

Students for Alternatives to Genetic Engineering (S.A.G.E.)

GENETIC ENGINEERING: THE RISKS

Genetic Engineering Issues at a Glance

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1996

- Vegetables, milk, and many other foods containing genes from viruses, bacteria, insects, and animals are on supermarket shelves today.
- These genetically engineered foods may contain allergens and toxins, and could result in serious unforeseen health problems.
- The U.S. and many other governments do not require these foods to be labeled.
- Many scientists and medical doctors believe genetic engineering will threaten health, the ecosystem, and the global food supply.
- Farmers and public are not being adequately informed of these dangers.
- Viable alternatives to the use of genetic engineering to solve the world's food problems exist.

Overview of Issues and Dangers

Is it safe for the biotech industry to tamper with millions of years of complex evolution at the genetic level of our foods and environment?

Molecular biologists and the biotechnology industry are making radical alterations to our food and environment through genetic engineering. Are they irresponsibly downplaying the risks and unforeseen negative side-effects? Human genes are being spliced into pigs, fish genes into tomatoes, and insect genes into potatoes. They are inserting virus, bacteria, and other genes into anything from the vegetables we eat to the ingredient crops of infant formula, soy milk, french fries, common sweeteners and food bases, soda, ketchup, cookies, and pizza. Many consumers are not yet aware that genetically engineered foods are already on the supermarket shelves.

Unpredictable side-effects

Despite claims that they could not occur, many recent unforeseen problems with genetically altered organisms verify the criticism that no-one can predict the complex and subtle side-effects of this kind of genetic manipulation. Serious problems have already occurred, and the long-range implications and risks of genetic engineering are unknown. Contrary to the image being generated, this industry is not a particularly scientific endeavor. Powerful economic and political forces are driving the widespread implementation of genetic technologies, and, as is often the case, industry is putting profit before safety. These mutated foodstuffs have no track record, yet the U.S. and other countries have, despite serious concerns from the international scientific community, approved these products for commercial distribution without requiring adequate testing or informative labeling. It appears they do not believe that the public has the right to know what they are eating.

Scientific advancement is a powerful tool with many benefits, however, science shows us that the more powerful a technology is, the more caution needs to be exercised in its usage. Genetic engineering is a very powerful technology, and a significant section of the scientific community believes that governments and research institutions should require, as a fail-safe measure, absolute safety first, in the introduction of this new technology. Genetic engineering is far from being an exact science. Molecular biologists can

intentionally or unintentionally create changes in the complex genetic and biological make-up of plants and animals that result in new unknown proteins and constituents, whose consumption can bring unknown side-effects. New, unsuitable organisms can also be created which threaten the environment.

According to some eminent experts in this field, the scenario is disconcerting: Erwin Chargoff, often referred to as the father of molecular biology, warned that all innovation does not necessarily result in "progress". Chargoff once referred to genetic engineering as "a molecular Auschwitz", and warned that the technology of genetic engineering poses a greater threat to the world than the advent of nuclear technology. "I have the feeling that science has transgressed a barrier that should have remained inviolate," he wrote in his autobiography, 'Heraclitean Fire'. Noting the "awesome irreversibility" of genetic engineering experiments being planned, Chargoff warned that, "...you cannot recall a new form of life... It will survive you and your children and your children's children. An irreversible attack on the biosphere is something so unheard-of, so unthinkable to previous generations, that I could only wish that mine had not been guilty of it."

Concerns are shared by many scientists. The Union of Concerned Scientists (a body of more than 1600 respected scientists from around the world, including more than 100 Nobel Laureates in the sciences) believes that genetic engineering of foodstuffs can present significant risks to health and the environment. They advocate sustainable agriculture as a more intelligent, viable solution.

The European Union (EU) has raised serious concerns about some genetically engineered crops now on the market, as has Japan. The EU has approved a measure requiring companies to label genetically modified food. Norway has also required the labeling, and banned certain types, as well as the release of genetically modified crops, animals, and other organisms into the environment. Austria and Luxembourg have banned the import of genetically modified grain, and other countries are considering doing so.

Genetic Engineering is spreading fast

The growth of the genetic engineering industry is not a small issue. At present, the genes of virtually every grain, vegetable, fruit, and legume have been genetically altered in the laboratory. Many of these crops are used in a wide range of common foods, and have arrived in the supermarkets. The short and long range side-effects of such products are unknown.

The bottom line it seems, with regards to genetic engineering, is that, without our consent, we are all being used as guinea pigs by a profit driven industry, for a dangerous technological experiment.

Modifying DNA

Genes are the working blueprint for every part of an organism, whether human, animal, or plant. They constitute the DNA (deoxyribonucleic acid), the biological intelligence of the organism - a natural entity of unrivaled complexity and sophistication. So much so that a new, fast growing branch of research in computer science involves the attempt to utilize the DNA's awesome computing power. If ever accomplished, it is estimated such a computer will be able to perform trillions of computations simultaneously in a single test tube of DNA. Or, store in one small jar, millions of times as much information as is possible in today's largest computer memories, making today's supercomputers seem primitive(54). Utilizing this computing power is one thing, but when it comes to understanding the immense complexities of DNA and its interactions within the body and the ecosystem, scientists are shooting in the dark.

Genetic engineering is the process of modifying the information contained in the DNA, particularly by artificially transferring the genes specific to one type of organism into another. These organisms are often referred to as 'transgenic'.

Why do it?

