Chapter 5

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A Legal Perspective

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Genetic modification (GM) of crops is an experimental application of biotechnology that involves manipulating the genetic code of plants to induce them to generate substances they do not produce naturally.

The techniques of modern genetics have made possible the direct manipulation of the genetic makeup of organisms. In agriculture, genetic engineering allows simple genetic traits to be transferred to crop plants from wild relatives, other distantly related plants, or virtually any other organism.

Combining genes from different organisms is known as recombinant DNA (rDNA) technology, and the resulting organism is said to be "genetically modified," "genetically engineered," or "transgenic." Genetic engineering may more correctly be termed genetic re-contextualisation where genes can be transferred to new contexts in order to generate new characteristics.

Recombinant DNA technology thus has brought a new precision to the process of crop development, which traditionally selects desired traits through crosses between crops and their wild relatives (a laborious and relatively imprecise method).

Genetic modification can be used in many ways to control a variety of traits of plants, and the consequences of one manipulation may be completely different from another based on the traits modified.

By far the most common genetically modified (GM) organisms are crop plants. But the technology has now been applied to almost all forms of life, from pets that glow under UV light to bacteria which form HIV-blocking "living condoms" and from pigs bearing spinach genes to goats that produce spider silk.

It is now technically feasible to take a gene from one species and make it part of the genome (genetic `blueprint') of another species. A toxin-producing gene from a bacterium can be added to corn to make it pest-resistant. The gene that makes a firefly glow at night can be added to a plant's DNA to make the leaves light up when the crop is ripe. A cow can be `engineered' to produce a drug in its milk. Human genes can be added to a pig's genome so that it grows organs for transplantation to man without being rejected by the patient.

Genetically-modified (GM) food is produced from plants or animals which have had their genes changed in the laboratory by scientists.

Plant breeders have learnt to apply GM technologies first developed for plants in 1983, to a wide range of crop species. The first applications of genetic engineering or genetic modification, as it came to be known, were in human medicine. Almost all the crops that we cultivate today are much changed from their wild ancestors. Breeding by selection and saving the best seed for the next generation has been in progress for many thousands of years. Farmers have been engaged in what we might term "traditional genetics" for thousands of years. They have long understood that like begets like, favouring the seed from plants with the most desirable characteristics.

In most crops, the incorporation of traits compatible with agriculture, such as free threshing in cereals, was achieved centuries ago. New plant types have also arisen by cross-breeding closely-related species. This is how we got oil seed rape and bread wheat.

But modern genetic modification of food introduces alien genes from one species to another completely different one, such as one or more genes of bacteria to the chromosomes of plants. The modern genetic technology interferes deeply with the natural structure of nature.

Crossing plants do not introduce special parts of DNA like terminator genes, marker genes as done by extreme genetic modification techniques.

In general, the creation and release of genetically modified organisms (GMOs) raises a different type of issue – biosafety. There is a risk that a transgenic plant will cross-pollinate a natural variety and produce mutations with unknown results. Large scale planting of pest-resistant biotechnological plants exposes the pest to the toxin on a scale unknown before. This can give insects and viruses a much greater imperative to become resistant – otherwise the species might die out. Organic farmers are afraid that a new strain of toxin-resistant insect would wipe out their crops. "On the other hand, an insect-free environment is also likely to be a bird-free environment."[1]

Scientists have tried to speed things up by exposing experimental plants to chemicals and radiation. This has the effect of producing hundreds of mutations among the genes. Some of these may be useful, others will not and the plants will be discarded.

Genetic engineering, on the other hand, is more specific. It allows scientists to select a single gene for a single characteristic and transfer that stretch of DNA from one organism to another - even between different species. Also called "biotechnology", genetic engineering is a high-tech process by which humans move specific genes from one organism into another organism. Conceivably, any gene from any organism can be moved into any other organism. These processes create some risks.

Ecological systems are extremely complex. Impacts at one level of the "food chain" can reverberate throughout the system. For example, changes in the invisible plankton in the sea can affect fish, and therefore affect humans. Likewise, the introduction of a genetically engineered organism in a particular ecosystem can have unforeseen impacts on various species in that ecosystem. Even when controlled experiments are concluded successfully,

[1] *Science for the 21st Century – A New Commitment "The possible and acceptable – ethics in science" – UNESCO's O P I*

there is no guarantee that the novel organism will not create a problem in a different ecological setting.

