Colonizing the Seed

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Arena Magazine, No. 36, Aug-Sept, 1998, pp. 41-44.

Genetic engineering will deliver 'designer' food crops capable of greatly improving contemporary agricultural systems ..... or so the story goes. The biotechnology industry and its supporters are holding out the promise of plants that can be engineered to our precise specifications, creating a future of environmentally sustainable agriculture, more flexible crops, and an abundance of food with which to finally bring an end to world hunger.

The reality, however, is that the genetic engineering of food crops represents a continuation — indeed an intensification — of the techno-industrial approach to agricultural production, and will intensify the social inequalities, concentrations of power and wealth, and ecological problems it has produced. Genetic engineering also creates *new* avenues for the corporate domination of agriculture, and poses new kinds of environmental threats, introducing an entirely novel form of industrial pollution into our vocabulary and into the world: *genetic pollution*.

The introduction of genetically engineered food crops effectively heralds a new stage in techno-industrial agricultural production, which I refer to as a shift from *chemical-industrial* to *genetic-industrial* forms of agriculture. The new biotechnologies transform our relationship to nature, as they enable us to engage with and reconstitute nature at the genetic level. The ability to manipulate nature at the genetic level now intersects with and reinforces, rather than replaces, the chemical level of engagement and control of nature. This more abstract level of engagement with nature transcends some of the constraints of earlier scientific plant breeding techniques in ways which enable chemical-industrial agricultural practices to be extended and more comprehensively established. The new biotechnologies will also facilitate the further commodification and corporatisation of agricultural production.

Maintaining and Extending Chemical-Industrial Agriculture

Most media reporting of new breakthroughs and the wonderful benefits of genetically engineered plants focus on the development of designer crops with novel end-product characteristics, such as tastier tomatoes, or potatoes that don't turn brown when cut. Yet most genetic engineering research and development is aimed at modifying the primary production process rather than such end-product characteristics.

The primary aim of most research and development can be understood in terms of the engineering of crops (and animals) that are better adapted to the requirements and conditions of chemical-industrial agricultural systems (ie. large-scale, monocultural, mechanised, chemical-intensive farming systems). Creating a closer fit between plants and chemical-industrial systems is one way in which the new biotechnologies make possible the extension and intensification of this form of agriculture.

The most common area of research and field-testing is in the development of *herbicide-tolerant crops*, which are aimed at better adapting crops to chemical forms of weed management. Herbicide-tolerant crops are engineered to tolerate contact with types of herbicides or dosages of herbicides that would previously have damaged the crop itself. Crops can now be engineered to enable a wider range of herbicides to be applied in higher dosages, on a wider range of crops, and in a wider range of situations (for example, both before and after the plants emerge from the ground).

In particular situations, herbicide-tolerant crops could, proponents claim, initially reduce the number of herbicide applications already being applied by making possible different weed management strategies, and they may enable the switch to supposedly less environmentally harmful, 'broad spectrum' herbicides. But on the whole, they will most likely further entrench and possibly expand the use and dependence upon chemical herbicides. Herbicide-tolerant crops will enable the more indiscriminate use of herbicides in a wider range of situations, including an expansion of aerial spraying practices.

As weeds continue to evolve resistance to herbicides, herbicide-tolerant crops become necessary to achieve effective weed-kills by allowing increases in the quantity and frequency of applications, or the switch to other types of herbicides. Crops need to be made tolerant to herbicides not only for direct spraying to control weeds, but also to protect them from spray-drift from neighbouring fields or from herbicide residues in the soil from previous crops. For example, the CSIRO is field trialing cotton which tolerates high doses of the herbicide 2,4-D to protect it from the spray-drift from 2,4-D applied to wheat crops.

Seed-chemical companies can also genetically engineer crops to tolerate their own particular brand of herbicides, and to thereby require farmers to purchase these companies' seed-herbicide packages. A prime example here is Monsanto's 'Roundup Ready' soybeans, which have been engineered to tolerate contact with their own herbicide Roundup, whereas non-modified soybeans cannot. When Monsanto's patent on Roundup runs out in the year 2000 — thus allowing other companies to sell similar glyphosate-based herbicides — Monsanto will maintain their market dominance by requiring farmers to sign contracts stipulating that only Roundup can be applied to their own herbicide-tolerant seeds. The contracts also prohibit farmers from saving seeds for replanting the following season. These herbicide-tolerant (and therefore herbicide-drenched) soybeans are the first genetically engineered wholefood to be sold in Australia, which is significant given that soybeans are used as additives in around 60% of all processed food products.

