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Patents, Climate Change and African Agriculture: Dire Predictions

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The African Centre for Biosafety (ACB) is a non-profit organisation, based in Johannesburg, South Africa. It provides authoritative, credible, relevant and current information, research and policy analysis on genetic engineering, biosafety, biopiracy, agrofuels and the Green Revolution push in Africa.

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Introduction

Uncertainty and apprehension often afford opportunity to the cunning. This is certainly the case with climate change. The multinational seed and agrochemical industry see climate change as a means by which to further penetrate African agricultural markets by rhetorically positioning itself, even if implausibly, as having the solution to widespread climate concerns. Their so-called "final solution" to deal with the impact of climate change on African agriculture depends on mass adoption of GM seeds and chemically intensive agricultural practices. This model poses serious biosafety risks and demands the surrender of Africa's food sovereignty to foreign corporations and the widespread acceptance of patents on life in Africa.

Despite its obvious pitfalls, this model is being aggressively promoted by multinationals, private philanthropy and some African national agricultural research programmes, often funded by the first two. The money and public relations forces backing the seed giants threaten to drown out other voices and other possibilities for African agriculture.

In this briefing, we expose the forces behind "climate ready" crops, including the central role played by gene giant Monsanto and provide data on patents on climate genes in respect to key African staple and other food crops.

Unsettling Climate Predictions for Africa

Africa may suffer greater environmental consequences from climate change than any other major world region. Although estimates are continually being revised and vary by region of the continent, it is very likely that climate change is creating conditions that will reduce the yield of current agricultural systems, exacerbating food security problems and creating new challenges.

The Intergovernmental Panel on Climate Change (IPCC) paints an unpleasant picture in its *2007 Synthesis Report*. Climate change, the IPCC has concluded, may "severely compromise"[1] Africa's agricultural yields, reducing them by up to 50% in some countries.

The Panel predicts large-scale changes in rainfall by 2020, with North and Southern Africa becoming drier and parts of East Africa potentially becoming wetter. On balance, the continent will be more arid: by 2080, the IPCC concludes there will be 5-8% more desert and dry-lands than at present. The continent is particularly vulnerable to changes in rainfall because, in Sub-Saharan Africa, over 95% of agriculture is rain-fed.[2] Drought impacts more harshly on crop yields in Africa than in regions where there is access to water for irrigation.

Compounding these problems, the IPCC notes that by the end of the 21st Century rising sea levels will compromise low lying coastal areas, damaging productive river deltas and salinifying fresh water supplies in coastal areas.[3]

Temperature increases will be particularly acute in Africa. The continent is predicted to be 3-4 degrees Celsius hotter by the end of the century (or sooner). This is a 50% greater rise in temperature than is predicted for the world on average.[4] Higher temperatures will change agriculture by, for example, shortening growing seasons for some crops and inhibiting pollination in others.

To maintain and expand food production and support the livelihoods of hundreds of millions of people in rural communities, African agriculture must respond to climate change, but how? By embracing a genetic engineering dream of multinational agrochemical and seed giants, or by relying on its own resources and innovative talent?

Responding to Climate Change: Surrender to Multinationals or Find African Solutions?

On a geological time scale, climate change is occurring with dizzying speed. On a human time scale it is unfolding somewhat more gradually, and will be felt more greatly between generations than within them.

The glimpse of a potentially dire future, provided by scientific observations and predictions, affords African farmers the possibility of collectively responding to new conditions, using traditional knowledge and *in-situ* methods, supported by agricultural research and extension, to create the seeds and production systems necessary to cope with a rapidly changing environment.

However, Africa is under constant pressure to extend the patent rights of the multinational seed industry, which argues that seed patents are needed in order for it to commercialize hybrid and other crop varieties. Patent monopolies undermine and stymie climate adaptation by African farmers because it constrains the free exchange of and experimentation with crop germplasm – critical activities for the development of African solutions.

