BAN TERMINATOR

Terminator Technology and Genetic Contamination

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www.banterminator.org

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The biotechnology industry is vigorously asserting that Terminator technology – genetic seed sterilization technology - offers a means of preventing the unwanted flow of genes from genetically modified (GM) crops. The industry argues that Terminator offers 'biosafety' benefits. However, the truth is that Terminator would not stop GM contamination, but would itself pose a serious biosafety risk. Industry's goal is to win acceptance for a technology that is designed to protect corporate patents and maximize profits by stopping farmers from saving harvested seed and forcing them to buy new seed every season.

> ***What is Terminator?*** *Terminator technology refers to plants that have been genetically modified to render sterile seeds at harvest (through an inducible molecular mechanism, which means that the gene for seed sterility or germination can be turned on or off from the outside – by treating the plants with a chemical or other factor). It is technically known as a Genetic Use Restriction Technology or GURTs. Terminator technology was developed by the multinational seed/agrochemical industry and the United States government to prevent farmers from saving and re-planting harvested seed developed by biotechnology and seed corporations. Terminator has not yet been commercialized or field-tested but tests are currently being conducted in greenhouses in the United States.*

The biotechnology and seed industry is promoting Terminator as a 'biosafety' solution to disguise its true role as a biological means of preventing farmers from saving and re-using proprietary seed. Terminator has been widely condemned as a threat to food security for the 1.4 billion people who depend on farm-saved seed.[1]

Genetic Contamination

In many areas of the world, gene flow (including through cross-pollination and seed dispersal) from genetically modified plants is causing unwanted genetic contamination – even in the South's centers of genetic diversity (the areas where our major food crops originate or where genetic diversity is greatest). In essence, GM contamination is a new type of industrial pollution that involves living, replicating organisms. This genetic pollution cannot be controlled or recalled, and contamination can increase over time.

Corporations are increasingly worried about legal liability and bad public relations resulting from the unwanted spread of genetic material from GM crops and the contamination of conventional and traditional seed stocks with GM seeds. The realities of contamination threaten to stop the approval of new GM crops that are

potentially lucrative for corporations, including "pharma" crops (plants modified to produce pharmaceutical compounds) and genetically modified trees. The biotechnology industry is eager to persuade the public that biotechnology can fix the GM contamination problem it has caused.

It is ironic that, in response to heightened concerns about genetic pollution, the industry is promoting Terminator technology as a 'biosafety' tool, which requires even further genetic modification and the introduction of additional modified genes. The argument put forward is that engineered sterility offers a built-in safety feature: if modified genes (whether pharma genes, herbicide resistance genes or Terminator genes) from a GM Terminator crop get transferred to related plants via cross-pollination, the seed produced from such pollination would be sterile – it would not germinate, thus contamination would not spread. However, this scenario fails even in its design to offer any protection against transgene contamination of harvested seed used as food or feed, since the genetic sequences, and possibly proteins, from engineered genes (both trait genes and Terminator genes) would be present after cross pollination, irrespective of intended seed sterility.

Terminator Failure: Terminator will not stop GM contamination.

Delta & Pine Land, the US seed company that is conducting greenhouse trials of Terminator plants and lobbies for its commercialisation claims in its promotion materials that Terminator *"provides the biosafety advantage of preventing even the remote possibility of transgene movement."*[2] There is no scientific data made available to support this sweeping claim. There is not even any data from the greenhouse trials. In order for Terminator to be contemplated as a 'biosafety' tool - that is "to prevent even the remote possibility of transgene movement" - it must offer 100% sterility. Every single Terminator seed would need to be completely sterile in the second generation. This implies zero tolerance for even the slightest failure. In other words, Terminator technology would need to be 100% effective in order to be considered as a potential option to stop contamination via gene flow.

In August 2005, a tornado destroyed two of Delta & Pine Land's greenhouses and damaged others. We do not know if Terminator plants were being tested in the greenhouses or what biosafety risks, if any, might be posed – but this event shows that even seemingly secure physical containment is vulnerable.
("D&PL storm losses top $1 million" Woodrow Wilkins Jr., *Delta Democrat Times* 30/08/05)

Scientists who have studied genetic seed sterilization models believe that Terminator will never be 100% effective or reliable as a gene containment mechanism because it will not achieve 100% seed sterility.[3] Terminator is a system that is made up of many constructs or pieces of genetic material that are genetically engineered into plants. In order to create sterile seeds, the technology relies on all of these constructs to work perfectly, over generations of seed breeding. Terminator depends on a number of steps and mechanisms to function and interact in succession, one after the other. The chances of failure are high and will increase with each component included in the system. Like any technology, Terminator will only be as good as its weakest link.