Another common area of research is in the genetic engineering of crops that produce their own insecticides, which I will refer to as 'genetic pesticides'. The naturally occurring *Bt (Bacillus thuringiensis)* group of microorganisms found in soils produce crystals that are highly toxic to some types of insects. Sprays and dried mixtures of fermented live *Bt* formulations have been used by farmers, particularly organic farmers, as a relatively environmentally benign insecticide for several decades. Now, however, genes from *Bt* microorganisms are being inserted directly into crops so that they will express these *Bt* toxins continuously through the leaves and stems of the plant. These *Bt* crops — or genetic pesticide crop — are intended to replace the use of some chemical pesticides in particular situations. Yet these genetic pesticides can be understood as further entrenching the toxic approach to pest control by engineering this approach directly into the plant's genetic structure, such that they produce their own insecticides from within. Like synthetic chemical pesticides, genetic pesticide crops will exert strong selection pressure on insects to evolve resistance to these toxins within a few years, particularly given the massive increase in *Bt* toxins being released into agroecosystems. When this occurs, chemical-industrial farmers will simply increase their use of chemical pesticides as before, whereas organic farmers will have lost the use of their *Bt* sprays.

Another concern is that the ecological and health consequences of the massive expansion and proliferation of live *Bt* toxins in the environment are unknown. The *Bt* toxins expressed by *Bt* crops have also had their toxicity and mode of operation altered, which may result in them remaining toxic for longer in the soil and in harming a wider range of insects and soil organisms, including beneficial insects that may feed on the target pests.

Bt crops will simply be used to add another toxic weapon to the tool-kit of the chemical-industrial farmer, rather than posing any challenge or offering a genuine alternative to this mode of farming. The toxic approach to pest control — which involves attempting to kill all insects with insecticides — is necessary in the context of large-scale, monoculture farming, since such crop uniformity creates ideal conditions for crop pests to multiply. This is in contrast to organic approaches, which utilise mixed or polyculture cropping methods to create the conditions in which a balance is maintained between the destructive pests and the benign insects which feed on them, and which prevent the build-up of destructive pests.

Any attempts to hybridise a wider range of crops (hybrid seeds tend to require chemical inputs and intensive irrigation), or to engineer plants that are able to be grown in previously inhospitable geographical areas, will also enable chemical-industrial practices to be expanded and intensified, thereby accelerating the current level of environmental degradation associated with these agricultural practices.

Genetically engineered crops may also be used to temporarily overcome some of the problems created by chemical-industrial agriculture itself, in order to allow these destructive practices to be continued at least in the short-term. An example already noted is herbicide-tolerant crops, which are designed in part to overcome the problem of resistant weeds by allowing greater and more frequent herbicide applications, or to overcome the problem of chemical spray-drift. Another example is the prospect of developing salt-tolerant crops that would be able to grow in soils that have been salinated due to irrigation-intensive industrial farming practices.

Even the genetic engineering of novel end-product characteristics into food crops is largely aimed at adapting crops for mechanical harvesting and a long shelf-life, and to the requirements of the food processing industry. The non-browning potato is being developed for the benefit of potato-chip producers. The so-called ‘Flavr-Savr’ tomato has had the gene responsible for the softening of the tomato’s cell walls switched off, thus staying firm and preventing it from appearing to age. The rationale for developing this ‘Dorian Gray’ tomato, as it should be known, is to enable it to be left to ripen on the vine for longer (and therefore to be tastier than your average industrial tomato), yet still be able to endure the rigours of long-distance transportation and a long shelf-life.

Genetic Pollution

Genetic-industrial agriculture will not only most likely exacerbate existing ecological problems associated with chemical-industrial agriculture, but also threatens to create new kinds of ecological and human health problems and risks. Some of these new threats can be understood in terms of the introduction of an entirely new form of industrial pollution into the world — *genetic pollution* — to add to the already existing problems of chemical and nuclear forms of pollution. I will define ‘genetic pollution’ as where the existence or proliferation of modified genes in foods or in the environment — resulting from the release of genetically modified organisms — directly create ecological or health problems and risks, or contaminate foods or ecosystems in some way.

