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2001: A Seed Odyssey RAFI's Annual Update on Terminator and Traitor Technology *Suicide Seeds: Not Dead Yet!*

Issue: Syngenta, the world's largest agrochemical corporation (created last year with the merger of Novartis and AstraZeneca) won its newest Terminator patent in November 2000. US-based Delta & Pine Land Co. vows to commercialize suicide seeds. Ironically, with increasing evidence of genetic pollution (that is, the escape of engineered genes from genetically modified (GM) crops via pollen), the US government, the biotech industry and some scientific bodies are promoting Terminator technology as a technical "fix" for gene escape from GM crops. Promotion of suicide seeds as a tool for "biosafety" is an illogical and unacceptable argument to justify commercialization of Terminator and Traitor technology.

Impact: If commercialized, Terminator and Traitor seeds will destroy national seed sovereignty and threaten global food security, especially for the 1.4 billion people who depend on farm-saved seeds and local plant breeding. If the Gene Giants are allowed to develop a new generation of GM plants whose traits can be switched on or off with the application of proprietary chemicals, bioserfdom is the inevitable outcome. New patents describing genetically modified plants with weakened immune systems that would ultimately depend on the application of a chemical to regain their natural defenses against pests and disease are the most troubling examples of Traitor technology to date.

Who is developing Terminator and Traitor technology? A moving target. Terminator patent portfolios are changing hands because the Gene Giants are consolidating, spinning off, and selling agbiotech interests. Syngenta, Delta & Pine Land and the U.S. Department of Agriculture, Pharmacia (Monsanto), BASF and DuPont hold Terminator patents; virtually all of the Gene Giants and many public sector institutions have interests in genetic trait control technology.

Policy Action: Unless governments take action to ban these technologies, Terminator and Traitor seeds will be commercialized. Governments will have important opportunities to reject Terminator at the World Food Summit Five Years Later in November 2001; at the Biodiversity Conventions' 6th Conference of Parties in April 2002; and at UNCED's Rio+10 in South Africa, in mid- 2002. As potential biological weapons, the use of Terminator/Traitor should also be banned by governments at the 5th Review Conference of the Biological and Toxin Weapons Convention in Geneva, November 2001.

Background

Terminator technology, the genetic modification (GM) of plants to produce sterile seeds, has been widely condemned by civil society, scientific bodies and many governments as an immoral application of agbiotech. If commercialized, Terminator would prevent farmers from re-using seed from their harvest, forcing them to return to the commercial seed market. Fertility is just one of many genetic traits that corporate scientists can switch “on or off” with the application of an external chemical. “Traitor” refers to genetic trait control technologies that could impose chemical dependencies in agriculture with grim implications for farmers, food security and the environment.

When Terminator technology came to public light in March 1998, “suicide seeds” shattered the myth that commercial biotechnology aims to feed hungry people. Terminator became synonymous with corporate greed, and blatantly exposed the industry’s goal of maximizing profits by destroying Farmers’ Rights and seed sovereignty. In 1999, in the wake of widespread public protest, Monsanto and AstraZeneca vowed not to commercialize Terminator technology.

Who Owns Terminator Patents?		
Company/Institution (followed by name of original assignee)	Patent Number	Date Issued
Syngenta (Novartis)	US 6,147,282	14 Nov. 2000
Syngenta (Novartis)	US 5,880,333	9 March 1999
Syngenta (Zeneca)	US 5,808,034	15 Sept. 1998
Syngenta (Zeneca)	WO9738106A	16 Oct. 1997
Syngenta (Zeneca)	WO9735983A2	2 Oct. 1997
Syngenta (Zeneca)	WO9403619A2 and A3	17 Feb. 1994
Delta & Pine Land/USDA	US 5,723,765	3 March 1998
Delta & Pine Land/USDA	US 5,925,808	20 July 1999
Delta & Pine Land/USDA	US 5,977,441	2 Nov. 1999
BASF (ExSeed Genetics, L.L.C./Iowa State University)	WO9907211	18 Feb. 1999
DuPont (Pioneer Hi-Bred)	US 5,859,341	12 Jan. 1999
Pharmacia (Monsanto)	WO9744465	27 Nov. 1997
Cornell Research Foundation	US 5,859,328	12 Jan. 1999
Purdue Research Foundation (with support from USDA)	WO9911807	11 March 1999

Today, three years after Terminator’s public debut, many would argue that the GM landscape has changed radically. After all, Bob Shapiro, Monsanto’s former CEO and fearless biotech booster, is looking for a new job. (Shapiro didn’t last even one year on the board of Pharmacia – the drug company giant that acquired Monsanto in March, 2000.)¹ From Manila to Mexico City, Tokyo to Toronto, Auckland to Porto Alegre, the controversy over GM crops and food rages. “Golden Rice,” “StarLink maize” and “Terminator” are words that ignite strong reactions, both pro and con, over the future of GM technology.