Genetic scientists want to transfer seemingly desirable qualities from one organism to another. For example, to make a crop resistant to a chemical pesticide, so that more pesticide can be used on crops, or, to make a product more marketable (eg. tomatoes that will squash less easily in harvesting, packing and shipping), therefore cheaper.

However, the situation with the current failures of genetic engineering (Bt cotton, rBGH in milk, canola[oilseed rape], 'Flavr-Savr' tomato, etc. [see below]), the subsequent rejection by farmers, the public's rejection of these products, along with the dangers predicted by many scientists, makes the biotech companies financially threatened. Huge investments by these companies may not pay off after all. Since, by nature, such large transnational companies are ruled by the need to raise stock price values, this seems to put them in a difficult situation. These large companies are currently switching from the pesticide and hybrid crop industry to biotechnology because these other technological practices are now failing worldwide - pest resistance is rendering pesticides useless and intensive farming is crippling the ability of the land to produce. This battle against nature has floundered, and now a new 'agricultural revolution' is promised with genetic engineering, but this is already showing serious signs of failure and damage to health and environment.

Why is it dangerous?

Many scientists have expressed strong concern about genetic engineering. According to molecular biology expert, Dr. John Fagan of Maharishi University of Management:

"Of the technologies now in use, genetic engineering is especially dangerous because many of the most common applications of this new technology threaten to generate unexpected, harmful side effects that cannot be reversed or corrected, but will afflict all future generations. The side effects caused by genetic manipulations are not just long term. They are permanent....Genetic engineers cannot fully and reliably predict the biological effects of these alterations. They cannot adequately predict how these manipulations will influence cellular functioning, the physiology and behavior of the organism as a whole, and the ecosystem into which that genetically engineered organism will be introduced. It is impossible to confidently predict the effects of genetic manipulations because of the complexity and interconnectedness of living systems. Whether we examine the simplest single-celled microorganism, or a human being, or the global ecosystem, we find a huge number of complex components. These take part in extremely intricate, coordinated interactions; all as part of one, vast, integrated, unified phenomenon - life."

Health & Environmental Risks

Some of the potential risks to health and environment from the production and consumption of genetically engineered foods that have been identified by scientists working outside the biotech industry:

- New toxins and allergens in foods.
- Other damaging effects on health caused by unnatural foods.
- Increased use of chemicals on crops, resulting in increased contamination of our water supply, food, environment, and
 - animal species - increased incidence of reproductive problems and birth defects, cancer, and other diseases.
 - Medical gene therapy could inadvertently mutate normal genes and could cause new genetic diseases or cancer, and
 - harmful side-effects will be passed on to offspring and all subsequent generations.
 - The contamination and threat to the natural environment upon which we depend for sustenance.
 - Genetic pollution - accidental introduction of defective genes into the gene pool, weakening species. Accidental creation of
 - new plant diseases, new pests, and new weed varieties resistant to herbicides.

- The spread of diseases across species barriers. Disruption of the ecosystem, locally and/or globally, loss of biodiversity,
- disruption of the food chain and global food supply. Disruption of soil ecology and reduction of soil fertility.

Health risks and biological break down

Genetically engineered organisms have already caused serious health problems, disabilities and death. The genetically engineered nutritional supplement - tryptophan - tested and approved by the U.S. Food and Drug Administration, resulted in, over a two year period, 37 people dead, 1,500 partially paralyzed, and 5,000 more temporarily disabled(6). In addition, many scientists fear that genetically engineered organisms could break down our natural and medicinal protection against diseases(8,9,16,25p.6), and that some may even promote cancer.

Got Milk?

A peer-reviewed medical study, in the International Journal of Health Services, suggests that the genetically engineered bovine growth hormone, rBGH, commonly administered to dairy cows to boost milk production, may promote cancer of the breast and colon(9). This product has been in widespread use on dairy farms in the U.S., and consumers have been drinking milk from these cows - largely unknowingly - for several years. In addition to the cancer risk, injecting rBGH reduces a cows life expectancy and increases her risk of disease, leading to increased use of anti-biotic injections, thus leaving residues of these drugs in the milk. The milk produced by the sick cows is less healthful because Mastitis results in increased secretion of white blood cells, or 'pus', into the milk.

Dr. Samuel Epstein, at the University of Illinois, who published this research paper, stated:
"In short with the active complicity of the FDA (U.S. Government Food and Drug Administration), the entire nation is currently being subjected to an experiment involving large-scale adulteration of an age-old dietary staple by a poorly characterized and unlabelled biotechnology product. Disturbingly, this experiment benefits only a very small segment of the agriculture industry while providing no matching benefits to consumers. Even more disturbingly, it poses major potential public health risks for the entire U.S. population."

The companies who have sold rBGH to farmers for years, have downplayed the risks to health of cows and humans, and have promoted the idea that this product will increase yields, and thus be a financial boon to the farmers. They have probably recouped their investment in this product by now, and so are now moving on to other genetically engineered products to sell to farmers at great profit, with little or no consideration of the risks.

Increasing Pollution

Genetic manipulation is also used to engineer breeds of crops which can withstand much greater amounts of pesticides and herbicides, in an attempt to counter naturally growing resistance to these products in agricultural pests. Such an approach will perpetuate and extend the already dangerous treadmill of chemical agriculture in widespread use today.