The world's largest seed and agrochemical companies view climate change as an opportunity to portray themselves as indispensible, and to further dominate global seed markets with their idea of "modern" agricultural practices (which, not by coincidence, bring them the greatest profit). These include the increased use of hybrid and genetically engineered seed varieties, supplanting open pollinated varieties and saved seed, and the increased application of agricultural chemicals.[5]

The activity of multinational seed and agrochemical companies in African national markets is presently variable, depending on the country and its dominant crops. Their presence is currently felt far more strongly in, for example, the temperate regions of Southern Africa where maize is grown on a large scale, than in the central African rainforest. The seed giants are seeking to expand their African presence, however, and their arrival has been heralded by pressure to expand intellectual property rights over plants.[6]

Syngenta, Monsanto, and others are positioning themselves to further penetrate African markets clutching the climate change banner. For example, Africa is currently a relatively

minor market for US-based Monsanto, but the company's ambition is clearly reflected on dozens of pages on its website (www.monsanto.com), which contains both the terms "climate change" and "Africa".[7]

The technological approach of the mega agricultural corporations is to use biotechnology to identify so-called "climate genes" related to stresses on crop plants that are likely to become more prevalent as the world's climate changes. These "abiotic" stresses include drought, heat, and salinity. By patenting genes conferring resistance to these stresses, and transferring them into seeds, companies hope to turn a changing climate into fat profits by opening up markets to genetically engineered crops.

Already in 2007, Monsanto bagged permits from the South African regulatory authority to conduct field trials with 4 events of its abiotic stress corn over a three year period. Monsanto is also conducting studies on drought tolerant soybean and cotton.[8]

Monsanto's Chairman Hugh Grant claims of his company's GE crop research: *"We're on the verge of an unprecedented technology explosion"*.[9] Nevertheless, "climate ready" crops are presently far more theoretical than real. No such crops have been commercialized anywhere in the world. Yet biotechnology media spin continues to promote GM climate crops such as drought tolerant maize as a fait accompli and the answer to maintaining agricultural productivity in a changing climate.

Even if GM drought tolerant crops were to be commercialized, these crop plants are not an appropriate developmental intervention for Africa to address climate change. An expensive and chemically-dependent agricultural system does not work where most farmers are unable to afford high-cost seed and extensive industrial inputs. This is quite apart from the biosafety risks that these crops pose, as well as the food sovereignty that Africans will have to surrender to enable the biotech industry to achieve a rural Africa smothered by patented "climate ready" GM cereals and grains.

Thus, social upheaval including land concentration, employment shifts and sacrifice of cultivated agricultural biodiversity are consequences that will flow from the adoption of these GM climate crops – if they were ever introduced on a large scale in African agriculture. It is well argued that GM "climate genes" are a distraction from real climate change solutions in agriculture.[10]

A Hard Look at Climate Change Patents and African Agriculture

A 2008 study by the ETC Group identified 532 patent applications on climate genes around the world.[11] The actual number today is certainly even higher, as the very limited availability of patent application information from some patent offices as well as publication delays due to patent secrecy obfuscates the true picture.[i] Moreover, since 2008, many new applications have been filed.

i The South African patent office, for example, does not publish patent applications. Patent documents are only published after a patent is granted.

A variety of approaches are taken in these patent claims. A few focus on specific crops, particularly major crops such as maize, soya, and cotton. More commonly, however, climate change related patent applications claim genes and biotech techniques that (in theory) can be used on a large variety of plants.

Thus the wave of climate-related crop patent claims typically do not only cover key global crops such as soya, maize, and rice, but also extend into others that are nationally or regionally important and may be central to food security and the rural economy in particular countries or regions.

In Africa examples of such crops include a variety of millets, cooking bananas, African rice, sorghum, Teff, and many others. While most climate gene patent claims are broad, in some cases companies have specifically claimed the use of climate genes in African crops. Some of these cases are highlighted below.

