etc group
action group on erosion, technology and concentration

Communiqué

May/June 2008 Issue # 99

Patenting the "Climate Genes"… And Capturing the Climate Agenda

Issue: The world's largest seed and agrochemical corporations are stockpiling hundreds of monopoly patents on genes in plants that the companies will market as crops genetically engineered to withstand environmental stresses such as drought, heat, cold, floods, saline soils, and more. BASF, Monsanto, Bayer, Syngenta, Dupont and biotech partners have filed 532 patent documents (a total of 55 patent families) on so-called "climate ready" genes at patent offices around the world. In the face of climate chaos and a deepening world food crisis, the Gene Giants are gearing up for a PR offensive to re-brand themselves as climate saviours. The focus on so-called climate-ready genes is a golden opportunity to push genetically engineered crops as a silver bullet solution to climate change. But patented techno-fix seeds will not provide the adaptation strategies that small farmers need to cope with climate change. These proprietary technologies will ultimately concentrate corporate power, drive up costs, inhibit independent research, and further undermine the rights of farmers to save and exchange seeds.

The Gene Giants are staking sweeping patent claims on genes related to environmental stresses – not just those in a single engineered plant species – but also to a substantially similar genetic sequence in virtually *all* engineered food crops. Beyond the U.S. and Europe, patent offices in major food producing countries such as Argentina, Australia, Brazil, Canada, China, Mexico and South Africa are also swamped with patent filings. Monsanto (the world's largest seed company) and BASF (the world's largest chemical firm) have forged a colossal $1.5 billion partnership to engineer stress tolerance in plants. Together, the two companies account for 27 of the 55 patent families (49%) of those identified by ETC Group.

Impact: Farming communities in the global South – those who have contributed least to global greenhouse emissions – are among the most threatened by climate chaos created by the world's richest countries. The South is already being trampled by the North's super-size carbon footprint. Will farming communities now be stampeded by climate change profiteering? The patent grab on so-called climate-ready traits is sucking up money and resources that could be spent on affordable, farmer-based strategies for climate change survival and adaptation. After decades of seed industry mergers and acquisitions, accompanied by a steady decline in public sector plant breeding, the top 10 seed companies control 57% of the global seed market. As climate crisis deepens, there is a danger that governments will require farmers to adopt prescribed biotech traits that are deemed essential adaptation measures. Will governments be pressured to give biotech companies *carte blanche* to use genetic engineering – and sidestep biosafety rules – as the last resort for tackling extreme climate?

Policy: Governments meeting at the U.N. Convention on Biological Diversity in Bonn (May 19-30) and at the joint United Nations-FAO High-Level Conference on World Food Security and the Challenges of Climate Change and Bioenergy (3-5 June 2008) must recommend that governments suspend the granting of all patents on climate change-related genes and traits. There must be a full investigation, including the social and environmental impacts of these new, un-tested varieties. Given the global state of emergency, ETC Group urges inter-governmental bodies to identify and eliminate policies such as restrictive seed laws, intellectual property regimes, contracts and trade agreements that are barriers to farmer plant breeding, seed-saving and exchange. Restrictions on access to germplasm are the last thing that farmers need in their struggle to adapt to rapidly changing climatic conditions. Farmer-led strategies for climate change survival and adaptation must be recognized, strengthened and protected.

Overview: The Potential Impacts of Climate Change on Agriculture and Food Systems in the South

Climate scientists predict that many of the poorest people in the global South – those who have contributed least to greenhouse gas emissions – will suffer the most damaging impacts. The United Nations 2007/2008 *Human Development Report* warns that the consequences of climate change could be "apocalyptic" for some of the world's poorest people.[1]

Human-induced climate change is triggering climate shocks in all ecosystems that will profoundly affect crops, livestock, fisheries and forests and the billions of people whose livelihoods depend on them. Agriculture and food systems in the South, especially in South Asia and Southern Africa, will be the first and most negatively affected. Extreme climate events (especially hotter, drier conditions in semi-arid regions) are likely to slash yields for maize, wheat, rice and other primary food crops. Recent studies on the potential impacts of climate change on agriculture in the developing world offer a uniformly grim prognosis. Consider the following examples:

- A temperature increase of 3–4 degrees Celsius could cause crop yields to fall by 15–35 percent in Africa and west Asia and by 25–35 per cent in the Middle East according to an FAO report released in March 2008.[2]

- 65 countries in the South, most in Africa, risk losing 280 million tonnes of potential cereal production, valued at $56 billion, as a result of climate change.[3]

- Projected increases in temperature and changes in rainfall patterns will decrease growing periods by more than 20 percent in many parts of sub-Saharan Africa. The most vulnerable communities across Africa are farming families in East and Central Africa, including Rwanda, Burundi, Eritrea, and Ethiopia as well as Chad and Niger.[4]

- Farmers in dryland areas of sub-Saharan Africa will experience revenue losses of 25% per acre by 2060. The overall revenue losses of $26 billion per annum would exceed current levels of bilateral aid to the region.[5]

- Asian rice yields will decrease dramatically due to higher night-time temperatures. With warmer conditions, photosynthesis slows or ceases, pollination is prevented, and dehydration sets in. A study by the International Rice Research Institute reports that rice yields are declining by 10% for every degree Celsius increase in night-time temperatures.[6]

- South Asia's prime wheat-growing land – the vast Indo-Gangetic plain which produces about 15% of the world's wheat crop – will shrink 51% by 2050 due to hotter, drier weather and diminished yields, a loss that will place at least 200 million people at greater risk of hunger.[7]

- Latin America and Africa and will see a 10% decline in maize productivity by 2055 – equivalent to crop losses worth US $2 billion per year.[8]

- In Latin America, losses for rain-fed maize production will be far higher than for irrigated production; some models predict losses of up to 60% for Mexico, where around 2 million smallholder farmers depend on rain-fed maize cultivation.[9]

- Wild crop relatives will be particularly vulnerable to extinction due to climate change. A study of wild plant species related to food crops estimates that 16-22% of the wild relatives of cowpea, peanut and potato will become extinct by 2055 and the geographic range of the remaining wild species will be reduced by more than half.[10] Crop wild relatives are a vital source of resistance genes for future crop improvement, but their habitat is threatened and only a small percentage of these species is held in genebank collections.

- Over a much longer time scale, 2070-2100, climate models predict extreme climatic changes and unthinkable projections for food security: During the last three decades of this century, the mean temperature in many of the world's poorest countries will surpass what the same countries experienced as the most extreme warm temperatures between 1900-2000. In other words, models predict that the coolest temperatures experienced during growing seasons in 2070-2100 will be warmer than the hottest growing seasons observed over the past century. In India, for example, between 1900-2000 the mean growing season temperatures hovered between 26 and 28°C; between 2070-2100 the mean growing season temperatures are projected to be approximately 29-30° in India. In Kenya, the mean growing season temperatures in the last century were approximately 21-22° C; climate scientists predict Kenya's mean growing season temperatures at the end of this century (2070-2100) will hover around 23-25ºC.[11]

In a world where both biodiversity and the livelihoods of traditional farming communities are under siege, big questions loom. Can farming communities and plants and animals adapt quickly enough to respond to climate change? Will breeding adaptations alone be able to keep up with abrupt or erratic climatic change? Will germplasm and adaptive traits be accessible to farmers and public breeders in regions of the South that need them most? Who will decide?

Hot Pursuit: The Corporate Grab on Climate-proof Genes (and patents):

For the world's largest agrochemical and seed corporations, genetic engineering is the techno-fix of choice for combating climate change. It is a proprietary approach that seeks to expand an industrial model of agriculture – one which is largely divorced from on-the-ground social and environmental realities. (It is also an approach that fails to learn from history. Many of the problems with saline soils and soil degradation, for example, have been exacerbated by the use of intensive production systems.) The Gene Giants are now focusing on the identification and patenting of climate-proof genetic traits (genes associated with abiotic stresses), especially related to drought and extreme temperatures. Abiotic stresses refer to environmental stresses encountered by plants such as drought, temperature extremes, saline soils, low nitrogen, etc.

Appendix A provides a list of 532 patent documents (both applications and issued patents) filed at patent offices around the world on stress tolerant genes and traits. This is not an exhaustive list. ETC Group uncovered 55 patent families (corresponding to a single "invention" submitted for intellectual property protection in more than one country), resulting in 532 separate patent documents. BASF (the world's largest chemical company) holds 21 of the 55 patent families. Together, Monsanto and BASF hold 27 of the 55 of the patent filings (49%). This is significant because Monsanto and BASF announced in March 2007 that they would enter a $1.5 billion partnership to develop crops that are more tolerant to adverse environmental conditions. Although Ceres, Inc. and Mendel Biotechnology are independent companies, both companies conduct joint research with Monsanto (and Monsanto holds an equity stake in Mendel). When the patent families held by Ceres, Inc. (4) and Mendel (3) are added to Monsanto and BASF's total – this consortium of research partners accounts for 34 of the 55 patent families (62%).

Patent filings do not predict the commercial viability of a technology, but they do show where companies are investing considerable time, scientific R&D, and money. The vast majority of patent claims have been awarded or filed in the past few years, indicating that this is a relatively new area of R&D for the world's major seed and agrochemical corporations.