Major areas of activity include:

Medicine - with major efforts in pharmaceutical production using living organisms and human gene therapy;

Agriculture - in which crops, livestock, and related micro-organisms are altered to increase production, influence disease patterns and environmental impacts, and so on;

Pollution cleanup - using genetically engineered micro-organisms to degrade harmful chemicals, such as PCBs;

Mining - to develop genetically engineered micro-organisms that can concentrate rare metals and re-pressurize spent wells to revitalize depleted mines; and

Biological weapons - adding to the arsenal of biological warfare agents, such as anthrax, by designing diseases to target selected populations of humans.

5.1 Genetically Modified Crops

The first transgenic plant - a tobacco plant resistant to an antibiotic - was created in 1983. It was another ten years before the first commercialisation of a GM plant in the United States - a delayed-ripening tomato - and another two years (1996) before a GM product - tomato paste - hit UK supermarket shelves.[2]

There are two main types of GM crops that are in commercial use around the world. These are either crops that have been developed to be resistant to certain crop pests, or crops that have been developed to be resistant to a particular herbicide (weed killer). These GM traits are being used in crops such as soya, maize, oilseed rape and cotton.

The development of GM plant technology raises three kinds of issues: the scientific, the ethical and the legal. Science is concerned with understanding the world in which we live and in particular the casual relationships that shape that world: for example the association between genes as a molecular sequence and the characteristics such as resistance to frost that genes express. Understanding such casual patterns is necessary if we are to alter or change the characteristics of plants in an informed way.

Ethics, by contrast, is concerned with what we ought or ought not to do. Ethical principles provide standards for the evaluation of policies or practices, for example, indicating that it would be wrong to carry out a certain genetic modification because to do so would threaten human health or harm the environment.

Despite the lack of controls to protect the environment in many countries, many northern companies appear to be using the less

[2] *BBC News special report 1999 - Food under the microscope*

developed countries as testing grounds for crops designed to suit their home markets. It is of very great concern that a situation of 'double standards' is evolving where developed countries are taking measures to protect their own environments but allowing their corporations to threaten the more vulnerable environments of less developed countries.

The development of GM crops has recently caused widespread unease in western countries too. The unease comes in diverse forms and in varying degrees of intensity. It is also based on a wide range of ethical beliefs.

On the legal front, genetic modification of crops raises various issues. In the true sense, genetic modification of a particular crop is an alteration of a crop that already exists in nature and which is being used by the people since centuries. Genetic modification of such crops cannot be termed as an invention; at the most it can be treated as innovation only.

Giving property rights to the modifier and depriving the people from using it without paying royalty cannot be permitted under any legal system. It also raises the issue of liability in the event of any unwanted situations arising out of such genetic modification.

5.2 Impacts of Genetic Modification

The genetic modification of crops has a dual impact. On the one hand it provides certain benefits such as higher yield, longer shelf life, pest resistance, improved taste, safer and more nutritious food, etc. On the other hand genetic modification of crops also poses several problems such as inadvertent contamination of food crops, resistance breakdown, ecological risks, alienation of some plant varieties, etc . Both the benefits and problems of genetic modification of crops are discussed in detail as under-

Potential benefits of GM crops

The new technologies called genetic engineering or genetic modification (GM) promise to revolutionize agriculture, medicine and animal husbandry. Genetically modified foods (GM foods or GMF) offer a way to quickly improve crop characteristics such as yield, pest resistance, or herbicide tolerance, often to a degree not possible with traditional methods. Further, GM crops can be manipulated to produce completely artificial substances, from plastics to consumable vaccines.

An optimistic view is that GM plants and food stuffs will make a great, possibly indispensable contribution to reducing mass hunger. They claim that GM plant technology will raise agricultural productivity, assist the development of safer, more nutritious foods with a longer shelf-life, and contribute to the goal of increased food security for the poor in developing countries. GM crops have the potential to assist in alleviating world hunger.

It can also prove very useful in countries where under-nutrition is a problem. A sustainable increase in the field performance of food staples depends on higher and more robust yield potentials. GM crops offer one way to achieve this, while potentially also encouraging reduced use of water and agrochemicals. Apart from under-nutrition, it could well prove feasible to greatly reduce malnutrition through the development of micronutrient-rich GM crops.

Apart from the question of improved global food security, it is theoretically possible that genetic modification could improve the flavour, texture, appearance, price and nutritional content of a number of plant foods. We could boost the vitamin content of fruits and vegetables, incorporate anti-cancer substances, and reduce our exposure to the less healthy oils and fats.

Bioengineers have also given us a new word to describe plants that have been altered to have medicinal properties - "nutraceuticals".

