for animal feed and industrial purposes as there were concerns that the Cry9C protein could cause allergies because it shares characteristics of other allergens. However, in September 2000, StarLink was found in corn taco shells and other foods, and over 300 corn products had to be withdrawn from the market<sup>21</sup>. Traces of StarLink corn were also found in corn based foods in Japan and Korea. It is not known how StarLink came to be in the human food chain - it may have been inadvertently mixed with other corn at a mill, a conventional crop may have cross-pollinated with a StarLink crop, or a farmer may have sold StarLink corn for human food to get a higher price<sup>22</sup>. Whilst StarLink is not being grown anywhere in the world at the moment, it may have contaminated other corn seed and remain in the food chain. The episode raises questions about the ability of regulatory authorities to control GE crops.

### Flawed data

There is disturbing evidence that even the limited data supplied to regulatory authorities is flawed or incomplete:

- Data about plant toxins and anti-nutrients (which interfere with our ability to make use of other nutrients in food) are often missing or show significant differences<sup>5</sup>. For example, in the EU applications for different types of GE corn or corn, the content of trypsin inhibitors and phytate (both important anti-nutrients in corn) were only determined in some, but not all cases<sup>5,23</sup>. Similarly, the content of sinapine - an antinutrient of canola (canola) - was not determined in all cases, and for Zeneca/Syngenta's GE tomato, TGT7F, data on several inherent tomato toxins were not given<sup>5</sup>.

- Many of the trials are based on only one or two seasons of growth and environmental effects are not considered in the dossiers. Deleterious effects of genetic engineering may not be immediately obvious and may only become apparent after several generations<sup>24</sup>, and environmental conditions can alter plant composition. Indeed, one study recommended 'special care' when investigating environmental effects on GE crops<sup>23</sup>.
- The data accepted for approval of a GE corn known as T25, which was produced by Aventis (then AgrEvo) and approved for cultivation and import in Europe in 1998<sup>25</sup>, has been reviewed and found seriously deficient by independent scientists. Although the corn was intended as cattle feed, no feeding or toxicity studies had been performed on cattle. A scientist said: "*I would not drink milk from [cattle fed] the forage with the present stage of knowledge*"<sup>26</sup>.
- Chicken feeding studies in support of Aventis' T25 corn have also been criticised by independent scientists, who drew attention to 'suspicious' trends in terms of the weights and mortalities of the birds. The scientists concluded that: "*... this study...is inadequate in terms of providing any evidence or conclusions. It is not of a standard that would be acceptable for publication in a scientific journal. It follows that neither do we consider the study as reported to be adequate for being taken into account as evidence of safety in connection with decisions to approve the use of the relevant GM corn. If anything, the results as reported arouse suspicions of real differences between the treatments*"<sup>27</sup>.

### Babies and infants most at risk

The Royal Society<sup>6</sup> recently considered the possible effects of GE foods on the health of babies and infants. The report recognised that food allergies are far more common in children than adults, stating that: "*food allergies occur in 1-2 % of adults and 6-8 % of children*". Therefore, children would be most vulnerable to any allergens that may have gone undetected in GE food. In the

report, infants are classified as a “*high risk group*” for post marketing surveillance of deleterious effects of GE foods in humans.

The Royal Society<sup>6</sup> also recognised that babies and infants are vulnerable to harmful effects from nutritional changes in their diet. Any changes in the composition of foods made from GE crops could be important when given to infants over a long period of time, especially if it is a food such as infant formula which infants may live off as a complete food. The report recommended that any GE ingredients in foods such as infant formulas “*should be investigated most rigorously*”.

## Conclusions

Although there are serious concerns about the safety of eating GE foods, the safety testing systems are inadequate. Genetic engineering can produce unintended and unexpected effects but the regulatory processes, which are based on the principle of ‘substantial equivalence’, are not designed to detect such effects. The systems used to detect allergenicity are incomplete and the data submitted by companies - supposedly demonstrating that their GE foods are safe - is often of poor quality.

The long term implications for human health of eating GE food are also not known (and have not been investigated), but babies and infants are especially vulnerable to allergies and changes in the nutritional composition of their diet. They are classified as a ‘high risk group’ for post marketing surveillance – but no such monitoring of either adults or children has ever taken place.

Therefore, Greenpeace believes that there is no basis upon which it can be claimed that the GE foods on supermarket shelves are safe to eat.

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# Antibiotic Resistance in Genetically Engineered Plants

**M**any of the genetically engineered (GE) crops which are already being grown on a commercial scale contain genes which are resistant to antibiotics used for the treatment of diseases in both humans and animals. These genes are unnecessary to the development of the GE plants themselves and could severely undermine the effective treatment of diseases if the antibiotic resistance is transferred to bacteria which are harmful to human and animal health.