In late 2007, 130 scientists from 12 countries gathered in Australia for the "Genomics of Drought Symposium." According to information shared at the meeting, some 50 genes have been reported to confer drought tolerance when over-expressed in transgenic plants.[12] Monsanto, Bayer, Syngenta, Dow, BASF and DuPont all have extensive research programs in transgenic drought tolerance. Their research focuses on major crop commodities (especially maize, soybeans, wheat) in temperate zones. The "climate correcting" genes will be sold in genetically engineered varieties that contain a growing number of "stacked traits," all of which will be subject to monopoly patent claims. Climate-tolerant varieties containing multiple proprietary genes will mean higher seed prices as well as added biosafety risks (see page 10).

After failing to convince an unwilling public to accept genetically engineered foods, biotech companies see a silver lining in climate change: An opportunity to assert that agriculture cannot win the war against climate change without genetic engineering. In other words, industry claims that biotech crops will offer essential adaptation measures. In the words of Keith Jones of CropLife International (industry-supported non-profit organization), *"GM foods are exactly the technology that may be necessary to counter the effects of global warming."*[13] In reference to his company's quest to develop drought-tolerant maize, DuPont spokesman Pat Arthur told *Scientific American*: "This is a more consumer-friendly [biotech] trait than some of the others that have come out."[14]

(See Appendix A for detailed list of patents.)

Who Controls "Climate-Ready" Genes and Traits?

Company	No. of Patents or Patent Applications	Abiotic Stress Traits Cited in Patent(s)	Patent Jurisdictions Where Applied for or Granted
BASF (Germany)	21	Drought; salinity; environmental stress; cold; heat	U.S., EPO, WIPO, Argentina, Austria, Australia, Canada, China, Germany, Norway, Spain
Bayer (Germany)	5	Stress resistance; environmental stress; drought; temperature, water or chemical load; abiotic stress.	U.S., EPO, WIPO, Argentina, Australia, Canada, China, Germany, Korea,
Ceres, Inc. (USA - partners with Monsanto)	4	Drought; cold; abiotic stress; flood; salinity.	U.S., EPO, WIPO, Australia, Brazil, Canada, China
Dow (USA)	2	Drought; heat	U.S.
DuPont (Pioneer Hi-Bred – USA)	1	Drought; cold; abiotic stress.	U.S., WIPO, Argentina
Evogene Ltd. (Israel - partners with Monsanto and Dupont)	2	Abiotic stress; salinity; drought; heat; cold; UV irradiation	U.S., EPO, WIPO, Brazil, Canada, China, Mexico, Russian Federation
Mendel Biotechnology, Inc. (USA - Monsanto holds equity stake)	3	Drought; abiotic stress.	U.S., EPO, WIPO, Australia, Brazil, Canada, China, Japan, Mexico
Monsanto (USA)	6	Drought; abiotic stress; nitrogen use efficiency; cold.	U.S., EPO, WIPO, Argentina, Australia, Brazil, Canada, China, Germany, Japan, Korea, Mexico, South Africa
Syngenta (Switzerland)	7	Drought; abiotic stress; cold; salinity.	U.S., EPO, WIPO, Australia, Brazil, Canada, China

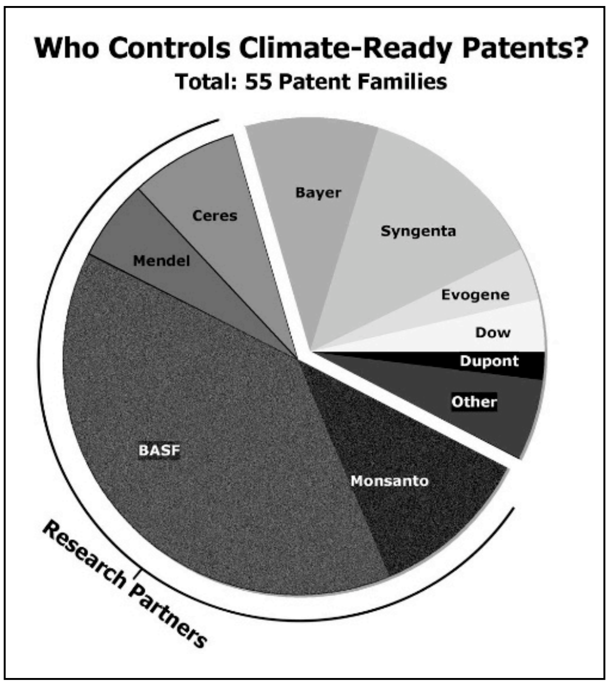
In a bid to win moral legitimacy for their controversial GM seeds, the Gene Giants are also teaming up with philanthro-capitalists to develop climate-tolerant traits for the developing world. Monsanto and BASF, for instance, are working with the International Maize and Wheat Improvement Center (CIMMYT) and national agricultural research programs of Kenya, Uganda, Tanzania and South Africa to develop drought-tolerant maize. The program is supported by a $47 million grant from the Bill & Melinda Gates Foundation. For its part, Monsanto and BASF have agreed to donate royalty-free drought-tolerant transgenes to the African researchers.[15]

Functional Genomics Approach: The conventional plant breeding approach relies on crop diversity from farmers' fields, often retrieved from gene bank collections. Breeders in search of drought tolerance, for example, would begin by studying crop varieties that have a proven track record of surviving water-scarce conditions. Rather than using time-consuming tools of conventional plant breeding and the "germplasm dependent" approach, however, genetic engineers are now turning to functional genomics – an approach that depends on computational "gene prediction" platforms to rapidly identify "climate-tolerant" genes and traits. Genomics information, robotics and massive computer power now make it possible to pinpoint genes of interest in a model plant – and then identify similar genetic sequences in the crop of interest. Rather than transferring genes from one plant to another, scientists are learning how to identify key gene sequences and then over-express a plant's own genes to achieve a desired result.

A note on terminology: The term "gene" refers to the physical and functional unit of heredity. However, the correlation between a *trait* and a *gene* is complex. Most plant traits are governed by more than one gene. A gene is an ordered sequence of nucleotides located in a particular position on a particular chromosome (and can exist in a series of alternative forms called alleles) that encode a specific functional product (i.e., a protein or RNA molecule). The combination of genes is one important determinant for the development of a plant's traits.

Traits associated with abiotic stresses are complex and determined by multiple genes. Scientists are trying to identify the particular region of the genome that is associated with the plant's physical form or traits. And they are using the information gleaned from research on model plants (such as *Arabidopsis thaliana*) to predict the location and function of similar stretches of DNA in other plant species.

Arabidopsis thaliana, a flowering mustard plant, is the lab-rat of plant molecular biology – because researchers have studied its molecular make-up more than any other plant. *Arabidopsis* is considered a model organism because it has a small genome, short life cycle, prolific seed production and it's relatively easy to engineer.[16] In December 2000, *Arabidopsis* was the first plant genome to be fully sequenced (and placed in the public domain). Researchers predict that they will decipher the function of all the plant's 25,000+ genes by 2010.[17] The goal is to build a "virtual plant" based on the *Arabidopsis* genome – a computer model that will allow researchers to simulate the growth and development of a plant under any environmental conditions. That's important because researchers believe that the knowledge they gain from *Arabidopsis* will explain the genetic behavior of other plant species.



Transcription Factors: Stress responses such as drought tolerance involve coordinated changes in many genes. Therefore, the ability to affect many changes with one gene is an attractive proposition. Genetic engineers are using "transcription factors" as a new tool to activate cascades of genes that function together to enhance stress tolerance – which is why many researchers are focusing on transcription factors in *Arabidopsis.* Not surprisingly, many of the patents related to transgenic stress tolerance (see Appendix A) involve transcription factors.
Transcription factors refer to a class of genes that control the degree to which other genes in a cell are activated. Transcription factors are able to recognize and bind to regions of DNA that have a specific sequence in the promoters of the genes they regulate. Thus, if a dozen genes all have that region of DNA somewhere in their promoters, they will all be regulated by the same transcription factor. Mendel Biotechnology explains why transcription factors are important: "Because transcription factors are key controlling elements of biological pathways, altering the expression levels of one or more transcription factors can change entire biological pathways in an organism."[18] In some cases, genetic engineers are also attempting to control the timing, tissue-specificity and expression level of the introduced genes for optimal performance. This is important if the stress resistance is to be triggered only at a specific time, in a specific part of the plant, or under specific stress conditions.

Stress-induced proteins: Genes that code for (i.e., determine the production of) single enzymes, ion transport proteins, or other functional proteins can also affect a plant's pathways. Transcription factors are a major focus of current research on transgenic stress tolerance, but it's not the only approach. Patent claims reveal that researchers are also focusing on genes that code for single enzymes, ion transport proteins, or other functional proteins that affect a plant's biological pathway. Some genes code for proteins that are key enzymes in biochemical pathways; when these proteins are over-expressed (in effect, when their volume is turned up), the products downstream in the pathway are likely to increase as well.
For example, the hormone ABA is important for stress tolerance in plants. By over-expressing a key enzyme for the synthesis of ABA, the level of ABA can be increased, and then this hormone can regulate a number of other genes. Ceres, Inc. (a privately-held biotech company in which Monsanto holds an equity stake) holds patents on a gene encoding an enzyme that is required to make ABA.[19]

Monsanto holds several patents on key enzymes that increase antioxidants, such as tocopherol (vitamin E is an example), which have been shown to protect plants against stress.[20] The genes were identified by screening for tocopherol levels in mutated *Arabidopsis* plants.

