Genetically Modified Crops in Africa: Implications for Small Farmers

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GRAIN

About this Briefing

This briefing was researched and written by Devlin Kuyek for Genetic Resources Action International (GRAIN) and a group of NGOs that aim to raise awareness about the implications of genetic engineering and intellectual property rights for small farmers in Africa. These NGOs include SACDEP (Kenya), RODI (Kenya), Biowatch (South Africa), ISD (Ethiopia), Jeep (Uganda), CTDT (Zimbabwe), Pelum (Regional, Southern Africa), ITDG (International), Gaia Foundation (International) and ActionAid (International).

The briefing looks at the push to bring GM crops and technologies to Africa and tries to sort out what the implications will be for Africa's small farmers. It especially focuses on the situation in East and Southern Africa. The briefing does not share the optimism of the proponents of genetic engineering. Rather, it views genetic engineering as an extension of the Green Revolution paradigm that failed to address the needs of Africa's small farmers and served only to exacerbate their problems.

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GRAIN is an international non-profit organisation which promotes the sustainable management and use of agricultural biodiversity based on people's control over genetic resources and local knowledge. To find out more about GRAIN, visit our website at www.grain.org

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1. INTRODUCTION

Genetic engineering has made a rapid entry into agriculture. In less than a decade since the commercial introduction of the first genetically modified (GM) crops, more than 50 million hectares have been planted to GM crops around the world.[1] Proponents claim that by transferring genes from one organism to another, genetic engineering can overcome the productivity constraints of conventional plant breeding. It is claimed that the new transgenic crops will reduce pesticide use and increase food security in developing countries—a promise that these countries desperately want to believe. It is also widely claimed that the 'new' global economy will be built on genetic engineering, and any country that stands on the sidelines will lose its future competitiveness. These claims have influenced policy-making circles in Africa. In a letter to then President Bill Clinton of the US, Kenyan President Daniel Arap Moi wrote, *"While the Green Revolution was a remarkable success in Asia it largely bypassed Africa. Today the international community is on the verge of the biotechnology revolution which Africa cannot afford to miss."* [2]

Amidst the enthusiasm for genetic engineering, there has been little space for critical reflection. Is this new technology appropriate for African agricultural systems and what are the implications if it is taken up? The experience of other countries shows that that leaping towards genetic engineering brings with it a wide range of biosafety issues and broader socio-economic impacts. It requires the acceptance of intellectual property rights on living organisms, the privatisation of public research, and expensive research and development (R&D) to the detriment of farmer-based innovation. What will this mean for Africa and its small farmers in particular? Moreover, is there any reason to believe that the new *"gene revolution"* will be any more successful than the failed Green Revolution in Africa?

"Genetic engineering is rapidly moving into the continent, running over biosafety concerns and democratic processes as it goes"

Despite these limitations and the potential dangers of GM crops, genetic engineering is rapidly moving into the continent, running over biosafety concerns and democratic processes as it goes. This briefing looks at who is pushing the technology and who is asking for it; it analyses whether GM crops are safe and questions whether African farmers really need it. It provides several case studies that look at some of the transgenic crops that are being used to lead the charge into Africa. These examples suggest that in addition to offering little to Africa's small farmers, they threaten to further undermine the fragile agricultural systems that these farmers depend upon.

2. THE PAST PREDICTS THE FUTURE

Did Africa miss a revolution?

The Green Revolution was not the complete success in Asia that President Arap Moi suggests. Productivity did increase (in terms of kilos of a single crop per hectare) but gains were mostly confined to areas with conditions suited to the Green Revolution technologies—irrigated lands with access to chemical inputs. So, while Green Revolution rice varieties could achieve yields of 10 metric tonnes per hectare (t/ha) at research stations, in practice most farmers only got 3-6 t/ha.[3] Production gains in a particular monoculture crop were also offset by production losses of other staples, vegetables and

[1] Clive James, "Global Status of Commercialised Transgenic Crops: 2001," *ISAAA Briefs*, No. 24.

[2] Letter from President Moi to US President Bill Clinton: www.biotech-info.net/Moi.html

[3] International Rice Commission, *Country Rice Facts*, FAO, December 1999.

fodder crops. Even where gains were achieved, the Green Revolution varieties were beset by disease and pest troubles that had previously not posed a problem. By demanding the widespread planting of genetically uniform crops under monoculture conditions, the Green Revolution rapidly displaced local varieties, which had much greater genetic potential to resist diseases. This set the stage for epidemics, as pests and diseases quickly overwhelmed the limited resistance potential of the new varieties and spread rapidly over the territories where the new variety was planted. Scientists have tried to keep these problems in check by increasing pesticide use and breeding resistance into new varieties, but they cannot keep up with the innovative capacities of the pests. Furthermore, the toxic nature of pesticides makes them particularly risky to use in developing countries. And, in tragic irony, breeders are slowly losing the race to develop new resistance lines as the widespread adoption of their varieties leads to the disappearance of more and more traditional varieties with the needed resistance genes.[4]

Similar problems exist in industrial countries, where the use of pesticides to defeat the ever-expanding resistance of pests and diseases has spiralled out of control. As a result, many have concluded that the entire logic of the Green Revolution needs to be shaken up. Others, however, are looking for new technology fixes to resolve the looming crises—and they believe biotechnology is the answer. To understand the implications of pushing biotechnology in Africa, it is important to look at Africa's experience with the Green Revolution.

"The Green Revolution crops were not developed for local conditions: rather, local conditions were expected to adapt to the technologies. Throughout most of Africa this was simply too much to ask."

Africa's Green Revolution

The major difference between the African experience of the Green Revolution and the Asian experience is that Africa had far fewer areas with suitable conditions for the Green Revolution technologies. The Green Revolution technologies were not developed for local conditions: rather, local conditions were expected to adapt to the technologies. Throughout most of Africa, this was simply too much to ask.

The technologies did not bypass Africa: they were available but unpopular and ineffective. For example, fertiliser use increased substantially from the 1970s onwards in Sub-Saharan Africa, while per capita agricultural production fell. The Green Revolution's high yielding varieties fared no better. In Malawi, despite the widespread release of hybrid maize, the average maize yield remains about what it was in 1961.[5] Yield increases were also low or stagnant across Africa in other important crops such as cassava, yams, rice, wheat, sorghum, and millet.[6] Even the Rockefeller Foundation admits that Africa's experience raises serious questions about the Green Revolution approach: *"Lingering low yields among African farmers for crops such as maize and rice, where adoption of improved varieties has been appreciable, call into question the overall value of the improved germplasm to local farmers."*[7]

Two major lessons can be drawn from this failed Green Revolution. For one, *"breakthrough"* technologies, brought in from the outside, can only have a limited success in Africa's complex ecology. African soils are generally unsuitable to intensive, monoculture production because of insufficient or excessive rains, high incidence of diseases and pests, and other factors.[8] Proper agricultural management requires a much more complex approach, as farmers across Africa know only too well. As the Rockefeller Foundation has slowly come to understand: *"The complexity of farmers' decision-making can be startling."*[9]

Secondly, the social, economic, and political conditions throughout Africa are as ill suited as the ecology to 'breakthrough' technologies. The World Bank estimates that half of its

[4] For a case study see Devlin Kuyek, *BB Rice: IRRI's First Transgenic Field Test*, Biothai et al, May 2000: http://216.15.202.3/publications/bbrice-en.cfm

[5] Joseph Rusike and Melinda Smale, "Malawi," in Michael Morris, (Ed), *Maize Seed Industries in Developinc Countries*, CIMMYT, 1998.

