



RAFI COMMUNIQUE

RURAL ADVANCEMENT FOUNDATION INTERNATIONAL

January/February, 1999

Traitor Tech The Terminator's Wider Implications

Issue: One year after the Terminator was identified by RAFI (March 1998), disturbing new dimensions to the trait control technology have appeared in more than two dozen patent claims from 12 institutes. This move the debate well beyond the Terminator's ability to genetically alter a plant to render its seed sterile. The Terminator is a threat to agricultural biodiversity, future scientific research, and to the food security of the 1.4 billion rural people who rely on farm-saved seed and community plant breeding. Companies are now working to control several important genetic traits with a number of external chemical catalysts. In this study, RAFI investigates patent claims that connect the Terminator's 'suicide sequence' to enhanced herbicide or fertilizer applications (thereby transferring the sterilization costs from the company to the farmer); other Terminator-type claims that reach beyond plants to insects and mammals; and still other patents that explicitly *weaken* the plant's pest and disease resistance capacity as part of the genetic sterilization process. *The ultimate goal appears not to be to force farmers to buy corporate seed every year but to force farmers to pay for their seed every year* - capturing enormous cost savings for the company and rendering the commercial merit of aggressive new plant breeding moot. Farmers are becoming trapped in a pattern of biological controls that lead inevitably to bioserfdom.

Impact: Dubbed "Traitor Tech", the new array of patents pose a huge challenge to community and national food security. The new technologies will be dominated by no more than a half-dozen transnational agro-industrial firms (or "Gene Giants") that already control virtually 100% of the biotech transgenic seed market. Their ability to insert and externally-manipulate vital DNA sequences within crops (and, possibly, insects and livestock) threatens national sovereignty over agriculture and other biological resources.

Economic Implications: Traitor Tech could expand rapidly to occupy the entire transgenic seed market by 2010 if not sooner. By this date, the Traitor "seed" market could match 80% or more of the entire global commercial seed market - or a sales value of about \$20 billion per annum. The real control over the food supply exercised through the control of the seed supply is, of course, vastly greater.

Fora: Whether Traitor Tech will be allowed to dominate world crop production or whether it will be banned by national patent offices and intergovernmental agencies will probably be determined during the course of 1999/2000. In 1999, the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) has the first opportunity to debate Traitor Tech during its 19-23 April session in Rome. In mid-May, CGIAR (Consultative Group on International Agricultural Research) convenes in Beijing where its original decision to reject the Terminator could be broadened. Also in May, the UN Commission on Science and Technology for Development (UNCSTD) will discuss this technology. In June, the subsidiary scientific body of the Convention on Biodiversity meets in Montreal to receive a scientific evaluation of the Terminator and to render its views. If and when the WTO's TRIPS review takes place, this could provide a mechanism that allows governments to ban the entire technology as a matter of *ordre public*. At present, the Terminator can only be rejected patent-by-patent. Rather than wait for TRIPS, RAFI recommends that each government reject all Traitor Tech patent claims immediately.

The Implications for Terminator and Traitor Technologies

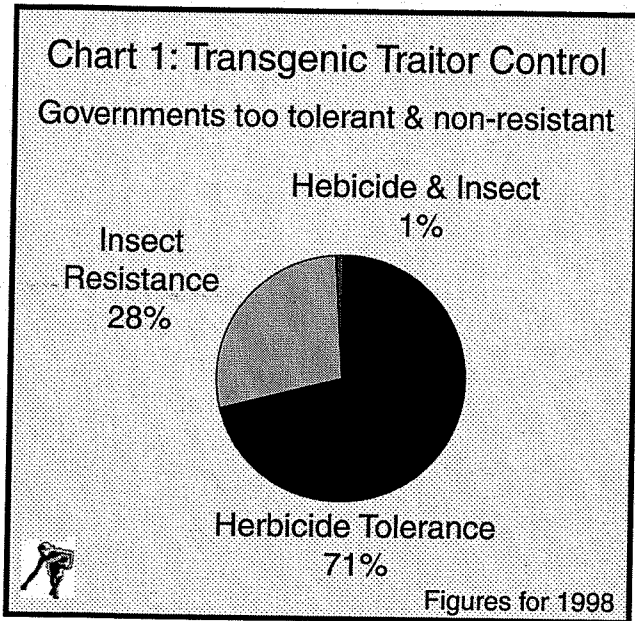
T'nT - Beginning an Analysis

Assumption: Following its discovery of the original Terminator patent, RAFI began a study of the technology's implications and applications. Its most obvious feature is that a suicide sequence of exotic genes, triggered by an antibiotic renders the seeds infertile in the next generation.

The Terminator offers no agronomic advantage whatsoever. Its benefit is exclusively for the Gene Giants who can use the technology to force farmers to re-purchase seed every growing season.¹

The brutish biological reality of this monopolistic strategy obscures the technology's more insidious dimensions. The original two Terminator patents - USDA/Monsanto (U.S. Patent #5,723,765 issued 3 March 1998) and AstraZeneca (U.S. Patent #5,808,034 issued September 15th 1998) -

actually prove that it is possible to switch on - or off - specific genes or, possibly, multi-gene traits - by applying whatever external catalyst the company prefers. Although using the technology to create sterility is the most lucrative possibility, RAFI theorizes the same strategy could trigger other traits with other negative implications.



This is not a conspiracy theory. It is market logic backed by recent experience. Twenty years ago, RAFI staff warned that pesticide manufacturers were buying into the seed industry in order to develop plant varieties that could tolerate their patented herbicides. RAFI's supposition was dismissed by both scientific and political institutions. Within two years of our prediction, however, pesticide manufacturers were openly developing herbicide-tolerant plants and, by 1998, 71% of the croplands sown to transgenic seeds contained herbicide tolerant traits (see Chart 1). RAFI's analysis in 1979 was based upon a realistic appraisal of the scientific opportunity proffered by an embryonic "biotechnology" industry; and, by a common sense understanding of the "natural" commercial tendency to reduce costs and maximize profit. RAFI is now applying this same analysis to Traitor Technologies.

Findings: Our conclusion is that the Terminator (suicide gene sequence) is one part of what can be most correctly described as Traitor technology. Industry's biotech breeders are focussing on the linkage between the Terminator's ability to sterilize second-generation seed with the technology's ability to promote other "Traitor" sequences in the first-generation seed.