Multi-Genome Patent Grab: The genomics approach is especially attractive to Gene Giants because it gives them an opportunity to make sweeping patent claims that extend far beyond a single crop – and often include multiple stresses. Many of the patents claim isolated DNA sequences that are associated with abiotic stress tolerant traits. Because of the similarity in DNA sequences between individuals of the same species or among different species – "homologous sequences" – **the patent claims extend not just to abiotic stress tolerance in a single engineered plant species, but also to a substantially similar genetic sequence in virtually all transformed plants.** The claims typically include any gene or protein with "substantial identity" that is associated with abiotic stress tolerance in transgenic plants, as well as methods for using the isolated gene sequences to engineer the plant to respond to abiotic stress.

For example, **DuPont's (Pioneer Hi-Bred)** November 2007 patent entitled "transcriptional activators involved in abiotic stress tolerance" claims a method for expressing the genetic sequences in a plant that improves its cold and/or drought tolerance (US Patent No. 7,253,000, patent family 45, Appendix A). The claims are not limited to drought/cold tolerance in a single crop – but to use of the technology in transgenic monocots (e.g., maize, barley, wheat, oat, rye, sorghum or rice) and dicots (e.g., soybean, alfalfa, safflower, tobacco, sunflower, cotton or canola). Monocots and dicots are the primary classes of flowering plants – and nearly all of the world's food supply comes from flowering plants.

Many of **BASF's** patents are similarly broad in scope. For example, U.S. Patent No. 7,161,063 (patent family 6, Appendix A) claims a specified polynucleotide sequence associated with increased tolerance to environmental stress found in any transgenic plant cell from monocot or dicot plants – including a whole plant, a plant cell, a plant part or a plant seed. To reinforce the multi-genome claim, the patent specifically claims the expressed gene in the following plants: "maize, wheat, rye, oat, triticale, rice, barley, soybean, peanut, cotton, rapeseed, canola, manihot, pepper, sunflower, tagetes, solanaceous plants, potato, tobacco, eggplant, tomato, *Vicia* species, pea, alfalfa, coffee, cacao, tea, *Salix* species, oil palm, coconut, perennial grass and a forage crop plant."[21] (In other words, virtually all food crops.) The isolated polynucleotide sequence is also claimed when it is used as a vector for transforming plants.

A **Syngenta** (Switzerland) patent application also seeks extremely broad claims. U.S. patent application US20060075523A1(patent family 47, Appendix A) claims gene sequences that confer abiotic stress tolerance – including "cold stress, salt stress, osmotic stress or any combination thereof." The claims extend to a "substantially similar" gene sequence from a monocot or a dicot plant, from a cereal (including maize, rice, wheat, barley, oat, rye, millet, milo, triticale, orchardgrass, guinea grass, sorghum and turfgrass). Also claimed are methods for using the specified gene sequences as vectors, expression cassettes, as well as plants containing such polynucleotides to alter the responsiveness of a plant to abiotic stress.

Gene Giants typically claim any plant that has been engineered to express what the companies claim as a proprietary gene or genes – that's the standard approach that biotech companies have been using for the past two decades. With the patent grab on climate genes we're seeing far more expansive claims – which are likely to result in conflicting/overlapping claims. In recent years, the world's largest seed companies have cross-licensed agricultural technologies with one another as a strategy to avoid costly patent battles and duck anti-trust regulations.[22] Given the existing partnership between BASF and Monsanto in this area, we are likely to see the largest companies cross-licensing proprietary biotech genes related to abiotic stress traits in transgenic plants.

Reality Check: Will corporate breeders be successful in engineering crops for climate tolerance? Genetically engineered drought tolerant plants are so far proving problematic. You're not likely to read a straightforward analysis of the problems in published scientific papers authored by company scientists, but other researchers focusing on drought are identifying problems.[23] The key stumbling block is known as the "pleiotropic effect."

Researchers pursuing genetically engineered drought-tolerance are finding that the expression of genes for drought-tolerance can have unpredictable and unwanted effects on other traits, including yield and quality. Like a sluggish computer that's over-loaded with bloated software, the genes associated with drought tolerance slow down the plant's development, resulting in smaller plants and delayed flowering. According to a report prepared by Australia's Grain Research & Development Corporation, **"The flaw is a profound one. It amounts to shifting the yield losses experienced in dry seasons onto the good years."**[24] (emphasis added)

Researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India also report drawbacks working with stress-responsive genes in transgenic crops. In a 2007 article they write: "Evaluation of the transgenic plants under stress conditions, and understanding the physiological effect of the inserted genes at the whole plant level remain as major challenges to overcome."[25]

Pleiotropy – The ability of a single genetic change to cause unintended physiological effects throughout a plant. Companies focusing on genetically engineered drought-tolerance are finding that genes for drought-tolerance can have unwanted effects on other traits, including yield and quality.

World's Largest Agrochemical Firms

Company	Agrochemical Sales 2006 US$ Millions	% Market Share
1 Bayer (Germany)	$6,700	19%
2 Syngenta (Switzerland)	$6,400	18%
3 BASF (Germany)	$3,850	11%
4 Dow AgroSciences (USA)	$3,400	10%
5 Monsanto (USA)	$3,300	9%
6 DuPont (USA) (Pioneer Hi-Bred)	$2,150	6%

Source: Sales data provided by Agrow World Crop Protection News, August 2007
Phillips McDougall, agrochemical consultancy based in the UK, estimates total market value of global agrochemical market in 2006: US$35,600 million

World's Largest Seed Corporations

Company	Seed Sales 2006 US$ Millions	% Market Share
1 Monsanto (USA) includes Delta & Pine Land	$4446	19%
2 DuPont (USA)	$2781	12%
3 Syngenta (Switzerland)	$1743	8%
4 Groupe Limagrain (France)	$1035	5%
5 Land O' Lakes (US)	$756	3%
6 KWS AG (Germany)	$615	3%
7 Bayer Crop Science (Germany)	$430	2%

Source: ETC Group. According to estimates provided by Context Network, the value of the global commercial seed market was $22,900 million in 2006 (includes seeds purchased from public breeding programs). Note: Dow also holds interests in seeds, but is not ranked in the top 10.

Corporate R&D Related to Genetically Engineered Climate Tolerant Genes:

All of the world's largest seed and agrochemical companies support research on drought and heat tolerant genes or other genetic traits for withstanding environmental stresses. The target crops are primarily transgenic maize and soybeans for temperate regions. **DuPont** (USA) hopes to have a drought-resistant maize on the market by 2012. According to DuPont spokesman Bill Niebur, "We've got our top talent in our organization working on this."[26] The company operates two, 200-acre research stations (in California and in an arid region of Chile) and thousands of test plots that are dedicated solely to drought research.[27] DuPont has a joint venture with Chinese biotech company Beijing Weiming Kaituo to develop genetic traits such as stress tolerance and nutrient utilization for maize and rice.

At the end of 2007 **DuPont** announced a new collaboration with **Evogene Ltd.** (Israel) that will give DuPont exclusive rights to several drought-resistant genes discovered by Evogene for maize and soybeans.[28] The genes were identified by Evogene's proprietary *in silico* "gene discovery technology" called the "ATHLETE."[29] (*In silico*, as opposed to *in vivo* or *in vitro*, refers to investigations performed through the use of a computer or computer simulation).

ATHLETE is the company's proprietary computer database and analysis program for finding gene function by comparing sequences from as many different plant species, tissues, organs, and growth conditions as possible. Evogene says its database consists of 8 million expressed sequences, 400,000 "proprietary gene clusters," and 30 plant species. The program clusters sequences according to a variety of criteria, and then determines which gene candidates to investigate further. It is an informed winnowing process. Identified sequences are then synthesized, cloned, and used to engineer model plants such as *Arabidopsis* and tomato for validation of function. If the over-expressed sequence results in the desired trait in *Arabidopsis*, then Evogene predicts that the homologous sequence in a crop plant will do the same. The company claims that it can discover novel genes, test them in model plants, and move them to crops, all in-house.

Evogene's website describes the platform it uses to identify key genes: "Athlete uses vast amounts of available genomic data (mostly public) to rapidly reach a reliable limited list of candidate key genes with high relevance to a target trait of choice. Allegorically, the Athlete platform could be viewed as a 'machine' that is able to choose 50-100 lottery tickets from amongst hundreds of thousands of tickets, with the high likelihood that the winning ticket will be included among them."[30]

Evogene also collaborates with **Monsanto** (USA, the world's largest seed corporation). A deal struck between the two companies gives Monsanto exclusive rights to a number of genes identified by Evogene that reportedly allow crops to maintain stable yields with lower applications of nitrogen.[31] The companies also collaborate on drought tolerance.