Bioengineers will argue that GM technology offers a chance to recover the situation. They say GM crops will require fewer chemicals that have low toxicity, are rapidly degraded and stay in the soil rather than being washed into rivers.

They will do this whilst at the same time producing higher yields. This could reduce pressure on those remaining uncultivated habitats.

Scientists are also investigating whether plants can be modified to produce new plastics and bio-fuels that would be kinder to the environment than the products based on oil.

Efforts are being made to breed cereals with better proteins, rape seed with fatty acids better suitable in case of certain diets, other plants missing proteins causing allergies and lactic acid bacteria resistant to virus in the production of milk and meat products thus turning the process of production and the product itself safer.

Against these, we must set the claims of those who say that GM food technology is a threat to human health and/or the environment and that its introduction will raise the profits of private suppliers whilst at the same time depriving poor producers of primary commodities access to markets and to the new varieties of seed. Critics argue that we do not know enough about the way genes operate and interact to be sure of what the outcome of any modification will be. They worry that the alterations could accidentally lead to substances that are poisonous or trigger allergies.

The genetic modification of food is said to produce food with:

- Longer shelf life
- Better properties
- Using less insecticies in agriculture

This is true in case of soyabeans but Roundup Ready soybean (a Monsanto product) can be efficiently cultivated only with the insecticide of Monsanto. The worldwide insecticides used for soybean will be monopolized therefore by Monsanto.

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Potential problems of GM crops

The power of genetic modification techniques raises the possibility of human health, environmental, and economic problems, including unanticipated allergic responses to novel substances in foods, the spread of pest resistance or herbicide tolerance to wild plants, inadvertent toxicity to benign wildlife, and increasing control of agriculture by biotechnology corporations.

Impact on Environment: Plant breeders can select genes which confer herbicide in new crop varieties. In theory, the new varieties allow the substitution of less toxic, less persistent and more "environmentally-friendly" herbicides for more problematic ones. Recent analysis, however, suggests that the new crops are likely to increase herbicide use. Most herbicides are used before planting because they would harm the plant if applied later. Herbicide tolerance allows a person to apply herbicides both pre-planting and post-emergence. With increased herbicide use comes a greater risk of groundwater contamination.

The introduction of novel organisms can also affect the ecology of a field and its environs. For example, one microorganism engineered to better convert crop wastes to ethanol was found by its designers to also harm a beneficial fungus in the soil, reducing the capacity of nearby plants to absorb essential nitrogen.

Farming and rural life: Many of these genetic engineering feats are meant to make farm production more "efficient," which will enable factory farms to grow larger and larger, concentrating the industry, encouraging vertical integration, and eliminating small family producers. Small towns will continue to decline. Overproduction of manure, increasing use of machinery and chemicals, and the introduction of novel genetic impacts will worsen environmental conditions in rural areas.

The anti-GM lobby is critical of the use of DNA from plant viruses and bacteria in the modification of crops - they fear this may also somehow trigger disease.

They have objected to the use of antibiotic-resistant marker genes in transgenic crops, which are included by scientists to test whether or not their main modifications have been successfully incorporated into a plant.

The critics argue the antibiotic-resistant genes could be passed to the micro-organisms that make us ill. If this happens, we might not have the necessary drugs to fight back.

Effects on biogeochemistry - The potential to cause changes in nitrogen and carbon recycling that depends on decomposition processes.

Increased persistence in the environment and invasiveness - A genetic modification may confer an ecological fitness advantage to the recipient plant, which potentially allows it to become persistent or invasive. Concerns about 'super weeds' have been raised regarding herbicide tolerance traits; however, traits such as disease, drought or insect resistance are more likely to confer an advantage to a recipient plant, since these pressures control natural plant populations.

Transfer of genetic material - Cross-pollination with other crops of the same species or near-relatives can give rise to hybrids which express the traits introduced by the genetic modification. Such gene-transfer may not be a hazard in itself; this would depend on the trait being transferred.

Instability of the genetic modification - Plants have the ability to inactivate inserted genetic material, particularly if there is a large number of copies inserted and if the constructs are large. In many cases, this may not pose a risk in itself, as the recipient plant is likely to revert to the wild-type. However, this would become an issue where a genetic modification was made to down-regulate a naturally occurring hazardous trait.

Unintended effects - While it is expected that inserted sequences of nucleic acid are well characterised, the exact positions of the insertion(s) cannot be predicted until more detailed analysis is completed. It is possible that the insertion can influence the expression of adjacent genes and their promoters, leading to unintended genetic modifications. These may not be hazardous, but the transformation event and its progeny would require careful monitoring.