## Why are they used?

Because the techniques used to introduce a foreign gene into an organism have a low success rate, scientists need to test whether the genetic engineering has worked. This is often achieved by transferring genes which confer resistance to particular antibiotics at the same time as the genes for the desired trait (e.g. insect resistance). The modified cells are then grown in a medium containing the relevant antibiotic(s). The only cells able to survive are those which contain the antibiotic resistance gene. As this 'marker gene' is closely linked to the gene with the desired characteristic, it can be concluded that these cells have been successfully genetically engineered and they are then grown to maturity.

Antibiotic marker genes have been used in the development of many of the GE crops which are now being grown on a commercial scale. These include Syngenta's herbicide and insect resistant corn, which contains ampicillin resistance genes, Monsanto's insect resistant Bollgard cotton, which contains genes that provide resistance to the antibiotics streptomycin and spectinomycin and also against the antibiotics kanamycin and neomycin, and Aventis' herbicide resistant canola, which contain genes resistant to kanamycin and neomycin antibiotics.

Although the antibiotic resistance genes serve no further function in the development and growth of the crops after the initial selection process, they remain in the plants' tissues throughout their lives. This has led to serious concerns over the consequences for human and animal health.

## Human and animal health threats

Antibiotics have been used extensively for the treatment of infectious diseases since 1944 and have been routinely included in animal feeds to prevent disease and promote growth. The overuse of antibiotics has resulted in antibiotic resistant bacteria which have already caused major medical and veterinary problems throughout the world. By 1990, almost every species of disease causing bacteria had developed at least partial resistance to antibiotics and in some cases (e.g. *Staphylococcus* infection), antibiotics have become almost totally ineffective<sup>1</sup>.

Marker genes are often resistant to antibiotics which are commonly used in both human and veterinary medicine. Eating foods derived from GE crops therefore poses a risk that the antibiotic resistance genes could be transferred to bacteria living in the digestive tract of humans and animals and render them immune to antibiotic drug treatments. There is scientific evidence that DNA from food uptake can survive in animal guts and can even be traced in somatic cells. Such foreign DNA could be traced up to 24 hours after feeding in spleen and liver cells.<sup>2</sup> Research also indicates that DNA released from bacteria or food sources within the mouth can be transferred to other oral bacteria<sup>3</sup>.

Antibiotic resistance can also be transferred to soil bacteria from decomposing parts of the plants.<sup>4</sup>

Proponents of genetic engineering claim that there is little likelihood that such gene transfer would actually occur, but scientists and regulatory authorities have expressed the view that even the slightest risk would be unacceptable. A survey of chemotherapists, for instance, revealed that 57% of respondents felt that Syngenta's GE corn should be banned until the ampicillin resistance gene is removed<sup>5</sup>. Similarly, the United Kingdom's Advisory Committee on Novel Foods and Processes (ACNFP) advised the British Government to vote against the authorisation to

market Syngenta's corn in Europe because of the risk of antibiotic resistance developing<sup>6</sup>.

## An unacceptable risk

Producers of GE plants containing antibiotic resistance genes argue that, even if these genes were transferred to human or animal gut bacteria, this would make little difference to the already high levels of antibiotic resistance<sup>7</sup>. Such an attitude is irresponsible, since any increase in antibiotic resistance could be disastrous for human and veterinary medicine. Syngenta's corn, for instance, confers resistance to ampicillin, which belongs to the penicillin group of antibiotics. These are the antibiotics most commonly used for the treatment of several serious diseases. Ampicillin itself is frequently used for the treatment of pneumonia, bronchitis and diphtheria. Similarly, several GE crops contain genes resistant to kanamycin, which is of concern as single mutation in this gene could give resistance against the amikacin antibiotics.<sup>8</sup> Amikacin is regarded as a 'reserve' or 'emergency' antibiotic in human medicine, i.e. at present it is used as little as possible in order that no resistances are produced among bacteria. The present of the streptomycin and spectinomycin antibiotic resistance gene in Monsanto's Bollgard cotton let the United Kingdom to object against the use of this product in animal feed. The UK was concerned that the use of the GE cotton seed in animal feed might lead to an increase in levels of bacterial resistance to streptomycin and spectinomycin. Both antibiotics are gaining in clinical importance in the treatment of human disease.<sup>9</sup>

The risks associated with antibiotic resistance genes in GE crops are clearly unacceptable. Alternative marker systems have been available for several years and the United Kingdom's Advisory Committee on Releases to the Environment (ACRE) has observed that "*it is good practice not to insert into plants unnecessary genes which have no purpose in the GM plant*"<sup>10</sup>. Others have described the practice of including antibiotic resistance genes as "*sloppy genetic engineering*"<sup>11</sup>.

