Genetically-Engineered Agriculture and the Re-invention of Nature - A Recipe for Ecological Disaster!

D. Jeevan Kumar

Agricultural biotechnology is an emerging area of biological research. It has some major, well-recognized areas of specialization. Transgenic technology is the most sophisticated one, which is attracting wide public attention for a variety of reasons.

In recent decades, scientists have immersed themselves in research involving manipulation of biological material. They claim to have made dramatic advances in our understanding of how biological organisms function at the molecular level, as well as in our abilities to analyze, understand and manipulate DNA molecules, which are the biological materials from which the genes of all organisms are made. It may be noted here that there is no substance so important as DNA, because it carries in its structure the hereditary information that determines the structure of proteins, instructions that define the cells, direct the cells to grow, divide and socialize in an organism, and therefore accounts for all the life forms on earth.

This technological breakthrough made by scientists enables them to shuffle the genes across the boundaries of species, genera and other biological groups. The Human Genome Project, which made enormous investments to develop
technologies for working with human genes, has accelerated the process, and the same technologies are found applicable to all other organisms, including plants. This discipline called genomics has contributed to powerful new approaches in agriculture and medicine, and has helped to promote the biotechnology industry.

Genetic engineering is a significant departure from conventional breeding. Genetic engineering transfers genes horizontally between unrelated species that would never interbreed in Nature. Viruses and other pieces of parasitic genetic material called plasmids and transposons can transfer genes horizontally. Parts of the most infectious natural agents are combined to make artificial vectors (carriers of genes), which are designed to overcome species barriers. Genes are spliced into these vectors.

In order to boost the expression of the foreign genes to well above the normal level, genes with strong genetic signals are typically introduced. These genes are called promoters or enhancers, and are most often from viruses. ‘Marker genes’ are introduced along with the genes of interest so that those cells that have successfully integrated the foreign genes into their genome can be selected. The most commonly used marker genes are antibiotic-resistant genes, which enable the cells to be selected with antibiotics.

Transgenic crop biotechnology has already entered farmers’ fields in many countries like the USA, Argentina, China, Canada, Australia, Mexico, Spain and South Africa. Crops like cotton, soyabean, corn, wheat, tomato, potato and rapeseed are the leading ones. Globally, the coverage of biotech crops is observed to be rapidly increasing. What was about 1.7 m ha in 1996 is now stated to have crossed 50 m ha.
Ecological Hazards of Genetically-Engineered Agriculture

Genetically-engineered agriculture introduces a variety of dangers to the environment and biodiversity. They are as follows:

1. A most commonly introduced class of gene products from the soil bacterium, *bacillus thuringiensis*, targeted at insect pests, has been shown to be harmful to pollinators and other beneficial species such as bees. These harmful effects can even go up the food chain. Purified Bt-toxins, similar to that found in some lines of transgenic Bt-crops are not degraded by soil microbes, and are still able to kill soil insects. The build-up of Bt-toxins in the environment will also accelerate the evolution of Bt-resistance among pests, rendering the toxin ineffective as an organic pesticide. Already eight species of insects have developed resistance to Bt-toxins, either in the field or in the laboratory, including diamond-back moth, Indian meal moth, tobacco budworm, Colorado potato beetle and two species of mosquitoes. Genetically-engineered Bt-crops continually express the Bt. Toxin throughout its growing season. Long-term exposure to Bt. Toxins promotes development of resistance in insect populations.

2. Hazards arise from transgenic plants engineered to be resistant to broad-spectrum herbicides. Most transgenic plants are engineered to be resistant to broad-spectrum herbicides such as glyphosphate, whose toxicity and danger to human health are well-documented. Broad-spectrum herbicides have a major impact on
biodiversity as they kill all other plants indiscriminately, which in turn destroys the insects, birds and other animals that depend on the plants for food and shelter. They also harm organisms and micro-organisms in the soil that are involved in nutrient recycling, and which are crucial for maintaining species diversity, productivity of eco-systems, and thus the stability of eco-systems. Herbicide-resistant transgenic plants may lead to increased use of herbicides, as these transgenic plants are already turning up as volunteer plants after the harvest and have to be controlled by additional sprays of other herbicides. Weeds and other species will very quickly evolve to be glyphosphate-resistant, even without cross-pollination.