Unfortunately, one thing has not changed. Though many have been lulled into thinking that the Terminator threat has diminished, the technology is moving closer to commercial reality. This issue of the *RAFI Communiqué* provides an update

on Terminator and Traitor technology. What has happened since RAFI’s last update in March 2000? Who holds Terminator patents? What are the key policy fora where Terminator will be debated in 2001-2002?

Updates: Terminator Patent Shuffle

BASF: In March 2000 German agrochemical firm BASF announced that it would invest \$680 million in agricultural biotechnology. In December 2000 BASF acquired US plant biotech firm, ExSeed Genetics, the co-owner (with Iowa State University) of a controversial patent, WO9907211, which is explicit in describing a method for preventing farmers from using saved seed for re-planting. RAFI has written to Hans Kast, President and CEO of BASF to ask if the company will abandon its newly acquired

Terminator patent. Last year, Kim Kuebler of ExSeed Genetics insisted that his company “is NOT developing so-called ‘terminator’ technology as some kind of third world protectionism, nor do we have any plans to do so.”² Will BASF make a similar pledge by agreeing to abandon its new Terminator patent?

TERMINATOR’S GLOBAL REACH?

Delta & Pine Land (Mississippi, USA) is the only company that has publicly declared its intention to commercialize Terminator seeds. With annual sales of US\$301 million, D&PL is the world’s 10th largest seed company. Subsidiaries and joint ventures include:

- Ellis Brothers Seed
- Arizona Processing
- Mississippi Seed
- Hartz Cotton
- Sure Grow Seed
- Turk Deltapine, Inc.
- D&M International LLC (joint venture with Monsanto)
- D&M Partners
- D&M Brasil, Ltda
- D&PL Argentina, Inc.
- D&PL China, Inc.
- D&PL China PTE, Ltd.
- D&PL Investing Corp.
- D&PL Investments, Inc.
- D&PL Mexico, Inc.
- Deltapine Paraguay, Inc.
- D&PL South Africa, Inc.
- D&PL International Technology Corp.
- Delta and Pine Land International, Ltd.
- Delta Pine de Mexico, S.A. de C.V.
- Deltapine Australia Pty. Limited
- D&PL Semillas Limitada
- Delta & Pine Land Hellas Monoprosopi E.P.E.
- D&PL Brasil, Ltda.
- D&PL Technology Holding Corp.
- CDM Mandyu S.R.L. (joint venture between D&M International and Ciagro)
- D&M Brasil, Ltda
- Atled Corporation
- Greenfield Seed Company
- Hebei Ji Dai Cottonseed Technology Company, Ltd. (joint venture controlled by D& PL China)
- Paymaster Technology Corp.
- Anhui An Dai Cottonseed Technology Company, Ltd (joint venture between D&PL China and Anhui Provincial Seed Corp.)
- MDM Maeda Deltapine Monsanto Algodao Ltda (joint venture between D&M and Maeda Administracao e Participacoes Ltda)

Delta & Pine Land (D&PL) and US Department of Agriculture: In a telephone interview earlier this year, Delta & Pine Land’s Vice-President for Technology Transfer, Harry Collins, told RAFI that the company is moving ahead with plans to commercialize its “technology protection system” (Terminator). D&PL, the world’s largest cotton seed company, jointly owns three patents on Terminator with the US Department of Agriculture. Despite mounting opposition from national governments, United Nations’ agencies, farmers, scientists and CSOs around the world, USDA has signaled that it will not abandon its patents nor condemn the technology.³ Paralyzed by an avalanche of public protest, however, USDA has so far failed to conclude a licensing agreement with D&PL. USDA’s partnership with the seed industry on Terminator is an egregious use of taxpayer money, and demonstrates the agency’s commitment to private gain over public good and the rights of farmers. With a new administration in Washington no change is likely.