If a hazard is realised in the course of a release, it may result in harm to human health if the GMO is toxic or allergenic, or to the environment, if population dynamics are affected, resulting in reductions of native species. The process of risk assessment examines whether or not it is likely that identified hazards are likely to be realised under the conditions of a proposed release.

Like other forms of genetic engineering, genetic modification of crops is based on the transfer of genetic material between species that in most cases could never reproduce in nature. If the gene is human or animal in origin, it must first be manipulated to make it less foreign to the plant. This "genetic construct" is then randomly spliced into the host organism's genome. Neither the site of insertion in the plant's genome, nor the number of copies of the 'transgene' that are incorporated, is controlled. The genetic construct can break apart, resulting in incorporation of gene fragments or failure to incorporate parts of the construct. Even if the genetic construct is totally incorporated into the plant, there can be several other problems -

- **Side-effects:** When a genetic system is perturbed by the introduction of a transgene with a new or modified effect, it is possible that unexpected effects will be encountered.

- **Gene silencing:** Scientists have, as yet, no control over where in the plant's chromosomes a transgene will integrate. Some regions of the plant genome contain large domains of non-coding DNA, which will be highly methylated. Transgenes inserted into this part of the DNA are prone to become methylated themselves, and eventually to cease to function. Gene silencing is effectively nonreversible and the GM plant will revert to the way it was before it was modified.

- **Instability:** Any set of genetic engineering experiments will yield a range of plants, some stable and some less so. The plant breeder will have to select on the basis of efficiency and stability and then, over several generations, breed the modified plant types into closely related varieties. Then, before release, the new variety will have to be tested at many different locations over several years. Otherwise, GM plants prone to being silenced would not be identified and excluded early in the breeding process. This would involve a considerable amount of time and financial resources to be expended on GM crops.

- **Resistance breakdown:** Disease or pest resistance conferred by a transgene can become ineffective.

- **Unintended consequences:** Unintended effects result from the unpredictable nature of the genetic engineering process, which in turn is conditioned by our still vast ignorance of the ecology of the cell. A prime example of this ignorance is the recent discovery-based on the results of the Human Genome Project-that human beings have much less genes than what was previously estimated.

  Unintended effects are quite common in genetically engineered crops, and include increased susceptibility to disease, nutritional differences, necrotic lesions, increase lignin content, and reduced levels of aromatic amino acids.[3]

- **Inadvertent GM crop contamination:** Thus far, we have only considered the unintended consequences of genetic modification to the crops that are modified. We have ignored the contamination threat that arises from the rough and ready nature of the food system, which has developed to grow and move huge quantities of grains quickly and cheaply. There are many possible modes of GM crop contamination from seed purchase through field to table: seed spillage; residues of modified seeds in farm equipment; volunteer growth; cross-pollination by wind, insect or animal; and post-harvest mixing in the grain-handling system. The field release of "third generation" transgenic crops that are grown to produce pharmaceutical and other industrial bio-chemicals will pose special challenges for containment if we do not want those chemicals appearing in the human food supply.[4] It is possible that crops transformed to produce pharmaceutical or other industrial compounds might mate with plantations grown for human consumption, with the unanticipated result of novel chemicals in the human food supply.[5]

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[3] *Kuiper et al 2001, p 516, Benbrook 2001, p 4, Saxena & Stotzky 2001a*

[4] *Dr. Norman Ellstrand, a geneticist at the University of California*

[5] *"Environmental Effects of Transgenic Plants The Scope and Adequacy of Regulation," Committee on Environmental Impacts Associated with Commercialisation of Transgenic Plants of the National Academy of Sciences, National Academy Press 2002, p 68*

5.3 *The case of Starlink*

A glaring example of one such contamination is the case of StarLink, a variety of modified corn engineered to produce Cry9C insecticidal toxin, which contaminated food products and corn seed stock with a potentially allergenic protein even with the use of gene containment measures. Due to concerns that this toxin might cause allergies, the Environment Protection Agency (EPA) approved StarLink in 1998 only for animal feed and industrial uses, not for human consumption. The EPA stipulated that StarLink could only be grown if: 1) A buffer strip 660 feet wide were planted around StarLink plots to mitigate pollen contamination of other corn; and 2) Both StarLink and buffer strip corn were segregated for distribution in non-food channels[6]. Despite these restrictions, StarLink contaminated a huge portion of the food supply. The estimated number of people who consumed contaminated supermarket products (e.g. taco shells, bags of corn meal, etc.) is in the tens of millions.[7] Hundreds of people who reported allergic reactions that they attributed to yellow-corn products were never tested[8]. Numerous lawsuits to recover lost income due to this contamination scandal are still wending their way through the courts.