[6] Humphrey Ezumah and Nkoli Ezumah, "Agricultural development in the age of sustainability: crop production," in G Bennet, WB Morgan, and JI Uitto (Eds), *Sustaining the Future: Economic, Social and Environmental Change in Sub-Saharan Africa*, United Nations University,1996, http://www.unu.edu/unupress/unupbooks/80918e/80918E0q.htm

[7] Joseph DeVries and Gary Toeniessen, *Securing the Harvest: Biotechnology, Breeding and Seed Systems for African Crops*, CABI Publishing: UK, 2001, p.50.

[8] Ezumah and Ezumah, *op cit*.

[9] DeVries and Toeniessen, *op cit*.

agriculture projects in Africa failed because they did not take into consideration domestic infrastructure limitations.[10] Farmers in Africa lack access to markets, infrastructure, research extension services, and all other forms of support. Moreover, women, who constitute the majority of farmers in Africa, are often left to manage their households and their farms with few resources, as the men look for wage labour far from home.

Under these conditions, security is the main priority: something that external technologies simply cannot provide. For example, in Zimbabwe, the 1992 drought wiped out a large percentage of traditional maize seeds and hybrids were brought in for the following season. According to Viollet Mandishona of the Zimbabwe Farmers Union: *"Initially the hybrids were a breakthrough. But the costs of inputs have become expensive."*[11] Kenya's National Farmers Union says that market liberalisation drove up prices of inputs, forcing many small farmers to move back from Green Revolution to subsistence agriculture.[12] Technology is a relatively insignificant constraint in African agriculture. If farmers had the incentives and conditions to allow them to concentrate their energies on farming, Africa could easily take care of its food security for generations to come. According to researchers Ezumah and Ezumah, the natural resources available in Sub-Saharan Africa are *"grossly under-utilised"*, as the continent only produces 0.8% of its potential agricultural yields. They argue that the *"main obstacles to increased crop production are socio-economic."*

To be fair, most proponents of biotechnology do not claim that GM crops can resolve all Africa's agricultural problems. They say genetic engineering is only one tool among many. But genetic engineering presents a whole range of social and economic concerns and new biosafety risks, which require considerable resources to manage. It shifts control over agricultural R&D towards foreign transnational corporations (TNCs) and constrains the collective nature of plant breeding that has existed since time immemorial. And, perhaps most importantly, it gives a second wind to the Green Revolution model, at a time when many farmers and scientists are looking at agricultural models that go in a completely different direction.

[10] André de Kathen, Pre-print version of report for the Federal Environmental Agency (Germany).

[11] Personal communication with Viollet Mandishona, July 2001.

[12] Personal communication with Mwangi David, KNFU, July 2001.

Sustainable Agriculture

Sustainable agriculture offers an entirely different approach to agricultural development from that of the Green or 'gene' revolutions. It encourages development within agricultural systems, in order to minimise if not totally eliminate, non-renewable external inputs, such as chemical fertilisers and pesticides. The technologies and practices that are utilised attempt to mimic natural ecosystems, such as multiple-cropping and alley cropping systems, and the *fadama* or inland valley systems that farmers have had wide success with in Africa.[1]

Sustainable agriculture is also based on the principle of equity where farmers are given access to seeds, knowledge, and other resources. In this vision, indigenous knowledge systems and biodiversity are the foundations of sustainable seed systems and farmers are active participants in plant breeding—from genetic conservation and crop improvement to the marketing and distribution of seeds. Scientists work alongside farmers to strengthen and support their breeding strategies. In this manner, plant breeding can enhance genetic diversity and develop varieties specific to the local culture and ecology. Moreover, sustainable agriculture works with rural people to address the larger socio-economic and political issues that impede agricultural development, self-reliance and food security.[2]

Perhaps the most important feature of sustainable agriculture systems is that they integrate the different tools available in a diverse and integrate d approach. While genetic engineers aim to find solutions exclusively at the gene level, practitioners of sustainable agriculture look at soil health, water management, and crop combinations. They take into account the socio-economic situation, gender questions, and the needs of farmers as expressed by them. Sustainable agriculture embodies complexity and diversity, while genetic engineering is based in simplicity and uniformity.

[1] Ezumah and Ezumah, *op cit.* [2] Communication from the Seed Science and Technology Division, Department of Agronomy, UPLB College, Laguna, the Philippines.

3. THE FORCES BEHIND THE CROPS

Who are the crop pushers?

Like the Green Revolution before it, GM crops have come to Africa from developments in the North. The driving force behind the development of GM crops is the pesticide industry. By the 1990s, the industry was beset by several major problems. For one, the chemistry was exhausted and it had become increasingly difficult and expensive to develop new pesticides. Second, the blockbuster pesticides were about to come off patent and the TNCs feared that generic producers would reduce prices and take an increasing share of the market. Off-patent pesticides already account for 53% of the entire global market and by 2005 they are expected to account for 69%, with a market value of $27 billion.[13] And finally, revenue from pesticide sales were on the decline in the North as more and more of the profits from agricultural production were being taken by the food retailers, processors, and distributors, who used their near monopoly positions to squeeze farmers.[14]

Genetic engineering has been brought in to resolve these problems. On the one hand, it provides a whole new area of science—biology—that the companies can turn to for new pesticides and hence, new patents. Companies can also modify crops so that they only grow properly when sprayed with their own pesticides and prevent farmers from using generic versions by way of contracts, thereby getting around the generic pesticide problem. As an added bonus, whereas a new pesticide costs between $40-100 million to bring through the regulatory process, it typically costs under $1 million to bring a new plant variety to market.[15] On the other hand, GM crops with added value, such as GM vitamin A rice or GM high-protein corn, enable the pesticide industry to increase its share of profits from the production of food and animal feed.

Once the pesticide TNCs understood the potential that GM crops could provide, they moved quickly, buying up all the most advanced biotechnology firms and the world's largest seed companies, and securing alliances with the major food and feed processors and distributors. Between 1997 and 1999, transactions by pesticide companies in the seed industry topped US$18 billion.[16] The top five pesticide companies now control roughly 30% of the seed market and 50% of all agricultural biotechnology patents, including 70% of all patents on genes for wheat and 47% of all patents on genes for sorghum.[17] The first crops introduced reflect corporate business strategies. In 1999, 78% of all the genetically engineered crops planted in the world were engineered for herbicide tolerance and the vast majority were engineered for tolerance to the herbicide Roundup (glyphosate).[18] For Monsanto, the world's leading supplier of Roundup and the owner of most Roundup-resistant GM crops, the GM crops were an effective way to protect sales of its herbicide, which was coming off-patent around the world in 2000-2001.