Given that, at this stage, the individual components of V-GURTs [Terminator] offer

less than 100% efficiency or reliability, the combination of these components in one organism will amount to still less. For example, if each of the 4 components performs to 95%, in combination their performance could reduce efficiency or reliability to as little as 81%.[4]

There are a number of known biological events that can interfere with the reliable performance of any one of Terminator's many components, thus rendering this complex technology incapable of fulfilling its claimed 'biosafety' role. For example, events such as gene silencing and epigenetic changes to transgenes (alterations to the molecular appearance of the DNA that block the cell's own reading mechanism from accessing the genetic information of the affected genes), mutations and loss or reduction of transgene activity, are problems that have been observed with GM technologies. Additionally, segregation of the genetic components that make up the Terminator mechanism from each other or from the GM trait that is to be 'contained' can occur during reproduction and could disable the Terminator mechanism. Importantly, the main aim of all living organisms is successful reproduction and this strong evolutionary pressure means that everything in the plant itself will be working to counteract and overcome Terminator genes and remain fertile.

The industry's promotion of Terminator as a technology to prevent gene flow is an admission that contamination is a problem. Ironically, the very companies that are responsible for GM contamination are now insisting that society accept a new, unreliable technology to try to fix this pollution problem.

In fact, Terminator could actually *increase* the level and seriousness of GM contamination. If governments allow corporations to use Terminator technology in an attempt to stop contamination, it could accelerate the development and field-testing of controversial new GM plants that pose additional risks to human health and the environment. For example:

- Plants are being modified to produce plastics and other industrial chemicals as well as pharmaceuticals and vaccines (pharma crops). The field testing of these crops is controversial because it is impossible to control or contain genetically modified organisms in open-air experiments. Scientists have warned that plants that constitute food and feed crops should not be genetically modified to develop pharma crops because unintentional contamination of the food supply is virtually inevitable.[5]

- Experiments with genetically modified trees have enormous potential for gene flow as trees are large organisms with a long life span, and trees produce abundant pollen and seed that is designed to travel long distances.[6]

Terminator could be a biosafety hazard with serious consequences for Indigenous peoples, local communities, peasants and small-scale farmers

If Terminator were to be accepted under the guise of biosafety, it would have devastating consequences for farmers, food security and food safety. Irrespective of any capacity to produce sterile seeds, pollen movement from Terminator crops would take place and lead to contamination of other (open pollinated) plants nearby, at least in the first generation. Seeds (e.g. grain for food) from those plants would contain the initial trait gene (e.g. pharma gene, herbicide resistance gene or Bt-

endotoxin gene) plus the Terminator genes intended to make them sterile. This contamination would affect related crops as well as wild relatives.

Terminator would have serious impacts on food security and food sovereignty for farmers and communities. Farmers who saved their seeds for replanting and whose crops had been cross-pollinated by Terminator plants grown in the area, could find that a percentage of their seeds did not germinate. This percentage could translate into significant yield loses. Farmers would not be able to identify the Terminator seeds until they replanted seed from the first harvest, and found that the seed does not germinate. People who depend on humanitarian food aid would risk particularly devastating crop losses if they kept food aid seed that contained Terminator genes for re-planting.

Farmers who found their seed contaminated with Terminator from nearby fields could lose trust in their own seed stock. If contamination is persistent, farmers could lose their traditional and local varieties and be forced to abandon their own seed that is adapted to local conditions and community needs. Loss of traditional varieties and decline in seed breeding would also threaten the practice and retention of traditional and local knowledge.

If corporations use Terminator as an experimental 'biosafety' tool to try and stop the spread of genes from high risk GM crops, like pharma plants, and it failed, farmers in the region who save seeds could unknowingly produce food contaminated with genes from pharmaceutical-producing plants, which are not intended for human consumption and pose health and safety risks.

Terminator genes could also spread unnoticed without initially causing sterile seeds in the second or third generation. During the phase of seed production by the seed company, the GM plant itself could potentially render Terminator genes inactive through a process called gene silencing. Under the gene silencing scenario, seeds contaminated with Terminator genes could be fertile. As gene silencing is reversible over generations, "silent" individual Terminator plants might at a later stage produce pollen with active Terminator genes thus resulting in sterile seeds at an unpredictable point in the future.

Additionally, Terminator itself gives rise to safety concerns and potential risks for food, feed and biodiversity, born out of the fact that it is a highly complex system of genetic engineering. For example, it is known that modification processes (transformation and tissue culture) result in genome scrambling at the integration site of transgenes and introduction of hundreds or thousands of genome wide mutations.[7] The application of Terminator would thus be more likely to enhance risks than minimize them.