The Transgenic Market: In order to understand the potential (and likely) impact of Traitor strategies, it is important to understand the development of the transgenic seed market and its close ties to the Terminator. As Chart 2 shows, the total global land area for transgenic varieties has exploded from virtually nothing in 1995 to almost 28 million hectares in 1998. The potential Terminator component within this "boom" market is no less impressive. The five dominant biotech breeders - Monsanto of the USA, AstraZeneca of UK/Sweden,

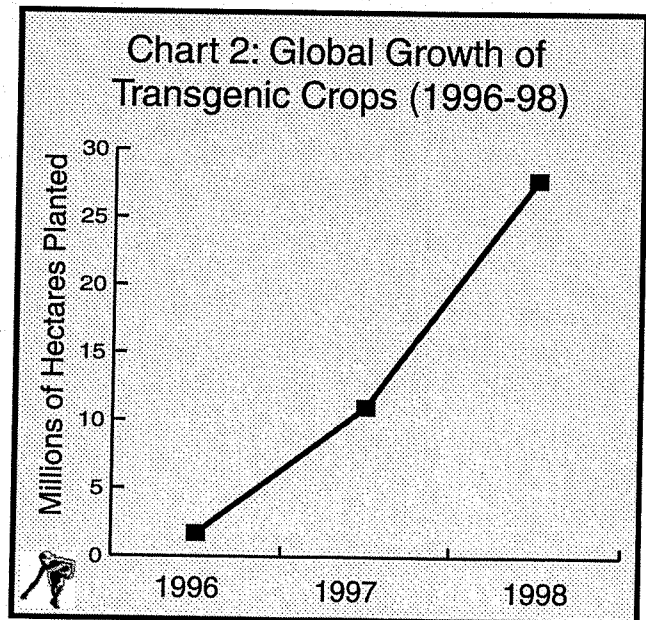
Novartis of Switzerland, DuPont/Pioneer of the USA, and Aventis (the recently announced merger of Hoechst and Rhone-Poulenc including AgrEvo - the joint Hoechst/Schering agbiotech firm) of France each have their own versions of Traitor patents.

In 1998 these companies collectively accounted for virtually 100% of the global transgenic market. Given the furious pace of industry consolidation, it is also likely that at least one or two of the others will acquire one or two of these companies. Indeed, on March 15, 1999, DuPont announced that it would pay \$7.7 billion to buy the 80% share of Pioneer Hi-Bred International that it does not already own. The only thing certain about the future shape of the Gene Giants is that there will be fewer of them.

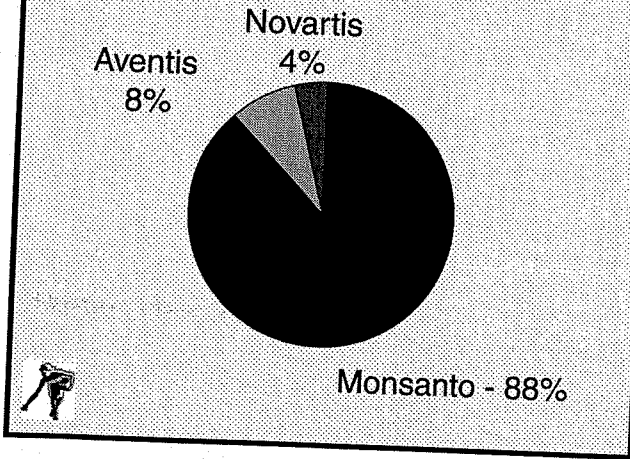
Traitor Technologies as the Launching Pad for Bioserfdom

The Potential Platform for Positive or Negative Genetic Traits

At one level, Traitor offers the opportunity to load a number of commercial characteristics onto a plant variety (or animal breed) which the company can choose to either activate or de-activate at or after the point of sale. This turns Traitor into a launching pad or platform technology upon which proprietary traits are placed. Farmers can buy seed like an industrialized farmer might buy a tractor - with or without so-called "value-added" accessories. Depending on what traits the farmer can afford - or what traits the company wants to disclose - external chemical sprays or soakings could activate the purchased qualities in the "platform" seed. The Gene Giants want to tie Traitor seed to their proprietary chemicals so that one is useless without the other. Economic and commercial realities point the way clearly to how the technology will evolve.



**Chart 3: Transnational Trait Control:
Transgenic Seeds Planted in the US, 1998**



In theory, apomictic seed could offer tremendous benefits to resource-poor farmers because farmers would gain the benefits of so-called "hybrid vigor" and still be able to save their seed for re-planting.³ It could theoretically offer fast and flexible plant breeding strategies that would be responsive to locally targeted breeding needs. But industry breeders have different priorities. Commercial breeders are eager to patent (or license) apomixis genes and use the technology as a means of lowering the cost of hybrid seed production. If they can successfully combine the benefits of apomixis (the ability to mass-produce low-cost clones) with the Terminator's suicide sequence - it will mean that farmers *cannot* save seed from apomictic varieties. Will the potential benefits of apomixis be monopolized by the Gene Giants, and ultimately used for precisely the *opposite* goal (preventing farmers from saving seed) for which it is best suited? RAFI considers this scenario highly likely.

If successfully commercialized, the development of sterile, apomictic hybrids threatens to further reduce genetic diversity in agriculture and increase crop vulnerability for farm communities. The impact on the corporate bottom line, however, will be to reduce production costs in multiplying Traitor "seed."

Apomixis Link: For the Gene Giants, one of the hurdles in developing "sterile" seed is the high cost of seed multiplication. One route for dramatically lowering the cost of producing hybrid seed is to create apomictic varieties. "Apomixis" is a natural, asexual type of reproduction in which plant embryos grow from egg cells without being fertilized by pollen. Apomixis offers a means of cloning plants through seed because the offspring are genetically identical to the mother plant. Apomictic seed is genetically uniform from generation to generation (unlike normal sexual hybrids or open-pollinated varieties). Plant breeders and molecular biologists have successfully transferred the genes that confer apomixis from a wild grass species, *Tripsacum dactyloides*, to maize. In 1998, the U.S. Department of Agriculture obtained the first patent on an apomictic maize plant (U.S. Patent No. 5,710,367).² CIMMYT (the International Maize and Wheat Improvement Centre in Mexico) and France's ORSTOM (a public agricultural research institute) have also worked jointly over the past decade to develop apomictic maize. The UK's John Innes Centre is also working on apomictic seed production and joining it with externally controllable traits including sterility. In early 1998, the Innes Centre received a patent on its technique (WO 9828431 - 7 Feb 98)

RAFI's Roster of Terminator-Type Patent Claims

#	Company	Patent #	Date
1	Monsanto	US 5,723,765	3 Mar 98
2	Monsanto	WO 9744465	27 Nov 97
3	CPRO-DLO	WO 9730166	21 Aug 97
4	Scottish Crop Research Institute (UK)	WO 9841643	24 Sep 98
5	Max Planck Institute (DE)	WO 9828430	2 Jul 98
6	John Innes Centre (UK)	WO 9828431	7 Feb 98
7	DuPont	US 5,608,143	15 Nov 94
8	DuPont	US 5,364,780	4 Mar 97
9	AstraZeneca (UK/Sweden)	US 5,808,034	15 Sep 98
10	AstraZeneca (UK/Sweden)	WO 9735983	2 Oct 97
11	AstraZeneca (UK/Sweden)	WO 9738106	11 Mar 97
12	AstraZeneca (UK/Sweden)	WO 9403619	17 Feb 94
13	Novartis (Switzerland)	US 5,847,258	8 Dec 98
14	Novartis (Switzerland)	US 5,804,693	8 Sep 98
15	Novartis (Switzerland)	US 5,789,214	4 Aug 98
16	Novartis (Switzerland)	US 5,777,200	7 Jul 98
17	Novartis (Switzerland)	US 5,767,369	16 Jun 98
18	Novartis (Switzerland)	US 5,689,044	18 Nov 97
19	Novartis (Switzerland)	US 5,654,414	5 Aug 97
20	Novartis (Switzerland)	US 5,650,505	22 Jul 97
21	Novartis (Switzerland)	US 5,614,395	25 Mar 97
22	Novartis (Switzerland)	US 5,842,542	20 Oct 98
23	Novartis (Switzerland)	WO 9803536	29 Jan 98
24	Novartis (Switzerland)	WO 9839462	11 Sep 98
25	BASF (Germany)	US 5,859,310	12 Jan 99
26	BASF (Germany)	US 5,814,618	29 Sep 98
27	Rhone Poulenc (France)	US 5,837,820	17 Nov 98
28	University of Texas (US)	US 5,846,768	8 Dec 98
29	University of California (US)	WO 9810734	19 Mar 98