Industry is now interested in bringing its technology to Africa. South Africa, with its large commercial farming sector and accommodating policy environment (see opposite), was the first and continues to be the most popular destination for GM seeds. The first GM crop, Bt cotton, was approved for commercial release in 1997 and by 2001 more than 200,000 ha were planted with GM crops. Industry is now trying to introduce GM crops in other African countries. Its major targets are the commercial maize and cotton-growing areas, since these crops already have well-established commercial market structures. For the same reasons, applications to introduce GM fruits and flowers for export production are probably not far off.

[13] *Agrow: World Crop Protection News*, 12 February, 1999.

[14] *Agrow: World Crop Protection News*, 2 March, 2000, and "The Farm Crisis, EU Subsidies, and Agribusiness Market Power." *Presentation of the National Farmers Union to the Senate Standing Committee on Agriculture and Forestry*, Ottawa, Canada, 17 February 2000.

[15] Henk Hobbelink, *Biotechnology and the Future of World Agriculture*, Zed Books: New Jersey, 1991, p 147.

[16] Manfred Kern, Aventis Crop Science, "Box 3: Commercial Applications of Biotechnology in Crop Agriculture," in G.J. Presley, *Agriculture Biotechnology and the Poor: Promethean Science*, http://www.cgiar.org/biotech/rep0100/contents.htm

[17] Devlin Kuyek, "Lords of Poison: The pesticide cartel," *Seedling*, June 2000, www.grain.org/publications/jun003-en.cfm and John Madeley, *Crops and Robbers*, ActionAid, UK, October 2001.

[18] Personal communication from Clive James, International Service for the Acquisition of Agri-biotech Applications (November 1999).

Biotech in the New South Africa

South Africa is well ahead of the rest of Africa when it comes to biotech. Already more than 200 permits for field trials have been issued and three GMO crops are commercially available. What makes South Africa such a fertile territory for GM crops? First, agriculture is dominated by a small number of large-scale farms that are highly integrated into the commercial seed market. Maize is the biggest crop, but there is substantial acreage of soya beans, wheat, and cotton. The South African seed industry is dominated by a handful of companies, most of them foreign. Monsanto and Pioneer Hi-Bred of the US control roughly 60% of the hybrid maize market. Other companies, such as Sakata, a Japanese vegetable and ornamental flower seed company, are also moving in. Second, with colonisation and the apartheid system, traditional farming practices have suffered from neglect. National Agricultural scientist Roger Ellis has closed gene banks three times in his career. According to him, *"The only people with traditional seed are the poorest of the poor."* But these small farmers have virtually no public extension support and only some of them receive support from non-governmental organisations (NGOs) working on sustainable agriculture. This has left the door open for seed and pesticide companies to develop extension programs with farmers associations desperate for assistance.

Third, the country's public research institutions, which have carried out biotech research since the apartheid years, are in the midst of a privatisation blitz. Institutions like the Council for Scientific and Industrial Research (CSIR), South Africa's premier biotechnology research institute, have had budget cuts over the past ten years, and, in response, have privatised their services, in whole or in part. The Agriculture Research Centres get only 45% of their salaries from public funds,[1] and half the CSIR budget comes from non-government sources.[2] As a result, the drive for funding or 'partnerships' with industry now guides the public research agenda—and biotech is a hot area. One CSIR scientist claims that the institution stands to make 5 billion Rand from its current bioprospecting activities: *"Enough to turn every bushman in the country into a millionaire."*[3] Fourth, South Africa has biosafety and intellectual property rights legislation in place that favours the biotech industry. South Africa has authorised field trials and commercialisation for numerous GM crops—the most recent being Monsanto's Roundup Ready Cotton. These and any commercial plant varieties are covered by strict plant breeders rights legislation and patents over the processes involved.

And finally, and perhaps most importantly, the government is very responsive to arguments about international competitiveness. The industry has a formidable lobby in place in South Africa to spin the message that biotechnology is the next industrial revolution and unless they jump on the biotech train, they will be left behind. The argument is a perfect fit with the current administration's agriculture policy, which focuses on an *"emergent"* class of black farmers, farming according to the same models that white commercial farmers used during the apartheid years. Any hopes that the administration would pursue a national food policy that would bring together issues such as land, agricultural development, biodiversity, and food safety, have been dashed by the new drive to make South Africa internationally competitive. In this context, community food security, food safety, biodiversity, and land redistribution are secondary concerns.

[1] Personal communication with Roger Ellis, Aricultural Research Centres, June 2001; [2] with Terry Watson, CSIR, June 2001; [3] with Terry Watson, CSIR, June 2001.

Yet the market potential in Africa for GM seeds is relatively small, and, in the near term, the public sector will remain the most significant actor in formal sector plant breeding. This means that public scientists have a particularly influential role to play when it comes to the introduction of GM crops in Africa. Although GM crops have only been introduced in a few African countries and most have yet to formulate a national position on biotechnology, research on GM crops is moving ahead in public research centres. Annex 1 lists some of the R&D taking place in public and private institutions in Africa.

Africa's approach to R&D can have important ramifications for future policy decisions. As public scientists become more involved in research on GM crops, interest in marketing them increases. Commercialisation is usually a project objective. The research project then creates a whole set of needs: scientists must have access to laboratory facilities, the country must have the capacity to manage biosafety concerns, and the foreign companies and institutions call for intellectual property rights legislation. In this way, a few minor biotechnology projects can exert significant influence over national policy. As pointed out by the late Stephen Dazie of the African Centre for Technology Studies: *"The development of biotechnology in Eastern and Southern Africa is not based on specific policies that governments have put in place but as a result of interests of individual scientists and some donor agencies."*[19] Kenya and Egypt have been subject to such influence (see boxes over page).

[19] Stephen Dazie, Jnr, "Biotechnology in Sub-Saharan Africa," ACTS Science and Technology Policy Paper, No. 1, 2001, p. 17.

Kenya's KARI: sweetpotato as the Trojan horse?

Donors exert significant influence over agricultural research and development in Kenya, especially when it comes to biotechnology. Between 1989 and1996, their contributions supported 65% of overall expenditures on agricultural biotechnology.[1] Donors exert particular influence over the Kenyan Agricultural Research Institute (KARI), which continues to operate at a *"considerable administrative distance from government bureaucracy."*[2] Despite this distance, KARI has exerted considerable influence over national biotechnology policy, particularly through its project on GM sweetpotato.

In 1991, Monsanto and KARI began a collaborative effort to develop GM sweetpotatoes for virus resistance. The first phase of funding came from the US Agency for International Development and the second, covering field testing and release, from the World Bank Agriculture Research Fund. Monsanto is said to have covered around 70% of research and development costs. Under the project, KARI scientists and Kenyan policy-makers have been sent for training at Monsanto's headquarters in the USA and have participated in various training workshops on biosafety and intellectual property rights. According to one of the KARI representatives involved in the project, the project had two objectives: *"to train KARI scientists and technical staff in all aspects of technology development, biosafety evaluation and IPRs and to prepare biosafety application and evaluation structures."*[3]

Once Monsanto and KARI developed the GM sweetpotatoes at Monsanto's laboratories, they applied to have them imported and field tested in Kenya. As noted by another participating institution at the time: *"The plant's imminent arrival is serving as a catalyst for the established National Biosafety Committee (NBC) to draw up biosafety regulations"*[4] Within two years the application went through, and the first season of field trials is now complete.