A review of a wide array of research, from various government bodies and respected scientific sources (including the United Nations Food and Agriculture Organization, U.S. Environmental Protection Agency, U.S. National Academy of Sciences, Danish Environmental Protection Agency, Union of Concerned Scientists, as well as published work in journals such as Nature, Lancet, Science, and many more), along with practical experience, shows that farming of crops with increased chemical treatment will lead to even higher levels of toxins and cancer causing agents in our food and water, as well as seriously threaten the health of farmers and farm workers. It will also further diminish nutritional value of food. The research shows that the resulting consequences of increased pollution on crops can include breakdown of the human immune system, increased reproductive problems, and fetal damage, as well as sickness and

serious debilitating mutation in wildlife species and farm animals. Chemical pesticides can also accumulate and combine in the environment and physiology to produce highly dangerous substances. These practices also deplete our soil, and increase pesticide resistance in insects and bacterium, as well as deplete essential beneficial species. Misuse, which is not uncommon, can lead to serious species annihilation. In addition, these methods have, along with other pollutants, contaminated the sea, causing illness and death in whales, dolphins, and other marine animals.

Worldwide, pesticides and herbicides have contributed, in part, to widespread malnutrition and disease, as well as very dangerous loss of bio-diversity. According to a major research report from the United Nations Food and Agriculture Organization (FAO), the spread of modern agriculture, along with the use of pesticides and herbicides, has helped to create very serious agricultural problems. These practices, spawned in the so-called 'Green Revolution' of the 1960's, have affected land fertility and the productiveness of the ecosystem in developing countries. According to the U.N., intensive farming, use of hybrid crops, and chemical treatment of crops, have contributed to widespread malnutrition and malnutrition associated diseases, through greatly depleted nutritional value of foods. In addition, they have caused loss of local beneficial species and essential biodiversity.

Critics of high tech. farming techniques point out that this approach has put the farming economies of developing countries at the mercy of giant multi-national agrochemical industries. It would be naive to think that the same would not happen with the technology of genetic engineering, being marketed by multinational companies, many of which are the same companies as have been selling pesticides, herbicides, and unsustainable hybrid crops worldwide, for decades. Genetic engineering is being hyped as the magic solution to these past grievous blunders, without any concern that the damaging effects might be even greater, and simply make a disastrous situation more hopeless. Rather than being a magic bullet solution, tampering with the genetic code of crops and organisms could actually further reduce the nutritional value of foods and fertility of the land.

Viable, productive, alternatives to the use of genetic engineering and high tech. farming, to solve the world's food problems are available, and supported by scientists worldwide (see section below - 'Solutions').

Human genome manipulation

In 1994, Dr. John Fagan, having spent many years researching genetic engineering, returned a hard won, \$614,000 major research grant, to the U.S. government's National Institute of Health (NIH), in order to bring attention to the potential dangers he saw with genetic research. He points out that, in addition to genetically modified foods on the market, genetic engineering is being used, with only a very partial understanding, to manipulate human genes as a medical treatment. According to Fagan, the complex and unpredictable results present grave danger to individual health and to the natural and precisely evolved sequence of the human genome, and even the future of world health. Hundreds of clinical trials are in progress in this poorly understood field.

In addition to these risks to health, it is well known that medicinal antibiotics used for treating humans and livestock, are already losing their effectiveness. Over the years, germs that survive treatment have bred in increasingly resistant strains. Many scientists fear that the effectiveness of drugs for farm animals and even humans, could be further weakened by anti-biotic genes, which are necessarily inserted into some common crops (fed to livestock) to monitor successful genetic transfer in the seeds.

Environmental Risks: How genetic engineering could break down our ecosystem

The long-range effects of the alterations genetic scientists are making to our environment cannot be known, and the results can never be recalled or contained. Our plant and animal species have evolved over millions of years in a holistic, interactive context. Suddenly introducing genetically engineered species upsets the intricate balance of our ecosystem, with changes which are unpredictable and would

not occur naturally. New genetically altered living organisms are now being released into the environment, and many scientists fear that some could mutate, reproduce, or migrate. They may transfer their new characteristics to other organisms - as has unexpectedly already happened in some instances. This type of scenario could make the effects of genetic mistakes irretrievable. Transfer of inserted genes across species has already occurred, despite experts claiming this could not happen. Genes inserted into canola (oilseed rape) plants to increase their ability to resist herbicides so that even more chemicals can be used to kill agricultural pests, have been shown to transfer these genes to weed relatives, raising the possibility of creating 'superweeds' - ie: resistant to pesticides. Proponents of genetic engineering claimed these transfers would not happen. Transfer has been noted in other species as well. Marker genes from sunflowers were seen to invade and persist in wild sunflower populations, and in a population of wild strawberries growing within 50 metres of a strawberry field, more than 50% of the wild plants contained marker genes from the cultivated plants. All of these transfers were thought impossible.

Some scientists are concerned that even rare genetic transfers from genetically engineered plants to wild ones could have devastating effects. Even if gene transfer to wild plants happens with less than 1% of the engineered products, some scientists fear that within 10 years we could have a moderate to large scale catastrophe involving 'superweeds', because there are be so many artificial genetic 'innovations' being released into the ecosystem.

Ecological imbalance - domino effect

In addition, scientists are concerned that unknown and unpredicted results of genetic engineering may alter essential ecological relationships between soil bacterium, insects, plants, and animals, and thus may endanger wildlife and/or their habitat, as well as the ecosystem itself. Some instances of this type of domino effect have already occurred and it is thought that further unintentional genetic modifications of the environment could, in the future, pose a threat to world agriculture and the global food supply.