More Hybrid Crops? Pioneer Hi-Bred International (soon to become a wholly-owned subsidiary of DuPont) is leading several other public and private researchers in the development of new ways to create sterility among the inbred lines used in hybrid seed multiplication. At first examination, RAFI interpreted Pioneers' numerous patent claims (seven U.S. claims were granted between February 10th 1998 and January 12th 1999) as little more than a two-step slide toward the Terminator. While this may ultimately arise, the intent of the patents appears to be to reduce the high cost of de-tasseling (emasculation) and to allow the company to more easily hybridize small grain cereals like wheat and barley. There is an intense and growing debate among researchers as to the validity of the "hybrid vigor" theory that has dominated maize breeding since the 1920's. Led by Dr's. Jean-Pierre Berlan of INRA (France) and Richard Lewontin of Harvard (USA), an increasing number of scientists are arguing that open-pollinated varieties, offered the same research support, inevitably out-perform hybrids. RAFI agrees with this analysis and regards the extension of genetic sterility strategies to other crops as agronomically and socio-economically unsound. Ultimately Pioneer's seven patents related to gene sterility are not included in RAFI's Terminator roster, but we believe that close monitoring of the company's strategy is in order.

Chemical Catalyst: All 29 Traitor Tech patents studied by RAFI trigger "inducible promoters" to an external chemical catalyst. In the "index" Terminator, the patent granted to USDA/Delta & Pine Land, the external catalyst is the antibiotic *tetracycline*. There are biosafety and cost concerns in using massive quantities of antibiotic-soaked seeds in the soil and the food chain, however. It is also a whopping cost that must be initially borne by the company and then passed onto the farmer directly in the price of the seed. In its second generation, Terminator claims are identifying more subtle ways to transfer catalyst costs from the 'expense' column to the 'profit' column by activating suicide (and other) traits via the sale of proprietary chemicals - preferably the company's own herbicides or insecticides. This only works, however, if the farmer is convinced that it is necessary to trigger the seed's suicide sequence in order to secure other qualities in the harvest. A diagram and technical description of Monsanto's Terminator strategy is appended to this report.

Junkie Genes: Consider AstraZeneca's new Verminator II patent, WO 9735983 that can create plants that need continuing exposure to a particular chemical not only for germination; but for continued healthy growth. The precise chemical necessary to avoid plant death depends upon the particular genes involved (AstraZeneca has at least three different promoter systems under patent claim); but the chemically dependent plant must have it in order to survive. From the company perspective, what could be more "logical" than mixing the chemical the plant requires with its own pesticides or herbicides? Eventually, as the company's technological ability to manipulate and design inducible promoter systems matures, the plant's chemical dependency might even be on the pesticide or herbicide itself. (A more detailed discussion of the AstraZeneca

technology is appended to this report along with diagrams.)

Is this an anomaly? Between March of 1997 and December of 1998, Novartis applied for no fewer than 12 closely related Terminator-type patents. The patents explicitly propose that the suicide sequence within the seed could be triggered by herbicides or even fertilizers. More to the point, the patents note that the inducible promoter strategy proposed would have the effect of *weakening* the plant's natural resistance to pests and diseases. Novartis, of course, is in the business of manufacturing the chemicals necessary to compensate for the weaknesses it also manufactures. Farmers are sold addict seeds with junkie genes that will not perform well without chemical (or, for that matter, biological) supplements - including the purchase of augmented herbicides that trigger the seed's sterility. This is truly Traitor Technology. Again, RAFI has a technical description of the Novartis' patents appended to this report.

More Traitor Traits: RAFI has found that many of the new Terminator-type patents look far beyond control of seed germination to the control of a wide range of secondary traits. Secondary traits can be of two kinds: first, activating the traits through spraying can either improve the productivity of the crop or the *process-ability* of the commodity (the end product). Equally, however, spraying could protect the crop or the commodity from the activation of negative traits - traits that unless halted, could render the crop unproductive for the farmer or unwelcome to the food processor. So far, the latter has been the Gene Giant's major objective. Since spraying to de-activate negative or "traitor" traits can be a great incentive for the farmer, it will be particularly attractive for the company.

Among the traits proposed for control in Novartis' claims are:

Input Traits:

- Germination;
- Flowering;
- Herbicide resistance;
- Insect resistance;

Output Traits:

- Nutritional qualities;
- Flavour qualities.

"GRIM", "Killers" and Other Species: Although all the Traitor patents uncovered by RAFI involve external chemical inducers, they do not all confine their targets to plants. One patent, issued to the University of Texas (U.S. #5,846,768 granted December 8th 1998) suggests that the inventors could activate a dormant suicide trait in insect pests by later spraying the crop with almost any chemical they can link to an inducible promoter. Indeed, the sequence could even trigger suicide through "natural causes" - changed climatic conditions, for example. The Texas researchers refer to their invention - actually a gene from a fly, as the "GRIM protein". (Not to be out-morbidized, AstraZeneca, which received its Verminator II patent [U.S. #5,808,034] on September 15th 1998 talks proudly of its "killer genes". The company concedes that its technique is "not desirable per se...").

What "Cell Size" for Farmers? Truth is Faster than Fiction

A team of scientists at the University of North Carolina, with support from Novartis and AgrEvo, has discovered a genetic switch that can manipulate the size of plant cells after the seed is planted. Although the work is still in the early stages, researchers speculate that the technique could have far-reaching applications - a chemical spray could be applied to maize plants to strengthen their stalks (thus preventing "lodging" - bending to the earth under the weight of ripening grain) as the crop nears harvest. Or, a grower could alter the cell structure of tomatoes before harvest, thus choosing between tomatoes grown for processing (small cells) or tomatoes preferred for fresh vegetable markets.⁴

A case study on DuPont conducted by Harvard Business School suggests that the shift to "output" traits (variety traits designed for food processors or consumers) will lead to fundamental changes in the way farmer's farm. For example, herbicides could be developed that target only a single protein-enhanced variety.⁵ (We note that DuPont won their first claim [U.S. #5,608,143] on the "External Regulation of Gene Expression" back in 1994 and a second patent on the same theme in 1997 [U.S. #5,364,780] a year less and a day ahead of the original Terminator!)