With the approval of the GM sweetpotato, some noticeable changes have taken place in biotechnology regulation in Kenya. The original process to establish biosafety regulations began with start-up funds from the Dutch government and was coordinated by the National Council for Science and Technology (NCST). The NCST convened a multi-disciplinary task force to produce regulations and guidelines, which some believe emphasised a precautionary approach.[5] Since then, however, US donors and their Kenyan project partners have come to occupy a much more influential position. Those trained through the sweetpotato project and other *"capacity building"* exercises supported by USAID occupy critical positions in policy-making and advisory circles. With new collaborative projects for GM cotton with Monsanto and GM maize with Syngenta, the lobby for biotechnology emanating from KARI is only going to get stronger.

[1] Cesar Falconi, "Agricultural Research Indicators: Kenya," *ISNAR Discussion Paper*, 1999, p.16; [2] Philip Pardy and Johannes Roseboom, "Trends in Financing African Agricultural Research,"in SR Tabor *et al* (Eds), *Financing Agricultural Research: A Sourcebook*, ISNAR, The Netherlands, 1998: http://www.cgiar.org/isnar/publications/books/FSB.htm; [3] Personal communication with John Wafula, Nairobi, Kenya, July 2001; [4] David Alvarez, "Connecting People to the Promise of Biotech : Update of the ISAAA Fellowship Program in Africa and Southeast Asia," *ISAAA Briefs No. 15*, ISAAA: Ithaca, NY, 2000; [5] André de Kathen, *op cit.*

From potatoes to patents in Egypt

Research on GM crops in Egypt is carried out by Agricultural Genetic Engineering Research Institute (AGERI), which was established with funds from the US Agency for International Development (USAID) and the United Nations Development Programme. AGERI's field trials of GM squash, potato, and tomato paved the way for the development of the country's biosafety regulations and its GM projects have also influenced intellectual property law in the country.[1] Now, through a joint research project with Monsanto, AGERI's Director says, *"We are paving the way for the acceptance of transgenic cotton in Egypt."*[2]

In 1997 AGERI began a three-year project with Pioneer Hi-Bred on Bt maize. With support from USAID, AGERI applied for a patent in the US on a strain of Bt it had collected as part of the project, but the terms of the agreement give Pioneer the option for an exclusive license on the patented gene or on any other genes identified during the course of the project.[3] Although the benefits to Egypt and its farmers in particular are far from evident, AGERI's patent and its alliance with Pioneer were able to influence Egyptian intellectual property policy. According to AGERI: *"As Egypt is undergoing a major agricultural reform in which the private sector will play an essential role, the Government of Egypt is currently modifying its existing patent law. Under a new draft law, agriculture, foodstuffs, medical drugs, pharmaceutical compounds, plant and animal species, and microbiological organisms and products are included as patentable subject matter . . . A new law such as this, and expanded understanding of intellectual property, should assist Egypt in acquiring technology more readily and in entering into more effective scientific strategic alliances that will help in developing new technologies and in strengthening local research capabilities."*[4]

[1] André de Kathen, *op cit*; [2] "Egypt researches biotech crops, sees income," *Reuters*, 16 March, 2001: http://www.checkbiotech.org/root/index.cfm?fuseaction=newsletter&topic_id=1&subtopic_id=8&doc_id=2861; [3] AGERI website: http://www.ageri.sci.eg/topic9/agpio.htm; [4] AGERI website: http://www.ageri.sci.eg/topic7/iprstat.htm

4. TRUSTING THE 'EXPERTS'

With GM crops either already in the field or on their way into the fields in a number of African countries, there is reason for concern. These are new technologies that have not been in the field for very long and that have not been subjected to extensive independent study on their impacts to human health. The risks presented by GM crops are in many ways similar to those presented by the introduction of pesticides, and rural communities in the South, once again, are the most at risk. In the case of pesticides, a number were introduced and later restricted or withdrawn in the North as their effects on human health and the environment became known, but they continue to be widely used in Africa and other parts of the South. In 1996, 43 million kg of banned or restricted pesticides were exported from the US—most to developing countries.[20]

With GM crops similar risks exist, but this time it will be impossible to withdraw the product if harmful effects are discovered after the crops are released since the modified genes can quickly spread through cross-pollination and reproduction. And, once again, Africa's small farmers will be the ones to suffer. According to the NGO network Agriculture Paysanne et Modernisation Africa: *"Farmers are the first category of people affected [by GM crops]. Since they are the ones who sow and harvest, they are the ones who find themselves on the first link of the food chain."*[21]

"The ecological questions don't even get touched. In fact, it is illegal to touch them."
Sally McCammon, science advisor to the US Department of Agriculture

Genetic engineering has created a set of unknowns that researchers and decision-makers have not had to consider previously. Each GM crop is the result of the transfer of genes from usually two or more species into the cells of another species to create a new, genetically modified organism. Scientists take genes that they believe are responsible for a particular trait in one organism and insert them into another organism, where they hope the trait will be reproduced. For instance, with GM Bt maize, the genes that make the soil microbe *Bacillus thuringiensis* toxic to certain pests are inserted into maize plant cells to develop GM maize plants toxic to pests. The transfer of the genes can produce unintended consequences, as it is impossible to predict exactly how the inserted gene will behave in the new organism.[22] To cite one example, studies have shown that certain plants are much more promiscuous (i.e. they cross pollinate more readily) when they are genetically engineered but scientists cannot explain why.[23] But such changes are not considered in the regulation of the crops. As noted by Sally McCammon, science advisor to the US Department of Agriculture: *"The ecological questions don't even get touched. In fact, it's illegal to touch them."*[24]

It is essential that the risks and the benefits are carefully taken into consideration and that those who stand the most to lose—farmers—are actively involved in the decision-making process. Moreover, GM crops bring with them potential socio-economic risks, such as patents and biological mechanisms for companies to control the seed supply. These have profound impacts on agriculture and should be considered in the evaluation of the risks and benefits.

Given the clear risk of GM crops, a precautionary approach to their release should be implicit, but often is not. This principle is enshrined in the biosafety guidelines of the National Biosafety Committee of the Philippines, one of the first developing countries to formulate its own biosafety guidelines.[25] Civil society organisations were involved in drafting these biosafety guidelines and their presence is reflected in the emphasis on

[20] "Exporting Risk: Pesticide exports from US ports, 1995-1996," *FASE Research Report*, 1998.

[21] Agriculture Paysanne et Modernisation Africa, *Synoptic Report on the Panafrican Workshop on Genetically Modified Organisms and Intellectual Property Rights*, Yaounde, Cameroon, November 1999.

[22] Barry Commoner, "Unravelling the DNA myth: The spurious foundation of genetic engineering," *Harper's Magazine*, Vol. 304, No. 1821, February 2002.

[23] Charles Mann, "Biotech goes wild," *Technology Review*, July/August 1999.

[24] *Ibid*.

[25] Department of Science and Technology, *Philippines Biosafety Guidelines*, DOST, Manila, 1991. Available on the World Wide Wed at http://www.binas.unido.org/binas/regs.php3

precaution and the requirement that alternatives be considered. A similar process would be appropriate for Africa. But so far, biosafety processes in Africa have had difficulty finding a transparent, inclusive and effective footing.