The extent of the contamination is startling when one considers that StarLink never represented more than 0.4% of US corn acreage[9]. Most of the contamination was probably due to post-

[6] *EPA Cry9C Fact Sheet 2000*
[7] *Freese 2001a, pp 14-15*
[8] *ibid, p 22*
[9] *EPA Preliminary Evaluation 2000, Table 5, p15*

harvest mixing of StarLink with conventional corn. Evidence that popcorn, sweet corn, white corn and especially seed corn stocks were also contaminated with Cry9C strongly suggests that StarLink pollen blown by the wind fertilized conventional corn, despite the 660-foot border strip requirement[10].

Another crop vulnerable to contamination is rice. Annual red rice causes problems because it is carried with cultivated rice and can significantly lower its value by reducing its processing characteristics.[11] Genes from cultivated rice can easily be transferred by hybridization to red rice and other relatives[12]. Varieties of rice resistant to two herbicides (imidazolinone and glyphosate) are under development[13]. If introduced, exchange of herbicide-resistant traits between these three varieties and weedy red rice could lead to doubly and triply resistant red rice, creating a weed problem of enormous proportions.

Current gene-containment strategies cannot work reliably in the field. Seed companies will continue to confuse batches, and mills will continue to mix varieties. Farmers will be unable or unwilling to follow planting rules. Most seriously, gene flow (like mixing) could result in GM material unintended for human consumption ending up in the human food chain[14].

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[10] *United States Department of Agriculture (USDA) News Release 2001, Hovey 2001*
[11] *USDA EA 96-355-01, pp 5-6*
[12] *Ellstrand et al 1999, p 545*
[13] *ibid*
[14] *Nat Biotech 2002, p 527*

5.4 *The risk of Monsanto's toxic plants*

Monsanto's present trials in India are being carried out on its genetically engineered "Bollgard" cotton or Bt-cotton which has genes from a bacteria engineered into it so that the plant produces its own pesticide contrary to Monsanto's claim. Bt-cotton is not "pest-resistant" but a pesticide producing plant. The severe ecological risks of crops genetically engineered to produce toxics include the threat posed to beneficial species such as birds, bees, butterflies, beetles which are necessary for pollination and for pest-control though pest predator balance. Nothing is yet known of the impact on human health when toxic producing Bt. crops such as potato and corn are eaten or on animal health when oilcake from Bt-cotton or fodder from Bt-corn is consumed as cattle feed. Further, while pesticide producing plants are being offered as an alternative to spraying pesticides, they will in fact create the need for more pesticides since pests are rapidly evolving resistance to genetically engineered Bt-crops. The wide spread use of Bt. - bacillus thuringensis containing crops could accelerate the development of insect pest resistance to Bt. which is used for organic pest control. Already eight species of insects have developed resistance to Bt. toxins, either in the field or laboratory, including Diamond back moth, Indian meal moth, Tobacco budworm, Colorado potato beetle and two species of mosquitos.[15]

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[15] *Shiva, Vandana - 'Monsanto's genetic engineering trials are dangerous', Navdanya newsletter, Aug 2003*

The genetically engineered Bt. crops continuously express the Bt. toxin throughout its growing season. Long term exposure to Bt. toxins promotes development of resistance in insect populations; this kind of exposure could lead to selection for resistance in all stages of the insect pest on all parts of the plant for the entire season.

Due to this risk of pest resistance, the U.S. Environment Protection Agency (EPA) offers only conditional and temporary registration of varieties. Bt. Monsanto's technology will therefore destroy beneficial biodiversity and create super pests both through wiping out pest predators and by creating pests which are resistant to pesticides. While Monsanto's pesticide producing Bt. crops are not based on the terminator technology, which terminates germination of seed so that farmers cannot save it they are in an ecological sense a terminator technology which terminates biodiversity and the possibilities of ecological and sustainable agriculture based on the conservation of biodiversity.

The ecological impact of Bt-cotton cannot be assessed on the basis of a 3 month trial. The trial needs to be carried out over 2-3 growing seasons and its impact needs to be assessed on all organisms, including soil microorganisms which have been known to be killed by the toxics in Bt-crops. To get the full-ecological impact of biodiversity destruction and genetic pollution caused by genetically engineered crops, the following steps are necessary.