Monsanto and **BASF** (the world's third ranking agrochemical company) are investing $1.5 billion on collaborative R&D to develop high-yielding crops that are more tolerant to adverse environmental conditions such as drought.[32] The colossal collaboration, perhaps the biggest joint biotech R&D program on record, will focus on stress tolerant traits for maize, soybeans, cotton and canola. The focus on these four commodity crops is not surprising because they are the crops that account for virtually all the world area planted in commercial GM plants.[33]

Monsanto has been testing drought-tolerant genes in South America for several years. In 2007 the company reportedly identified at least 800 genes offering drought-tolerance and improved yields.[34] "More than we would have thought," remarked Rob Fraley, Monsanto's chief technology officer.[35] The company claims that its drought-tolerant maize achieves yield benefits of up to 12 bushels per acre, and promises to be a blockbuster product; the product will be available after 2010.[36]

In addition to in-house R&D, Monsanto farms out gene and trait discovery to companies like **Ceres, Inc.** (California, USA) and **Mendel Biotechnology** (California, USA). Ceres' website claims that it holds "the world's largest collection of plant gene intellectual property" and that it's Monsanto's "largest external supplier of plant biotechnology."[37] Drought tolerance is just one of the traits in its pipeline.[38]

Not to be outdone, Mendel Biotech also holds patents on key genetic engineering methods for drought tolerant maize and soybeans, and boasts that it was the first company to develop drought-tolerant technologies for plants.[39] Monsanto holds exclusive licensing rights to Mendel's technology (for large-acreage crops and vegetables). Mendel focuses on transcription factors. According to Mendel scientists, the 25,000+ genes in the *Arabidopsis* genome are controlled by about 1,800 different transcription factors. By analyzing the function of all *Arabidopsis* transcription factors, Mendel scientists claim that single transcription factors can control complex traits such as the ability of plants to withstand freezing or drought, resist disease, use nitrogen efficiently and other complex traits. The company holds a number of exclusive monopoly patents on specific transcriptional factors related to abiotic stresses such as drought.

Syngenta is developing "water optimization technology" for maize that is designed to thrive in both excessive and limited rainfall. The company claims that trials in North and South America have achieved consistently positive yield results in both dryland and irrigated conditions.[40] The company aims to commercialize its first drought-tolerant maize by 2011. The leader of Syngenta's North American maize breeding program told *Farm Industry News*: "What we are developing is drought genes that will enable plants to make better use of water, eliminating or reducing yield reduction caused by variable water conditions."[41]

In January 2008 California-based plant biotech company, **Arcadia Biosciences**, announced that it had successfully completed its first field trial for genetically engineered drought-tolerant tobacco (an experimental crop). The company claims that its drought-tolerant crops could be commercially available by 2016. The drought tolerant technology was developed by an international research team, led by the University of California-Davis, which has applied for patents on the gene technology.[42] Drought-tolerance was achieved by inserting into the tobacco plants a gene that interrupts the biochemical chain of events that normally leads to the loss of the plant's leaves during water shortage.[43] By genetically suppressing the death of leaf cells, the plants are better equipped to survive drought and sustain yields.[44]

In April 2008 Arcadia Biosciences announced a multi-crop research and commercial license agreement with **Mahyco** in India for Arcadia's nitrogen use efficiency and salt tolerance technologies. Mahyco is India's largest private seed company and has a 50/50 joint venture with Monsanto (Mahyco Monsanto Biotech Ltd.) to market transgenic seeds in India. According to Mahyco spokesman, Usha Zehr, "Nitrogen use efficiency will bring great benefits to Indian farmers by providing better yield under existing conditions or leading to lowering of nitrogen fertilizer applications in some areas and still maintaining yields."[45]

Biotech Carbon Credits and Corporate Subsidies for Climate Friendly Crops: Biotech companies are hoping to exploit market-based carbon credit schemes to win new markets for crops engineered with so-called climate-ready genes. In China, U.S.-based Arcadia Biosciences is working with government authorities in the Ningxia Hui Autonomous Region to develop a carbon credit methodology so that farmers who plant the company's genetically engineered rice can earn carbon credits.[46] The company claims that its GM rice will require less fertilizer because it is engineered to absorb nitrogen fertilizer more efficiently. Chemical fertilizers are a major contributor to global greenhouse emissions. Arcadia's GM rice has not received regulatory approval, and is not yet commercially available. If the Clean Development Mechanism of the U.N. Framework Convention on Climate Change can be convinced that GM crops are "green" and climate friendly, carbon credits for rice farmers will create a demand for genetically engineered seeds and a bonanza for the biotech industry.

Monsanto is also hoping to cash-in on carbon credit trading schemes for farmers who grow the company's GM crops. In December 2007 Monsanto joined the Chicago Climate Exchange (CCX), North America's only voluntary carbon credit exchange program.[47] Monsanto claims that its "Roundup Ready" crops – plants engineered to withstand the spraying of its proprietary weed killer (brand-name Roundup) – promote the use of conservation tillage by reducing the need to till the soil to achieve weed control.[48] The Farm Bureau, an insurance company, is enrolling farmers who practice no-till, allowing farmers to trade carbon sequestration credits on the CCX.

The U.S. government's Federal Crop Insurance Company announced in October 2007 that it will begin a pilot program in 2008 that offers a discount to farmers who plant Monsanto's "triple-stack" maize seeds on non-irrigated land – reportedly because the biotech maize engineered for herbicide tolerance and two kinds of insect resistance provides lower risk of reduced yields when compared to conventional hybrids.[49] (Monsanto's own data were used to substantiate this claim.)

Genetically engineered climate-hardy crops will undoubtedly sell for top dollar. Farmers in the U.S. already pay premium prices for biotech seeds that are loaded with up to three genetic traits. For example, Monsanto's "triple-stacked" biotech maize seed sells for about $245 per bag – compared to $100 for conventional maize seed.[50]

Market-based carbon trading schemes for GM crops, as well as the U.S. government's corporate seed subsidy for Monsanto's maize, raises a host of concerns. Will governments someday require farmers to adopt prescribed biotech traits to cope with climate change? Will it lead to a "state of technological emergency" in which corporations are given *carte blanche* to use genetic engineering as the last resort for tackling climate change?

Public Sector Agricultural Research Responds to Climate Change:

The goal of climate-proofing poor peoples' crops is reinvigorating international plant breeding institutes that see their mission as science-based solutions to hunger, poverty and food security in the global South. In 2006 the network of 15 "Future Harvest" centers that operate under the umbrella of the Consultative Group on International Agricultural Research (CGIAR) announced plans to intensify research on "climate ready" crops to blunt the impacts of global warming.[51] (In fact, the CGIAR was first to use the term "climate ready" to refer to plant breeding efforts to develop abiotic stress tolerance in crops. Whether intentional or not – it's a slogan that immediately brings to mind Monsanto's "Roundup Ready" transgenic crops).

In 2006, the CGIAR spent about $70 million on climate change-related research (about 15% of its total budget of $470 million). This work includes studies that assess vulnerability of agricultural systems in the developing world to climate change. At the end of 2007 CGIAR pledged to at least double the amount it devotes to climate-change research, including: 1) Plant breeding for resistance to diseases and insects as well as abiotic stresses such as drought and flooding; 2) Cropping systems (soil management, crop diversification, integration of crops and livestock); 3) Water management (technologies and policies to increase water use efficiency).

CGIAR scientists are using classical breeding, marker-assisted selection and genetic engineering to improve 'defensive traits' in widely-cultivated, high yielding varieties. The highest-profile research focuses on climate-resilient cereals – especially maize and rice – for the tropics. Most of the CGIAR's research does not currently employ transgenics – but that could change soon. CGIAR also points out that its focus on abiotic stress tolerance in crops is not new. Working with national agricultural researchers in sub-Saharan Africa, the International Maize and Wheat Improvement Center (CIMMYT) claims that it has so far developed more than 50 drought-tolerant maize varieties (conventionally bred) that are being grown on about one million hectares worldwide.

CGIAR's Transgenic Research on Drought and Stress Tolerance: Although corporate spending on climate-tolerant transgenic research far exceeds the amount spent by publicly-funded institutes, several CGIAR centers are conducting research on transgenic stress tolerance in crops – especially transcription factors (DREB gene) in wheat, rice, groundnut (peanut) and potatoes.

At its headquarters in Mexico, CIMMYT researchers inserted the DREB1A gene from *Arabidopsis thaliana* into wheat. In 2004, despite international controversy over transgenic wheat trials (GM wheat has not yet been commercialized), CIMMYT conducted transgenic wheat field trials in Mexico – and plans to conduct more trials in the future.[52] The gene construct, provided by the Japan International Research Center for Agricultural Sciences, reportedly confers crop tolerance to drought, low temperatures and salinity. In CIMMYT's 2004 Annual Report, CIMMYT's lead researcher on drought tolerant wheat, Allesandro Pellegrineschi stated that, given the appropriate investment, it might be possible to produce drought-tolerant transgenic varieties within five years. Pellegrineschi is now at DuPont (Pioneer).

Researchers at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India are also using the DREB1A gene to develop drought tolerant transgenic groundnuts (peanuts) and pigeonpeas.

According to ICRISAT researchers, the transgenic crops have not yet been field-tested.