The widespread and well documented ill-effects of high tech. farming methods may be added to by the technology of genetic engineering. In one contained experiment, a genetically engineered bacterium developed to aid in the production of ethanol unexpectedly produced residues which rendered the land in which it was planted infertile. New corn crops planted on this soil grew three inches tall and fell over dead. If unpredicted problems occur after a genetically engineered organism has been released, bees, birds, and wind can carry the seeds (and the problem) into neighboring fields. At least one non-genetically engineered virus, being bred to cut rabbit numbers, has recently escaped from controlled quarantined research facilities in Australia, and spread like wildfire among the rabbit population - with ominous results. Some genetically engineered organisms could do the same, with tragic consequences (Genetically engineered viruses are being developed for general release into the environment in an attempt to control wild rabbit populations. Mutated seeds, bacteria, and viruses, could even piggyback on our international travel and trading system across continents and oceans, creating new unsuitable species (this kind of damaging transfer is already occurring with many normal organisms, and could be greatly compounded by genetic engineering).

In Britain recently, the life-span of female ladybirds (ladybugs) was reduced to half when they ate aphids which fed on genetically altered potatoes, in greenhouse tests. The ladybirds also laid 30% fewer eggs. The potatoes were engineered to produce their own pesticide to ward off aphids, succeeding to some extent, but leaving significant numbers to feed on the potatoes. Because both the ladybird's lifespan and reproduction capabilities were dramatically reduced, this means at least twice as many ladybirds would be needed to eat the remaining aphids - a quite unmanageable scenario. None of these negative side-effects were predicted. Yet others may go undetected as subtle changes occur in the plants, insects, and soils. Anywhere near adequate monitoring of the innumerable entities and interrelationships even in a local ecosystem is impossible.

As many observers have stated, since we do not know what the consequences will be, and when we find out it will be too late, it is the responsibility of governments and research institutions to enact the utmost

safety precautions, and require, and monitor, strict long-term quarantine and testing.

Genetically engineered cotton fails to control pests - costs farmers dearly

Genetically engineered Bt cotton sold to farmers last year with the promise of pest control has flopped in the fields from Texas to Georgia. Many cotton bollworms survived in the new crop, and farmers had to apply chemical insecticides at extra expense. In addition, the escaping bollworms raised doubts about the bollworm resistance management plan implemented by biotechnology corporation, Monsanto, to prevent the development of Bt-resistant bollworms. Over the years bollworms have developed resistance to insecticides and farmers have had to apply more and more, increasing the risk of toxins in the plant, soil and water supply. This cotton was developed to make plants resistant to bollworms, and thus reduce the amount of pesticides the farmer has to apply. However, the approach failed, and chemical use is just as necessary. Some farmers face losses of \$500,000 to \$1,000,000. In addition, because of the complexity of genetic information within the intricacies of the ecosystem, and the known phenomenon of potential gene transfer to other species, the long-term effects of this GE cotton are unknown, thus the possible disruption of the soil-food web in ways that may not be easily traceable. Therefore this release is unscientific and irresponsible.

Neither increased pesticide use nor genetically engineered crops are the answer to agricultural pest problems (see section below - 'Solutions').

The farmers who are being sold the technology of genetic engineering are not being told of the dangers, but are being led into the belief that this will help their business. The over-emphasis on genetic engineering and other high-tech farming techniques is especially regrettable because it is unnecessary. Far safer sustainable agricultural methods are available that can feed all of humanity. (See the section below: 'Solutions'.)

If we learn one thing from the 20th century it should be that, despite their professed advantages, many technologies backfire on us, producing disastrous side effects, eg: nuclear pollution and waste which nobody wants in their locality, ozone depletion, acid rain, the countless hazards of modern medicine, pollution from factories and motor cars. Much of this leads to the breakdown of the immune system for the individual, and severely weakens the ecosystem at large. In every case it takes years, even decades, for the dangers to be taken seriously, often leading to disastrous results. At this time we must learn to make careful choices in our use of the knowledge and technology at our command.

Over time, every technology becomes more accessible to more people, in more countries. A case in point is the use of DDT pesticide. DDT was greatly hyped at its introduction, but is now banned in the U.S. and other industrial countries. Yet it is still manufactured in the U.S. (or by U.S. companies abroad) and other countries, and sold abroad, where it is widely used. Another more dramatic example are the dangerous nuclear and biological weapons (some of which could be genetically engineered) now known to be in the hands of unstable countries around the world.

The wider accessibility of genetic engineering technology statistically increases the chance of mistakes even by careful researchers, not to mention less careful scientists who lack complete education, or harbor ill intent. Widespread availability of genetic engineering technology could create a very dangerous scenario for the world.

Genetic engineering poses the greatest danger of any technology yet introduced. Safety testing will never be adequate, because organisms once introduced can never be recalled from the environment, and their effects will spread without limit. If action is not taken now, virtually everyone in the world could soon be eating genetically engineered food, and farmers and consumers will reap the negative results.

Is it necessary?

Through proper coherent management we already have the ability to feed the world's population without the risks posed by genetic engineering. As has been common practice in the past, commercial and political motives are taking precedence, with little regard to the possible dangers, which, with genetic engineering are very serious.