The problem begins with the overall lack of information about GM crops. In Zambia, the extension services and education system lack the capacity and trained personnel to inform farmers about GM crops, there are no university courses in biotechnology, and journalists have little access to reliable information. As noted by one Zambian researcher, *"This has created a situation where the agricultural sector as a whole is vulnerable to misinformation and the opinions circulated by those with vested 'pocket' agendas, a phrase commonly used in Zambia to mean 'having hidden, selfish interests'."* [26] In South Africa, the GMO Act was finalised in 1999 without a process of public consultation. Two years later, the National Biotechnology Strategy was announced without consultation with NGOs, farmers, trade unionists, or social scientists. According to Biowatch South Africa: *"The 'public consultation process' consisted of a series of unannounced phone calls, asking a few questions of participants on biotechnology."*[27] Poor communities have the hardest time accessing information and decision-makers, as their lack of resources and the bureaucratic hurdles make it practically impossible.[28]

"The public consultation process' consisted of a series of unannounced phone calls, asking a few questions of participants on biotechnology."

The lack of information is compounded by the increasing collusion between governments and the seed industry lobbies. Instead of information, the public gets propaganda, not only from overt lobby groups like the US-based International Service for the Acquisition of Agri-biotech Applications (ISAAA) in Kenya or Africa Bio in South Africa, but from government departments and public research institutes as well. Nevertheless, in many countries in Africa there are genuine efforts underway to establish effective biosafety regulations. This is no small task given that most African countries are desperately short of the resources needed to effectively regulate GM crops. Seed TNCs have, on occasion, taken advantage of this environment to avoid regulatory scrutiny. In Zimbabwe, Monsanto field tested its GM cotton before national regulations were in place without notifying the authorities. When the government found out, the crops were quickly destroyed. But, even with regulations, the government may not have the capacity to ensure safety. According to a member of Zimbabwe's Biosafety Board, one Monsanto application for a Bt crop was more than 1,000 pages long.

The Biosafety Protocol of the Convention on Biological Diversity that was adopted in January 2000 was supposed to help resolve some of these biosafety difficulties. The Protocol created a funding mechanism for building national biosafety capacity in developing countries and established an Advance Informed Agreement that obliges parties exporting GM seeds destined for agricultural purposes to give the importing country written notification. Yet, there is no obligation on exporting parties when it comes to GM crops destined for processing or direct human or animal consumption. This leaves Africans without control over the GM crops entering their countries, especially when it comes as food aid from the US and other exporting countries looking to unload the surplus production that Europe and Japan will not accept. As the President of Kenya recently said about US food aid entering the country: *"Our confidence was established in the fact that if Americans are eating it, it should be safe for our starving people."*[29]

The situation leaves African biosafety vulnerable to a range of interested parties. The most active is the seed industry, which is pushing African countries to harmonise biosafety regulations with the US. Mark Condon of the American Seed Trade Association recently

[26] K Chinsembu, & T Kambikambi "Farmers' perceptions and expectations of genetic engineering in Zambia," *Biotechnology and Development Monitor,* 2000, No. 47, pp 13-14.

[27] Biowatch SA, letter to Dr. Rob Adam, DACST, 23 October 2001.

[28] Personal communication with Environmental Justice Network Forum, Gauteng, June 2001.

[29] R Paarlberg, "Policies towards GM crops in Kenya" in *Governing the GM Crop Revolution: Policy Choices for Developing Countries. 2020 Vision Food, Agriculture, and the Environment :Discussion Paper 33,* December 2000.

told a gathering of seed industry representatives and politicians in Africa: *"If we are to be successful in feeding a growing world population, seed and biotechnology needs (sic) to move freely regionally and globally without being restricted by national regulatory obstacles."*[30] The World Bank is helping the seed industry out in this realm. Under its seed policy guidelines for Africa, the Bank ensures that governments receiving money from the Bank *"work with international organisations to establish laws and regulations that allow: (a) sale of products from transgenic plants; (b) testing of transgenic plants; (c) introduction of transgenic plants; and (d) patenting of genes."* Bank representatives meet regularly with seed TNCs to check if the companies have any problems introducing transgenic varieties. If problems exist, *"it is reasonable to withhold money for public research until governments allow private technology transfer, which demonstrates an appreciation of modern agricultural technology."*[31]

Another key player is the biosafety 'industry', which has emerged and is trying to convince governments to try and turn their vulnerable position to their advantage. Some biosafety consultants are urging governments to look to the seed industry for the funds to cover the costs. For instance, John Mugabe of the African Centre for Technology Studies says, *"Countries of Africa could build their competencies through strategic alliances between their public biotechnology R&D agencies and leading private firms such as Monsanto. The alliances would be formed around joint biotechnology R&D projects, with the necessary emphasis on scientific and technical aspects of risk assessment and management."*[32] In Zimbabwe, one NGO is taking a very different approach. It is helping to take biosafety decisions directly to the affected farming communities.

[30] "ASTA's Vision for an African Seed Trade Association." Presented at the *Preparatory Meeting for the Establishment of an African Seed Trade Association*, Lilongwe, Malawi, 8-10 April 1999.

[31] SSASI Team, World Bank, *Initiatives for Sustainable Seed Systems in Africa*, http://www.fao.org/ag/AGP/AGPS/Abidjan/Paper12.htm

[32] John Mugabe, "From Cartegena to Nairobi: Towards an African Agenda on the Biosafety Protocol," *ACTS Working Paper*, Nairobi, May 10, 2000.

A local approach to biosafety in Zimbabwe:

Zimbabwe is a target for seed TNCs for GM cotton and GM maize. Applications are currently pending for Bt cotton and Bt maize - both important crops for smallholder farmers.

The Intermediate Technology Development Group (ITDG), an NGO active in Zimbabwe, has developed an *"impact assessment methodology of GE organisms on the livelihoods of resource-poor people."* It helps communities to assess technologies by comparing the technology with sustainable agriculture methods. The exercise consists of six steps:

Step 1: Introduction of the programme, with group discussions on farming systems (community strengths and assessment of assets related to crop/animal production).

Step 2: Group information sharing on GM crops and group sharing on sustainable agriculture.

Step 3: Farmers' response, questions and clarifications about the technologies

Step 4: Assessment of the technology under a Sustainable Livelihoods Framework.

Step 5: Overall assessment by farmers.

Step 6: Feed back on the communication approach and process.