According to Harry Collins, the licensing agreement with USDA is “irrelevant” for D&PL because it does not prevent the company from commercializing the technology. Collins told RAFI that D&PL is still conducting research on Terminator in greenhouses, involving both cotton and tobacco. The company does not plan to conduct field tests in 2001.⁴

Syngenta, the world’s largest agribusiness firm, was formed on 13 November 2000 with the merger of AstraZeneca and Novartis. The next day the company won its newest Terminator patent, US Patent 6,147,282, “Method of controlling the fertility of a plant.” (The patent was issued to Novartis – but the company’s intellectual property goes to Syngenta.) With *pro forma* 1999 sales of US \$7 billion, Syngenta is the world’s largest agrochemical enterprise, and the third largest seed corporation.

US Patent 6,147,282 is the latest in a series of Terminator patents won by Novartis. This patent carries the same abstract and main text as US patent 5,880,333, identified by RAFI last year.⁵ The patent describes a complex system for chemical control of a plant’s fertility. The application of a chemical inducer can be used to either abolish or restore a plant’s fertility. RAFI has written to David Evans of Syngenta to request that the company make a public pledge to abandon its patents on Terminator, and to disavow all further research on the technology.

Monsanto – Pharmacia announced that it would acquire Monsanto in November 1999 just weeks after Monsanto’s CEO pledged that his company would not commercialize Terminator seeds. Would the new company (with a new CEO) honor Monsanto’s pledge? In July 2000 the *New York Times* reported that Monsanto was collaborating with Scotts Co. to develop GM turf grass and that the companies would

employ Terminator technology to prevent gene flow. RAFI contacted Monsanto’s Director of Public Policy, Kate Fish, who responded: “We stand by our announcement of last October... To reiterate,

neither Monsanto, nor any of our technology licensing partners – including Scotts – are working on sterile seed technology in their application of Monsanto’s biotechnology traits.”⁶

The Green Gene Defense: Apologists for Terminator

Proponents of Terminator argue that engineered sterility could play a valuable role in controlling the escape of engineered genes from GM crops to related plants and wild relatives. Engineered sterility offers a built-in safety feature, they claim, because if genes from a Terminator crop escape into the wild, the seed produced from unwanted pollination will not germinate.⁷ The argument is not new. Ironically, in the face of increasing evidence of cross-pollination from GM crops, the “Green Gene” defense of Terminator is gaining ground. Several recent reports issued by scientific bodies make the dangerous suggestion that there are environmentally friendly and acceptable uses for Terminator because it could be used to prevent unwanted gene flow in GM crops. Not very long ago, scientists downplayed the potential problem of escape of engineered genes from GM crops. Today we are being asked to accept engineered sterility as a biosafety bandage for GM crops with leaky genes. Apologists for Terminator include, for example:

- In April 2000 the National Research Council (NRC) of the National Academy of Sciences (USA) released a report entitled, “Genetically Modified Pest Protected Plants: Science and Regulation.” The report refers to Terminator technology as “...a more effective method of confining gene flow,” particularly when it relates to reducing wild species invasion. The report notes that if Terminator technology were pursued on a commercial scale “it could reduce the need to regulate transgenic crops based on weedy relative consideration.” The NRC report concedes that the technology is “highly controversial” and also recognizes that “because of concerns raised about using chemicals to turn on genes in the environment, it is unclear whether or not such a technology will be acceptable.”
- The United Kingdom’s, *Advisory Committee on Releases to the Environment (ACRE)* advises the government on risks of genetically modified organisms. ACRE’s annual report, published in March 2001, reviews a number of possible strategies to ameliorate risk of GMOs, including the Terminator technology, which it describes as “a promising technique for genetic isolation.”⁸ The report notes that “it is beyond the scope of this guidance to consider the socio-economic and ethical debate raised by this capability [genetic seed sterility].”
- In July 2000 seven science academies from the South and North released “Transgenic Plants and World Agriculture,” prepared under the auspices of the Royal Society of London, the U.S. National Academy of Sciences, the Brazilian Academy of Sciences, the Chinese Academy of Sciences, the Indian National Science Academy, the Mexican Academy of Sciences and the Third World Academy of Sciences.⁹ The report candidly outlines many of the failures of commercial biotechnology to address the needs of the South’s resource-poor farmers before concluding, “it is critical that the potential benefits of GM technology become available to developing countries.” In RAFI’s opinion, the report takes a kamikaze nose-dive when discussing GURTs, or genetic use restriction technology, another name for Terminator and Traitor technology:

*“GURTs potentially have beneficial applications for consumers, growers, and the environment that should not be overlooked in debates over intellectual property rights. For example, GURTs could be used to prevent transgenes from spreading to closely related wild plants by preventing germination of any crossbred seeds. Furthermore, this technology could potentially eliminate the problems of “volunteer” plants that appear from seed left in the field after harvest. Volunteer plants must be eliminated before the next crop is planted because they are hosts for pests and pathogens and can nullify the benefits of crop rotation.” -- Excerpt on GURTs from *Transgenic Plants and World Agriculture*.*

Leaky GM Genes and Biotech Bailouts

The StarLink maize debacle in the United States (and beyond) demonstrates increasing evidence of unintended gene flow, and the inability of regulatory systems to contain genetic pollution from GM crops. StarLink is the brand name for Aventis’ GM insect-resistant maize that illegally entered the food supply; the GM crop was approved by the US government only for livestock feed because of

concerns that its toxic protein (Cry9C) could trigger allergic reactions in some people. When traces of StarLink were discovered in the food supply, it resulted in massive recalls of over 300 maize-based food products. After StarLink maize appeared in grain shipments destined for export, grain markets were disrupted, prices tumbled and US farmers lost valuable markets. As a result, unsold stockpiles of US maize are at their highest level in eight years.¹⁰

In March 2001 the US Department of Agriculture announced that it would spend \$20 million in taxpayer money to bail out the seed and biotech industry, by purchasing 300,000 to 400,000 bags of maize seed contaminated by gene flow from Aventis' StarLink genes.¹¹ StarLink maize was planted on less than 0.02 percent of all US maize cropland in 2000, but cross-pollination with other maize varieties resulted in maize seed contaminated with StarLink genes. The federal bailout is using government funds that would normally go to disaster relief for farmers.

John Wichtrich, general manager for Aventis CropScience admits that StarLink's leaky genes cannot be contained. At a speech to North American Millers Association in March 2001 Wichtrich asked his audience, "I know you are wondering: 'Will there ever be an end to this?' Unfortunately, as of right now, the answer is no - there will never be an end as long as there is a zero tolerance for Cry9C in food."¹²

The ultimate goal of genetic seed sterility is neither biosafety nor agronomic benefits, but bioerfdom.

Unacceptable Trade-Off: Biosafety for Bioerfdom

Instead of admitting the biosafety risks of GM crops and the inability of current regulatory programs to contain them, the Gene Giants, allied scientific bodies and government regulators are seizing the opportunity to promote the use of Terminator as a biosafety tool for minimizing the unintended spread of transgenes. Genetic seed sterility offers a method to contain unwanted gene flow, they argue, and it will also bring added agronomic benefits, such as preventing pre-harvest crops from sprouting prematurely. The USDA, which jointly holds three patents on Terminator technology, champions the use of Terminator to prevent gene flow in GM crops.¹³ The agency, of course, has a blatant conflict of interest as both developer and regulator of GM technology.

In RAFI's opinion, the logic is flawed and dangerous. The ultimate goal of genetic seed sterility is neither biosafety nor agronomic benefits, but bioerfdom. No matter what rationale is used by the Gene Giants to engineer social acceptance of genetic seed sterility, the technology is unacceptable because it will ultimately be used to maximize seed industry profits by forcing farmers to rely on commercial seed stock. Terminator will threaten biodiversity, and jeopardize food security for the world's poor. In September 2000 the FAO's Panel of Eminent Experts on Ethics in Food and Agriculture concluded that Terminator was "unethical."

"The panel unanimously stated that the 'terminator seeds' generally are unethical, finding it unacceptable to market seeds, the offspring of which a farmer cannot use again because the seeds could not germinate. Genetic Use Restriction Technologies are not inherent in genetic engineering. While corporations are entitled to make profits, farmers should not have to become dependent on new seeds from the supplier every season." -- FAO's Panel of Eminent Experts on Ethics in Food and Agriculture¹⁴

Chloroplast Engineering: New Technology To Topple "Green" Apologists for Terminator?