Added Biosafety Concerns: CIMMYT acknowledges that the development of crops engineered for environmental stress tolerance will "require substantial advances in biosafety assessment and regulatory approval that are very different to the first generation of commercial transgenic crops…"[53]

CIMMYT cautions: "Genetically engineered crops for abiotic stress-prone environments pose new questions regarding safety and impact. For example, new phenotypes resulting from transgenic technology for abiotic stressful environments may lead to increased competitiveness if the transgenes are introgressed into wild populations. Furthermore, the use of regulatory genes such as *DREB* may potentially have a cascading effect on a variety of gene pathways (as compared to the first generation of transgenic crops which were based on one gene-one product systems). Some of these cascade effects will be intended while other will not, some will be known but others will be less easy to define."[54]

CIMMYT's New Partnership Paradigm: Despite biosafety concerns, CIMMYT is prepared to embrace transgenic drought tolerant crops for sub-Saharan Africa. CIMMYT researchers acknowledge that multinational companies control key genes for drought tolerance in transgenic crops, and that public sector deployment of patented transgenes could raise liability issues if researchers were accused of infringing patented genes or technology. As a way to avoid liability issues, CIMMYT researchers propose that a "user-led philanthropy-private-public partnership paradigm" could make possible "transgenic solutions" for drought tolerant maize in sub-Saharan Africa.[55]

CIMMYT researchers write: "If this new partnership paradigm succeeds, the access to proprietary technologies that can lead to stable grain yields in complex drought-prone areas will allow resource-poor African maize farmers to harvest a reasonable crop in most years, which will almost certainly lead to improved food security, better well-being, enhanced livelihoods and increased opportunities to enter the market economy, even for farmers residing in harsh environments."[56]

To bring the new "partnership paradigm" to fruition, CIMMYT researchers propose to initiate a facilitated dialogue with the relevant corporation "to ensure this transgenic technology becomes available to the resource-poor maize farmers of sub-Saharan Africa." ETC Group does not know if the facilitated dialogue ever took place with the relevant corporation. We do know that CIMMYT and national agricultural research programs of Kenya, Uganda, Tanzania and South Africa are working jointly to develop drought-tolerant maize. The program is supported by a $47 million grant from the Bill & Melinda Gates Foundation. In March 2008 the African Agricultural Technology Foundation announced that Monsanto and BASF have agreed to donate royalty-free drought-tolerant transgenes to the African researchers who are working with CIMMYT.[57]

In other words, CGIAR is side-stepping controversial issues of ownership and control of drought-tolerant genes, and at the same time facilitating and supporting the introduction of genetically engineered crops in sub-Saharan Africa. The Bill and Melinda Gates Foundation – which is becoming a major funder of the CGIAR system – is clearly influencing CGIAR support for a market-based orientation to the introduction of agricultural technology in Africa. Gates's market-based approach will ultimately mean high-tech seeds accompanied by intellectual property laws, seed regulations and other practices amenable to agribusiness. To African farmers, this is hardly philanthropic.

CIMMYT's unilateral action raises a policy turf issue with FAO. CGIAR's 15 institutes agreed more than a decade ago that policy oversight regarding the use of plant genetic resources would rest with the FAO Commission on Genetic Resources for Food and Agriculture and that any changes in CGIAR policies would have to be cleared by the FAO Commission. Since the BASF/Monsanto proprietary traits may be inserted into CIMMYT's publicly-held germplasm and subjected to unknown licensing conditions, clearance from the FAO Commission is necessary.

The trilateral partnership is controversial because the Gates and Rockefeller Foundation's Alliance for a Green Revolution for Africa (AGRA) has pledged *not* to introduce GM seeds during its first 5-year program. By working with national agricultural researchers and CIMMYT on a separately funded program for drought tolerant maize (outside of the AGRA envelope) – all three parties seemingly duck accountability for research supporting the introduction of genetically engineered seeds in sub-Saharan Africa. The big winners, of course, are BASF and Monsanto, who can now point to their philanthropic efforts to give royalty-free drought-tolerant genes to the neediest farmers in Africa – with full endorsement from public plant breeding institutes.

Non-Transgenic Research: Although CGIAR appears to embrace the promise of transgenics for Africa, the vast majority of the Group's breeding work for abiotic stress tolerance does not (yet) involve genetically engineered crops. Most of the current research involves identifying traits in farmers' seeds and using classical breeding and marker assisted selection to develop new varieties. Two prominent examples appear in box below.

Farmers' Crop Diversity as Source of Adaptive Traits

Waterproofing rice: Flooding and seasonal flashfloods already cause losses worth US$1 billion per annum to rice farms in South and Southeast Asia, conditions that are expected to worsen with rising sea levels and extreme climate events. When scientists from the International Rice Research Institute (IRRI) and the University of California-Davis started searching for genes that would allow Asian rice to withstand prolonged flooding, they knew right where to look: The trait for flood-tolerance derived from a farmers' variety, Dhullaputia,[58] identified over 50 years ago in Orissa, India as the world's most flood-tolerant rice variety.[59] Using marker-assisted selection (not transgenics) the researchers were able to isolate the submergence tolerant gene, Sub1A, and then transfer it to a rice variety that is grown on more than 5 million hectares in India and Bangladesh, known as *Swarna*. Most rice can tolerate flooding for only a few days, but researchers say the new variety, *Swarna-Sub1*, can withstand submergence for two weeks without affecting yields. IRRI has conducted field trials on the flood resistant rice variety in Indonesia, Philippines, Vietnam (with plans to field test in Cambodia, Thailand, Laos, Nepal, China in 2008).[60] It could be commercially available by 2009.[61]

Beating the Heat: Rice is now the fastest growing food source in sub-Saharan Africa, and CGIAR scientists predict it will become the leading agricultural commodity in many parts of the continent.[62] The African Rice Center (WARDA) is developing heat and drought-tolerant rice varieties by crossing African rice species (*O. glaberrima)* with the higher yielding Asian rice (*O. sativa)*.[63] Not surprisingly, drought-prone environments of Africa are precisely where researchers have found traditional African rice that can withstand hot and dry conditions. Drought tolerant features of African rice (*O. glaberrima)* include, for example, deep and thick roots, early maturity, rapid leaf rolling and high water use efficiency.

Researchers have also identified traits in African rice that make it more tolerant to heat stress. *O. glaberrima* has a mechanism that limits transpiration rates – meaning evaporation of water from the plant's leaves – allowing it to avoid heat stress during hotter and dryer conditions.[64] African rice also offers the advantage of flowering earlier in the morning when the temperature is lower. This is especially important because rice is extremely sensitive to high temperatures during flowering (over a 2-3 week period). When temperatures exceed about 35° C, the viability of pollen is greatly reduced, causing yield loss. The peak time of day for flowering of most Asian rice (*O. sativa*) varieties is 11:00 a.m. – when temperatures in many rice growing regions of Africa can surpass 35° C. By contrast, *O. glaberrima*, usually flowers early in the morning, at around 7 or 8 a.m. – allowing it to escape the hottest temperatures of the day. Shifting flowering to the early morning hours is one strategy breeders are pursuing to protect rice from adverse effects of climate change.

Some Recent Partnerships to Address Impacts of Climate Change on Agriculture

Crop	Countries Involved	Partners	Funders
Drought resistant and salt tolerant barley varieties (conventional breeding and transgenics)	National agricultural research programs in Egypt, Algeria, Tunisia		International Development Research Centre of Canada & The New Partnership for Africa's Development (NEPAD)
Drought-tolerant maize for Africa (conventional breeding and transgenics)	Kenya, Uganda, Tanzania, South Africa	National agricultural research programs of Kenya, Uganda, Tanzania, South Africa, CIMMYT. Monsanto & BASF will license royalty-free traits for drought tolerance.	Bill & Melinda Gates Foundation and Buffett Foundation contributed $47 million to African Agricultural Technology Foundation for this initiative.
Stress-tolerant Rice	Within three years, the project expects that 300,000 farmers in South Asia and 100,000 farmers in Sub-Saharan Africa will have adopted the initial set of improved varieties.	IRRI and Africa Rice Center	Bill & Melinda Gates Foundation - US$19.8 million over 3 years (announced January 2008)
Drought tolerant maize	China, Vietnam, Philippines, Indonesia, Thailand	CIMMYT	Asian Development Bank
Drought tolerant wheat (transgenic field trials conducted in Mexico)	Mexico	CIMMYT	Japanese government and Japanese International Research Center for Agricultural Sciences

Farmer-Based Strategies for Resilience in Confronting Climate Change

> "Adaptation is ultimately about building the resilience of the world's poor to a problem largely created by the world's richest nations."[65]
> – *Human Development Report* 2007/2008

Technological fixes (especially patented ones) will not provide the adaptation strategies that poor farmers need to ensure food sovereignty in the face of climate change. But what are the alternatives?

The genetic diversity of plants and animals and the diverse knowledge and practices of farming communities are the two most important resources for adapting agriculture to local environmental conditions. Genetic diversity has enabled agriculture to respond to change over the past 10,000 years, and it's precisely this diversity that will play a key role in adapting agriculture to climate chaos in the decades ahead.

Plant breeding will play an essential role in adapting agriculture to rapidly changing climate. But formal sector scientists are not the only innovators. Even using the most sophisticated climate models and the most advanced technologies, the reality is that scientists are not very good at predicting what happens at a very local level – on and in the ground.

Crop genetic diversity plays a key role in coping with environmental stresses and is the cornerstone of small farmers' livelihood strategies, especially in the South. A 2008 study by FAO on local seed systems in four Southern African countries found that over 95 percent of the seed used by farmers is locally produced.[66] Worldwide, an estimated 1 billion people depend on farmer-saved seeds. FAO's study notes that small farmers can benefit from the introduction of improved genetic materials, but that "the limitation of the formal sector lies in its incapacity to address widely varying agro-ecological conditions or the needs and preferences of small-scale farmers."[67]

In local seed systems, the primary emphasis is not on high yields and productivity – but on resilience and risk-adverse qualities in the face of harsh, variable and sometimes unpredictable conditions.