- *A full biodiversity assessment of the ecosystem in which the GMO is to be introduced.*
- *Impact of genetically engineered crop on diverse species including pollinators and soil microorganism.*
- *Risks of transfer of genetically engineered traits to non-engineered crops through horizontal gene transfer and pollination.*

None of these essential steps for ecological risks of GMOs have been carried out in Monsanto's present trials with Bollgard cotton in Karnataka.[16]

When Monsanto states that they have had 93% success they are referring to agronomic performance, not to ecological safety. Further, since the bt-technology is aimed at pesticide production, not yield increases, Monsanto is deliberately distorting facts when it refers to yield increasing characteristics of Bollgard cotton.

Monsanto has forced the genetically modified Bt Cotton crop on Indian farmers. Agriculture in India makes up the livelihood of 75m of the population. In 2002 over 90% of the crops failed. When insurance companies could not cover the damage to farmers, Monsanto did not offer any compensation. Monsanto does not engineer their crops to be conducive to foreign soil, weather, farming patterns, and the Indian crop failure can be attributed to this.[17]

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[16] *Shiva, V - 'Monsanto's genetic engineering trials are dangerous', Navdanya newsletter, Aug 2003*
[17] *Joel Wainwright from the Dept. of Geography, Ohio State University, USA*

The industrial agriculture companies, such as Monsanto, can easily gain foreign access through trade agreements potentially installed under the WTO. In one district in India, in 1 month, 76 farmers committed suicide due to indebtedness. This is reflective of the larger problem: hundreds more farmers had the same fate.[18]

Monsanto is also misinforming the public when it states that pesticide producing plants mean no pesticide needs to be sprayed. The primary justification for the genetic engineering of Bt. into crops is that this will reduce the use of insecticides. One of the Monsanto brochures had a picture of a few worms and states, `You will see these in your cotton and that's O.K. Don't spray'. However, in Texas, Monsanto faces a law suit filed by 25 farmers over Bt. cotton planted on 18,000 acres which suffered cotton bollworm damage and on which farmers had to use pesticides in spite of corporate propaganda that genetic engineering meant an end to the pesticide era.[19]

Cotton boll worms were found to have infested thousands of acres planted with the new breed of cotton in Texas.

The clearance of Monsanto's trials with toxic plants without the democratic consent of concerned governments, from state to local level, and democratic participation of the public in bio-safety decisions reveals the loopholes and inadequacies in the present bio-safety regulations both from the democratic perspective and the ecological perspective.

[18] *Shiva, V - 'Monsanto's genetic engineering trials are dangerous', Navdanya newsletter, Aug 2003*
[19] *ibid.*

When the US overproduced genetically modified corn, the country forced it on Mexico using the rights of the NAFTA (free trade agreement). This is a sad irony since Mexico has over 1000 indigenous types of corn (180 biological types). Dr. Oswald Spring suggests that the 78 billion spent on importing food be spent instead on "jobs, infrastructure, livelihoods" in Mexico.[20]

Accessing the agricultural sector of trade is the United States' prime concern, and is being driven by insatiable agribusiness US corporations such as: Cargill, Monsanto, ConAgra. These huge multinational corporations are driving the liberalization of trade but the blind greed is transparent. "Will it be food sovereignty or free trade for Cargill?"[21] Agriculture and free trade cannot co-exist.

Industrial agriculture is highly inefficient. 10 cal of energy are spent to make 1 cal of food in industrial agriculture. There are more inputs, more chemicals, and $400 billion in subsidies. It (industrial agriculture) takes more than it gives. Indeed, it has taken the lives of many farmers.

5.5 The protein potato hoax

First it was the "Golden Rice Hoax" to sell genetically engineered foods as a solution to hunger and poverty and blindness due to Vitamin A deficiency. We showed that greens and fruits and vegetables that could be grown in every backyard provided hundreds of times more Vitamin A than "golden rice". Now we are

[20] *Shiva, V - 'Monsanto's genetic engineering trials are dangerous', Navdanya newsletter, Aug 2003*
[21] *Dr Shiva, Vandana – In Motion Magazine, 2003*

being sold a "Protein Potato" hoax as part of anti-hunger plan formulated in collaboration with government institutes, scientists, industry and charities. The potato is claimed to contain a third more protein than normal, including essential high-quality nutrients, and has been created by adding a gene from the protein-rich amaranth plant. The protein-rich genetically modified potato could help combat malnutrition in India. Its developers say the "potato" could help tackle nutrition problems amongst the country's poorest children".

However, inserting genetically engineered genes for proteins from amaranth into potatoes, and promoting potato as a staple for mid-day meals for children is a decision not to promote amaranth and pulses (the most important source of protein in the Indian diet). Amaranth contains 14.7 gms of protein per 100 gm of grain, compared to 6.8 gm/100gm in milled rice and 11 gm/100gm in wheat flour and 1.6 gm/100 gm in potato.