There is the possibility that the modified genes of genetically engineered plants could be transferred via cross pollination to surrounding wild and domesticated plants. Surrounding weeds could in this way acquire the same environmental advantages that the modified crops were engineered to possess, thereby creating new weed problems or other unpredictable ecological dynamics. This flow of modified genes could also contaminate other non-modified crop varieties, which would be particularly unwelcomed by those farmers attempting to maintain older seed varieties and who are actively opposing such genetic modifications.

A common area of research is in the development of virus-resistant crops. This is being achieved by inserting genes from viruses into the genetic structure of the plant in order to confer protection against viral infection (and which can be understood as a genetic form of inoculation). However, there is growing evidence that these viral fragments can recombine with naturally-occurring viruses, possibly creating new or more severe diseases in crops.

Transgenic foods may also pose more direct threats to human health. One such danger relates to the possibility of allergic reactions to transgenic foods when genes from one plant are inserted into another, thereby also potentially transferring the allergic reactions experienced by some groups of people. For example, people allergic to brazil nuts experienced allergic responses when they ate soybeans containing nut genes. Such transgenic foods can be understood as having been genetically polluted or contaminated by foreign genes that have been directly inserted there via human intervention, and which are directly responsible for creating this adverse physical reaction. The insertion of viral fragments and antibiotic-resistant marker genes into crops could also indirectly create threats to human health.

Genetic Uniformity

The widespread commercial release of genetically engineered plants will continue the process of eroding the diversity of plant varieties that still exist in the world. This is a process begun many decades ago, as the few new industrial seed varieties that were supplied by seed companies began to replace the enormous diversity of varieties within each crop that have been developed by traditional farmers over thousands of years. Much of this plant diversity has already been lost. The industrial manufacture and supply of seeds is creating a level of uniformity of crop varieties that may threaten future food security.

The new biotechnologies further heighten this biological uniformity through the new tissue culture techniques that have been developed for reproducing seeds in factories. These new techniques for the first time allow millions of genetically identical copies of a particular seed variety to be reproduced. But in mass-producing these perfect copies, they introduce an even higher level of uniformity into plant varieties and into farmers' fields. As noted earlier, such highly uniform plant varieties create ever more serious pest problems.

There is also another type of uniformity made possible by genetic engineering. By allowing the transfer of genes across all species boundaries, genetic engineering begins to erase the distinctions and boundaries *between* species. The genetic structure of all life-forms, and the parts which make it up, become interchangeable with every other. One consequence of this erosion of species boundaries will be that we will hardly know any more what it is that we're eating. What looks, feels, smells, and even tastes like an apple may also contain genes from a capsicum or a pig or a human. But what if all you really wanted to eat was an apple?

Extending Commodification and Corporate Control

Genetic-industrial agriculture will enable seed-chemical corporations to extend their control over farmers and over the entire industrial food chain. Genetic engineering techniques have made possible the extension of the private ownership and patenting of life-forms down to the level of the gene. The new patenting and intellectual property regulations will permit corporations to continue to freely appropriate unpatented seeds from around the world, to modify a single gene of these seeds, and then patent and acquire exclusive rights over them. These new patenting laws are clearly designed to transfer the ownership and control of the world's seed diversity — most of which has been developed and maintained by traditional farmers in the Third World — into the hands of First World corporations. Meanwhile, seed/biotech corporations have been buying out or taking control of seed banks and smaller seed companies in order to reduce the availability of unpatented and non-hybrid seed varieties.

It is in the interests of these corporations that farmers repurchase these patented seeds year after year. There are two strategies now being used to prevent farmers from being able to save and replant their seeds from the previous year's crop. Firstly, seeds may be engineered to be biologically sterile, like the hybrid seeds of the Green Revolution. Hybrid seeds produce high yields but do not perform well if they are saved and replanted, ensuring that farmers repurchase their seeds every year. Genetic engineering now makes possible the creation of hybrid varieties of some common food crops that had previously proven too difficult or too costly to hybridise using earlier plant breeding techniques. It will also be possible for scientists to deliberately engineer any crop variety to be sterile or non-reproducible. This technique, which critics refer to as 'Terminator Technology', has been patented in the USA, and will be used to target important crops such as wheat and rice. In these ways, the logic of 'planned obsolescence', and therefore the interests of the corporation, will be able to be engineered directly into the seed's DNA.