New breakthroughs in "chloroplast engineering" may foil industry attempts to promote Terminator as a unique biosafety tool for containing unwanted gene flow in GM plants. A chloroplast is an organelle found in the green tissues of plants (chloroplasts give plant tissues their green colour). Chloroplasts contain their own genetic material (genome). Up to 50,000 plastid genomes can be present in a given plant cell.

Scientists recently modified the chloroplast genome of tobacco and potatoes. The technique is described as a "milestone" for plant biotechnology because multiple genes can be engineered through

a single transformation event.¹⁵ And, since chloroplasts do not transfer genes from pollen, some scientists predict that the new technique will prevent escape of foreign genes through pollen. According to molecular biologist Henry Daniell of the University of Central Florida, “Chloroplast genetic engineering is emerging as an alternative technology that overcomes many of the environmental concerns of nuclear genetic engineering.”¹⁶ RAFI does not advocate any GM technique; chloroplast engineering is cited here because it illustrates that technologies are evolving rapidly and it is irresponsible to suggest that agriculture is dependent on genetic seed sterilization as a method for containing foreign genes.

Traitor Technology

In 1999, RAFI first identified AstraZeneca and Novartis’ patents for “chemically dependent” plants – dubbed Traitor Technology by RAFI.¹⁷ Using inducible promoter systems, the coding sequence for a protein is under the control of a chemically inducible promoter. In other words, a plant’s genetic traits can be turned “on or off” with the application of an external chemical catalyst. Molecular biologists now have the ability to control a wide range of traits such as a plant’s defenses against insects or diseases, tolerance to herbicides, or flowering, fruit ripening, flavor, nutritional qualities, and male or female sterility. Research and development of inducible promoter technology is now commonplace in biotech laboratories. For RAFI and other CSOs, the specter of “negative trait” technology controlled by a handful of Gene Giants is unacceptable.

With Traitor technology, a more frightening scenario unfolds: proprietary seeds will be biologically bound with company chemicals in such a way 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 traits and inputs.

If companies are allowed to engineer and commercialize GM seeds that perform only with the application of a proprietary pesticide or fertilizer, for example, this technology will reinforce chemical dependencies in agriculture – and both farmers and food security will be held hostage to the Gene Giants. This is not, as some would suggest, a reckless conspiracy theory. It is market logic backed by recent experience. The integration of the agrochemical and seed industry is well documented by RAFI and others. The development of herbicide tolerant seeds, i.e. the marketing of proprietary GM seed technology and companion weed killer, is only the most recent and well-known example. Worldwide, herbicide tolerant GM seeds accounted for 74% of the total area devoted to GM crops in 2000.¹⁸ With Traitor technology, a more frightening scenario unfolds: proprietary seeds will be biologically bound with company chemicals in such a way 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 traits and inputs.

New Traitor Tech Patents Involving Immune-Compromised Plants

Owner	Patent #	Issued
Syngenta (Novartis)	US Patent 6,091,004	18 July 2000
Syngenta (Novartis)	US Patent 6,057,490	2 May 2000
Syngenta (Novartis)	US Patent 6,107,544	22 Aug 2000
DuPont (Pioneer)	WO 0070059	23 Nov 2000

Missing Immunities

Especially alarming are patents describing plants that have weakened immune systems. Last year, Action Aid, Berne Declaration, GeneWatch and the Swedish Society for Nature Conservation identified three new Novartis patents of this type.¹⁹ DuPont holds a more recent patent which involves reducing a plant’s natural

disease resistance (see table). In most cases, the inventors claim that they are developing “immune-compromised” plants for research purposes, to test the efficacy of fungicides, to examine plant-pathogen interactions, or to enhance disease resistance, for example. But some patents suggest otherwise and the work is not merely theoretical.

To be clear, the stated aim of most of these patents is to modify plants for *enhanced* disease resistance. The desired trait, of course, would depend on the application of an external chemical inducer. (Farmers could be required to use a proprietary chemical in order to take advantage of the desired trait.) But the patents also describe the development of plants whose natural immune system is disabled, and would therefore be highly vulnerable to pests and disease – unless chemicals are used to restore the plant’s missing immunities.