3. Once released, genes cannot be recalled, and have the potential to multiply and recombine out of control. Transgenes and marker genes have spread to wild relatives by cross-pollination, thereby creating potential super-weeds. A recent report suggests that transgenes may be up to 30 times more likely to escape than the plant’s own genes.

4. Transgenes and marker genes may also spread by horizontal gene transfer. Secondary horizontal transfer of transgenes and antibiotic-resistant marker genes from genetically-engineered crop plants into soil bacteria and fungi have been documented in the laboratory. Plants engineered with genes from viruses to resist virus attacks have actually showed increased propensity to generate new, often super-infectious viruses by
horizontal gene transfer and recombination with infecting viruses. A genetic parasite was found to have jumped into many unrelated species of higher plants.

5. Genetically-engineered crops may spread antibiotic-resistant marker genes to pathogenic bacteria in the environment, and may also contribute to generating new viral pathogens.

6. Genetic engineering of agriculture will also lead to the practice of mono-culturing. The goal of the biotech revolution is to create superior varieties that can be planted as monocultures in agricultural regions all over the world. The switch to a handful of “the best” patented transgenic seeds will further erode the genetic pool, as farmers abandon the growing of traditional varieties in favour of transgenic products. Jeremy Rifkin refers to a Catch-22 situation that lies at the heart of this new technology:

On the one hand, the success of the biotech revolution is wholly dependent on access to a rich reservoir of genes to create new characteristics and properties in crops and animals grown for food, fibre and energy, and products used for pharmaceutical and medical purposes. Genes containing novel and useful traits that can be manipulated, transformed and inserted into organisms destined for the commercial market come either from the wild, from landraces (traditional crops) and domesticated animal breeds, and from human
beings. Notwithstanding its awesome potential to transform Nature into commercially marketable commodities, the biotech industry still remains utterly dependent upon Nature’s seed stock – germplasm - for its raw resources. At present, it is impossible to create a ‘useful’ gene in the laboratory. In this sense, biotechnology remains an extractive industry. It can mine genetic material, but cannot create it, de novo. On the other hand, the very practice of biotechnology – gene splicing, tissue culture, clonal propagation and mono-culturing – is likely to result in increased genetic uniformity, a narrowing of the gene pool, and loss of the very genetic diversity that is so essential to guaranteeing the success of the biotech industry in the future.

7. Transgenic crops pose an even more direct threat to the world’s remaining centres of crop diversity. These centres are the regions that contain both wild relatives and landraces and are the reservoirs for providing new genetic material for purposes of breeding. There is growing concern that the large-scale introduction of transgenic crops could contaminate the world’s remaining centres of crop diversity. Gene flow from transgenic plants to landraces is inevitable in the wake of ambitious plans by the biotech industry to aggressively market their new “super seeds” in every agricultural region of the world. It will probably be impossible to shield the few remaining centres of crop diversity from the increasing encroachment of transgenic crops.
8. Genetically-engineered agriculture poses other problems for developing countries. As Prof. M.D. Nanjundaswamy points out, genetic engineering of crops focuses on yield and not on the by-products. After the fibre has been removed, cottonseeds are used to extract oil for cooking and protein for making stock feed. “All these will be casualties, the first being fodder availability. And when you have toxin-producing plants, fodder availability will be nil, since you cannot feed it to animals. Most cattle will have to be consigned to the slaughter houses for lack of fodder,” he says. Moreover, the dependence on genetically-engineered plants will lead to the destruction of local varieties. “Already the so-called Green Revolution has destroyed soil fertility, killed friendly pests and reduced yields, which should make us stop and wonder whether we really need such technologically developed plants. They are unnatural. They are made by crossing not the same species, but different species. We have to think of what kind of consequences this will have and the damage it might cause of which we shall not know for generations to come.”