Gene Prospectors and Agrochemical Giants Unite

Large seed and agrochemical companies have formed research alliances between themselves and with smaller companies involved in "gene discovery" relating to climate change crops. The largest commercial collaboration to date is a $1.5 billion deal between Monsanto and the German chemical company BASF,[12] both of which in their own right hold major portfolios of climate change related patent claims. In June 2009, Monsanto in conjunction with BASF announced the discovery of a naturally-occurring gene that can help maize plants combat drought conditions and confer yield stability during periods of inadequate water supplies.[13] The gene in question was first identified in the bacterium *Bacillus subtilis* subjected to cold stress conditions and further research has demonstrated that cspB helps plants cope with drought stress. Monsanto hope to make the drought tolerant plants commercially available by as early as 2010 pending the necessary regulatory approvals. Additionally Bayer,[14] Syngenta,[15] Dow, BASF[16] and DuPont[17] all have extensive research programs in the area of drought tolerance.[18]

Monsanto has also clinched climate change deals with Ceres,[19] Mendel Biotechnology,[20] and Israel-based Evogene;[21] all smaller biotechnology companies that are aggressively filing patents. These companies are working with Monsanto to commercialize climate change related genes. In mid-2008, Monsanto acquired a 13% equity stake in Evogene.[22]

However, Monsanto is not alone in working with Evogene, which has developed genome analysis and gene identification methods that are particularly attractive to the seed giants. Evogene also has climate change related collaborations with DuPont (owner of Pioneer Hi-Bred)[23] for soya and maize and with the French government's Centre de cooperation internationale en recherché agronomique pour le développement, (CIRAD) for cotton.[24] It has other deals with Syngenta (soya pest resistance) and Bayer (rice productivity).[25] It even has a venture in Namibia to produce agrofuels from desert plants.[26]

Public-Private Research Agreements

Research alliances often further extend into public sector plant breeding and research programs through collaborative agreements.

Ceres, a Monsanto ally, has signed a deal for exclusive access to high biomass sorghum lines from Texas A&M University.[27] Sorghum is a major African (and Texas) crop that is notably drought-tolerant. Its qualities have recently attracted renewed interest in the crop for grain, agrofuels and fodder production, including a controversial genetic engineering project in South Africa.[28] For decades, Texas A&M has been a major US and international source of publicly released sorghum breeding lines; however, this public resource has now been endangered through Ceres' exclusive arrangement.

The Water Efficient Maize for Africa ("WEMA") project has a particular focus on the continent. Funded by the Bill and Melinda Gates and Buffet Foundations, the WEMA project involves Monsanto, the International Maize and Wheat Improvement Center (CIMMYT, based in Mexico), the African Agricultural Technology Foundation and the national agricultural research institutions of Kenya, Uganda, Tanzania and South Africa.

The project aims to develop and release conventional and transgenic drought-resistant maize varieties which, its sponsors say, will be made available royalty-free to small farmers in Southern Africa. Project participants play up the fact that Monsanto is allowing the project to use some of its proprietary maize germplasm and biotechnology techniques.

While Monsanto and partners characterize WEMA as an example of corporate largesse and how biotechnology can (allegedly) solve climate change challenges, critics including the African Centre for Biosafety charge that it is more accurately understood as a Trojan horse intended to hook African farmers on GM seeds, and Monsanto products in particular.[29]

A Sample of Patent Claims Extending to African Crops

It is impossible to predict which, if any, of the hundreds of patent claims on climate genes will ultimately prove commercially valuable or useful in Africa. Because most claims are so broad – applying to use of the genes in almost any plant – at this stage of technological development, there are few concrete examples beyond predictable attempts to introduce transgenic drought tolerance traits into the largest global crops such as maize and rice. (All of which remain, as of late 2009, experimental.)

Nevertheless, patent documents often make specific assertions about African crops. A complete survey would run to hundreds of (repetitive) pages. Here, a sample of the types of climate related crop claims that are being made is provided, to offer a more concrete view of potential implications for Africa:

- In WO2009013750,[30] Evogene claims more than 700 climate-related gene sequences in a single patent application. This is merely one of the Monsanto-linked company's many patent claims on climate-related genes.

The 700 sequences relate to stress tolerance, biomass accumulation, and yield in plants. The claims extend to the use of the gene sequences in any plant, although the patent application contains a list of preferred plants in which the company suggests its biotech approach is particularly appropriate. These include key crops for Africa such as maize, peanut, cotton, wheat, manioc, sugar cane and banana, as well as important vegetable crops such as tomatoes, peppers, eggplant, and others.