For example, an earlier Novartis patent (now owned by Syngenta), US Patent No. 5,804,693, describes genetically modified “universal disease susceptible” plants which produce reduced levels of salicylic acid -- a key mediator of plant resistance to a wide variety of pathogens (bacteria, fungi, viruses). The inventors subsequently modified a “disease sensitive” plant to express the Bt gene for insect resistance, but only when triggered by a chemical inducer. Such plants would be unusually vulnerable to bacteria, fungi and viruses, unless immune responses are also re-engineered back into the plant. Restoration of immune responses would also be subject to regulation by external chemicals. A series of Novartis patents (see table) involve other components of the plant’s immune system, and include the isolation of strains with weakened immune systems. US Patent 6,057,490, now held by Syngenta, specifically describes the protection and use of non-immunity mutants – plants that are modified *not* to express systemic acquired resistance genes.²⁰ Additional Syngenta patents in this series – with additional claims -- are expected to issue in the near future.

Would agrochemical companies intentionally create weakened plant strains? They already have. Would they attempt to commercialize “disease susceptible plants” that would require chemical spraying to restore missing immunities? There is nothing to stop them. Control of negative trait technology, and especially the engineering of immune-deficient plants could readily be classified as a hostile and non-peaceful use of living organisms, prohibited under the Biological & Toxin Weapons Convention (BTWC) of 1975. The BTWC, which outlaws the development and possession of all biological weapons, must urgently recognize Terminator and Traitor technology as potential biological weapons.

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Building Momentum to Terminate the Terminator

Last year, governments meeting at the 5th Conference of Parties to the Convention on Biological Diversity in Nairobi recommended a moratorium on the field-testing and commercial use of genetic use restriction technologies (GURTs). They also requested that FAO’s Commission on Genetic Resources for Food and Agriculture prepare a study on the socio-economic impacts of GURTs, which is now underway.²¹

Action by national governments around the world will determine the future of Terminator and Traitor Technology. Intergovernmental organizations have a critical role to play in raising global awareness and formally banning these technologies. Key international fora in 2001-2002 include:

World Food Summit Five Years Later: When heads of state meet 9-15 November 2001 in Rome they have the opportunity to re-affirm the recent findings of FAO’s Panel of Eminent Experts on Ethics, which concluded that Terminator seeds are unethical, and recommend that member nations ban the technology. They will also have the opportunity to draw on the findings of a report now being produced by FAO’s Commission on Genetic Resources for Food & Agriculture, which will examine the socio-economic impacts of genetic use restriction technology (GURTs).

The 1972 Biological and Toxin Weapons Convention: The BTWC will hold its Review Conference in November 2001 for the purpose of reviewing and strengthening the Convention of 1975, ratified by 143 governments. The BTWC Convention must recognize Terminator/Traitor technologies as potential biological weapons and violations of the Treaty.

COP6 – The Sixth Conference of the Parties to the Convention on Biological Diversity meets in The Hague, 8-26 April 2002. After numerous studies on genetic trait control technology, COP6 should be prepared to recommend a ban on Terminator as an anti-farmer technology that threatens biodiversity and national seed sovereignty.

UNCED's Rio+10: Over 100 Heads of State meeting in South Africa in mid-2002 (date to be determined) will have the opportunity to call for a ban on Terminator and Traitor technology as an immoral application of genetic engineering that threatens biodiversity and development.

¹ Anonymous, "Shapiro to Step down from Board," *AgBiotech Reporter*, February 2001, p.30.

² Letter from Kim Kuebler, Director of Marketing, Ex Seed Genetics, to Alex Wijeratna, Action Aid, 23 June 2000. The letter appears on ExSeed Genetics' web site: <http://www.exseed.com/nws62300.html>. RAFI made repeated attempts to reach Kuebler by phone to inquire about the current status of the company's Terminator patent, but our calls were not returned.

³ For further background, see: "USDA Refuses to Abandon Terminator Technology," RAFI News Release, 28 July 2000.

⁴ Personal communication with Harry Collins, Vice-President for Technology Transfer, Delta & Pine Land, February 2001.