When compared to bringing nutrition through grains like amaranth, genetically engineered potatoes will in fact create malnutrition because it will deny to vulnerable children the other nutrients available in grain amaranth and not available in potato.

In 2003, several potato growers of Uttar Pradesh and other parts of country committed suicides because of over production and no buyers. While the farmers are spending Rupees 255/quintal on production, potatoes are being sold for Rupees 40/quintal, leaving farmers at a loss of Rupees 200 for every quintal produced. Per hectare the costs of production are between Rupees 55,000/ha to Rupees 65,000/ha, of which Rupees 40,000 is the cost of seed alone.

The crisis for potato growers, like the crisis for producers of tomatoes, cotton and oil seeds and other crops is directly related to World Bank and W.T.O. driven trade liberalisation policies, of which the new agricultural policies is a direct outcome. The policies of globalisation and trade liberalisation have created a potato crisis, in particular, because of the shift from diversity and multifunctionality of agriculture to monocultures and standardisation, chemical and capital intensification of production, and deregulation of the input sector, especially seeds leading to rising costs of production.

The impact of the new agriculture policy has been to promote a shift from food grains to vegetables and perishable commodities. While grains can be stored and consumed locally, potatoes and tomatoes must be sold immediately. A vegetable-centred policy thus decreases food security and increases farmers' vulnerability to the market.

The genetic uniformity and monoculture of potato through introduction of GM potato would be disastrous for Indian farmers and could lead to more suicides due to increased cost of production and vulnerable market due to withdrawal of state from effective price regulation leading to collapse in prices of farm commodities.

5.6 *Horizontal gene transfer*

Another potential route for contamination of the environment is the transfer of genetic material from transgenic plants to bacteria or other unrelated organisms, one form of a phenomenon known as horizontal gene transfer (HGT). Several laboratory studies have demonstrated the transfer of antibiotic resistance genes, which are engineered into plant cells during the genetic manipulation process in order to permit selection of those cells that have incorporated the transgene.

Horizontal transfer of genetic material is much more likely to occur if the recipient organism has DNA that contains sequences in common with the donor DNA. Horizontal gene transfer can take place from transgenic plant to soil bacteria, soil fungus or intestinal organisms, or from recombinant plasmid to oral bacteria.

5.7 *Terminator Gene: A new threat*

Terminator is the popular name for a complex set of experimental genetic manipulations that render seeds sterile through production of a toxin that kills the seed embryo. Developed by the US Department of Agriculture (USDA) as a way to prevent "unauthorized regeneration" of seeds with patented engineered traits (USDA Terminator 2000), one proposed application is to prevent the spread of pharmaceutical and other co-engineered genes[22]. However, if pollen containing the combination of

[22] *Biologics Meeting I 2000, pp 119, 122*

with altering farming practices to grow genetically modified crops, they will likely pale in comparison to liability risks like liability from inadvertent contamination of food crops, liability risk from substandard quality, liability risk from accidental consumption or theft, etc. Already, Pfizer's Chris Webster has reported a case in which "modified live (vaccine) seeds have wandered off and have appeared in other products".[23]

The cultivation of genetically modified crops exposes not just such farmers, but also all farmers, to an unprecedented degree of liability: lawsuits brought by neighbouring farmers or the company sponsoring such modification, and even government sanctions. If a farmer's crop contaminates a neighbour's field, the neighbour could sue on the basis of trespass, nuisance, negligence or strict liability. A person is strictly liable for engaging in abnormally dangerous activity, even if he/she is not reckless or negligent, and could be sued by anyone who suffers damage as a result. Such damages could include financial losses from inability to sell a contaminated crop or loss of organic status. In one case decided by the Washington State Supreme Court, an organic farmer successfully sued an aerial pesticide spray company for economic losses related to drift of sprayed pesticide onto his farm.[24]

A farmer under contract to supply organic, non-GM or even merely food-grade crops could find himself in breach of contract were his crops to be contaminated. Such contamination could

[23] *Biologics Meeting II 2000, p 77*
[24] *Manufacturing Drugs and Chemicals in Crops Bill Freese, July 2002*

even occur through the farmer's unwitting purchase of contaminated seeds. This latter possibility is illustrated by the extensive adulteration of seed stock with StarLink's Cry9C gene.[25]

5.9 GM Plants and Patents

The development of techniques for the genetic modification of plants has challenged the concepts of what is and is not patentable. In the case of GM crops, intellectual property is particularly important because the products i.e. seeds can easily be multiplied by farmers and growers. Without patent protection, farmers and growers would be able to freely multiply fertile seed of approved GM crops and start up costs would not be recoverable.