Traitor Technologies as the Control Pad for Agri-Food Monopoly:

The Opportunity to Exercise Market Control

Regulating the Irregular: One might assume that the deliberate introduction of negative quality characteristics in seed would be a "hard sell" in the marketplace and among regulators. Not necessarily. First, biotech breeders can be expected to argue that the provision of beneficial transgenic sequences comes with either additional biosafety risks or with complex "side-effects" (something the pharmaceutical companies - who own the seed companies - are used to defending) that can be readily ameliorated with the timely spraying of their patented pesticides. Secondly, whether spraying activates positive genes or de-activates negative genes will not be resolved scientifically. It will be finessed via corporate advertising campaigns. Thirdly- and most significantly - the original Terminator - the one invented by the U.S. government and Monsanto's soon-to-be subsidiary - is itself a negative (or traitor) trait!

RAFI is not theorizing what the Gene Giants *may* do. In essence, they have already done it. There are more than two dozen patents - accepted and pending - that disclose variations on genetic sterility or Traitor technology. If Traitor Technology is allowed to reach the market, industry will have won! It will have overcome the seemingly insurmountable hurdle of convincing regulators and farmers that using suicide seeds is acceptable in food production. If regulators buy into that logic, the "sell" on other Traitor characteristics will be no problem.

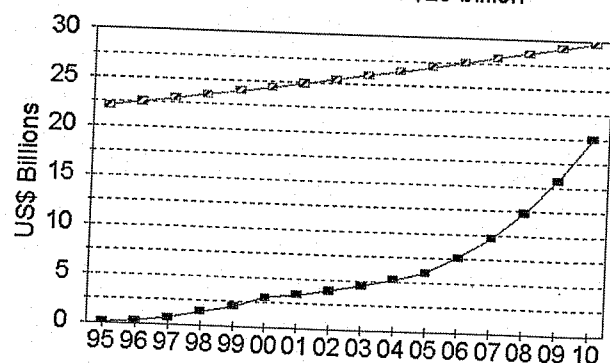
Dirty Seeds: In the future, national and international seed regulations could be adjusted to encourage the spread of Traitor "seeds". This will be orchestrated in two ways - first, industry will argue (as they have already) that their seeds offer an additional level of biosafety protection for transgenic species. They will insist that Traitor increases environmental security in the global multiplication, shipment, and planting of biotech seed stocks since the seeds are sterile and can't possibly leak transgenic genes into other crops or weeds. On this basis, agribusiness will describe - and government regulators will accept - Traitor as the vehicle (control pad) of choice for all planting material.

Secondly, Gene Giants will point to the threat posed by traditional open-pollinated seeds in *polluting* Traitor fields. Especially where the Traitor crop contains valuable output (or processing) traits, corporations will argue that "volunteer" seed (unplanted or drifted seed) from adjacent fields is a nuisance and contaminant. It might also be argued that open-pollinated *contaminants* could distort precision-farming readings⁶, attract or carry pests and diseases for which Traitor "seeds" are unprotected; or mix with Traitor-related catalysts in untested ways that could further damage the ecosystem, etc. Building on the popular urban myth that farmers are destroying nature, Traitor will be described as the responsible "green" solution to an age-old problem.

The Next Bio/Chemical Frontier: For pesticide patent-holders, the opportunities just keep on coming. By creating new uses for, and augmenting their old agrochemicals, the Gene Giants can extend the lifetime of their current patents - or acquire supplementary patents for pesticides already accepted by regulators. As companies work to perfect Traitor technology, bundling seeds and chemicals ever more tightly together, they will also attempt to transform (or, at least, repackage) their agrochemical business into a "catalytic promoter" business with an array of biological/chemical sprays and coatings. While modified pesticides will continue to be part of the package, they may be joined by microbials, and the entire package will be wrapped in the environmentally friendly image of the catalytic promoter.

Chart 4: Global Biotech Market

Biotech share will exceed \$20 billion



■ Biotech Seed ○ All Seed

Ultimately, the objective of agribusiness is not to force farmers to buy seed every growing season – but to force farmers to pay for seed every season. Some of the patents already in play allow the suicide sequence to be reversed or suspended through exposure to an external catalyst. The real goal here is to force farmers to bring their harvested Terminator seed to the company representative every season in order to re-trigger the seed's germination and to obtain all the catalytic inputs for the variety deemed necessary by the company. Farmers will have to pay top dollar just to re-use their own seed. Gene Giants will save themselves much of the tremendous expense (and risk) of seed multiplication, warehousing, transporting, etc. (including the threat of seed crop losses due to poor conditions) while still multiplying their sales and profit. Farmers will only buy new seed when the company introduces new varieties. However, the incentive for varietal innovation will drop like a stone in an oligopolistic market wherein farmers have no seed of their own and no local seed sources.

The world's largest seed companies often multiply their seeds in more than one region and hemisphere in order to take advantage of different growing seasons and conditions. It is not unusual for companies to have seed production facilities in Tanzania or Morocco; in Chile and Mexico; or New Zealand and California, in order to service their primary markets in Europe and North America. The cost of producing, transporting, and storing these seeds is high. Companies must also gamble on growing conditions. Further, they have been dependent upon the purchasing whims of farmers who may want to switch varieties forcing the company to carry stock that may never be sold. Some (not all) of these costs increase when farmers can't save their seed. While the increased profits far outstrip the costs, companies can vastly hike their profitability and simplify their operations if Traitor Tech can force farmers to do much of this work for the companies by making them save and repurchase their own seed. Gene Giants are also spending billions every year on plant breeding and chemical adaptation bringing forward new varieties to tie the farmer tighter to company products. Much of this cost can be turned to profit when farmers are obliged to recycle/repurchase their old seeds.

Time line: Genetic seed sterilization insures that the seed company's technology can't be re-used - without showing the company the money, at least - and that sales will be repeated season after season. If successfully commercialized, Terminator will become the control pad of choice for every commercial biotech breeder the moment it comes to market. Within 2-3 years of its introduction, all of the land area sown to transgenic crops will be Terminator fields. RAFI estimates that by 2010 a majority of the world's non-subsistence farmland will be sown to Traitor "seed" - unless the technology is banned. In less than ten years, twelve thousand years of farmer-saved seed and community plant breeding could be irreversibly brought to an end.

Industry analysts record that the global market for transgenic seed went from no sales at all in 1995 to \$1.35 billion in 1998. The same analysts project sales in excess of \$6 billion for transgenic seed by 2005 and could rise to \$20 billion by 2010. The current global market for all commercial seed is approximately \$23 billion.⁷ RAFI predicts that the overall shape of the industry will change considerably in the coming decade. The role and market for seed growers and seed cleaners and conditioners will be transformed while the dominance of those who control germplasm will increase. The overall size of the commercial seed industry may grow at only 2% per annum but the biotech breeders' share could climb to 80% or more of total industry turnover. By 2010, this will be attached to Traitor technologies. Charts 4 and 5 help tell the story.

