

Terminator Technology – Five Years Later

- Syngenta wins new patent on Terminator
- USDA and International Seed Federation extol benefits of Terminator seeds
 - UPOV: Terminator has “considerable disadvantages for society”
 - New “Exorcist” Technology Aims to Silence Anti-GM Public

Issue: Since March 1998 the ETC Group (formerly known as RAFI) has been monitoring the efforts of multinational agrochemical and seed corporations to develop Terminator seeds – plants genetically engineered to render sterile seeds (that is, the second generation seeds will not germinate). Terminator technology is being developed as a biological mechanism to extinguish the right of farmers to save and re-plant seeds from their harvest, thus creating greater dependence on the commercial seed market.

Impact: Terminator technology is a threat to food security, food sovereignty and Farmers’ Rights. Together with hundreds of civil society, farmers’ and indigenous peoples’ organizations worldwide, ETC Group has campaigned for a global ban on suicide seeds.

New Developments: While claiming not to have reversed their position against commercialization of Terminator seeds, some Gene Giants are continuing to seek new patents on genetic seed sterilization and others are boldly advocating in favor of GURTs (genetic use restriction technology) in intergovernmental negotiations. In a self-serving but well-reasoned memo, the international body that coordinates plant breeders’ rights, UPOV, concluded earlier this year that Terminator “has considerable disadvantages for society.” Stung by negative publicity related to the escape of DNA from genetically modified (GM) plants, industry continues to “greenwash” Terminator by promoting it as a biosafety tool for containing unwanted gene flow from GM plants. Biotech company Maxygen has unveiled a new technology that is designed to banish foreign DNA from GM plants as a way to silence critics of genetic engineering. ETC Group calls it the “Exorcist” technology.

Policy: As a warm-up for the WTO Ministerial meeting in Cancún in September, ministers of trade, agriculture and the environment from 180 countries have been invited to Sacramento, California for an International Ministerial Conference and Expo on Agricultural Science and Technology, June 23-25, 2003. Sponsored by USDA (owner of 3 Terminator patents), US AID and the US Department of State, the US government should be held accountable for its role in developing and licensing an anti-farmer, anti-diversity technology for use in the developing world. The Subsidiary Body on Scientific, Technical and Technological Advice will review Terminator at its November 2003 meeting in preparation for the March 2004 Conference of the Parties to the Convention on Biological Diversity (CBD) in Kuala Lumpur, Malaysia. COP7 may have one last chance to ban genetic seed sterilization before it’s commercialized and released in farmers’ fields. At its next meeting, the FAO Commission on Genetic Resources for Food and Agriculture should pass a resolution condemning Terminator. Negotiations on “The Right to Food” at the UN Human Rights Commission and at FAO must include the inalienable right of farming communities to save, exchange and develop plant varieties without restriction. Terminator must be banned as a violation of Food Sovereignty and The Right to Food.

Background

For five years running, Terminator technology has been widely condemned as an immoral application of genetic engineering. The Director General of FAO, the President of the Rockefeller Foundation, and the Consultative Group on International Agricultural Research are among those individuals and institutions that have publicly disavowed the technology. In addition, Monsanto and AstraZeneca (now Syngenta) – the world's second and third largest seed corporations – have publicly stated that they will **not** develop Terminator seeds for commercial sale. One company, US-based Delta & Pine

Land, the world's largest cotton seed company, has publicly announced that it actively seeks to commercialize Terminator technology. (Although Monsanto tried to acquire Delta & Pine Land in 1999, the takeover bid collapsed, in large part due to public controversy over Terminator.)

Given the almost universal condemnation of Terminator seeds, why are the Gene Giants continuing to seek patents on genetic seed sterilization? What are GURTs, and why are V-GURTs and T-GURTs confusing intergovernmental negotiations to ban Terminator?

Frequently Asked Questions:

What exactly is Terminator technology?