⁵ For detailed background information, see: "Terminator Two Years Later: RAFI Update on Terminator/Traitor Technology – A Report Prepared in Preparation for the Fifth Conference of Parties to the Convention on Biological Diversity," May, 2000. Available on RAFI's web site. <http://www.rafi.org>

⁶ For further background, see: "Snakes in the GM Grass," *RAFI News Release*, 26 July 2000, <http://www.rafi.org>

⁷ Collins, H. "New Technology and Modernizing World Agriculture." Unpublished paper distributed by Dr. Collins at the June 1998 meeting of the FAO Commission on Genetic Resources for Food and Agriculture in Rome. See also, USDA's document, "Fact Sheet: Why the USDA's Technology Protection System (a.k.a. "Terminator") Benefits Agriculture," available on the internet: <http://www.ars.usda.gov/misc/fact.htm>

⁸ "Advisory Committee on Releases to the Environment: Sub-group on Best Practice in GM Crop Design Guidance on Principles of Best Practice in the Design of Genetically Modified Plants," available on the internet: <http://www.environment.detr.gov.uk/acre/bestprac/guidance/index.htm>

⁹ "Transgenic Plants and World Agriculture" is available on the internet: <http://bob.nap.edu/html/transgenic/index.html>

¹⁰ Anonymous, "StarLink Confuses Markets, Sparks Lawsuits," *AgBiotech Reporter*, March 2001, p. 1.

¹¹ Kaufman, Marc. "Going Backwards: U.S. Will Buy Back Corn Seed; Firms to Be Compensated for Batches Mixed With Biotech Variety," *Washington Post*, 8 March 2001.

¹² Bickley, Rah. *Knight Ridder/Tribune*, "Biotech Firm Executive Says Genetically Engineered Corn Is Here to Stay," 20 March 2001.

¹³ US Department of Agriculture, "Fact Sheet: Why the USDA's Technology Protection System (a.k.a. "Terminator") Benefits Agriculture," available on the internet: <http://www.ars.usda.gov/misc/fact.htm>

¹⁴ Food and Agriculture Organization of the United Nations, Panel of Eminent Experts on Ethics in Food and Agriculture, First Session, Rome, 26-28 September 2000, unpublished report.

¹⁵ De Cosa, et al. "Overexpression of the Bt cry2Aa2 operon in chloroplasts leads to formation of insecticidal crystals," *Nature Biotechnology*, Vol. 19, January 2001, p. 71.

¹⁶ Daniell, Henry. "Engineering Multiple Genes in a Single Transformation Event: Another Milestone in Plant Biotechnology," *Information Systems for Biotechnology News Report*, 1 March 2001. See also,

¹⁷ For detailed background information, see RAFI Communiqué, "Traitor Tech: The Terminator's Wider Implications," January/February 1999. Available on RAFI's web site: <http://www.rafi.org>

¹⁸ James, Clives. "Global Status of Commercialized Transgenic Crops: 2000," ISAAA Briefs No. 21: Preview. ISAAA: Ithaca, NY

¹⁹ Warwick, Hugh. *Syngenta: Switching off farmers' rights?*, published jointly by Berne Declaration, Swedish Society for Nature Conservation, GeneWatch UK, Action Aid, October, 2000. While this publication identifies many additional patents, some initially identified by RAFI, we categorize only three of the new Novartis patents as "traitor" technologies. These include: US 6,057,490, US 6,091,004, US 6,107,544. (RAFI makes a distinction between those patents that involve primarily male sterility to facilitate making F1 hybrids. In addition, RAFI does not include patents that we classify as more "generic" inducible promoter patents.

²⁰ For further analysis of this patent, see: Warwick, Hugh. *Syngenta: Switching off farmers' rights?*, published jointly by Berne Declaration, Swedish Society for Nature Conservation, GeneWatch UK, Action Aid, October, 2000.

²¹ For additional background on COP5 and Terminator, see: RAFI News Release, "COP5 Cops Out," 16 June 2000. The final text on GURT's at the COP 5 recommends: **e) Recommend that, in the current absence of reliable data on genetic use restriction technologies without which there is an inadequate basis on which to assess their potential risks, and in accordance with the precautionary approach, products incorporating such technologies should not be approved by Parties for field testing until appropriate scientific data can justify such testing, and for commercial use until appropriate, authorized and strictly controlled scientific assessments with regard to inter alia, their ecological and socio-economic impact and any adverse effects for biological diversity, food security and human health have been carried out in a transparent manner and the conditions for their safe and beneficial use validated.**

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