With so many farming practices having been discredited in the past, we should be alert to the dangers of radical interference with nature. The system of taking everything out and giving nothing back in intensive agricultural, including the use of hybrid plants and pesticides, has already damaged public health and the environment, and has resulted, worldwide, in widespread malnutrition and loss of bio-diversity. Compounded to this, according to the British Royal Commission on Environmental Pollution, 10% of the world's soil has already been lost this century. This is due, in part, to unsustainable and unnatural, large scale farming, and is a major problem in countries such as the U.S. which rely on these intensive techniques.

Genetic engineering is being hyped in the same way all these other failed practices were, but is even more dangerous by far. It will make the environmental situation worse, not better. The agriculture that we rely on today cannot be counted on to sustain future generations. Genetic engineering will perpetuate the reliance on high tech, unnatural farming practices, and, in the long run, could damage the farmer's business and the ability of the land to produce.

The chemical and biotechnology industries, as well as some in the medical establishment, would have us believe that we are at war with nature. Such beliefs and attitudes are unnecessary. We have learned that it is more sensible and rewarding to find ways to operate in harmony with nature's laws, rather than against them, and to understand and utilize what nature provides, rather than attempt to defeat the larger ecosystem in order to further small gains.

Solutions - viable, life-supporting, solutions

Sustainable agriculture - a financially viable solution

Today, a large number of scientists support sustainable agriculture and organic farming as a financially viable alternative for farmers, rather than the vicious circle of intensive and high tech. farming approaches. According to the Union of Concerned Scientists, sustainable agriculture refers to a food and fiber production system that can maintain high levels of production for society at large, with minimal environmental impact, and that can support viable rural communities. They discuss the problems of intensive farming and the benefits of sustainable agriculture - for health, environment, and the farming business - on their website: - see the UCS' discussion of 'agriculture', 'sustainable' at: www.ucsusa.org

Such a system embodies practices that ensure profitability of farms both large and small, protect workers and the environment, and conserve natural resources. These methods commonly involve diversity in crops and animals, crop rotations, and reduced dependence on synthetic inputs, such as pesticides and chemical fertilizers.

Scientists worldwide agree that these kinds of techniques offer a solution to world agriculture and food problems, and a viable alternative to the dangerous introduction of genetic engineering into farming.

Better financial prospects for farmers through organic farming

For the 7th year in a row organic industry sales in 1997 grew more than 20% in the U.S. In 1995 sales in the U.S. grew to \$2.8 billion in 1995, a 21.7% increase over 1994, and included \$1.87 billion in natural product stores, 210 million in mass-market outlets, and \$715 million in direct farm and export sales , and in 1997, overall sales grew a further 20% on the previous year. This trend has not gone unnoticed on Wall

Street, and investment banks are becoming very interested. As conventional supermarkets add organic products, and as more supermarket-style natural food stores open, consumers are increasingly exposed to and accept many organic products. And as demand increases, farmers devote more land to organic products. The U.S. Department of Agriculture estimates that 1,127,000 acres of U.S. farmland were in organic production in 1994 - an increase from about 550,000 acres in 1991. Strong demand for organic products in the European market is also causing excitement among investors. For example, one in every 20 babyfood jars bought in the United Kingdom is from organic agriculture, growing at almost 50% a year. According to the supermarket chain Sainsbury's, demand for organic products is growing so strong that the English supermarkets now have to import about 75% of organic produce they sell. In France, according to the Minister of Economy and Finances, French farmers can hardly keep up with a consumer demand that jumped 25% in 1996 alone. La Vie Naturelle reports that all "grand chefs" in Paris are cooking with organic foods. In Denmark according to the Soil Association, organic foods already claim 15% of the food market and this is predicted to reach 20% by the year 2,000. And according to an industry survey done by Novartis, a chemical and biotechnology company, 54% of Americans would favor organic products if only they had the choice.

These figures show that organic farming is a hugely growing market because consumers are demanding natural foods, and farmers can create a viable lucrative business in this area. This trend is not only necessary, but inevitable worldwide. When we cooperate with nature abundance is the natural by-product, and now science and research, worldwide, is supporting this approach. The fight against nature is over, and the 21st century can prosper in the inherently nourishing character of the Earth.

In addition, since genetic engineering is being wrongly and dangerously hyped as a solution to world hunger problems, some point out that an effort to educate on the benefits of vegetarianism would be valuable, since it requires 10-20 times less land and 60-100 times less water to feed a vegetarian, with all necessary minerals and nutrients, as it does a meat-eater.

A study by two Stanford University researchers has found that two or three bad grain crop years in a row will hurt the world's poorest, who already spend much of their income on food - by percentage, the most. The researchers also note that the potential harm done by grain shortages is exacerbated by the fact that 38% of the world's grain production is being fed directly to livestock for meat production. In 1995 and 1996, the price of wheat rose 40 percent and the price of corn rose 60 percent. Such escalations in price not only heighten the risk of hunger, they also heighten the chance for social unrest and political destabilization, the researchers conclude.

Some estimates say that even a 10% reduction in meat consumption could significantly increase availability of grain food for all around the globe.

Research also shows that vegetarianism promotes health as well, and significantly decreases incidence of disease, therefore much less would need to be spent on health care, and more could be spent on developing sustainable agriculture and educational programs at home and in developing countries.

Organic farming, advocates say, is valuable for the additional reason of deep ecology - the observed inter-dependence of life, as an intricate, inter-locking whole, and our spiritual responsibility to maintain that for future generations.

What can the bio-tech industry do to help?