Using a number of different techniques, scientists can genetically engineer plants to produce seeds that grow to maturity, but those seeds will not germinate if replanted. The technique involves a method whereby a gene can be turned on or off in a developmentally regulated fashion and a procedure for controlling the expression of an engineered gene from the outside, using a chemical inducer or other factor, such as cold treatment.

What is the current status of Terminator seed technology?

Terminator technology has not yet been commercialized. According to Harry Collins, Vice-President of Technology Transfer for Delta & Pine Land: "We continue to work toward commercialization of TPS [Technology Protection System is the proprietary method used by D&PL to produce Terminator seeds]. In the test species, tobacco, the system was proven to work, in the lab and greenhouse."¹ Collins also told ETC Group that the US Department of Agriculture has tested Terminator with tobacco and cotton plants, "but only in the lab and greenhouse." Collins emphasizes

that, "TPS [Terminator] has never been tested in the field, anywhere in the world."

When will it be commercialized? Harry Collins of Delta & Pine Land responds, "I cannot give an estimate, at this time." A technical report prepared for the FAO Commission on Genetic Resources for Food and Agriculture (PGRFA) in 2002 states: "The pace of biotechnology development should allow GURTs [Genetic Use Restriction Technology] and their products to become functional in the next five to ten years."

Which companies/institutions hold patents on Terminator?

Delta & Pine Land and the US Department of Agriculture; Syngenta, DuPont, Monsanto, BASF, and Purdue, Iowa State and Cornell universities. (For details, see chart, p. 7).

Which United Nations bodies are debating Terminator? Terminator technology has been on the agenda of the Convention on Biological Diversity since May 1998. From Bratislava to Nairobi to The Hague – Terminator has been the most hotly debated issue on the agbiodiversity agenda

– but government negotiators have failed to take decisive action to recommend a ban on Terminator. The CBD has recommended that governments and Parties take a “precautionary approach” but it has done so by calling for a weak and partial moratorium on genetic use restriction technology.²

The FAO Commission on PGRFA last considered the issue of Terminator/Traitor at its October 2002 session, especially in the context of the Farmers’ Rights.

Are there any possible benefits to be derived from Terminator seeds?

Terminator seeds were developed for the purpose of maximizing seed industry profits by preventing farmers from re-planting seeds from their harvest. As a biological control, Terminator is a more powerful, longer-lasting appropriation tool

than intellectual property or other legal regimes that seek to deny farmers the right to save seed.

In an effort to promote Terminator technology, the US Department of Agriculture (co-owner of three Terminator patents with Delta & Pine Land) and the International Seed Federation recently submitted written statements that extol the potential benefits of Genetic Use Restriction Technologies [GURTs] for small holder farmers and indigenous and local communities. The comments were submitted to an Ad Hoc Technical Expert Group established under the auspices of the Convention on Biological Diversity. USDA and the International Seed Federation identify four benefits of Terminator technology for smallholder farmers.³ ETC Group responds below.

The US Government and the International Seed Federation have identified four potential benefits of Terminator Technology for smallholder farmers, indigenous and local communities

ETC Group Responds

1. GURTs will increase the amount of research and development efforts devoted to “value-added crops.”

ETC Group Responds: We agree. If Terminator is commercialized, the Gene Giants will accelerate R&D efforts to incorporate genetic seed sterility into *all* GM seeds offered for commercial sale. Why? Because Terminator technology offers a more powerful tool for monopoly control of plant germplasm than intellectual property. Unlike patents and plant breeders’ rights, Terminator seeds are not time-limited, there is no user exemption for farmers, researchers or breeders, and no threat of compulsory licensing. If commercialized, Terminator technology will be applied to major food crops such as wheat and rice that have not provided major revenues for the seed industry in the past (because farmers

typically save seed from wheat and rice harvests, and because these crops have not been hybridized on a large, commercial scale).