In one training with farmers, participants discussed fertility requirements, weevil resistance, and environmental impacts. They wanted to know whether the toxin that kills maize stalk borers would not also affect them in the long term, by eating the stalks and the cobs or by eating meat of animals fed on Bt-maize stalks. Farmers wanted to know how Bt crops could affect soil structure, how resistance in pests could build up, and how Bt seed would be priced. There were also concerns about health, religion and power-relations. Participants expressed a general feeling of powerlessness in the face of agribusiness marketing and the lack of government services. According to one participating farmer, *"We may be given seed, or sold it cheaply by companies for a while, but then the subsidy may be withdrawn and we've all lost the varieties we used to use."* Another farmer mentioned the difficulties of controlling GM crops, *"We could talk to our neighbours to try and reduce contamination by keeping the maize varieties separated from each other…but without bylaws we can't make decisions as a community on excluding varieties".*[1]

[1] Jessamijn Miedema, "Discussing genetic engineering with communal farmers in Zimbabwe," in Michel Pimbert, Tom Wakeford and PV Satheesh, *Citizens' Juries on GMOs and Farming Futures in India*: http://www.ids.ac.uk/ids/env/GMOsIndia.pdf

Bt Cotton and biosafety

Monsanto's Bt cotton or Bollgard Cotton was the first commercial GM crop released in Sub-Saharan Africa and Africa's experience with it reveals much about the problems of biosafety on the continent. Currently, all officially approved production of Bt cotton in Africa takes place in South Africa, where it is grown on 100,000 ha by 1,530 commercial farmers and 3,000 small-scale farmers mostly in the Northern Province, with some in KwaZulu-Natal and the Orange Free State. Monsanto also planted Bt cotton in Zimbabwe in 1998 without permission, but the crop was burnt before flowering as soon as the authorities found out.[34] The company has now applied for official approval of GM cotton under a joint venture with Quton Seeds, a subsidiary of the Seed Company of Zimbabwe. Monsanto also has applications pending in Kenya, where it has a collaborative project with KARI to field test and eventually commercialise Bt cotton, and in Uganda, where it is working with the Kawanga National Agricultural Research Organisation. Bt cotton presents significant ecological concerns in Uganda, given its rich diversity of cotton varieties. The same concerns also exist in Zimbabwe and Southern Africa where there are indigenous cotton varieties.[35]

"It would be wise for those who feel they cannot resist the 'fatal attraction' of GM crops to remember the old Zambian adage: If you have to test the depth of the water, do not put both legs in the water"[33]

Bt cotton has not been approved in Zambia but it has been planted in the country nevertheless. A cotton operation run by a US company called Dunavant recently provided Bt cotton to farmers participating in its out-grower schemes without informing the farming community or other stakeholders. The Bt cotton was grown for one season in trials at the organisation's fields in Magoye in Zambia's southern agricultural belt and was then discontinued, but Zambian officials believe that it is still being grown in the country.[36] Besides Zambia, there are unconfirmed suggestions that the Bt cotton has found unofficial routes into Malawi and Swaziland, where seeds were supposedly taken across the South African border by a South African cotton farmer with a wife in Swaziland.

In South Africa, where Bt cotton has been grown for several years, the process is more official. Monsanto did go through the regulatory channels and there are even resistance management strategies that require growers to leave a refuge of 5% of their crops unsprayed with pesticides and 20% sprayed.[37] The resistance management strategies are used to prevent the development of resistance to Bt by the bollworm—the target pest of Bt cotton. The problem is that none of the regulations are enforced, particularly in the areas where small farmers have taken up the seeds. Monsanto maintains that the refuge strategies are not necessary since the bollworm is endemic to the areas where small farmers are growing the cotton and there are plenty of natural hosts all around. Plus, Monsanto says that it is doing its own monitoring of Bt resistance. If the government wants a resistance management plan, then, Monsanto argues, it is up to the government to carry out the inspections and enforcement. As of February 2002, four years after the crop was released in South Africa, responsibility has still not been resolved.[38]

Despite these biosafety concerns, Bt cotton is likely to be the flagship for opening seed markets to GM crops in a number of African countries. Monsanto's promotion of Bollgard cotton in Africa is based on the supposed success of its Bt cotton project in the Makhatini Flats in KwaZulu-Natal province, South Africa. According to one of the small farmers participating in the project, Bollgard increased his yield by 27%, reduced insecticide applications by 80%, and increased his income by US$150 per hectare. In his community, 410 small scale farmers plant Bollgard on 750 hectares, and the numbers keep

[33] Chinsembu & Kambikambi, *op cit.*

[34] André de Kathen, *op cit.*

[35] Cotton South Africa web site: http://www.cottonsa.org.za/history_cotton_sa.html

[36] Chinsembu & Kambikambi, *op cit.*

[37] Personal communication with Andrew Bennet, Monsanto, Pretoria, South Africa, June 2001.

[38] Personal communication with Andrew Bennet, Monsanto, 19 February, 2001.

increasing even though the technology fees that Monsanto charges are quite high.[39] What explains the apparent success? For one, the technology works, at least in the short term, at killing off certain insect pests and thereby reduces pesticide use. But, more importantly, the Bt cotton is made available through a collaborative project between the National Department of Agriculture, the South African Land Bank, Monsanto, and VUNISA Cotton, a private company that contracts out production of cotton to local farmers.[40] The joint effort offers farmers easy access to markets and credit to purchase inputs.

But the early success rests on a fragile foundation. The Bt cotton farmers are not the only farmers in the area. Most of the Bt cotton production is handled by farmers of the Ubombo Farmers Association, and, as a result of the project, their political influence has increased. Recently, they successfully lobbied the Department of Water Affairs and Forestry (DWAF) to release water in the nearby dam a few weeks early, since the maturation period for Bollgard is on average two to four weeks shorter than usual. The normal flooding period, however, was established by the DWAF through consultations with the floodplain farmers and is arranged to suit the needs of their subsistence crops, mainly maize and beans. When the water was released early, these farmers lost their crops.[41] The success of the Bt cotton farmers does not necessarily translate into success for the community.

Success for the cotton farmers themselves is also fragile. Cotton is a cash crop and success is not only measured by productivity but by the market price. South Africa, which dismantled its Cotton Board in 1997 and is in the midst of liberalising its cotton market, imports over half of its cotton. This makes the country increasingly vulnerable to price fluctuations. For example, in 2000, the largest cotton crop in 10 years in China flooded the world market and, even though other areas were undergoing slumps in production, global prices fell sharply.[42] The supposed success of the small-scale cotton farmers in Makhatini rests on a guaranteed market and the privileged provision of credit and infrastructure support, such as the regulation of the dam.[43] If this support disappears as cotton prices fall, the losses will be severe for the farmers. Even Monsanto's lead cotton researcher in South Africa wonders how small farmers will cope with the liberalisation of the cotton market.[44]

There is also the problem of dependency that the Bt cotton project encourages. Part of the reason why Bt cotton has been taken up by small-scale farmers in South Africa is that it provides some short-term relief to a system in need of serious reform. Most rural communities in South Africa lack access to productive land and those that do have access to land are constrained by labour shortages, as men are constantly migrating in search of work. Farming is left to women, who can usually only farm on a part-time basis, and they have minimal access to and control over the resources needed to carry out effective agricultural management practices. Bt cotton is taken up in these conditions because the technology is in the seed. In the words of a Monsanto representative, "*the benefits of Bt cotton are inversely proportional to the level of management that farmers are capable of.*"[45] In the Makhathini Flats, the Bt technology proved so popular in the 2000/2001 growing season that around 95% of the 4,000 smallholder farmers were predicted to adopt the same Bt cotton variety in the subsequent season.[46] Already, 55%-60% of all cotton sold in South Africa is Bt cotton.[47] This is setting the stage for a disaster.

In China, where Monsanto's Bt cotton has also been rapidly introduced, a speaker at the Asia Crop Protection Markets Conference in late 2000, voiced his concern about the growing reliance on Bt cotton in China and observed that it was getting *"out of control."*

[39] T Buthelezi, "A South African farmer's experience with Bt cotton," in JS Wafula and DM Kimoro (Eds), *Opportunities for Reviving the Cotton Industry in East Africa Through Biotechnology: Stakeholders Meeting,* ABSF Document No.2, April 2001.