Chart 5: Transgenics Share of 5 Crops
Global Coverage in 1998

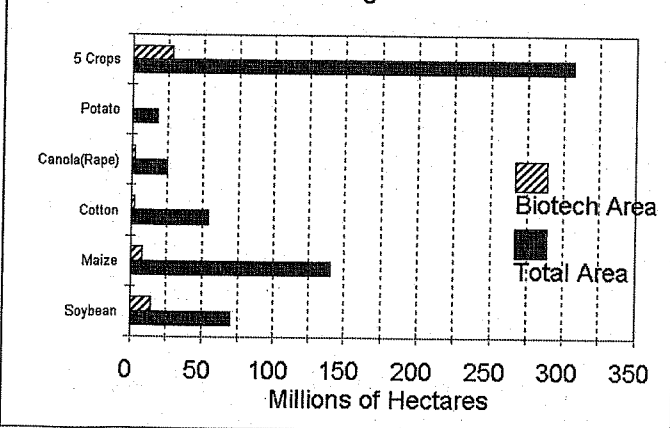
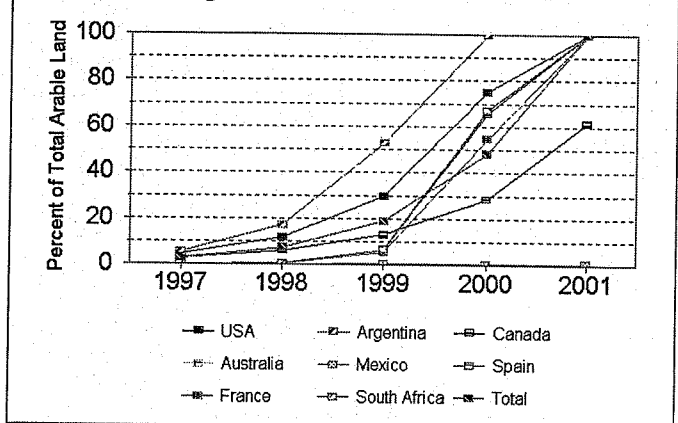
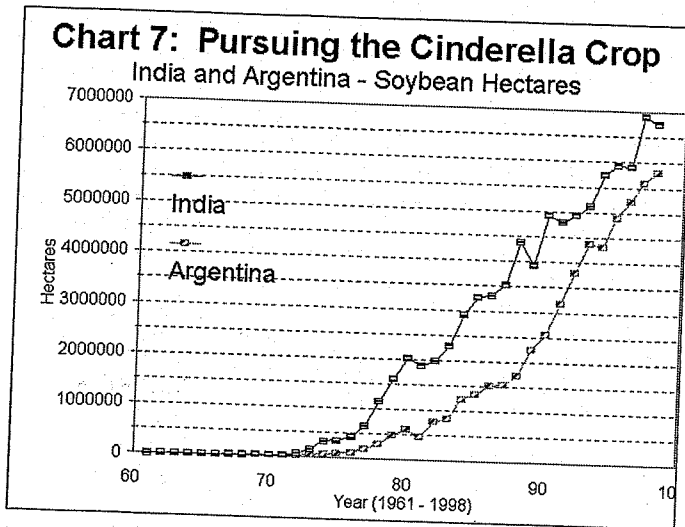


Chart 6: Global Trend Pre-Traitor
Transgenics Trend in Lead Countries



To date, the market for transgenic seed has been effectively limited to five crops (soybeans, maize, cotton, potatoes, and the "canola" type of rapeseed) in eight countries.⁸ Nevertheless, transgenic varieties now cover more than half the soybean hectares in the USA and Argentina. It is expected that China, the former USSR, and much of Eastern Europe will become major users of transgenic seed in the next two years. It is also possible that a number of Latin American states - most notably Brazil (EMBRAPA is already making deals with Monsanto for access to the firm's *Bacillus thuringiensis* (B.t.) and herbicide-tolerant genes) - will adopt transgenic crops in the near future. A pitched battle is being waged over the

acceptance of transgenic crops in India but the outcome is by no means certain. *Wherever transgenics go, Traitor is sure to follow.*



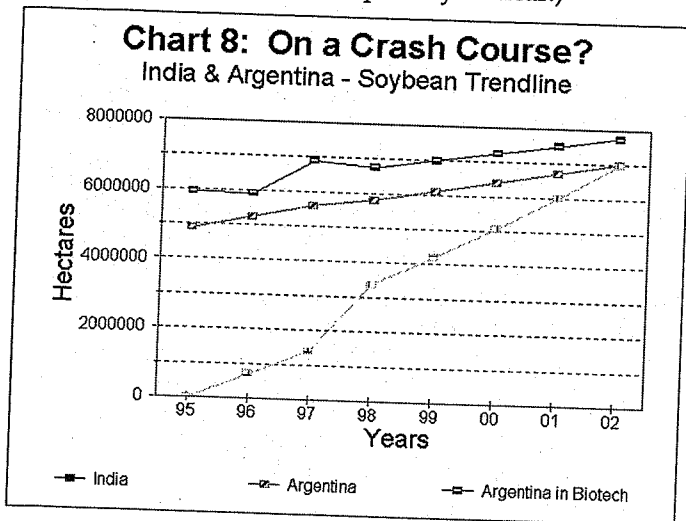
Depending on the outcome of the debate in the EU, the boom market for biotech breeders will shift from the North to the South (and East) by 2001-2002. Traitor "seeds" could come on stream 5-10 years afterward and will quickly conquer the transgenic areas. Chart 5 indicates the trend-line for the countries currently accepting transgenic crops. (Note that the political scene for transgenics in France is especially unclear.)

and enjoy almost identical areas of crop production. More than half of Argentina's soybean crop is now under transgenic varieties and that percentage is predicted to increase to over 80% in 2-3 years. If India follows the same pattern - first into transgenics and then (inevitably) into Traitor, the impact on poor farmers in India could be traumatic. There are nearly 100 million farms in India, and over 80% of Indian farmers depend on farm-saved seeds.⁹ Charts 6 and 7 describe the current and projected scenario for soybeans in the two countries.

Traitor Technologies Fall-Out

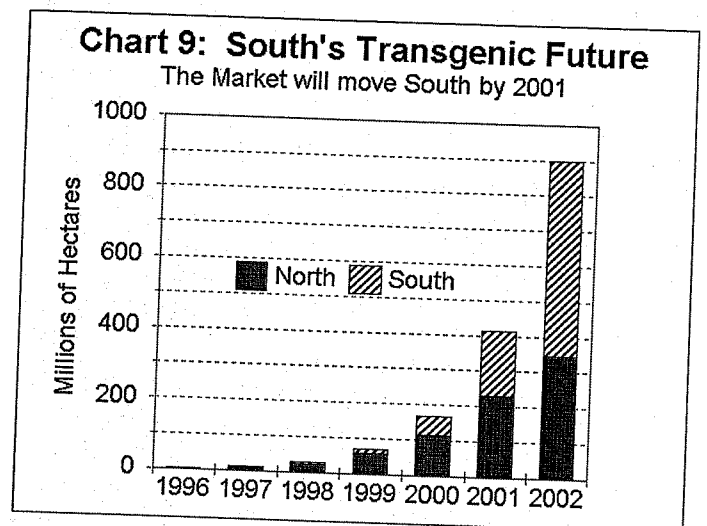
The Implications for Farm and National Food Security