Genetically modified Terminator seeds will be neither affordable nor relevant to the needs of resource-poor farmers; but that doesn’t mean poor farmers won’t get access to Terminator seeds. A recent study on Terminator conducted by Wageningen University for the Food and Agriculture Organization of the United Nations, finds that “Serious seed security risk can be expected for those already seed insecure poor farmers who are not able to save their own seed for the next season. Risks of crop losses due to absent viability exist when poor farmers access the grain market for their seed (in many cases 20% of farmers), often at a late moment.”⁴ If the grain contains Terminator genes and the farmers

unknowingly plant it as seed, it would not germinate. Similarly, farmers who depend on humanitarian food aid risk serious crop loss if they unknowingly use food aid containing Terminator genes as seed.⁵

“...the poorest farmers in these farming systems, however, who often sow grain channeled for consumption instead of seed, risk significant yield drops if V-GURT [Terminator] grain enters local markets through trade or relief channels.”⁶

2. GURTs could improve the ability to reduce unintended gene flow from transgenic [genetically modified] crop varieties to non-transgenic varieties and wild relatives of crops.

ETC Group responds: The technical report prepared for the FAO Commission on Genetic Resources for Food and Agriculture acknowledges that Terminator could be used to prevent unwanted escape of genetic material into the wild. The report notes, “However, this mechanism may not work adequately.”⁷ A recent article in *Nature Biotechnology* emphasizes that, “Terminator may not function as intended. Unresolved questions remain about proper segregation of multiple gene, consequences of gene silencing, and the presence of transgenic pollen.”⁸

Even if Terminator technology were not technically problematic, it is unacceptable and dangerous to suggest that agriculture is dependent on genetic seed sterilization as a method for containing genetic pollution from genetically modified plants. GM contamination is a serious problem that must be addressed, but food security for poor people must not be sacrificed to solve industry's genetic pollution problem. If

The promotion of Terminator seeds as a biosafety mechanism to prevent GM pollution is biotech's Trojan Horse. If Terminator technology wins market acceptance under the guise of biosafety, it will be used as a monopoly tool to prevent farmers from saving and re-using seed.

GM seeds are ecologically unsafe they should not be used.

3. GURTs could add value by reducing the occurrence of “volunteer” weeds or preventing unintended cross-pollination and gene flow with weed species or other varieties that may be prevalent in small holder farms or traditional agriculture.

ETC Group Responds: Terminator seeds were not developed as a method to prevent germination of volunteer weeds in farmers' fields. The ultimate goal of genetic seed sterility is neither biosafety nor agronomic benefits, but bioserfdom – eliminating the right of farmers to save seed from their harvest and creating dependency on commercial seed sources. Besides, volunteer weeds are not a problem that requires a high-tech solution on smallholder farms.

4. GURTs could contribute important new basic knowledge of plant genomes and reproductive biology overall. These potential benefits may accrue to smallholder farms and indigenous and local communities over time.

ETC Group Responds: Terminator is not about sharing knowledge and information, it is about controlling and restricting access to plant germplasm. A vast amount of money (both public and private) has been squandered on the development of an anti-farmer technology that threatens to diminish farmer selection and breeding. Over 1.4 billion people – primarily poor people in the developing world – depend on farm-saved seed as their primary seed source. Terminator technology seeks to create dependency on external inputs and it will undermine local seed and plant breeding autonomy. Imagine what could be done to assist smallholder farmers and indigenous

peoples if these resources were devoted instead to enhancing the capacity of farmers to develop their own agro-ecological farming systems for sustainable food sovereignty.

Name Games: GURTs HURTs

The term “genetic use restriction technology” (GURTs) was introduced in 1999 in a report prepared for the Convention on Biological Diversity. Seeking to avoid the non-scientific term “Terminator,” the authors chose to introduce the broader concept of GURTs terminology.⁹

- **GURTs – genetic use restriction technology is a very broad term that refers to the use of an external chemical inducer to control the expression of a plants’ genetic trait. This could include the trait for sterility, or any other trait such as colour, ripening, cold tolerance, etc.**
- **T-GURT refers to the restriction of a specific trait in a plant. This is what ETC Group calls “Traitor Technology.”**
- **V-GURT refers to restriction of the variety by engineering plants whose seeds will not germinate if replanted. This is Terminator Technology.**

So what’s the problem with GURTs terminology? GURTs is a very general term that refers to the restriction of *any* genetic trait in plants that can be switched on or off by the application of an external chemical inducer. Today, many scientists are experimenting with genetic switches in plants to either activate or repress the genetic expression of specific traits. The companies argue that genetic trait control will offer farmers a menu of traits that can be turned on or off depending on the farmers’ needs. The primary goal, however, is to give seed and agrochemical companies greater control over crop germplasm.