It may be too naive to hope that, by switching their roles, the biotech industry might help the move to a healthier world. Based on current trends in society, surprising and unlikely as it may seem, an opportunity arises for the biotech industry to make a positive move, and potentially lift their stock values. By switching to the growing sustainable agriculture and organic farming business, with their managerial expertise and financial weight these companies could generate worldwide business in this field. This move would elevate worldwide health problems and result in a healthy and abundant environment. Perhaps these companies, if they get involved now, could generate the most positive and nourishing age humankind has

ever known. All it takes is intelligence, managerial expertise, and resolve.

However, if they don't do it, it is inevitable that others will, in order to meet the growing demand, and the biotech companies stock values, tied to the doomed practice of genetic engineering, will crash. They will miss out on probably the fastest growing and most sustainable business in the world. The opportunity is wide open for these wealthy companies to create positive change and world health. The evidence is abundant, and recognized by scientists worldwide. Sustainability and natural approaches are the trend of the 21st century (this is even recognized by research done within the chemical and biotech industry itself, as the survey from Novartis shows). The direction is inevitable due to the failure of intensive farming, pesticides, and other high tech. approaches.

By observation of current trends it seems inevitable that farmers worldwide will turn to sustainable agriculture as the new agricultural norm. The coming generation will not accept genetically engineered foods (or genetic manipulations to the human genome), and the biotech industry will flop. Nature has consistently outwitted high tech, destructive approaches in farming. As we have seen the only measurable success such approaches have had is the destruction of the ecosystem and breakdown of world health. This evidence suggests that the biotech and pesticide industries switch their roles to natural farming now, before it is too late for them.

Deeper life-supporting solutions

Technology should benefit humankind and nature holistically, and not be detrimental to the Earth and our future. Through proper coherent management we already have the ability to feed the world's population without the risks posed by genetic engineering, and in addition, create a peaceful, pollution-free planet.

'Students for Alternatives to Genetic Engineering' (S.A.G.E.), who question the wisdom of genetic engineering go further with their reasoning. Although, like many other groups involved public awareness campaigns we advocate effective methods of progress, such as the implementation of sustainable and organic agricultural educational programs, and government grants to help farmers make the switch. We also support natural or non-toxic medicine, emphasizing the need for education in medical preventative health programs, as a better way to go than genetic engineering and the statistically ineffectual mass drug-oriented transnational industry, in which we are now so heavily embroiled. S.A.G.E., like others, calls for a great deal more government funding of scientific research in these more life-supporting solutions.

However, in addition to this, S.A.G.E. maintains that the wide-spread problems facing the planet are not necessary in this day and age. Our analysis suggests that these problems are a problem of the prevalence 'partial knowledge' - ie. loss of a natural awareness of the wholeness of life.

In the following overview we discuss this lack, and the problem that even a well-intentioned, highly environmentally aware person will be handicapped in their ability to produce truly life-supporting and effective actions, if their minds and thinking are not functioning from the level of the innate subtle intelligence of nature itself. To counter this lack our fundamental awareness and perceptions would need to be vastly expanded - a transformation in consciousness - and this, we believe, can only be achieved through re-attuning our very being with the inner intelligence of nature's evolutionary functioning.

The difference between partial and holistic knowledge?

Partial knowledge has been comprehensively and precisely defined by Maharishi Mahesh Yogi, whose work and writings reveal his status as world authority on the philosophical and practical implications of a holistic approach to knowledge. He describes 'partial knowledge' or 'partial awareness', as the state in which the mind's perception is limited to the localized, objective world, which is only one third of the total sphere of awareness. The other two thirds, completely missing from today's education and common awareness are:

1. The dormant, yet unlimited subjective potential of the individual, which directly integrates the holistic intelligence of nature.
2. This subjectivity's finely correlated interrelationship with the world.

Without knowledge of these aspects of existence, awareness can be only partial. A partial and fragmented awareness results in thoughts, words, and actions, which can never be in the best interests of the world's population and the whole of nature. The deeds of a person with this state of awareness are in danger of being detrimental to life - ie. non life-supporting. Our current scientific education as it stands today is essentially based on partial awareness, and as such, is unpredictable and dangerous. For example, altering the super-complex genetic blueprint of any organism is clever, but especially dangerous, because it is being done with only partial knowledge of the unknown inner workings of nature. This can only result in unpredicted side-effects. Eg: What happens to people when they eat food that has more pesticide in it? What does genetic engineering do to the soil, now and in the future? What happens when a genetically engineered plant interbreeds to produce a new species? Will it be dangerous? Poisonous? What subtle ecological changes will occur? There is no way to predict the outcome, no way to tell the consequences of these actions for future generations.

Because of partial awareness, holistic, life-supporting decisions and actions are virtually impossible to make. In this limited state of consciousness, despite good intentions, one is a 'football of circumstances', closed to nature's all-encompassing intelligence - the power of evolution itself, thus 'kicked around', with little real power to make progressive changes. S.A.G.E. considers that this lack of holistic knowledge is the root cause of all wrong and dangerous decisions and actions in the world, past and present.

In order to evolve a more complete scientific approach to problems which is spontaneously mistake-free and automatically life-supporting, the human race, it is suggested, needs at this time to make an evolutionary step forward from partial awareness to the holistic, integrated, and greatly expanded state of awareness - the evolutionary pinnacle of human life, innate with a natural potential for global harmony and life-supporting progress.

Holistic knowledge, as Maharishi explains, has the qualities of broad awareness and deep comprehension. When knowledge is holistic, the mind directly perceives everything as intimate to itself at the most fundamental level. This is the true unified state of life, infinitely correlated with the whole, and unbounded in nature. In this state the awareness cognizes directly from the level of nature within oneself where all of nature is connected in a unified wholeness.