## Calls for precaution and a ban

Because of the unnecessary presence of antibiotic resistance genes and the serious implications for human and animal health, many biosafety committees and governments have opposed the introduction of these crops. Norway banned them altogether. Austria and Luxembourg have banned Syngenta's corn, Switzerland did not allow a planting experiment with a GE potato

because the potato contained a kanamycin resistance gene. From the British Medical Association<sup>12</sup> to the European Parliament a variety of institutions have demanded a ban of antibiotic resistance genes in GMOs.

Precaution clearly demands that any use of antibiotic resistance genes be prohibited. There is no reason to risk any further health threats from antibiotic resistance to serve short term industry interests.

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## HEALTH AND ENVIRONMENTAL RISKS OF GENETICALLY MODIFIED SOYA

### REGULATORY NEGLIGENCE

The approval of Monsanto's genetically engineered Roundup Ready Soybean (RRS) by the US, UK and EU authorities is a textbook example of regulatory negligence. One would expect that approvals should guarantee that the use and consumption of RRS will be safe for the environment and for human health. This is not the case.

In the USA, genetic modification of foods would normally be regulated by the 1958 Food Additives Amendment to the Food, Drug and Cosmetic Act. This places the burden of proof on a company to demonstrate the safety of new substances added to food. That requirement was bypassed, however, when US former Vice-President Dan Quayle announced 'regulatory relief' for the biotechnology industry in 1992 [Goldburg, 1994].

Thus, a manufacturer may now simply state that an introduced protein does not raise any safety concerns and is not likely to be a macro-constituent in the human or animal diet in order to avoid Food and Drug Administration (FDA) testing requirements [Goldburg, 1992]. RRS was submitted to the US Dept. of Agriculture's Animal and Plant Health Inspection Service [APHIS]) for approval on the grounds that it does not constitute a 'plant pest': no independent scientific evidence, toxicological studies or long-term food studies were required by APHIS [1994].

In the EU, RRS was first assessed by the United Kingdom authorities, after consultation with the Advisory Committee on Novel Foods and Processes (ACNFP) for its safety as a food. Monsanto had submitted no toxicological assessments, no independent verification of its conclusions, and no peer review of its methodology, which was highly questionable.

UK approval was granted despite the fact that the ACNFP 'acknowledged that it was not possible to predict the effect of genetic drift on a plant's metabolism. It is therefore impossible to predict what long-term effects, if any, the genetic modification may have on the plant.' [MAFF, 1995]

Neither the US nor the EU would have granted approval for GE soya had they fully complied with existing guidelines. EC Directive 90/220 states that approvals of GMOs should be given only in accordance with the principle of preventive action and the 'step by step' principle. These principles were not observed at the time of original approval in the USA, when the FDA interpreted existing implementing regulations in the weakest possible way. The EU thus had a residual obligation to ensure 'the protection of human health and the environment' as required by those principles. It has not met that obligation.

It must be stressed that the human health assessments submitted to both the US and EU authorities were granted on the basis of engineered soya that **HAD NOT BEEN TREATED WITH GLYPHOSATE**. In reality, therefore, absolutely no data have been made available to regulatory authorities concerning RRS in the form in which it will actually be used. In addition, all field trial data related to US trials; EU authorities did not even request European ecosystem data.

It is therefore essential that the following points be considered by EU competent authorities - not merely in the case of Monsanto's soya, but for all genetically modified foods. RRS is only one of several glyphosate-resistant crops – canola, sugar beet, corn, potato, tomatoes, cotton and flax - being readied by Monsanto for commercialisation. Each will increase exposure to Roundup Ready genes and to glyphosate, thereby magnifying any unexpected effects which might arise.

## ALLERGENICITY

IgE-mediated food allergies occur in 5-8% of infants under the age of 3 and in 1-2% of adults [Taylor, 1994]. Soybeans are one of the eight most common allergenic foods in the US. Moreover, Taylor observes that: 'Other foods that are not commonly eaten seem to have the potential to trigger serious allergies if exposure is increased.' It must also be remembered that '... the prevalence of [food sensitivities] seems to be increasing as more proteins are added to commercially prepared foods' [Nestle, 1996]. RRS and the other Roundup Ready crops now in the pipeline will add to this risk by increasing the novel proteins found in foods.

As a result of its studies, Monsanto concluded in its application to the ACNFP [1994] that 'the allergenic potential of GTS [engineered soya] and the products derived from these soybeans is not expected to be different from other soybean varieties.' [emphasis added] Yet in the same document, Monsanto admitted that 'there are no predictive assays available to assess the allergenic potential of proteins'.