Unfortunately, GURTs is confusing terminology, and the Gene Giants are using this to their advantage in intergovernmental negotiations. For example, the International Seed Federation’s recent paper extolling the potential benefits of GURTs for small farmers, indigenous peoples and local communities makes no reference to Terminator or V-GURTs, only GURTs. This is significant because the paper was authored by Harry Collins, Vice-President of Delta & Pine Land, and Roger Krueger of Monsanto. Co-author Krueger writes about the virtues of GURTs for smallholder farmers, indigenous peoples and local communities, without mentioning that his company, Monsanto, has publicly vowed not to commercialize V-GURTs – or Terminator technology. By using the general term GURTs, the seed industry argues that genetic trait control technologies (T-GURTs) could have potential benefits for farmers and agricultural productivity. But industry also dodges the clear-cut case against Terminator (V-GURTs) and the calls to ban it. Industry is hiding behind GURTs, and thus making it more difficult for government negotiators to take decisive action against Terminator.

In a recent presentation before an Expert Panel on GURTs convened by the CBD, Delta & Pine Land’s VP for Technology Transfer, Harry Collins, made a plea for “unbiased” appraisal of the potential benefits of GURTs.¹⁰ But Collins failed to point out that his company and USDA have a vested financial interest in the approval of Terminator technology.

Environmental, agriculture and trade representatives have little time to study the difference between V-GURTs and T-GURTs. If told that GURTs could have potential advantages, they are less likely to consider a ban on Terminator [V-GURTs] – that offers *no* agronomic advantages.

UPOV on Terminator:

What does the International Union for the Protection of New Plant Varieties (UPOV) say about GURTs? UPOV is an intergovernmental body that establishes international rules for plant intellectual property for the developers of new plant varieties. UPOV concludes that, in comparison to Plant Breeders' Rights, Terminator technology "may have considerable disadvantages for society."¹¹

"Plant material of varieties containing GURTs cannot be used as genetic material for further breeding; free access to genetic resources will be hindered by GURTs. GURTs does not provide any benefit sharing." – UPOV Report on Terminator, January 10, 2003

UPOV points out that Terminator technology extends to more than one variety and does not allow any exemption for farmers saving seed, or for researchers or breeders. UPOV's memo makes very valid points about the dangers of Terminator, but ultimately it is self-serving. The memo concludes that if a State fails to establish UPOV-style Plant Breeders' Rights, breeders may have to resort to GURTs to protect their economic interests. In other words, plant breeders' rights is the lesser of two evils?

Syngenta wins new Terminator patent – with application pending for a second

Note: Every time ETC Group reports that Syngenta has won a new Terminator patent, the company writes to complain that we are ignoring their public position not to commercialize Terminator technology, and that we are misrepresenting their views. That is not our intention. We acknowledge (again) that Syngenta has publicly pledged not to commercialize Terminator seeds. We also acknowledge that some of the new patents make specific mention of male and/or female sterile plants to use in hybrid seed production. However, we cannot ignore the fact that Gene

Giants are continuing to refine genetic seed sterilization technologies, as described in new patent claims, that could be used to commercialize Terminator seeds in the future.

With 2001 annual sales of US\$5,430 million, Syngenta is the world's second largest agrochemical corporation, accounting for almost 20% of the global market. Syngenta is the world's third largest seed corporation, after Dupont and Monsanto.