> "A powerful tool for meeting development and sustainability goals resides in empowering farmers to innovatively manage soils, water, biological resources, pests, disease vectors, genetic diversity, and conserve natural resources in a culturally appropriate manner." - Executive Summary of the Synthesis Report of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), April 2008[68]

While genetic uniformity is the hallmark of commercial plant breeding (uniformity is one of the standard criteria for plant intellectual property), farmer-breeders deliberately create and maintain more heterogeneous varieties – in order to withstand diverse and adverse agro-ecological conditions. These plant breeding skills, rooted in local-level realities, are needed to adapt agriculture to climate change.

Seed diversity is managed and used in a dynamic and complex system. It includes traditional staple crops, market crops, minor crops and wild plant species. Farming communities manage/maintain thousands of crops/species and wild plants that are not part of international trade, and have been largely neglected or overlooked by formal sector breeders. Gene banks hold only a small fraction of germplasm that will be needed for future breeding work. By one estimate, well over 90% of useful genetic variability may still be in the wild.[69] (For example, It is estimated that only 35% of the genetic diversity of cassava, one of the world's most important root crops, has been collected.) Similarly, many wild relatives of crops, which FAO identifies as particularly important for the food and livelihood security of farming communities, are not represented in gene bank collections.[70] Wild crop relatives and minor crops are now recognized as a valuable and relatively untapped source of adaptive breeding traits. Whether in intensive, market-oriented or marginal production systems, recent studies are confirming what farming communities already know: farmers are plant breeders who actively develop new crop varieties.[71]

The crop diversity developed and maintained by farming communities already plays a role in adapting agriculture to climate change and variability. And history shows that farmer-bred seeds can be adopted and dispersed rather quickly. In Nepal, for instance, two farming communities in the same valley developed new rice varieties for high-altitude areas. One of the farmers' varieties performed much better than rice varieties introduced by the formal sector – and was subsequently adopted by farmers and spread over wide areas.[72] In the Brazilian community of Sol da Manha, farmers and formal sector breeders collaborated in the improvement of a local maize variety selected for low nitrogen use.[73]

Farmers typically draw on breeding materials from within their own communities as well as germplasm introduced from outside – including commercial varieties. SEARICE, a Philippines-based civil society organization, reports that during the 10-year period 1994-2004, the Filipino national rice research institute released 55 inbred rice varieties. During the same decade (over an 8-year period; 1998-2004) farmer-breeders on the island of Bohol developed 89 rice varieties.[74]

Climate models predict that major food crops of particular importance for food security in the South are especially vulnerable to impacts of climate change (for example, Southeast Asia rice and Southern Africa maize). One important adaptation strategy for farmers is to switch from highly vulnerable to less vulnerable crops.[75] Crop diversification must also include under-utilized species that offer natural tolerance to environmental stresses such as heat, drought, cold, etc.

Adaptation to climate change is not just about seeds – it's about farming systems. Farmers can adapt to changing climate by shifting planting dates, choosing varieties with different growth duration, changing crop rotations, diversifying crops, using new irrigation systems, etc. Farmers cultivate early- and late-maturing varieties of the same crops to increase the period of food availability and to spread out the amount of labor required at harvest time.

Farmer-led strategies for climate change survival and adaptation must be recognized, strengthened and protected. Farming communities must be directly involved in setting priorities and strategies for adaptation. Where appropriate, formal sector scientists can work with farmers to improve conservation technologies, strengthen local breeding strategies, and assist in identifying and accessing seed accessions held in seed banks. This may involve strengthening and expanding farmer-to-farmer networks for exchanging and enhancing crops and varieties that are already well-adapted to local environments. It may also involve facilitating access to new sources of germplasm for farmer experimentation and breeding.

No Climate Safety Net: The detrimental effects of climate crisis are not just a matter of geographic vulnerability – but also depend on a region's ability to pay for adaptation measures. For some farmers in OECD countries, for example, risks are already mitigated through agricultural subsidies – around US$225 billion in OECD countries in 2005[76] – and through public support for disaster insurance. For poor countries, there is no climate safety net. Even the most basic resources are scarce. Africa currently has one meteorological station for every 25,460 km^2 – one-eighth the minimum level recommended by the World Meteorological Organization. By contrast, the Netherlands has one weather station for every 716 km^2.[77] Investment in plant breeding is another important adaptation measure. A survey of 19 African countries by FAO reveals that financial support for plant breeding in 2005 was lower than it had been in 1985.[78]

Climate Change:
Corporate Response vs. Farmer Response
In Silico* vs. *In Situ

Gene Giants' Approach	Farmers' Approach
Use *in silico* approach (massive computer data and robotics) to find interesting genes and traits.	Select most resilient plant varieties.
Use functional genomics to identify and over-express genes for abiotic stress tolerance.	Investigate under-utilized species that offer natural tolerance to environmental stresses such as heat, drought, cold, etc.
File for exclusive monopoly patents on abiotic stress related traits for multi-genomes.	Eliminate all barriers to germplasm exchange including intellectual property, WTO-inspired seed laws, phony trade barriers, corporate oligopoly, etc.
Win market-based subsidies for use of climate ready crops or…convince government regulators that farmers must plant proprietary climate-ready seeds.	Engage in farmer-to-farmer alliances and germplasm exchange as well as appropriate partnerships with formal sector breeders

Conclusion & Recommendations

Genetically engineered "climate tolerant" seeds are a technological fix that distracts from the root causes of climate change and the urgent need to cut greenhouse gas emissions and reverse consumption patterns – especially in the North.

In the face of climate chaos and a deepening global food crisis, the corporate grab on climate tolerant genes is business as usual. A handful of transnational seed and agrochemical companies are now positioned to determine who gets access to key genetic traits and what price they must pay. These patented technologies will ultimately concentrate corporate power, drive up costs, inhibit independent research, and further undermine the rights of farmers to save and exchange seeds.

The South is already being trampled by the North's super-sized carbon footprint. Farming communities now risk being stampeded by a corporate climate agenda. Proprietary research on climate tolerant genes and traits is sucking up money and resources that could be spent on decentralized and affordable approaches, especially farmer-based strategies for climate change survival and adaptation.

Governments must respond urgently. There are two immediate opportunities: 1) The biennial Conference of the Parties to the Convention on Biological Diversity (COP9) is meeting in Bonn, Germany, May 12-30. 2) The Secretary-General of the United Nations hopes to have a comprehensive plan to tackle the global food crisis by the beginning of June when an emergency meeting of prime ministers, agriculture ministers, and the heads of major agencies will meet in Rome June 3-5.

Governments meeting in Bonn and Rome face the specter of a global food and hunger crisis propelled by the agrofuels boom (food vs. fuel), commodity speculation, corporate hegemony and the ever-present climate crisis.

In this state of emergency governments must urgently:

Suspend all patents on climate-related (e.g., abiotic stress) genes and traits and conduct a full investigation, including the potential environmental and social impacts of transgenic abiotic stress tolerant seeds.

Recognize, protect and strengthen farmer-based breeding and conservation programs and the development of on-farm genetic diversity as a priority response for climate change survival and adaptation.

Adopt policies to facilitate farmers' access to and exchange of breeding materials and eliminate current restrictions on access to seeds and germplasm (especially those driven by intellectual property, agribusiness-inspired seed laws, trade regimes and corporate oligopoly). In the midst of climate crisis, spiraling food prices and food scarcity, restrictions on access to seeds and germplasm are the last thing that farmers need in their struggle to adapt to rapidly changing climatic conditions.

Appendix A

A Sample of Recent Patents and Patent Applications on "Climate-Tolerant" Germplasm/Technologies

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
1.	**Agrigenetics, Inc. Mycogen Seeds (Dow Agrosciences)**	**US7273970**	Inbred corn line BE1146BMR	Drought Heat	**2007-09-25, 2003-10-03**
2.	**Agrigenetics, Inc., Mycogen Seeds (Dow Agrosciences)**	**US20050076401A1**	Inbred corn line 4VP500	Drought Heat	**2005-04-07, 2003-09-15**
3.	**Agrinomics LLC (Joint venture – Exelixis Plant Sciences and Aventis CropScience)**	**EP1685242A4** WO05002326A3 US20070266454A1	Generation of plants with improved drought tolerance	Drought	**2007-12-12, 2004-06-23**
4.	**Agrinomics LLC (Joint venture – Exelixis Plant Sciences and Aventis CropScience)**	**US20070266453A1** WO05002325A3	Generation of plants with improved drought tolerance	Drought	**2007-11-15 2004-06-23**
5.	**BASF Plant Science GmbH and Performance Plants, Inc.**	**US20080072350A1** WO03012116A2 WO0216625A3 US20060037108A1 US20060031966A1 US20060021092A1 US20040219525A1 US20040010821A1 US20030204865A1 US7262338 US7172881 JP2004521610T2 EP1421197A2 EP1349946A2 CN1564869A CA2456050AA CA2420325AA BR0113512A AU0188478A5 ZA0301579A	Polynucleotides encoding plant prenyl proteases	Drought	**2008-03-20, 2007-07-17**
6.	**BASF Plant Science GmbH**	**US20080072347A1** WO0246442A3 WO0177356A3 WO0177355A3 WO0177354A3 WO0177311A3 WO0177161A3 US20070226842A1 US20070192908A1 US20070157344A1 US20070157334A1 US20070079400A1 US20040216183A1 US20040199946A1 US20040194163A1 US20040148658A1 US20040128721A1 US20040107463A1	Transcription factor stress-related proteins and methods of use in plants	"Environ-mental Stress"	**2008-03-20, 2007-05-23**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		US20030097675A1 US20020152502A1 US20020102695A1 US20020069432A1 US20020066124A1 US20020059662A1 US7271316 US7259294 US7189893 US7179962 US7166767 US7161063 US6867351 US6818805 US6720477 US6710229 US6689939 US6677504 ES2279810T3 ES2277922T3 ES2272466T3 ES2272461T3 EP1881073A3 EP1795600A3 EP1783229A3 EP1760146A3 EP1760145A3 EP1728870A3 EP1373530B1 EP1335986B1 EP1311693B1 EP1294912B1 EP1268830B1 EP1268830A2 EP1268828B1 DE60131772C0 DE60126920T2 DE60126920C0 DE60126771T2 DE60126771C DE60125245T2 DE60125245C0 DE60124880T2 DE60124880C0 DE60123079T2 DE60123079C0 CA2405750AA CA2405721AA CA2405708AA CA2405703AA CA2405697AA CA2404857AA AU0243190A5 AU0155261A5 AU0155250A5 AU0155249A5 AU0153247A5 AU0149941A5 AT0380248E AT0355383E			