The idea that a more abstract level of existence related to mind is more fundamental than outward matter, contradicts common education today which teaches that matter (the physiology) gives rise to consciousness. However, the former concept is more prevalent in the more advanced areas of scientific research. Eminent physicist Max Plank, considered one of the greatest minds of this century, regarded "...consciousness as fundamental. I regard matter as derivative from consciousness." According to French physicist Bernard D'Espagnat, "The doctrine that the world is made up of objects whose existence is independent of human consciousness turns out to be in conflict with quantum mechanics and with the facts established by experiment."

Some highly regarded physicists have come to consider the fundamental basis of mind and nature as being identified with the level of the unified field now discovered by modern physics. The unified field is the home of all the fundamental aspects of existence, and unifies them in a homogeneous, infinitely correlated, wholeness. This transcendental level of nature is, of course, at the basis of the mind and body as well, and some physicists have deduced, is fundamental to consciousness itself. Maharishi has explained that the 'unified field' is not an inert, dead entity. Its very nature is one of perfect correlation, all-comprehension, and infinite energy - it is lively - not dead, but live; not asleep, but alert. True alertness, or consciousness, is its domain alone. As the essence of mind and nature, this fundamental level of life can be experienced as a living reality by the exquisitely designed human mind and nervous system.

As Maharishi explains: "Complete knowledge of consciousness is the complete knowledge of the basic

reality of life, which is available in the field of one's own Transcendental Consciousness... The conscious human mind, identifying itself with this level of nature's functioning, gains the ability to perform in the style with which nature performs its activity at its most fundamental level."

Developing this depth of awareness is the role of Maharishi's Transcendental Meditation? technique. The transcendental level of existence, the fundamental basis of nature, Maharishi maintains, can be naturally and effortlessly experienced as a living reality by the incomparable 'supercomputer' of the brain, nervous system, and general physiology. With this depth of consciousness, every thought, word, and action, is spontaneously imbued with the holistic intelligence of nature itself - 'natural law'. Thus the holistic, creative evolution of nature is automatically upheld by one whose awareness is functioning from this level. The supreme sophistication and comprehensive power of the human mind can be naturally developed to live this state of all-comprehensive awareness, and the deeds of such a person are spontaneously (ie. effortlessly) life-supporting. For example, if education were truly holistic in this sense, scientific inquiry and implementation of powerful technologies such as genetic engineering would naturally and spontaneously avoid creating negative side-effects, since evolution in nature has a holistic, integrated direction, and this is the foundation of a fully realized awareness.

The necessity of an age-old, time-tested technique

It is unlikely that the holistic state of awareness can be achieved by simply deciding to live that awareness, or by practicing to perceive unity, and committing good actions. It must be lived naturally in every neuron, cell, and impulse of one's being, spontaneously permeating all our thoughts and actions. The unified level of existence, the transcendental level of awareness, needs to be experienced directly (and effortlessly) until the mind and body resonates authentically from that level.

Logically, the technique for achieving this must also have been cognized directly from that unified level of existence, where all the laws of nature have their basis. This is the characteristic of Maharishi's Transcendental Meditation?, time-tested, coming from the most ancient and holistic tradition of knowledge - the Vedic tradition of India. 'Veda' means 'knowledge' in the Sanskrit language, and according to Maharishi, Vedic seers of ancient times perceived directly the truth of existence, at the transcendental level of their own consciousness - the unified field. Our individual consciousness can reflect that level by developing higher states of consciousness through Maharishi's Transcendental Meditation? and his 'yogic flying' program, thereby expressing only the life-nourishing power of evolution itself. This is what is called enlightenment, and is the birth-right of every human being on Earth.

Robust Scientific Validation

What amounts to powerful scientific validation of these effects is evidenced by the collected research on Maharishi's Transcendental Meditation? and 'TM-Sidhi program?', which has been conducted over 30 years, and is the largest and strongest body of research in the world on any program to develop human potential. The more than 500 scientific studies conducted at 200 independent universities and institutions in 33 countries and published in over 100 leading scientific journals have documented that this technology benefits every sphere of life: physiological, psychological, sociological, and ecological. The findings in each area of study have been replicated many times, and meta-analyses, which are the most quantitatively rigorous means to review a body of research, have found a high degree of consistency of the results. Studies using the most sophisticated, rigorous research methodologies that are designed to prove causality have strongly verified and extended preliminary findings. This demonstrates that Maharishi's Transcendental Meditation? and TM-Sidhi program? causes the wide range of benefits in mental potential, health, and social behavior.

The positive effects which have been extensively documented for the individual practicing Transcendental Meditation? and TM-Sidhi Program? include greater clarity of thinking and improved academic standards, more spontaneously holistic thinking, more efficiency in action, greater creativity, harmony, greatly improved health and strengthened immune system, more efficient and powerful brain and physiological

functioning, more appropriate life-supporting actions, and improved relationships.

Worldwide Effects

Since the deepest aspect of our own nature, the transcendental level of human consciousness, is not separate from the unified basis of existence - the transcendental level of nature itself (the unified field) - these positive effects for the individual spontaneously manifest in society at large, by virtue of the unity of existence at that level. We know from science that nature is more powerful at more fundamental, subtle levels, therefore a small percentage of the population practicing these techniques, which nourish life from the most fundamental, universal aspect of nature, can effortlessly and spontaneously create these nourishing effects for the whole of society and the whole world. This phenomena, known as the 'Maharishi Effect', has been documented in over 40, closely scrutinized, scientific research studies. Many of these have been published in peer reviewed scientific journals, such as the International Journal of Neuroscience, the Journal of Conflict Resolution, and Social Science Perspectives.