With 8 patents on Terminator technology, and one pending, Syngenta is the undisputed leader in proprietary techniques related to genetic seed sterilization. The company's newest Terminator patent, US 6,362,394, published 26 March 2002, is entitled "Juvenile hormone or one of its agonists as a chemical ligand to control gene expression in plants by receptor mediated transactivation." The patent describes a technique to control the expression of any gene in plants by applying an exogenous chemical, specifically the insect juvenile

Syngenta is the world's second largest agrochemical corporation, ranks number three in seeds, and holds more Terminator patents than any other company.

hormone and related molecules. The new discovery reported is that juvenile hormone will interact with the receptor protein made by the insect *Ultraspiracle* gene. In the presence of juvenile hormone, this receptor/hormone complex binds to specific DNA sequences (response elements) resulting in expression of the adjacent (target) coding sequence. Any gene can be engineered to be the target of juvenile hormone activation by adding the response elements. The patent describes ways to generate a more efficient and specific method for using juvenile hormone and related molecules to turn on and off genes in plants. The patent describes how male and/or female sterile

plants could be produced for use in hybrid seed production. It is not much of a leap to imagine how the system described for male and female sterility could be used to

make Terminator crops, although this application is not specifically described in the patent.

Who Owns Terminator Patents?

Company/Institution (followed by name of original assignee)	Patent (or application) number	Date Issued
Syngenta -- application	US20010022004A1	filed: 21 March 2001
Syngenta	US 6,362,394	26 March 2002
Syngenta (Zeneca)	US 6,228,643	8 May 2001
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
DuPont (Pioneer Hi-Bred)	US 6,297,426	2 Oct. 2001
DuPont (Pioneer Hi-Bred)	US 5,859,341	12 Jan. 1999
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
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

Source: ETC group (www.etcgroup.org)

New Patent Application: Syngenta has a similar but distinct US patent application pending: US200110022004A1, "Control of gene expression in plants by receptor mediated transactivation in the presence of a chemical ligand." The application describes a way to chemically control gene expression in plants using two different receptor genes that interact. In the

presence of an added chemical, these receptors control a target gene, either turning it on or off. By using tissue-specific or developmentally-regulated promoters to direct the synthesis of the receptors and/or the target gene, the chemical control of gene expression could be designed to affect any part of the plant. Examples of chemicals proposed for

inducing gene expression are “an insecticide, and insect hormone, or antagonists or agonists of insect hormones.” The company particularly likes the idea of using chemical insecticides to induce gene expression because “...insecticides have the additional benefit of already being examined for agricultural production, making such chemicals ‘ready-to-use’ for field application to crops.” The patent states that the “method is useful for controlling various traits of agronomic importance, such as plant fertility” and they also describe various ways to produce male and/or female sterility for hybrid seed production.

Syngenta has a strong incentive to link the expression of a plants’ genes to an external chemical inducer. If the Gene Giants can successfully engineer seeds to express traits with the application of a proprietary insecticide, it means farmers become more dependent on the company’s products: GM seed + companion chemical. This is the same model used in the development of herbicide tolerant GM plants (genetically modified plants that can tolerate the spraying of a chemical weedkiller – e.g., glyphosate.) Terminator and Traitor technologies (GURTs) will reinforce chemical dependencies in agriculture that are costly and hazardous for farmers and the environment.

And now...the *Exorcist* Technology

Willem P.C. Stemmer, vice president of R&D at Maxygen, Inc., a California-based biotech company, has applied for a patent on transgene deletion technology – a technique to remove foreign DNA from genetically modified plants.¹² ETC Group dubs it the “Exorcist Technology.” The idea is to chemically induce removal of foreign DNA from the pollen or fruit, or the entire plant, before the crop is harvested. The crop would theoretically benefit from the presence of the GM trait, but the harvested food product would be GM-free. Maxygen scientists believe that gene excision could wipe-out public resistance to GM plants because, without foreign DNA, people would no longer perceive engineered plants as a threat to food safety.¹³ But that’s not all. Stemmer writes that transgene excision will reduce the possibility of unwanted gene flow and eliminate the need to segregate transgenic crops from non-transgenic crops. Finally, Stemmer points out that gene deletion will give farmers the ability to replant non-transgenic seeds that they harvest from their transgenic plants – simply by applying an external chemical inducer to their crop.