Terminator is designed to maximize industry profits, not stop contamination

Corporations have always been clear that Terminator was developed to be a patent protection tool. *"The new technique is to protect U.S. technology and seed patents,"* stated Terminator inventor Melvin Oliver from the United States Department of Agriculture.[8] Delta & Pine Land, a US-based company that is developing Terminator seeds, refers to its method of genetic seed sterilization as their "Technology Protection System" because it is designed to prevent farmers from re-planting the company's genetically modified seed. The corporate seed industry began stressing

the 'environmental' arguments for Terminator after global protest threatened to shut down development and commercialization of the technology.

Monsanto's activities show what biotechnology corporations really want with Terminator. The company is vigorously suing farmers in the United States and Canada for allegedly infringing patents by saving seeds that contain Monsanto's proprietary genes.[9] As a means of preventing farmers from re-using patented seed without paying, Terminator would be the perfect solution for Monsanto and other biotechnology corporations. If commercialized, Terminator technology would allow Monsanto to enforce protection over its patents while avoiding costly lawsuits, high-priced lawyers and the bad publicity generated by taking farmers to court.

Although Terminator needs to be 100% effective in order to prevent contamination via gene flow, a lower effectiveness of only 80% sterility of harvested seed would be sufficient to deter farmers from saving and replanting seeds and force them to buy seed on the commercial market. Yet 80% efficiency would open the doors wide for uncontrollable escape of transgenes (both GM trait genes and Terminator genes).

Summary

It is paramount to reject the dangerous argument that Terminator can be used as a 'biosafety' tool. Terminator would not stop contamination, and instead, the technology would itself pose an additional biosafety hazard. The potential consequences of Terminator for peasant farmers and Indigenous peoples around the world are serious and warrant a ban on the development, field-testing and commercialization of Terminator technology.

* **Note:** This briefing draws on the in-depth analysis of Terminator models presented by EcoNexus. For more information: www.econexus.info

Action Required:

Endorse the Ban Terminator Campaign and get involved – write to us or visit www.banterminator.org for more information.

Reject the argument that Terminator can be used as a 'biosafety' tool. In fact, Terminator seeds represent a potential biosafety hazard and open the doors for further contamination. Organizations that campaign to raise awareness about GM contamination and its impacts (including genetically modified crops, trees or biopharmaceutical plants) should reject the argument that Terminator could offer a viable method of stopping gene flow.

Ask your government to establish a national ban on Terminator and strengthen the international *de facto* moratorium on Terminator that exists at the United Nations Convention on Biological Diversity: Visit www.banterminator.org for more information and for background materials.

Write letters to the editor of your newspaper if you see arguments that Terminator should be accepted as a means to stop contamination from GM crops.

Join with others in your area who are campaigning against Terminator. For contacts in your community see www.banterminator.org

More Resources:

Ban Terminator Campaign	www.banterminator.org
Biosafety Information Centre	www.biosafety-info.net
ETC Group	www.etcgroup.org
EcoNexus	www.econexus.info - This website will soon offer detailed scientific analysis of Terminator technology

[1] See ETC group, "Statements Against Terminator," www.banterminator.org
[2] Delta & Pine Land, "Technology Protection System: Providing the Potential to Enhance Biosafety & Biodiversity in Production Agriculture", 2005.
[3] Dr. Ricarda Steinbrecher, "Why V-GURTs (Terminator) fails the requirements as a biological containment tool for biosafety", submission to SBSTTA10, EcoNexus, February 2005.
[4] Dr. Ricarda Steinbrecher, "Is V-GURTs (Terminator) the answer to transgene contamination?", EcoNexus. First prepared for the EU–India Dialogue Study on Biotechnology, Biosafety and IPRs in the Context of Globalisation, March 2005. This paper will be available on www.econexus.info by November 2005.
[5] Union of Concerned Scientists, *A Growing Concern: Protecting the Food Supply in an Era of Pharmaceutical and Industrial Crops*, December 2004.
[6] Claire G. Williams, "Framing the issues on transgenic forests," correspondance*, Nature Biotechnology* 23 (530-532). June 2005.
[7] Wilson A, Latham J and Steinbrecher R. "Genome Scrambling – Myth or Reality? Transformation-Induced Mutations in Transgenic Crop Plants." *EcoNexus Technical Report*, EcoNexus, 2004. Available at www.econexus.info. Hard copies are available by contacting A.Wilson@econexus.info.
[8] Ethirajan Anbarasan, "Dead-end seeds yield a harvest of revolt", *UNESCO Courier*, 1999.
[9] Centre for Food Safety, *Monsanto vs US Farmers*, United States, January 2005. www.centerforfoodsafety.org

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