## ANIMAL FEEDS

Monsanto presented the UK authorities with a toxicological assessment section that is 10 lines long, based on the fact that the company did not consider toxicological assessment to be 'appropriate' [1994]. Monsanto instead carried out five 'animal wholesomeness studies' (using soy not treated with glyphosate). These studies would not have been able to detect any unexpected long-term effects of the genetic modification:

- \* A 6-week broiler chicken study with processed soybean meal: No 'substantial differences' from control subjects were found. The term 'substantial difference' is not defined.
- \* A 4-week study with raw soybeans on dairy cows: Fat-corrected milk production was slightly higher (3.5%) for cows fed GTS.
- \* A 10-week catfish feeding study with processed soybeans: fish fed GTS consumed 2.85% less feed (expressed as percentage of mean body weight) than fish fed the control diet (3.63%).
- \* A 4-week unprocessed soybean meal study on rats: All animals 'appeared healthy', and no statistically significant differences in weight or consumption occurred. It must be noted, however, that 'dark livers were observed in some animals in all groups at necropsy'.
- \* A 5-day quail feeding study with raw soybean meal.

On the basis of these and other inevitably imprecise tests Monsanto has made the following claims [1994]:

- \* CP4 EPSPS - the altered enzyme conferring glyphosate resistance - is inactivated by the heat processing required prior to consumption of soybeans by humans and most farm animals:

Denaturation will not inevitably cause these to lose their allergenic properties. [Aas, as quoted in Goldburg, 1994] Certain parts of the structure of the protein which triggers allergenicity may remain even though the whole molecule is not intact.

- \* The soybean recipient has a history of safe use, allowing one to assume freedom from unintended adverse effects from the engineered gene:

Soybeans are one of the eight most common allergens in the US, even when not modified. No testing has been done which would establish what the long-term effects of modification might be to the allergenicity of soy.

- \* CP4 EPSPS shows 'no significant homology to any known protein allergen' and can therefore be expected not to give rise to allergic effects:

Severe allergic reactions have been observed in adults with no history of food allergies following consumption of foods which they had never before eaten and which were not generally regarded as allergic. [Koepeke and Fine, cited in Goldburg, 1992]

As the Austrian Environment Ministry has observed, Monsanto has supplied no experimental data on this question; its conclusions are based on sequence comparisons with known EPSPS proteins. The results - 26% identity and 51% similarity - are 'insufficient to allow the risk of allergy to be excluded.' [Austrian Environment Ministry, 1996]

## **HERBICIDE USE**

Monsanto states that it carried out an 'objective study of the effects of the introduction of Roundup Ready soybeans on farmers' production costs and on quantifiable environmental conditions.' [1996] That study was carried out by Sparks (SCI), an agricultural market research firm. Projections were based on 'best estimates from Monsanto field data and approved label use rates'. The study considered three main components:

- (1) Pounds of active ingredient;
- (2) The costs that farmers incur for herbicides;
- (3) Other costs of production related to herbicide application.

Monsanto claims that: 'By focusing on pounds of active ingredient, this study addressed quantifiable environmental effects of the introduction of Roundup Ready soybeans.' In fact, it did nothing of the sort: summaries of incomplete data sets, without any consideration of substance toxicity and with no independent verification, do not allow determination of quantifiable effects.

Total weight of herbicide use is not a good yardstick by which to assess environmental impact. Glyphosate is one of the most toxic herbicides used today: minute quantities are capable of damaging or killing plants.

## ENVIRONMENTAL EFFECTS

Monsanto has made claims concerning the environmental safety of both RRS and glyphosate for which no adequate data are provided [Monsanto, 1994]:

- \* 'RRS exhibits no plant pathogenic properties'

Plots were evaluated by breeders walking through them and visually checking for the appearance of possible disease symptoms. [Monsanto, 1993]

- \* 'RRS is no more likely to become a weed than the non-modified parental varieties':

Wild soy becomes a weed in warmer climates. Monsanto's own report states that opportunities for hybridization would occur in China, Taiwan, Japan, Korea, and the former USSR, where wild related species occur.[Monsanto, 1994] Monsanto intends to use RRS in the latter region and are hoping to import it to Japan soon.

- \* 'Glyphosate is considered to be a herbicide with low risk for weed resistance.' [Monsanto, 1993]

Monsanto itself notes [1993] that one important factor contributing to resistant weeds is frequent applications without crop or herbicide rotations. Yet no-till, single-herbicide monoculture is precisely what RRS is meant to encourage.

## CONCLUSIONS

The regulatory and scientific treatment of Monsanto's application for approval of GE soybeans is little short of scandalous. The voices of consumers and environmentalists have been lost in this approval process. It is time they were heard. By the time any risks are realised, it will be too late to address them easily: it would be very sad indeed if the EU had learned nothing from the lessons of BSE and endocrine disrupting chemicals.

Such risks are not worth taking, merely in order to increase the profits of a few chemical giants. As the New England Journal of Medicine noted recently: 'From the standpoint of human nutrition, soybeans are just fine the way they are.' [Nestle, 1996]

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