ETC Group believes that the Exorcist strategy is particularly dangerous because it shifts all of the burden from the biotech industry to the farmer and to society. In response to the problem of unwanted gene flow, the farmer is being asked to apply a chemical that will excise the offensive transgenes. ETC Group envisions a scenario where the farmer is obliged to buy the inducer chemical from the seed seller in order to turn off the expression of the socially and environmentally undesirable transgenes.

This is a new bag of genetic tricks to fix industry’s leaky genes and public relations problems. But it won’t make agriculture more profitable for farmers, nor will it be more sustainable or safer for society. Why should society accept a new, unproven technology to fix a defective one?

How does “The Exorcist” work? The patent describes a technique to remove genes from specific parts of a crop plant, such as the fruit or pollen, or from the entire plant. The basic idea is to add another gene next to the engineered trait gene (for example, a trait may be herbicide tolerance or insect resistance). The

additional gene would code for an enzyme that cuts DNA at specific sequences. Those specific sequences recognized by the enzyme would be put on either side of the enzyme gene and engineered trait gene. When the enzyme gene was activated, the enzyme produced would cut out the DNA in between the two recognition sequences, thus removing all of the engineered DNA, except for one of the recognition sequences, which would be left in the genome. The result could be very little engineered DNA, and no more engineered protein. The company hopes it will mean less public resistance to genetically engineered foods.

“You are going to need some elegant and fine genetic engineering to make this really reliable. But if [Exorcist] does work, it could have some real benefits for people who are anti-GM. Someone is going to give it a try.” – David Ow, US Department of Agriculture, quoted in article by Philip Cohen, New Scientist, 6 July 2002, p. 35

Would the proposed technology work well enough to base a food safety and a "safe sex" strategy on it? Maxygen scientists admit that the technology may not work as

designed, resulting in “transgenic residues” – whether DNA or protein.¹⁴ The technology is unproven and untested.

In March 2003 ETC Group contacted Willem Stemmer to inquire about the status of Exorcist Technology.¹⁵ Stemmer insisted that his gene deletion strategy is “an angle that the company is not interested in pursuing,” and he asked that the company [Maxygen] not be linked to his idea. When we pointed out that the company is listed as assignee on the patent application, Stemmer responded that the company is not pursuing the technology. Stemmer refused to comment when he was asked whether or not he would abandon the patent application, but he acknowledged that negative publicity had influenced the company’s decision not to pursue the Exorcist technology.¹⁶

Policy: Recommendations on Terminator:

The Biodiversity Convention’s SBSTTA must recommend that Terminator technology be banned as a clear threat to food sovereignty and agricultural biodiversity.

In March 2004 the 7th Conference of the Parties to the CBD must adopt a clear policy recommending that Parties adopt measures to prohibit field-testing and commercial approval of Terminator technology.

As a lead-up to the Cancún WTO Ministerial in September, the US government plans to showcase new and controversial agricultural technologies at its Sacramento Ministerial Meeting on agricultural technologies in June. The US government should be held accountable for developing and licensing a technology that threatens food security for over 1.4 billion people in the developing world.

“The Right to Food,” now being reviewed by the Human Rights Commission and the FAO, must include the inalienable right of farming communities to save, exchange and develop plant varieties without restriction. Terminator technology should be condemned as an offense against Food Sovereignty, Farmers’ Rights and the Right to Food.

Gene giants and other institutions holding Terminator patents should surrender their patents to a third party, such as the Food and Agriculture Organization of the United Nations, as a means of publicly demonstrating that the company/institution has no intention of

commercializing a technology that will biologically restrict the right of farmers to save seed from their harvest, or the use of chemical inducers to restrict the viability of purchased seed.

Policy: Recommendation on Exorcist Technology

If Maxygen's transgene deletion technology is not in the dust bin now, it should be. ETC Group will monitor the patent application on Exorcist technology. We recommend that the patent application be abandoned.