The overall aim of the patent system is to stimulate innovation for the public good. By rewarding the inventor with a monopoly on his invention for a fixed term, the system aims to provide investors with a means of recouping returns on investments in R&D. It also encourages disclosure of inventions so that others may benefit from the knowledge and further the field. To be granted a patent, an invention must meet the three criteria of patentability. It must be novel, inventive and show utility or industrial application.

In the case of GM crops, two public concerns have been visible. One has been with the legitimacy of "owning life". Various

[25] *US Department of Agriculture News Release 2001*

interest groups have been campaigning, on ethical grounds, against the concept that property rights can exist in genetic material or activities associated with it.[26] The other concern, more amenable to the fine-tuning of legal arrangements, has been with the patenting of GM crops and the research techniques associated with the development of GM crops. Patent holders may be reluctant to licence patents with broad claims to key technologies to their competitors or to public sector research institutions. Companies may seek patents that will not advance research or production, but which deter competitors and prevent research in areas that threaten their monopoly.

Prior to the development of genetic modification (GM), patents on plants were not widely granted in the US or Europe. Over 200 US patents in the 'plant biotechnology' category have now been granted. In Europe, the development of patents on plants has been slower. The only means by which plant varieties can be protected has been under the UPOV Convention (Union for the Protection of New Varieties of Plants). Under UPOV, which was founded to provide international protection to the plant breeding industry, the breeder is awarded an exclusive right to sell the reproductive material for 20-25 years. There are two important exemptions to the plant variety protection afforded by UPOV. First, other breeders may use the variety to develop new varieties under the research exemption provision. Secondly, farmers may save seed for crop production though not for sale to other farmers, under the Farmers' Exemption Provision.

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[26] *Dworkin G (1997) Property Rights in Genes, Philosophical transactions of the Royal Society of London series B (Biologicla Sciences) 352 1077-1086*

Nevertheless, a number of plant patents have been allowed in Europe after protracted debate over whether the plants concerned were varieties or not. However, a decision in a case of 'Plant Genetic System' in 1995 by the European Patent Office (EPO) somewhat reversed this emerging policy by refusing a patent on GM crop, restricting instead the allowable claims to GM cells. Generic inventions such as wheat modified with Bt. gene are not plant varieties eligible for protection under UPOV and are therefore patentable.

5.10 Policy on GM Crops

There are three main types of principle that are relevant to the evaluation of policies or practices regarding GM crops. The first principle is a principle of general welfare, which enjoins governments and other powerful institutions to promote and protect the interests of citizens. The second is the maintenance of people's rights, for example their rights to freedom of choice as consumers. The third is the principle of justice, and it requires the burdens and benefits of policies and practices to be fairly shared among those who are affected by them.

Different societies have set different values on the acquisition and use of scientific information. It is the ethical basis of the regulation of commercial development and production of GM crops and the promotion of genuinely useful research by government action that mostly concerns us. For most individual consumers, the choice whether to consume or not consume GM food is not a matter of ethics. A consumer who thought GM food unsafe would be unwise but not wicked to eat it. Only if consuming GM food is thought to be intrinsically wrong, is its consumption ethically wrong, and directly so. The consumption of GM food would be ethically problematic, but in an indirect fashion, if its production did harm, violated rights, or caused injustice.

GM crops do not raise questions about the rights of plants, in the way that animal experimentation raises questions about the rights of animals; nor do they raise questions about the welfare of plants. However, some people perceive GM crops as 'unnatural'. Others argue that it is unethical to treat nature in an "industrial" fashion, not simply because of the unfortunate consequences of so doing, but because they believe it is intrinsically wrong.

The government of a modern democratic society is obliged not merely to accommodate the deeply held moral convictions of its citizens, but to treat them with respect. The task of governments cannot be to legislate or regulate by making these convictions the basis of law but it is rather to pursue policies that can command something close to a reflective consensus. This is why safety, health, economic well-being and the avoidance of environmental degradation are commonly the goals of policy. To say this is not to ignore what some of our correspondents describe as 'intrinsic' ethical considerations, but it is to say that they must enter policy in more complicated ways than for example, considerations about safety and health.

There is no single principle that should determine our conduct or the making of policy. We cannot assume that considerations either of welfare or of rights or even of justice taken on their own should be decisive in deciding what we are to do. Consequently, we need to consider the meaning and implications of each of these principles as part of our overall assessment.