Evogene's list also includes a number of economic plants (e.g. ornamentals and tree species) and crops native to Africa, some of which are important to many other countries in the world. Some of these are summarized in the following table:

Scientific name	English common name(s)
Abelmoschus esculentus	Okra
Albizia amara	Bitter albizia
Baikiaea plurijuga	Rhodesian Teak, Zambian Teak, Zambesi Redwood
Coffea Arabica	Coffee
Eleusine coracana	Finger millet
Peltophorum africanum	Weeping wattle
Pennisetum sp.	Pearl millet and other millets and grasses
Sorghum bicolor	Sorghum
Sporobolus fimbriatus	Dropseed grass (used for forage)

- Another Monsanto ally is US based genomic technology company, Ceres Inc., now also billing itself as "the energy crop company".[31] Ceres' businesses include selling its own seeds, which include types of sorghum and other grasses designed for the production of agrofuels. The company is also a "gene and trait provider" for traditional food and other crops, some which may be marketed by Monsanto.[32]

Ceres has filed for patent monopoly on a wide variety of climate-related genes. A wave of recent Ceres patent applications stake claims to climate genes in both energy (agrofuels) crops and in food crops. Like Evogene's tide of claims, Ceres' patent applications are too numerous to discuss each in detail. Some, however, are summarized in the following chart:

Patent application	Title	Indicative climate change application
WO2009102965	Drought and Heat Tolerance in Plants	Reduce use of water
WO2008073617	Increasing Tolerance of Plants to Low Light Conditions	Adapting crops to higher latitudes or altered growing season at high latitudes
WO2008069878	Modulating Lignin in Plants	Sequestering carbon, increasing biomass (for agrofuels)
WO2008064222	Shade Tolerance in Plants	Increase planting densities
WO2008064128	Broadly Expressing Regulatory Regions	Control expression of stress related genes
WO2007106593	Nucleotide Sequences and Corresponding Polypeptides Conferring an Altered Flowering Time in Plants	Enhance fertilization by inducing early flowering in crop plants
WO2007044988	Nucleotide Sequences and Polypeptides Encoded Thereby Useful for Modifying Plant Characteristics in Response to Cold	Faster germination

Some Ceres patent applications claim dozens of gene sequences or, in some applications, such as WO2009102965, hundreds of gene sequences. In many cases the aggressive style of the claims also covers any other gene sequences 70% or more similar to those provided.

Ceres' patent applications claim use of the genes in a wide variety of plants, often as wide as claiming use of the gene sequences in all monocotyledonous and dicotyledonous plants. Plants that are specifically noted in patent claims include a number that are particularly important for Africa, including sorghum, maize, cotton, millets, rice, sugarcane, coconut and oil palms, and many others

- Switzerland-based Syngenta, one of Monsanto's competitors in genetically engineered crops, is also lining up climate change related patent claims. Many of these are drought and agrofuels related and have implications for Africa. Syngenta's patent claims include:

Patent application	Title	Indicative climate change application
EP1925672 (A1)[33]	Abiotic stress responsive polynucleotides and polypeptides	Saline soil resistant plants
WO2006060376	Stress tolerance in Plants through Selective Inhibition of Trehalose-6-phosphate Phosphatase	Drought resistant plants
WO2005084331	Sorghum Gene Expression Profiling	Drought resistant plants
WO2005021723	Nucleic Acid Molecules from Rice Controlling Abiotic Stress Tolerance	Drought resistant plants

- In WO2007028121, the US firm Evolutionary Genomics claims that it has identified yield related gene sequences from maize, wheat, barley, sugarcane, sorghum, pearl millet, rice (*O. sativa*) and red rice (*O. rufipogon*). (Red rice is a wild relative and weed of cultivated rice that is also thought to be a key wild ancestor of the domesticated crop.)[34]

The patent application claims use of the gene sequences in marker-assisted breeding to increase crop yield. Evolutionary Genomics has signed an exclusive deal with Texas-based RiceTec for the latter to commercialize its rice yield technologies.[35] (RiceTec gained notoriety in 1998 when it was granted a US patent on Indian basmati rice lines, which was subsequently challenged by the Indian government.)