¹ Harry Collins, personal communication with ETC Group, 27 February 2003.

² See especially, Decision V/5 on Agricultural Biological Diversity, Provisions on genetic use restriction technologies (GURTs) COP-5, Nairobi, May 2000. Paragraph 23: Recommends 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 impacts 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...

³ Benefits of GURTs were extracted from two papers: Harry B. Collins and Roger W. Krueger, "Potential Impact of GURTs on Smallholder Farmers, Indigenous & Local Communities and Farmers Rights: The Benefits of GURTs," unpublished paper prepared for the Ad Hoc Technical Expert Group Meeting on the Potential Impacts of Genetic Use Restriction Technologies on Smallholder Farmers, Indigenous and Local Communities and Farmers' Rights, Montreal, 19-21 February 2003. Collins is the vice-president of Delta & Pine Land; Krueger is an employee of Monsanto. The paper represented the views of the International Seed Federation. The second paper used to identify benefits of GURTs: "Submission of the Government of the United States of America to the Ad Hoc Technical Expert Group on Genetic Use Restriction Technologies, Montreal, Canada, February 19-21, 2003." The US Department of Agriculture was represented by Nancy Ragsdale.

⁴ Visser, B., D. Eaton, N. Louwaars and I.M. Van der Meer. 2001. Potential impacts of genetic use restriction technologies (GURTs) on agrobiodiversity and agricultural production systems. FAO, Rome, Italy.

⁵ FAO Commission on Genetic Resources for Food and Agriculture, "Potential Impacts of Genetic Use Restriction Technologies on Agricultural Biodiversity and Agricultural Production Systems: Technical Study.: Prepared by the Ninth Regular Session, Rome, 14-18 October 2002. Available on the Internet:

⁶ *Ibid.*, p. 5.

⁷ *Ibid.*, p. 4.

⁸ Henry Daniell, "Molecular Strategies for Gene Containment in Transgenic Crops, *Nature Biotechnology*, Vol. 20, June 2002, p. 581-586.

⁹ "Consequences of the use of the new technology for the control of plant genetic expression for the conservation and sustainable use of biological diversity," FAO, June 1999, (UNEP/CBD/SBSTTA/4/9/Rev. 1).

¹⁰ Ad Hoc Technical Expert Group Meeting on the Potential Impacts of Genetic Use Restriction Technologies on Smallholder Farmers, Indigenous and Local Communities and Farmers' Rights, Montreal, 19-21 February 2003. ETC Group was also represented on the Technical Expert Group.

¹¹ "Memorandum Prepared by the Office of UPOV on the Genetic Use Restriction Technologies," Submitted to the Secretariat of the CBD, January 10, 2003. Available on the Internet: <http://www.upov.int>

¹² US Patent Application No. 20020078476, "Methods and compositions relating to the generation of partially transgenic organisms," published June 20, 2002.

¹³ Robert J. Keenan and Willem P.C. Stemmer, "Nontransgenic crops from transgenic plants," *Nature Biotechnology*, March, 2002, Volume 20, p. 215-216.

¹⁴ *Ibid.*

¹⁵ Hope Shand, ETC Group, interviewed Dr. Stemmer by telephone on 27 March 2003.

¹⁶ See, for example, Philip Cohen, "Begone Evil Genes," *New Scientist*, 6 July 2002, p. 33-36.

The Action Group on Erosion, Technology and Concentration, formerly RAFI, is an international civil society organization headquartered in Canada. The ETC group is dedicated to the advancement of cultural and ecological diversity and human rights. www.etcgroup.org. The ETC group is also a member of the Community Biodiversity Development and Conservation Programme (CBDC). The CBDC is a collaborative experimental initiative involving civil society organizations and public research institutions in 14 countries. The CBDC is dedicated to the exploration of community-directed programmes to strengthen the conservation and enhancement of agricultural biodiversity. The CBDC website is www.cbdcprogram.org