Genetic engineering has serious ecological risks, according to Vandana Shiva. This is the reason Article 19.3 of the Convention on Biological Diversity called for a Biosafety Protocol. This is also the reason why several countries in Europe have banned all genetically-engineered crops, and the UK has responded to the call of citizens by imposing a moratorium on release of genetically-engineered crops. Most recently, the International Federation of Organic Agriculture Movements (IFOAM), the world’s largest body for organic agriculture, called for a ban on genetic engineering in agriculture, because it poses hazards without being necessary for the development of agriculture.
Vandana Shiva also points to the inadequacies of present bio-safety regulations in this country. The clearance of Monsanto, the multinational agribusiness company’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 regime, from both the democratic perspective and the ecological perspective. The bio-safety regulation regime needs to undergo dramatic changes by increasing public participation in decisions related to genetic engineering. The clearance for trials of genetically engineered crops needs to be given, not just by the Union Government, but also by all levels of government, from the State to the local level. Further, before any clearance is granted for trials of a particular genetically engineered crop, the application for trials should be notified to the public as part of the citizen’s right to know. Public hearings need to be organized in the specific villages and districts and States where the trials and introductions are planned. The scientific framework of the ecological impact of genetically engineered crops on bio-safety, ecosystem health and public health also needs to be upgraded for dealing with the impact of field trials under diverse ecological contexts existing in India. If the government fails to fulfill these ecological and democratic criteria for field trials of genetically engineered crops, we will have further evidence that the promotion of genetic engineering by corporations like Monsanto are based on dictatorial, distorted and coercive methods. In such context, genetic engineering in agriculture must necessarily be anti-Nature and anti-democratic.

The commercial enclosure of the world’s seeds – once the common inheritance of all humankind – in less than one century, while hardly given more than a passing notice in the media, is nonetheless one of the more important developments
of modern times, writes Jeremy Rifkin. Just a century ago, hundreds of millions of farmers, scattered across the planet, controlled their own seed stocks, trading them freely among neighbours and friends. Today, much of the seed stock has been bought up, engineered and patented by global companies and kept in the form of intellectual property. Farmers wishing to plant for future harvests are increasingly dependent on access to these same companies, to whom they have to pay a fee for use of what was a commonly-held good a short time ago. For their part, the chemical and pharmaceutical companies have little desire to champion the interests of small peasants and independent farmers around the world who still grow traditional landraces, passing on their heirloom crops from one generation to another. The independent farmer, growing traditional varieties, is seen less as a curator of potentially valuable resources and more as a potential buyer of the new patented seeds. The biotech corporations seek his patronage and make every effort to sell him their brand of seeds. By focusing on short-term market priorities, the biotech industry threatens to destroy the very genetic heirlooms that might one day be worth their weight in gold as a new line of defence against a new resistant disease or super bug.

The re-seeding of the planet with a laboratory-conceived Second Genesis is likely to enjoy some enviable short-term market successes, only to ultimately fail at the hands of an unpredictable and non-compliant Nature, concludes Rifkin. While the genetic technologies we have invented to re-colonize the biology of the planet are formidable, our utter lack of knowledge of the intricate working of the biosphere we are experimenting on, poses an even more formidable constraint. The introduction of new genetic engineering tools and the opening up of global commerce, allows an emerging “life industry” to “reinvent” Nature and manage it on a worldwide scale. The new colonization, however, is without a compass.
There is no predictive ecology to help guide this journey and likely never will, as Nature is far too alive, complex and variable to ever be predictably modeled by scientists. We may, in the end, find ourselves face-to-face with an ecological disaster of our own making!

References