- Another aspect of climate change relates to the shifts in the geographic range and severity of plant diseases and pest infestations. For instance, warmer or wetter conditions could be conducive to fungal infections or alter populations of insect pests and/or their natural predators.

A number of companies and institutions have recently made patent claims on genes that could be used to combat disease and pest problems influenced by climate change. These include claims by DuPont, the University of Maryland (US), and Michigan State University (US).

In WO 2006083399, the University of Maryland lays claim to a method of genetically engineering plants so that they have stronger resistance to bacterial and fungal infections. It claims use of the technique for rice and maize (and others); specifically including the African rice species *Oryza glaberrima. O. glaberrima* is a subject of scientific interest, but is infrequently cultivated outside of Africa. Thus the claim suggests an intention to pursue the patent on the continent.

In WO2006050313, Michigan State University claims more than 100 plant, animal, and microbial gene sequences (including sequences from human beings and the African clawed frog, *Xenopus laevis*) for the purpose of genetically engineering plants to make them unpalatable to insect pests. The patent application asserts a claim to use of the genes in any crop plant as well as a number of tree types.

- Through its subsidiary Pioneer Hi-Bred, DuPont Corporation is also claiming climate genes. In WO2009094527, DuPont claims "transcriptional activator" sequences related to abiotic stress, particularly drought and temperature. The "transcriptional activators" (also called transcription factors), are genetic sequences that regulate (i.e. turn on and off) stress related genes. Potentially, these sequences can be used to regulate the operation of multiple genes related to particular abiotic stresses. DuPont claims use of the sequences in all monocotyledonous and dicotyledonous plants, but specifically includes maize, barley, wheat, oat, rye, sorghum, rice, soybean, alfalfa, safflower, tobacco, sunflower, cotton and canola (rape).

- Monsanto ally Mendel Biotechnology has also focused on transcription factors related to abiotic stress. In WO2007028165, one of many patent applications, Mendel/ Monsanto claim transcription factors identified in the experimental plant Arabidopsis and counterparts that the company identified in major food crops – particularly soya, rice, and maize – although the claims extend to any plant.

- BASF, sometimes through its Belgium-based subsidiary Cropdesign, has filed numerous climate change related patent applications. In WO2009065912, BASF make sweeping claims to the use of genes from diatoms (a type of algae) to increase "yield-related traits". In the application, the terminology can be misleading as the "yield related traits" do not all relate to intrinsic crop yield. Rather, they include traits such as making a plant grow faster or adapt to temperature extremes.

Like other companies, BASF claims use of the sequences in practically all plants, including many that are important for Africa. BASF specifically lists crops including millets, cotton, rice, sweet potatoes, sugarcane, tobacco, and many horticultural crops including papaya, passion fruit, peppers and custard apples (*Annona spp.*). BASF reaches further to claim use of the genes in smaller crops including cola nuts, brazil nuts, edible cacti (*Opuntia spp.*), hibiscus, pomegranate, and many others.

- Michigan State University (MSU) develops turfgrasses for sporting fields, golf courses, parks, urban landscaping, and other uses. It is a large business – in the US the turfgrass seed production industry is second in size only to that of maize seed.[36]

Climate change related stress threatens turfgrass varieties with drought, heat, and other problems. In WO2008097606 and WO2009099415, MSU claims genes from a Moroccan fescue, asserting that these can be inserted into US ryegrasses to make them drought tolerant. MSU also claims the Moroccan genes when inserted into other crops, including important African crops like millets, maize, sorghum and cotton.

Conclusion

There are no easy quick fix solutions to addressing African agriculture's adaptation to climate change. However, we condemn the expediency of the biotechnology in trying to profit from impending tragedy to further its own selfish corporate interests. The so-called solutions proffered by the pro-GM machinery are nothing short of mirages that distract from finding African solutions.

We urge African governments to at least investigate the patent claims set out in this briefing, particularly those that resemble classic "biopiracy" in asserting ownership to African genetic resources that are then sold elsewhere for profits.

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