Farm Security: Traitor will directly impact the wellbeing of non-subsistence farmers in several ways. First, it will immediately increase the seed costs of farmers who do not routinely buy hybrid or other specialist seeds (where seed saving is unusual for agronomic reasons). These are costs incurred at the front-end of the growing season when farmers can least afford additional expenses. Not only will farmers have to purchase seed more often than in the past, the seeds themselves will be more expensive than open-pollinated seeds every time they are bought. The share of agricultural inputs (mostly seeds and pesticides) in farm costs soared 86% in the United States in the past decade and will rise much further and faster with Traitor Tech. Second, it will inevitably tie farmers to the purchase of certain chemicals whose costs will also rise as farmers find themselves locked into a production mode they no longer control. Thirdly, as corporations exercise their patent monopolies over Traitor systems, farmers will have to accept licensing and marketing arrangements that will determine their input sources and their output customers. As the biotech industry moves to develop processing traits alongside its input traits, vertical mergers will transform the agro-industrial food system into a handful of powerful international enterprises controlling all aspects of production and processing. With this monopoly, the farmers' share of the food economy will decline still further.



Whether South or North, the trajectory for market acceptance of transgenic crops appears to be similar. Large farmers, whether in Argentina, South Africa, Australia, or the USA, adopt the biotech varieties quickly. Despite growing levels of consumer concern over genetically engineered crops and food, early indications are that large commercial growers will at least try the new seeds as soon as they become available. Unless there is a crop disaster (a distinct and distressing possibility), RAFI projects the trend line in Chart 5 for the eight countries that have already accepted transgenic crops.

Consider the possible parallels between Argentina and India. Since the 1970s for example, Argentina and India have both moved into soybeans at almost identical rates



In RAFI's opinion, the next generation of corporate mergers (and other contractual arrangements) will link today's Gene Giants to global food processing and trading

enterprises. Over time, the Traitor emphasis will slide from "input" to "output" traits useful to reduce storage, transport or other energy related processing costs and to create branded, "value-added" products at the retail level. RAFI will write more on this trend in the months ahead.

Biosafety

There are no standards if there are no choices

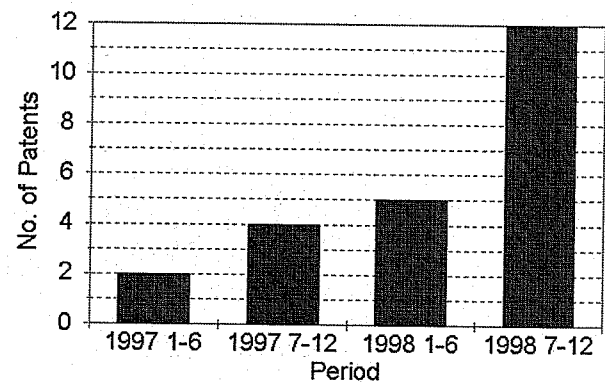
Of what use is the debate on biosafety and the ecological impacts of genetically modified organisms if the only options available to farmers are transgenic Traitor seeds sold by a half-dozen Gene Giants? As the public sector loses its independent capacity for innovation it is also losing its ability to monitor technologies they don't understand. Over time, the irresistible force of corporate greed will overwhelm the highly movable object of government policy and regulation. There is no biosafety without capacity. The new Traitor Tech will be rationalized into acceptability.

Can the famous small biotech "start-up" companies keep the Gene Giants honest in such a fast-changing technological environment? Not if the industry's 1998 experience holds true in 1999. The number of biotech IPOs (Initial Public Offerings) fell to 12 during 1998 from 22 in 1997. IPO proceeds plummeted to \$417 million from \$750 million. Over 50% of US biotechnology companies are currently operating with only two years cash or less.¹⁰ In Europe alone during 1998, there were more than \$66 billion in mergers in the Life Industry. The competition is evaporating.

Food Security: Economic pressures to adopt Terminator and Traitor technologies will also afflict subsistence farmers. In the past, a number of governments in the South have required farmers to use certain plant varieties as a condition of government or commercial credit. In the mistaken belief that they are strengthening urban food security and/or export markets - it is possible that governments will legislate the use of Traitor as a requirement to market or for access to credit, irrigation, or other services. Secondly, commercial and even non-commercial creditors (such as micro-credit institutions) have shown that they are prepared to pressure farmers to adopt specific technologies as a pre-requisite to loans. Thirdly (as Australia's Bill Hankin has suggested), millions of tenant and sharecropper farms may also be pressured by their landlords to adopt Traitor on the assumption that this is the best means of maximizing profitability. Finally, of course, marketing tactics could also lure some desperate farmers to embrace the technology in the hopes of transcending an immediate crisis. Within a handful of years after the widespread adoption of Traitor Technology, resource-poor farmers will no longer have traditional seeds to return to. According to the Food and Agriculture Organization of the United Nations, 1.4 billion poor people depend upon farm-saved seed and community plant breeding for their food security. These are the people most at risk.

Food Aid Security: The plight of the poor could be harmed further by well-intentioned food aid and seed-aid programmes that inadvertently spread Traitor Technologies. It is not unusual for destitute farmers who have lost their own seed supply through some disaster to attempt to plant food aid "grain" as seed. Food aid shipments coming from Mediterranean or sub-tropical climates in OECD countries - or coming via the purchase of "grain" in neighbouring tropical countries (say a grain shipment from South Africa to Angola, for example) - has a reasonable chance of yielding a harvest. If, however, the food aid shipments include Traitor "seed", the crisis for farmers could double when nothing grows.

Chart 10: US "Traitor" Patents Issued
Terminator-type Patents - 1997-98



Seed Security: The full impact of the spread of Traitor to its declared priority target - Third World farmers - is difficult to exaggerate. First and foremost, as poor farmers are driven away from seed-saving and plant breeding, agricultural biodiversity - including our genetic choices for future needs - will collapse and field genetic erosion will accelerate to rates that could all-but-eliminate *in situ* diversity. Of equal importance is the destruction of community plant breeding. Farmers who can't save seed can't breed new varieties. The half-dozen Gene Giants that will dominate the seed supply will not be breeding for resource-poor farmlands. Millions of subsistence farms will be driven to extinction and hundreds of millions of poor people will join the rural landless or the burgeoning ranks of urban migrants.

The erosion of *in situ* genetic diversity will be accompanied by a dramatic narrowing of the genetic base of those Traitor varieties offered to surviving farmers. These genetically identical clones (remember apomixis) will exacerbate harvest vulnerability. Incidents of crop failures and genetic wipeouts will increase. Rather than strengthening food security, food insecurity will afflict more hungry people.

Public gene banks may not be particularly disrupted but they will increasingly find themselves servicing the interests of the few remaining corporate breeders who will patent the genetic traits they discover in the banks and prevent others from accessing the same material. Non-profit *ex situ* seed collections may also be compromised.

As has happened in the past with national lists (of acceptable plant varieties) and the European Common Catalogue, pressure may be exerted to prevent non-governmental seed libraries and other seed-saving initiatives from maintaining, exchanging, and growing non-Traitor seed.