Cutting-edge science

A growing number of scientists recognize the 'Maharishi Effect' as the cutting edge science and technology of the 21st century, and the most effective tool available in changing the current negative trends in the world, to positivity, creativity, and life-supporting progress, in a natural, effortless, and non-invasive way. Traditional political and economic endeavors are failing to divert current negative trends because global consciousness is not fully evolved, and is mired in a limited capacity to create life-supporting activity and solve problems. The dangers of genetic engineering, for example, are the result of such limitations in awareness at the foundation of humanity's global consciousness. Thus, it is beginning to be recognized that, through these techniques, and by utilizing the Maharishi Effect, higher states of consciousness must be generated for the whole world in order to have any real positive impact.

Enlightened education

The 20th century provides ample evidence worldwide that the current education system is seriously lacking something fundamental and universal. The serious problems facing humanity today are the result of partial knowledge, and fragmented development in education. Thus, scientists have repeatedly created technologies which are detrimental to health and the environment, and society has administered their destructive force indiscriminately. Genetic engineering is another in the list of dangerous technologies that result from the ongoing tradition of partial knowledge in our educational institutions.

Because of the difference between partial and holistic knowledge, it becomes apparent that the fundamental solutions can only come from an education which develops the whole individual, where the objective studies are embedded in knowledge and experience of the source of one's full creative potential - the unified level of nature itself. This kind of enlightened education is a new concept to most people, and Maharishi University of Management, (based in Fairfield, Iowa), is unique, in that it provides this holistic education. The concept, and supporting research, has been touched on, however the full logic and scope of the above definitions cannot be detailed here. Maharishi University of Management Webpage at : www.mum.edu is a useful guide to more information.

It is only at this university that the student has been given the opportunity to develop the full creative potential of the mind and naturally create enlightenment for him or herself, and even the whole world.

** Note: All of the above concepts and descriptions about partial and holistic consciousness are extracted from the various publications and knowledge given by His Holiness Maharishi Mahesh Yogi. (Available at bookstores, and Maharishi University of Management Press, Fairfield, Iowa, USA.)*

Conclusion: Science, Government, and Industry in the 21st Century

It has become apparent in the 20th century that science, government and industry cannot safely be treated as separate entities.

The responsibilities of governments and research institutions in these areas have been seriously undervalued. With the power we have gained through science we have learned that economic forces cannot indiscriminately drive the implementation of scientific technologies without careful monitoring. In addition, scientific progress and prowess should not only be recognized as the glamorous creation new techniques and tricks, but far more attention and scientific respectability, should be given to research which assesses potential risks of a new technology. Emphasis must be put on the study of the long-term, intricate, biological and ecological implications of any implementation of a new technique. It is also important that governments spend as much, if not more, on such assessments, and that powerful new technologies are explored to the full, before they are allowed to become commercial commodities.

More 'air time' and discussion at all levels - media, university, and governmental - should be given to research which shows up the problems we create. The excitement and heroic stature we have traditionally given to the discovery of new and clever techniques, must be purposefully transferred to that research which protects us from our own shortcomings.

If the United Nations find serious problems with intensive farming techniques, if government's research finds the chemical and high tech. agricultural industry causes dangerous effects on health and environment, if scientists worldwide are concerned about pollution, ozone depletion, and problems of global warming, then, even if there is disagreement, it is better create the habit of curbing these effects first, rather than wait for disaster and then try to clean it up.

Genetic engineering, the most powerful and irreversible of all our technologies, has had many serious problems already, and needs to have strict government regulation and containment monitoring.

In addition, government's funding of research, education, and implementation of safe, non-toxic, natural technologies, must be greatly increased globally. If significant numbers of scientists support sustainable agriculture, and scientific research backs up this approach, then such findings must also be given full airing in the media and our educational institutions worldwide. Indeed, because of the non-toxic nature of such approaches, and their proven time-tested efficacy, they should be given affirmative bias, rather than the usual suppression, particularly in view of the problems we face and the powerful economic and commercial forces which perpetuate them. Governments worldwide must make serious and strenuous efforts to disentangle themselves from such forces and special interest groups. Otherwise democracy is a fallacy.

Finally, if science is to serve its true purpose as impartial observation, we must take note and give importance and full exposure to properly conducted research, even if the findings are unusual and foreign to our experience. We must learn, and consciously teach in our educational establishments, not to shy away from good research, simply because the hypotheses challenge our worldview, or require significant re-adjustment at the individual, local, national, and international level. If more than 500 scientific studies, many published in top scientific journals, shows the efficacy of an unfamiliar, ancient, meditation technique, in creating positive effects for the individual and society at large, we must actively ensure that such well documented effects are not suppressed, but promoted in the media, education institutions, and government agencies. For this to happen there must be more government funding of impartial evaluation of scientific research in all fields, and governments must create major departments and funding to encourage diverse, well evidenced, alternative possibilities, as well as ensure that significant research, its implications, and implementation, are introduced into schools and colleges, in an unprejudiced fashion, especially when it refers to the sustainability and expansion of health, happiness, and affluence for the whole world and future generations.