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		AT0354666E AT0348181E AT0346945E AT0339509E			
7.	**BASF Plant Science GmbH**	**US20080052792A1** WO0145495A3 WO0145494C2 WO0145494A3 WO0145493A3 WO0145492A3 US20070261131A1 US20070157343A1 US20050014265A1 US20040111768A1 US20040055032A1 US20030217392A1 US7235713 US7223903 US7220896 US7164057 ES2279777T3 ES2258489T3 EP1797754A1 EP1280398A2 EP1280397B1 EP1251731A2 EP1244349B1 DE60034069T2 DE60034069C0 DE60027772T2 DE60027772C0 AU0129136A5 AU0129123A5 AU0127341A5 AU0127340A5 AT0357135E AT0324780E	Transcription factor stress-related proteins and methods of use in plants	Salinity Drought Temperature	**2008-02-28, 2007-05-24**
8.	**BASF Plant Science GmbH**	**US20080005808A1** WO06050038A3 EP1807523A2 EP1707145A2 CN11072877A CA2583173AA AU5302590AA	Vesicle Trafficking Stress-Related Polypeptides and Methods of Use in Plants	"Water-limited" conditions	**2008-01-03, 2005-10-27**
9.	**BASF Plant Science GmbH**	**US20070294783A1** WO06044912A2 EP1805310A2 CN11040048A CA2582304AA AU5295398AA	Scarecrow-Like Stress-Related Polypeptides and Methods of Use in Plants	"Water-limited" conditions	**2007-12-20, 2005-10-19**
10.	**BASF Plant Science GmbH**	**US7303919** US7176026 WO03040171A3 US20080050820A1 US20070157345A1 US20050066396A1 US20030182692A1 EP1451326A4 CA2466412AA	Protein kinase stress-related polypeptides and methods of use in plants	"Environ-mental stress"	**2007-12-04, 2006-12-12**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
11.	**BASF Plant Science GmbH**	**WO07118790A3**	Active potassium channel transporters (AKT) and their use to create stress tolerant plants	Increased growth under normal or stress conditions	**2007-10-25, 2007-04-03**
12.	**BASF Plant Science GmbH**	**EP1910545A2** WO07012576A3 CA2615837AA AU6274048AA AR0054509A1	Combination of lipid metabolism proteins and uses thereof	Increasing plant growth under adverse conditions of drought, cold, or light	**2008-04-16, 2006-07-14**
13.	**BASF Plant Science GmbH**	**US7220585** WO03040344A3 US20080022427A1 US20030172408A1 EP1451325A4 CA2465951AA	Transcription factor stress-related polypeptides and methods of use in plants	Drought Low Temperature	**2007-05-22, 2002-11-12**
14.	**BASF Plant Science GmbH**	**US20070111311A1** EP1615998A4 EP1654368A2 US20060137042A1 WO04092349A3 WO05014828A3 NO20054490A0 CN1813060A CA2532312AA CA2521752AA	Plant cells and plants with increased tolerance to environmental stress	"Environ-mental Stress"	**2007-05-17, 2005-10-14**
15.	**BASF Plant Science GmbH**	**EP1915452A2** WO07020198A2 AU6281420AA	Nucleic acid sequences encoding proteins associated with abiotic stress response and plant cells and plants with increased tolerance to environmental stress	Environmental Stress	**2008-04-30, 2006-08-03**
16.	**BASF Plant Science GmbH**	**WO07110314A3**	Proteins associated with abiotic stress response and homologs	Drought, Heat, Cold, Salt	**2007-10-04, 2007-03-12**
17.	**BASF Plant Science GmbH**	**WO07011771A3** AU6270193AA AR0054173A1	Yield increase in plants overexpressing the MTP genes	"Environmental Stress"	**2007-01-25, 2006-07-13**
18.	**BASF Plant Science GmbH**	**WO07011736A3** EP1907555A2 AU6270158AA AR0054170A1	Yield increase in plants overexpressing the SHSRP genes	"Environmental Stress"	**2007-05-24, 2006-07-13**
19.	**BASF Plant Science GmbH**	**WO07011681A3** EP1907554A2 AU6270287AA AR0054167A1	Yield increase in plants overexpressing the HSRP genes	"Environmental Stress"	**2007-08-23, 2006-07-13**
20.	**BASF Plant Science GmbH**	**WO07011625A3** EP1907552A2 AU6270321AA AR0054171A1	Yield increase in plants overexpressing the ACCDP genes	Environmental stress	**2007-06-07, 2006-07-13**
21.	**BASF Plant Science GmbH**	**WO06134162A3** EP1896575A2 CA2612016AA AU6259019AA AR0053638A1	Lecitin-like protein kinase stress-related polypeptides and methods of use in plants	Drought, low temperature	**2007-03-22, 2006-06-16**
22.	**BASF Plant Science GmbH**	**EP1520028A4** US20040016016A1	Compositions and methods for improving	Drought	**2006-08-16, 2003-**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		WO04000015A3 CA2485689AA AU3238286AA	plant performance		**06-19**
23.	**BASF Plant Science GmbH**	**WO06055631A3** US20080052794A1 EP1814378A2 CN11102665A CA2587401AA AU5307824AA AR0051503A1	Casein kinase stress-related polypeptides and methods of use in plants	Drought, temperature	**2006-05-26, 2005-11-17**
24.	**BASF Plant Science GmbH**	**WO06032707A3** EP1794304A2 CA2579927AA AU5286427AA	Plant cells and plants with increased tolerance to environmental stress	Environ-mental stress	**2006-12-07, 2005-09-23**
25.	**BASF Plant Science GmbH**	**US20060064784A1** WO04018687A3 EP1529112A2 CA2494626AA AU3246349AA	Nucleic acid sequences encoding proteins associated with abiotic stress response	Environ-mental stress	**2006-03-23, 2003-07-01**
26.	**Bayer Bioscience N.V.**	**WO07107326A1**	Stress resistant plants	Stress resistant	**2007-09-27, 2007-03-16**
27.	**Bayer Bioscience N.V.**	**WO06045633A1** EP1807519A1 CN11090971A AU5298784AA	Stress tolerant cotton plants	Abiotic stress	**2006-05-04, 2005-10-27**
28.	**Bayer Bioscience N.V.**	**WO06032469A3** EP1794306A2 US20070300322A1 KR7060128A CN11040049A CA2581257AA AU5287499AA AR0056256A1	Stress resistant plants	Stress tolerant	**2006-07-06, 2005-09-16**
29.	**Bayer CropScience GmbH**	**US20070124839A1** WO07062737A3 DE102005057250A1 AR0057179A1	Active substances for increasing the stress defense in plants to abiotic stress, and methods of finding them	Abiotic	**2007-05-31, 2006-11-27**
30.	**Ceres, Inc.**	**US7241937** WO05105836A3 US20060064785A1 EP1740705A2 MX6012262A CN1973044A CA2564807AA BRI0510155A BR0510155A AU5238475AA	Methods and materials for improving plant drought tolerance	Greater growth rate under drought conditions, enhanced drought recovery, or lower transpiration rate	**2007-07-10, 2005-04-22**
31.	**Ceres, Inc.**	**US20060150285A1** WO06066193A3 US20060143735A1	Nucleotide sequences and polypeptides encoded thereby for enhancing plant drought tolerance	Abiotic stress (e.g., high or low temp., drought, flood)	**2006-07-06, 2005-12-16**
32.	**Ceres, Inc.**	**EP1831379A2** WO06066134A3 CN11115841A CA2592919AA AU5316360AA	Nucleotide sequences and polypeptides encoded thereby useful for enhancing plant drought tolerance	Abiotic stress (e.g., high or low temp., drought, flood)	**2007-09-12, 2005-12-16**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
33.	**Ceres, Inc.**	**US20060112454A1** WO05118823A3 EP1753865A2 CA2568367AA BRI0510481A AU5250447AA	Nucleotide sequences and polypeptides encoded thereby useful for modifying plant characteristics	Abiotic stress e.g. low temperature, drought, or salinity	**2006-05-25, 2005-05-27**
34.	**Evogene Ltd**	**EP1625199A4** WO04104162A3 US20060123516A1 WO07020638A2 RU5140106A MX5012565A CN1823168A CA2526440AA BR0411182A	Methods of increasing abiotic stress tolerance and/or biomass in plants and plants generated thereby	Abiotic stress, such as salinity, water deprivation, low temp., high temp., or UV irradiation	**2007-11-28, 2004-05-20**
35.	**Evogene Ltd.**	**WO07049275A2**	Isolated polypeptides, polynucleotides encoding same, transgenic plants expressing same and methods of using same	Stress tolerance	**2007-05-03, 2006-10-24**
36.	**Mendel Biotechnology, Inc.**	**US20070240243A9** US20070226839A1 US20060015972A1 US20050097638A1 EP1546336A4 WO06033708A3 US7238860 US7223904 US7193129 US7135616 US6946586 US6717034 US6664446 WO05047516A3 WO05038034A3 WO05030966A3 WO04076638A3 WO04031349A3 WO03014327A3 WO03013228A3 WO03013227C2 WO03013227A3 WO02079403C2 WO02079403A3 WO02077185A3 WO0217430A1 WO0215675C1 WO0215675A1 WO0136598A1 WO0136597A1 WO0136444A1 WO0135727A1 WO0135726A1 WO0135725A1 WO0126459A3 US20080010703A1 US20070209086A1 US20070186308A1	Plant transcriptional regulators of drought stress	Drought	**2007-10-11, 2003-11-13**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		US20070101454A1 US20070061911A9 US20070033671A1 US20070022495A1 US20060272060A1 US20060242738A1 US20060162006A9 US20050172364A1 US20050160493A9 US20050155117A1 US20050120408A9 US20050086718A1 US20050076412A1 US20040128712A1 US20040045049A1 US20040019927A1 US20040019925A1 US20030233680A1 US20030229915A1 US20030226173A1 US20030217383A1 US20030188330A1 US20030167537A1 US20030131386A1 US20030121070A1 US20030101481A1 US20030093837A1 US20030061637A1 US20030046723A1 US20030041356A1 US7345217 US7196245 MX3008922A MX2004884A MX2004882A MX2004881A MX2004880A MX2004878A MX2004870A MX2003669A JP2004500044T2 EP1682668A2 EP1673462A2 EP1668140A2 EP1659180A3 EP1601758A4 EP1566444A3 EP1485490A4 EP1420630A4 EP1420630A2 EP1406483A4 EP1381268A4 EP1312132A1 EP1231835A4 EP1230345A4 EP1230344A4 EP1230256A4 EP1229782A4 EP1229781A4 EP1229780A4			