[40] Andrew Bennet, Monsanto South Africa, presentation in Pietermaritzburg, 6 March 2002; and Linda Beyers, Yousouf Ismael, Jennifer Piesse and Colin Thritle, "Can GM-technologies help the poor? The efficiency of Bt cotton adopters in the Makhathini Flats of KwaZulu-Natal," Paper for the consultation meeting on *Biotechnology and Rural Livelihood-Enhancing the Benefits*, The Hague, June 2001.

[41] Personal communication with Elfrieda-Pschorn-Strauss of Biowatch SA, April 24, 2002.

[42] Cotton South Africa, Market Report for 2000, http://www.cottonsa.org.za/economic_info.html

[43] Y Ismael *et al*, "Farm level impact of Bt cotton in South Africa." *Biotechnology and Development Monitor,* No. 48, pp 15-19, 2001. http://www.biotech-monitor.nl/4806.htm

[44] Personal communication with Andrew Bennet, June 2001.

[45] *Ibid.*

[46] Y Ismael *et al*, *op cit.*

[47] Claire Bisseke, "Green Light for first GM food crop to be produced in SA," *Financial Mail,* December 14, 2001.

Speaking from personal observation, he warned farmers to be vigilant because there were other problems associated with Bt cotton. It is, for example, more susceptible to the fungal disease Fusarium wilt than conventional cotton.[48] For small farmers in South Africa, how will they respond to a disease or pest that the Bt cotton variety proves susceptible to and that spreads rapidly from farm to farm? No variety can remain resistant to all pests and diseases, especially when it is widely used in a given area, and with the rapid adoption of Bt cotton in South Africa, it is only a matter of time before an epidemic strikes leading to crop losses and increases in pesticides.

Bt cotton may provide a small amount of relief to small farmers in the near term, but it threatens to make matters worse in the end. Rather than a technology fix, small farmers in South Africa and other African countries need the support of rural development strategies that give farming communities control over their own resources and build local knowledge and technology systems. Farmers must be able to choose to avoid a cycle of debt and dependency. Bt cotton, however, encourages farmers to 'farm by formula' by applying chemical fertilisers and pesticides when planting single seed varieties that have not yet been selected for local conditions and where pesticide application is a prerequisite. In the short term pesticide use may be reduced, but agronomic and economic dependence remains. Alternative strategies that rely to a greater extent on locally available inputs and that provide farmers with the tools to analyse what is happening in their fields, to adopt strategies to make appropriate variations in their practices, to understand when pests threaten economic loss and to take preventive measures to improve soil by the addition of organic matter have proven effective.[49] Farmers involved in organic cotton projects in Senegal and Tanzania, for instance, produced equal yields to those achieved with conventional production without using costly inputs.[50] But, to make this step to sustainable agriculture, farming communities need the socio-economic conditions that will allow them to manage their crops effectively. The solution is ultimately political, not technological.

[48] Barbara Dinham, "GM cotton - farming by formula?" *Biotechnology and Development Monitor*, No. 44, pp 7-9, 2001: http://www.biotech-monitor.nl/4403.htm

[49] *Ibid.*

[50] Jules Pretty and Rachel Hine, *Reducing Food Poverty with Sustainable Agriculture: A summary of new evidence*," Centre for Environment and Society, University of Essex, February 2001, http://www2.essex.ac.uk/ces/ResearchProgrammes/CESOccasionalPapers/SAFErepSUBHEADS.htm

What some proponents say about GM crops and Africa

Florence Wambugu, Director of the AfriCentre of the International Service for the Acquisition of Agri-biotech Applications: *"The farmers and hungry people of Africa need this technology."*[1]

James Schroeder, Deputy Under-Secretary US Department of Agriculture: *"The USDA is committed to a long-term strategy to support research and technical assistance aimed at improving African food production and security. Biotechnology to improve African food production and security must play a role in this strategy."*[2]

John Mugabe, African Centre for Technology Studies: *"National economic and industrial competitiveness are now dependent on the ability of a country to effectively develop, apply and trade in biotechnology."*[3]

Per Pinstrup-Anderson, Director General International Food Policy Research Institute, USA: *"What really bothers me is the increasing opposition, especially in Europe, to using biotechnology for agriculture . . I don't want to be melodramatic but there are several hundred million hungry people in this world."*[4]

[1] Florence Wambugu, "Protestors don't grasp Africa's needs," *Los Angeles Times*, November 11, 2001; [2] *Agbiotech Reporter*, December 2000; [3] John Mugabe, *op cit*; [4] Charles Mann, *op cit.*

5. SURELY THERE IS A BETTER WAY?

The emotion and excitement around GM crops expressed by some scientists and policy makers is hard to understand. For all the money, research and advertising that have been devoted to their development, GM crops offer remarkably little in the way of possible benefits. The Biotechnology Trust of Zimbabwe (BTZ), for instance, was initially established to identify problems facing smallholder farmers that could be addressed with biotechnology. It asked a number of researchers to go out in the field to talk with small farmers to identify the most pressing problems and come up with proposals for biotechnology research. But none of the researchers ended up identifying genetic engineering applications—all of the proposals were for non-transgenic R&D. As a result, BTZ had to revisit its definition of biotechnology to include non-GM crops.[51]

"Most, if not all, of the GM crops being developed for African agriculture are not oriented towards the needs of Africa's small farmers."

Most, if not all, of the GM crops that are being developed for African agriculture are not oriented towards the needs Africa's small farmers. For example, researchers in Zimbabwe are trying to develop GM cowpea with resistance to the herbicide atrazine. The idea is to make it easier for larger-scale commercial farmers planting maize and spraying atrazine to rotate their fields with cowpea.[52] GM sweetpotato, which is being developed by Monsanto and KARI in Kenya, is touted as a solid example of a GM application that has been developed specifically for small farmers. But, as the case study below illustrates, the GM sweetpotato has used up vast resources for a technology that will do little for small farmers, but will instead create new dangers.

Something else is going on. The push for GM crops is part of a shift towards corporate-led agricultural R&D that has been happening in other areas of the world for some time now and is spreading to Africa. GM crops bring a range of new elements into agricultural R&D, most notably patents that have given TNCs more control over public research and the world's seed supply. With the patents they hold on GM crops, corporations can prohibit farmers from saving seed from year to year. Once a farmer chooses to plant GM crops, it becomes very difficult to rethink that choice, particularly in the face of aggressive marketing and sales campaigns by the manufacturers and the widespread endorsement of such crops by government agencies.[53] TNCs, not farmers, will then be able to determine what crops are grown and how. The example of Bt maize highlights the implications of these emerging issues as collaboration between public and private research increases with the development of GM crops.

Sweeter potatoes without biotech

Sweetpotato is a major crop in small-scale agriculture throughout Africa. It is regarded as an insurance crop, offering an important source of food, income, and animal feed. There is very little commercial sweetpotato production in Africa, and most of it is grown using sustainable agriculture methods, without chemical inputs. Public and private researchers have paid relatively little attention to sweetpotato, despite its importance to the rural poor in Africa. Nevertheless, farmers have developed many varieties of sweetpotato on their own and have had a great deal of success in managing pests and diseases.