Sovereignty: Traitor Technologies mean the surrendering of farmer and national sovereignty over food security. The seed - the first link in the food chain - will be surrendered to the monopoly control of a few corporations that will determine what genetic qualities will be grown; under what costs and conditions; and how (or if) positive and negative traits will be triggered by external agents. The creation of such a level of dependency related to such a basic human need is unprecedented.

Terminating the Traitor

Possible Initiatives for Governments and Civil Society

Context: The quarter-century long industry campaign for intellectual property monopoly over living materials faces a decisive battle in 1999/2000. The outcome will be determined first and foremost, by public concern and civil action. The battle theatre will shift between the European Court of Justice, the WTO TRIPs Review, South governments, and United Nations agencies such as FAO, UNCTAD, and the Biodiversity Convention. In the midst of the fray, it is important not to lose sight of industry's primary purpose - within which, intellectual property is a weapon, not a goal. Industry has two objectives - first, to secure societal acquiescence to a virtually unlimited and unregulated global patent-property culture. Second, to entrench intellectual property as a non-tariff barrier to market entry for all but the most powerful members of the corporate clique. Mega-mergers - often driven by patent and technological opportunities - are already transforming the once-diverse life industry into a handful of homogeneous club members. The club trades patent licenses and markets among themselves and excludes public and lesser-private enterprises. Independent public research is becoming extinct. Entrepreneurial small private science is being priced out of the patent poker game. But, new *negative* technologies (Traitor Tech) are being developed with built-in exclusivity and long-range controls. In an oligopoly, patents become marginal. The first (and arguably the worst) of the negative technology generation are agriculture's Terminator and Traitor technologies. Peculiarly, these technologies offer a case wherein banning the patents means banning the technologies. The fight against Traitor, focuses the whole "life patenting" debate while raising the alarm over the wider strategy. Here are some ideas for action.

Civil action: In the months since the Terminator patent was first granted in the United States and RAFI issued its first news warning about the inherent dangers in the new technology, Civil Society Organizations have been remarkably successful in building a strong atmosphere of opposition to the Terminator. Most significantly, the Government of India has publicly declared its opposition to the Terminator and the CGIAR (Consultative Group on International Agricultural Research) - the world's most

important ag research network - has stated firmly that it will not use the technology in its breeding work with farmers. Many other governments and UN agencies are studying the technology. Among them, UNCTAD's UNCSTD (UN Commission on Science and Technology for Development) and the Convention on Biological Diversity are evaluating the technology during 1999. Global Response, a CSO with 4000 members in 40 countries has launched a campaign to ban the Terminator and its members are asking the UN Food and Agriculture Organization (FAO) to help. State legislators in New Hampshire (USA) have introduced a bill to study the impact of genetic seed sterilization on biodiversity. Citizen's groups from San Francisco to Stockholm and from Argentina to Zimbabwe have taken up the issue of Traitor Tech by every conceivable means from letter writing to lectures, from songs to seminars, and from posters to pie-throwing. In response, the two earliest Terminator claimants - Monsanto and AstraZeneca, have offered unconvincing noise about listening to public concern and even suggesting that they might not be interested in the technology. The U.S. Department of Agriculture, after being bombarded by protests over the Terminator patent (which it co-owns with a Monsanto subsidiary), has stated that it won't incorporate the technology in plant varieties it releases to farmers. The situation is clear. Traitor Tech can be defeated. Concerted opposition over the next two years could put an end to this "damaged goods" technology.

National Action: Under the terms of the WTO's Trade-Related Aspects of Intellectual Property Rights (TRIPs) chapter (Article 27.2) any government can reject an intellectual property claim related to a plant variety if it poses a threat to the environment or offends *ordre public* (public morality). The TRIPs agreement is scheduled for review in 1999 and there is heavy political pressure from the United States, Australia, and Japan to toughen its provisions. However, in recent years, the French Government has invoked *ordre public* to prevent intellectual property claims related to human DNA and the British Government has banned patents related to landmines. By invoking *ordre public* to reject the Traitor patents, governments can achieve three goals:

1. Under the terms of the WTO, governments rejecting an otherwise valid intellectual property claim are obliged to ensure that the invention is *not* used within their territories. Thus, prohibiting the claim is tantamount to banning the technology;
2. Using the opportunity provided by the TRIPs review, and the momentum gained through the rejection of patents by a number of States, concerned governments can argue that the language in Article 27 should be expanded to allow bans not merely on individual plant varieties but on whole technologies applied to plants (such as Terminator).
3. If successful, this broad-spectrum approach to *ordre public* could create the necessary political space for some governments to insist that intellectual property over "life" be against their national public morality.

International Activities:

A number of intergovernmental organizations have a role to play in banning the Traitor Technology...

UNCTAD - The Geneva-based agency's UN Commission on Science and Technology for Development (UNCSTD) will hold a meeting May 17-21 in Geneva. The Commission may consider statements or even a recommendation hostile to Traitor Tech.

FAO - The FAO Commission on Genetic Resources for Food and Agriculture meets in Rome April 19-23, 1999. Governments could make the following decisions...

1. The Commission could declare that Traitor Technologies are a threat to agricultural biodiversity and to the wellbeing of the 1.4 billion rural people who rely on farm-saved seed and local plant breeding;
2. FAO could advise the public that it would not accept donations or purchase of Terminator "seed" for its seed emergencies programme;
3. FAO could publicly declare that grain containing Traitor Tech cannot safely be used in food aid shipments since desperate farmers sometimes use the grain as a source of seed when their own varieties have been lost;
4. FAO could advise that it is studying whether or not Terminator "seed" can be described as seed since it does not meet the definition of an embryo that is capable of reproduction (hybrids are generally capable of reproduction although they tend not to breed "true");
5. FAO could agree to discuss with CGIAR the need to update its germplasm trust accord to ensure that none of the 500,000 seed samples in their international collection are made available to researchers developing Terminator varieties since this would be a violation of their agreement to prevent monopolies over the genetic resources.

CBD SBSTTA - The Subsidiary Body on Scientific, Technical, and Technological Affairs meets annually in Montreal. It will meet from June 21-25 1999 to review a scientific evaluation of the impact of Terminator on biodiversity (the date may shift to July or September). Governments could recommend against the technology. In addition to declaring that Terminator imperils biodiversity, SBSTTA could join FAO in noting that seeds that have been genetically sterilized cannot be called "seed".

CGIAR - The Consultative Group on International Agricultural Research meets in Beijing May 24-28 and in Washington the last week of October. The CGIAR could decide not to allow internationally held germplasm to be used in Traitor Technology.

UN/FAO - The Committee on World Food Security meets in Rome May 31 - June 4 1999. Governments could endorse the FAO Commission position in April and go on to agree that food aid and seed distribution must be free of Traitor Tech.

WTO - The World Trade Organization's TRIPs Council will meet irregularly throughout 1999. The most

important intergovernmental session will come when WTO ministers meet in Seattle, Washington from November 30 to December 3rd, 1999. Although the gathering is partly ceremonial, it is also an opportunity for South governments to challenge the Traitor tech patents and to call for a ban of the Terminator.