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		CA2516645AA CA2456979AA CA2456972AA CA2442496AA CA2391569AA CA2391446AA CA2391443AA CA2390600AA CA2390597AA CA2390594AA CA2386170AA BR0416473A BR0415345A BR0414654A BR0407822A BR0314389A BR0208573A BR0015635A BR0015634A BR0015633A BR0015632A BR0015631A BR0015628A BR0014750A AU4290050AA AU4214935AA AU3285856AH AU3285856AA AU2313749AA AU2245718AA AU0780463B2 AU0186617A5 AU0183439A5 AU0119199A5 AU0117683A5 AU0117682A5 AU0117671A5 AU0117656A5 AU0116101A5 AU0115698A5			
37.	**Mendel Biotechnology, Inc.**	**WO07028165C1** WO07028165A2 US20060195944A1	Stress tolerance in plants	Abiotic stress; may include include salt, hyperosmotic stress, heat, cold, drought, or low nitrogen conditions	**2008-04-03, 2006-08-31**
38.	**Mendel Biotechnology, Inc.**	**WO06069201A3** EP1836307A2 CA2591936AA	Plant stress tolerance from modified AP2 transcription factors	Abiotic stress	**2006-06-29, 2005-12-20**
39.	**Monsanto Technology LLC**	**US7230165** EP1546334A4 WO04013312A3 US20040045051A1 CN1681928A CA2492945AA BR0313270A AU3268083AH	Tocopherol biosynthesis related genes and uses thereof	Drought	**2007-06-12, 2003-08-05**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		AU3268083AA			
40.	**Monsanto Co.**	**WO08002480A2** US20080040973A1 US20080040972A1 US20080000405A1 US20070295252A1 US20070271636A1	Transgenic crop plants with improved stress tolerance	Water deficit stress	**2008-01-03, 2007-06-23**
41.	**Monsanto Technology LLC**	**WO07027866A3**	Transgenic plants with enhanced agronomic traits	Enhanced nitrogen use efficiency, increased yield, enhanced water use efficiency, enhanced tolerance to cold stress	**2007-03-08, 2006-08-30**
42.	**Monsanto Technology LLC**	**WO05060664A3** US20050235377A1 EP1699926A4	Stress tolerant plants and methods thereof	Abiotic stress	**2005-07-07, 2004-12-08**
43.	**Monsanto Technology LLC**	**WO05033318A3** US20050097640A1 EP1668141A2 MX6003596A KR6080235A JP2007507229T2 CN1886514A CA2540348AA BR0414880A AU4278752AB AU4278752AA	Methods for enhancing stress tolerance in plants and methods thereof	Abiotic stress	**2005-04-14, 2004-09-29**
44.	**Monsanto Technology, LLC**	**WO07044043A2** WO06069017A2 US20060179511A1 EP1827079A2 EP1827078A2 CA2595171AA AU5337132AA AU5319354AA AR0051856A1	Transgenic plants with enhanced agronomic traits	Enhanced nitrogen use efficiency, increased yield, enhanced water use efficiency, enhanced tolerance to cold stress	**2007-04-19, 2005-12-19**
45.	**Pioneer Hi-Bred International, Inc. (DuPont)**	**US7317141** US7253000 US20060026716A1 US20060162027A1 WO05103075A1 AR0048710A1	Transcriptional activators involved in abiotic stress tolerance	Abiotic stress, e.g. cold or drought	**2008-01-08, 2006-03-22**
46.	**Plant Research International B.V. (Wageningen University)**	**WO07030001A1**	A transgenic plant having enhanced drought tolerance	Drought	**2007-03-15, 2005-09-06**
47.	**Syngenta Participations AG**	**US20060075523A1** WO03027249A3 WO03008540A3 WO03007699A3 WO03000906A3 WO03000905A3 WO03000904A3 WO03000897A3 US20070089180A1 US20070056055A1	Abiotic stress responsive polynucleotides and polypeptides	Abiotic stress such as cold stress, salt stress or osmotic stress	**2006-04-06, 2005-09-14**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		US20050177901A1 US20050032156A1 US20040016025A1 US20040010815A1 US20030135888A1 EP1576163A4 EP1409696A2 EP1402042A2 EP1402038A2 EP1399561A2 AU2345250AA AU2341542AA AU2341541AA AU2325266AA AU2316997AA AU2314417AA			
48.	**Syngenta Participations AG**	**WO07060514A3**	Methods and compositions for modulating root growth in plants	Abiotic stress	**2007-05-31, 2006-08-04**
49.	**Syngenta Participations AG**	**US20070006344A1** EP1742527A2 WO05102034A3 CN11023175A BRI0510045A AU5235311AA	Regulatory sequences for expressing gene products in plant reproductive tissue	Abiotic stress	**2007-06-21, 2005-04-19**
50.	**Syngenta Participations AG**	**WO05084331A3**	Sorghum gene expression profiling	Abiotic stress	**2005-09-15, 2005-03-01**
51.	**Syngenta Participations AG**	**WO05021723A3** US20050097639A1	Nucleic acid molecules from rice controlling abiotic stress tolerance	Abiotic stress, Drought	**2005-03-10, 2004-08-27**
52.	**Syngenta Participations AG**	**US7230159** WO03076597A3 US20050120410A1 AU3220146AH AU3220146AA	Nucleic acid sequences encoding the BOS1 gene and promoter from *Arabidopisis thaliana* and uses thereof	Biotic and/or abiotic stress tolerance, and to use such nucleic acids to assist germplasm enhancement by breeding	**2007-06-12, 2005-01-14**
53.	**Syngenta Participations AG**	**WO03048319A3** US20040219675A1 EP1453950A4 AU2357044AH AU2357044AA	Nucleotide sequences encoding proteins conferring abiotic stress tolerance in plants	Abiotic stress tolerance, enhanced yield, disease resistance, or altered nutritional composition	**2003-06-12, 2002-11-27**
54.	**None (University of California-Davis)**	**US7256326** US7250560 US7244878 US7041875 US6936750 US20060195948A1 US20030046729A1 US20050144666A1 US20050155105A1 US20050204430A1 WO9947679A3	High salt plants and uses for bioremediation	Salt	**2007-08-14, 2005-02-24**

	ASSIGNEE	PATENT/APP. # and patent family members	TITLE	TARGETED STRESS	PUB. DATE, FILE DATE
		CA2323756AA AU2821499A1			
55.	**None**	**US20050034191A1**	Salt tolerant oil crops	Salt	**2005-02-10, 2003-07-10**

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