Secondly, all patented seeds will now be legally sterile, as the new patenting and plant breeding regulations give patent holders rights which enable them to prohibit farmers from freely saving and replanting their seeds. Farmers either have to repurchase their seeds, or pay royalties to the company to save and replant patented seeds. To help enforce these regulations, new DNA 'finger-printing' techniques can be used to identify the genetic structure, and therefore the ownership, of crops growing in any farmer's fields.

For the first time in history farmers are losing both the ability and the right to save and replant their seeds. Yet it is these very practices of saving, replanting and cross-breeding seeds by farmers that have created the enormous diversity of domesticated crops and crop varieties we have inherited to this day. One of the consequences of the non-reproducibility of these 'static' seeds is that plants will no longer be able to dynamically evolve within and maintain their adaptation to local agroecological conditions, such as local climates, soils and pests.

As Vandana Shiva argues, through these processes the seed is transformed from a self-generating and shared resource into a commodified input of an industrialized production system. These biotechnological interventions can also be understood as further extending the colonization and commodification of the seed. Techno-industrial agriculture *colonizes* the seed in the sense that it penetrates into and takes control of the functioning of the seed, and imposes its own logic upon it — the logic of accelerated productivity, in-built obsolescence, and private-corporate ownership. The seed is *commodified* in two senses: first, in the sense that farmers must pay for a product that they formerly attained from the plant at no cost; and secondly, in the sense that farmers are no longer involved in the reproduction of the seed, and therefore are not able to shape the character of it, and are instead delivered a ready-made, pre-packaged product.

In these ways, farmers will become more dependent on the agribusiness corporations that supply the seeds and other agricultural inputs. Genetic engineering therefore makes possible the further growth and centralization of control of the food sector in the hands of transnational food corporations. In this sense, genetic engineering does not so much constitute a more precise control over nature, as make possible a more precise control over farmers. It is not only biological processes, but also social structures and power relations that are being re-engineered through this new technology.

Farmers that are already locked into the techno-industrial system will find it difficult to avoid the adoption of any new seeds or inputs that increase the 'productivity' of their farms, regardless of how narrow, short-term and ecologically degrading these 'productivity increases' are. Farmers otherwise risk being priced out of the market due to the downward pressure on prices that result from increased levels of output. It is small-scale Third World farmers whose livelihoods have been most seriously affected by such dynamics.

The new biotechnologies also present a further threat to farmers where new tissue culture techniques are used to manufacture industrial substitutes for agricultural crops. For example, the development of artificial sweeteners replaces the need for sugar-cane crops, thereby reducing their demand and further depressing prices. Other crops that are currently threatened by industrial substitutes include cocoa and vanilla. Third World communities and countries that have been forced into dependency upon these cash-crops are the hardest hit by this form of substitutionism.

Proponents of the new biotechnologies typically claim that the new seeds and techniques will be essential for feeding a growing global population. But of course hunger and malnutrition even today are not the result of food scarcity. Rather they are due to people being denied access to land to grow food or an adequate income with which to purchase food. Global hunger already exists on a wide scale in the context of a global over-supply of food. Much of this excess food (one third of all global grain production) is wasted by being fed to livestock to produce meat and hamburgers for those able to afford it. Genetic-industrial agriculture will, in fact, most likely exacerbate global poverty and malnutrition given the way it will favour large-scale producers over small producers and undermine local agricultural markets. In this sense, techno-industrial agricultural systems directly create food scarcity for many people given the way they transform the culture and structures of food production, distribution and demand, even if they increase the overall volume of food produced globally in the short term.

There are, broadly speaking, two ways of resisting the techno-industrialization and globalization of agricultural production and exchange. The first — in terms of 'oppositional' forms of politics — is to actively campaign directly on these issues by lobbying and pressuring governments, institutions and industry to reform their policies and practices. The second approach — in terms of a more constructive form of politics, or a politics of creating alternatives — is to attempt to unplug ourselves from the institutions and lifestyles that support the growth of the global techno-industrial system, and then to directly create and support alternative forms of production, distribution and exchange. This could include supporting food co-operatives and small retail outlets, instead of supermarkets; supporting seed exchange networks; purchasing organically and locally grown produce; forming direct links with agricultural producers and communities; and growing and preparing our own foods wherever possible — anything, in fact, that allows individuals and communities to exercise greater and direct control over all aspects of the agricultural food chain, and over other spheres of everyday life.