Summary

Terminator and Traitor Technologies

Traitor Technologies Launch Pad:

Terminator/Traitor technologies will be combined with apomixis to mass-produce inexpensive, sterile clones.

Terminator will be adapted to switch on (and off) other single-gene (or, possibly, multi-gene) traits such as herbicide tolerance, insect resistance, and yield or processing properties.

Traitor technology will mate company seed with company chemicals in such a way so that they are completely dependent on one another. Farmers will have no choice but to use both, and will depend on a handful of companies for virtually all crop inputs.

Ultimately, Terminator "seeds" will be armed with a diverse payload of proprietary genes/traits that can be switched on or off by the corporation at the point of sale depending on the farmers' ability to pay or the seller's market interest.

In the future, traits will be externally activated/de-activated by external chemical inducers - and linked to pesticide or fertilizer applications, for example. This will result in costly and potentially hazardous chemical dependencies.

The farmer's incentive to "voluntarily" buy chemical sprays could be "positive" - to activate genetic sequences favouring yield or processing qualities; or "negative" - to de-activate non-beneficial "side-effect" genes linked to traits that would otherwise damage the crop.

Newly discovered patented traits will be linked to Traitor and Terminator technologies not for agronomic reasons, but for company profits.

In either case, the frontier between "positive" and "negative" measures will reside purely in the mind (and marketing campaign) of the corporation. The effect will be to transfer the chemical costs of activating/de-activating genetic traits from the company to the farmer - while still increasing the market for proprietary chemicals.

Unless it is banned, the Terminator will spread wherever transgenic crops are introduced and will become the launch pad technology carrying all transgenic traits as soon as it is commercialized.

Traitor Technologies Control Pad:

Terminator patents will be widely licensed (and used) by any biotech breeder having proprietary traits.

The specialized nature of some transgenic traits will lead regulators to describe Terminator as an "additional layer" of biosafety that will evolve (in policy terms) as "consumer protection".

As breeding advances increasingly come from companies with proprietary/transgenic traits, conventional breeding initiatives (and markets) will wither until Terminator usage becomes the standard for progress and safety.

Second generation Terminator patents will (if necessary) be licensed to a limited oligopoly of dominant enterprises trading markets and traits.

Governments will regulate against open-pollinated ("saveable") seed which will be seen as "dirty" seed capable of polluting neighbouring fields and undermining processing qualities.

Traitor Technologies Fall-Out:

A major escalation in crop production costs (seeds and chemicals).

A further marginalization (and elimination) of millions of small farms unable to bear the burden of higher costs and unable to obtain seeds suited to their high-stress, marginal farming environments.

Bioserfdom - the remaining farmers will become renters of proprietary germplasm obliged to buy, grow, and sell under contract to the corporate food oligopoly.

A vast and rapid decline in agricultural genetic diversity in the centres of origin of the world's most important food crops.

More crop failures brought on by genetic uniformity and technology vulnerability.

Increases in food prices with patent/technology monopolies and a new wave of mega-mergers between

agricultural input corporations and food processing enterprises.

Escalating international dependency, food insecurity, and hunger.

CHART SOURCES:

Chart 1: RAFI, based on Clive James, "Global Review of Transgenic Crops: 1998" (Preliminary Executive Summary and Principal Tables)

Chart 2: RAFI, based on Clive James, "Global Review of Transgenic Crops: 1998" (Preliminary Executive Summary and Principal Tables)

Chart 3: Sparks Companies. Sparks Companies is a Memphis-based consulting firm. Their estimate is based on information provided by companies, US Grains Council Value Enhanced Corn Quality Report, Furman Selz LLC, NatWest Securities. The estimate cited does not include herbicide tolerant varieties marketed by American Cyanamid and DuPont that are not transgenic.

Chart 4: RAFI projection, based on information from Sparks Companies and Clive James. Chart assumes 2% annual increase in regular seed market.

Chart 5: RAFI, based on data from Clive James and FAO statistics.

Chart 6: RAFI projection, extrapolating from data provided by Clive James and Sparks Companies.

Chart 7: RAFI projections based on market trendlines.

Chart 8: RAFI, projections based on numerous market data sources.

Chart 9: RAFI, projections based on data from Sparks Companies.

Chart 10: RAFI, based on patent office data.

¹ For a detailed background examination of the Terminator, please see *RAFI Occasional Paper Series* Vol. 5, No. 3: *RAFI Impact: The Terminator File* August, 1998, also available at: <http://www.rafi.org>

² Please see *RAFI Occasional Paper Series* Vol. 5, No. 1: *Terminator Trends: The Silent Spring of Farmers' Rights*, June, 1998 available at www.rafi.org as a PDF file. This document provides a discussion of apomixis.)

³ For further background on apomixis, see the report of the Bellagio Apomixis Conference, April 27-May1, 1998, and the Bellagio Declaration. On the internet at: <http://billie.harvard.edu/apomixis/apotech.html>.

⁴ Shamp, Jim. "Scientists find genetic "switch" for cell size," *The Herald Sun*, November 6, 1998. The discovery is also reported in *Science*.

⁵ West, J. "E.I. du Pont de Nemours and Company," *Harvard Business School Case Study*, November 19, 1998.

⁶ Please see *RAFI Communiqué* (March/April 1997) *Bioserfdom: Technology, Intellectual Property and the Erosion of Farmers' Rights in the Industrialized World* for a discussion of precision farming.

⁷ According to world seed statistics maintained by the International Seed Federation and ASSINSEL the total commercial market for seed planting material is \$23,520 billion (see: <http://photon-17.iprolink.ch/~assinsel/stat.htm>). RAFI has chosen to use a slightly more conservative figure of \$23 billion.

⁸ James, C. "Global Review of Commercialized Transgenic Crops: 1998," (Preliminary Executive Summary and Principal Tables), ISAAA, No. 8, 1998.

⁹ Swaminathan, M.S., *Farmers' Rights and Plant Genetic Resources*, *Biotechnology and Development Monitor*, No. 36, September/December 1998, p. 7.

¹⁰ Dorey, E., "Will Investors Return to Biotechnology?" *Nature Biotechnology*, Vol. 17, February, 1999, p. 128.

VISIT RAFI ON THE INTERNET

You're invited to visit RAFI's website. You'll find *RAFI Communique*, Occasional Papers, Press Releases, and more, including special theme areas on issues like the human gene patenting, the basmati rice patent, and our "Geno-types" news briefs. You may also subscribe to our e-mail listserver and even send an e-mail to government officials about the Terminator Technology right from our pages. Simply point your web browser to:

<http://www.rafi.org>

PLEASE TAKE NOTE!

CHANGE OF ADDRESS FOR RAFI COMMUNIQUE

Effectively immediately, correspondence regarding RAFI Communique and other RAFI Publications, including subscriptions, renewals, requests for past issues, book and map orders, payments, and changes of address should be sent to:

**RAFI Publications
PO Box 68016 RPO Osborne
Winnipeg MB R3L 2V9
CANADA**



RAFI Communique
PO Box 68016 RPO Osborne
Winnipeg MB R3L 2V9
CANADA

BY AIR MAIL
POR AVION