Under certain conditions disease can present a problem. The sweet potato virus disease (SPVD) is perhaps the most important disease affecting sweetpotato production. It

[51] Personal communication with Doreen Mnyulwa, July 2001.

[52] Personal communication with Dr Sithole, University of Zimbabwe, July 2001.

[53] M. Philipson, "Agricultural law: containing the GM revolution." *Biotechnology and Development Monitor*, No. 48, 2001.

forms through the interaction of two other diseases, sweetpotato feathery mottle virus (SPFMV) and sweetpotato chlorotic stunt virus (SPCSV), neither of which present a problem on their own.

In 1991, Monsanto and KARI began a collaborative project to develop GM sweetpotato with resistance to SPFMV. Under the project, KARI scientists worked with Monsanto scientists at Monsanto headquarters in the US to transform sweetpotato with a viral coat protein gene conferring resistance to SPFMV. While the viral coat protein gene is patented by the International Potato Centre (CIP) and the Scripps Institute in the US, the genetic construct incorporates marker and promoter genes patented by Monsanto. The participating institutions have agreed to make these available to KARI on a royalty-free basis. At present, a variety of sweetpotato has been genetically engineered and the first season of field trials has been undertaken in Kenya.

"Sweetpotato has wild relatives throughout Africa, and a transgene could spread to these species through cross-pollination."

The proponents of the technology suggest that the GM sweetpotato will *"play a critical role in the fight against hunger,"*[54] but a closer look reveals some concerns and suggests that there are alternative approaches that KARI can pursue that would be more appropriate for Kenya's small farmers.

First, the technology presents a number of biosafety concerns. Scientists studying GM papayas engineered with a similar trangene admit that the genetic construct *"may end up mixing with DNA from other viruses that infect the GM papaya plants, possibly resulting in the creation of new, potentially more virulent disease-causing viruses."*[55] Such dangers are particularly problematic with sweetpotato production in Africa, since new varieties *"quickly spread through informal exchanges of vine cuttings from farmer to farmer."*[56] Once the GM sweetpotato is introduced it will be impossible to control its use and withdraw it if evidence of harm emerges later on. Furthermore, sweetpotato has wild relatives throughout Africa, and the transgene could spread to these species through cross-pollination.[57]

Second, there are concerns that the disease resistance will not be effective. The GM sweetpotato will still be susceptible to a low level of infection from SPFMV and it could still interact with SPCSV to form SPVD. Other risks include what is known as *"synergy,"* in which the mere presence of the genetically engineered virus in the plant's DNA makes it sicker than it would otherwise be when infected by another plant virus.[58] Moreover, since transgenic sweetpotato is based on a single gene resistance technology, it can easily break down if it is not grown with a number of varieties in proximity that do not express the transgenes. In Hawaii, the widespread use of GM papayas with disease resistance has created considerable virus pressure and there are already signs that the papaya is *"less disease-resistant than advertised."*[59]

Finally, there are alternative methods for increasing yield in sweetpotato that are more appropriate and less costly. Farmers control disease by planting 4-5 different varieties in a typical crop and selecting healthy vines for planting the following year. Through constant selection and exchange, farmers have developed a wide diversity of sweetpotato varieties with excellent disease resistance, many of which have not yet been characterised by public researchers. In fact, it is the high-yielding clonal varieties developed by formal sector breeders that are most susceptible to disease.[60] In order to avoid the risks inherent in GM technology and the enormous costs, KARI could have turned to alternative approaches that support farmer breeding strategies and help farmers to maintain on-farm diversity.

The Biotechnology Trust of Zimbabwe has taken this approach. It runs a sweetpotato

[54] Quote is from Monsanto's website: http://www.monsanto.co.uk/news/technology_cooperation/crop.html

[55] Carol Kaesuk Yoon, "Stalked by deadly virus, papaya lives to breed again," *New York Times*, July 20, 1999. For further information see: A Greene & RF Allison, "Recombination between viral RNA and transgenic plant transcripts," *Science* 263, 1994, pp 1423-1425, and H Lecoq, *et al*, "Aphid transmission of a non-aphid transmissible strain of zucchini yellow potyvirus from transgenic plants expressing the capsid protein of plum pox potyvirus," *Molecular Plant-Microbe Interactions* 6, 1993, p 403.

[56] Martin Qaim, "The Economic Effects of Genetically Modified Orphan Commodities: Projection for Sweetpotato in Kenya," *ISAAA Briefs* no. 13, ISAAA: Ithaca, NY and ZEF: Bonn, 1999, p19.

[57] *Ibid.*

[58] Carol Kaesuk Yoon, *op cit.*

[59] "Big Isle papaya crops tainted," *Hawaii Tribune-Herald*, April 7, 2000, Front Page.

[60] Martin Qaim, *op cit.*

micropropagation programme in collaboration with farmer-breeders. In the first year of the programme, BTZ collected 101 different varieties from farmers' fields and conducted trials of 27 varieties at a time in different locations. Local farmers were invited to rank the varieties according to various criteria and the 19 top varieties were selected to be sent out for multiplication at a main nursery and, subsequently, several satellite nurseries. The project supports farmer breeding strategies by giving them access to varieties from other communities that they themselves have evaluated. Other projects have worked with farmers to improve sustainable agriculture practices, such as the Freedom from Hunger project in Ethiopia, which increased yields of sweetpotatoes on small farms from 6 to 35 t/ha, working with 2,300 farmers on 2,150 ha.[61]

Unfortunately, KARI and its partners did not consider these risks, limitations and alternatives in their decision to pursue the project. According to a report commissioned by the developers: *"In analyses used to decide whether or not to start a certain research project, such uncertainty about the research success is usually accounted for with the help of probability functions. In our case, however, the research project is already under way."*[62]

Bt Maize: Big companies working for big farmers?

Maize is Africa's second most important food crop and is grown across the continent in a wide variety of ecological conditions. Small and medium-scale farmers on less than 10 ha are Africa's most important maize producers, accounting for 95% of total production.[63] Their efforts are constrained by a number of environmental factors, such as drought and soil fertility, but pests can also cause significant problems. Cereal stemborers, the larval stage of certain moths (*Busseola fusca, Sesamia calmistis, Eldana saccharina, Chilo archalociliellus* and *Chilo partellus*), can cause the loss of about 20% to 40% the potential yield of a maize crop. Moreover, they are difficult to control because the eggs and the larvae are hidden deep inside the stems.

Stemborers are a major pest in nearly every area where maize is grown. Given the importance of maize in commercial agriculture, it is therefore not surprising that stemborers have been a major target for agribusiness. In recent years, the industry has turned its attention almost exclusively to genetic engineering, and the incorporation of the Bt gene in particular, to deal with the problem. Bt maize was planted on 5.9 million ha in 2000.[64] Across the globe, Bt maize is controlled by the large seed TNCs through patents on the relevant technologies and all the Bt maize planted in the world is sold by the major seed TNCs. In Africa, Monsanto, Pioneer Hi-Bred and Pannar have commercialised Bt maize in South Africa, where it was planted on 50,000 hectares in 1999.[65]

The Bt maize sold by the seed TNCs is not designed for small farmers. The varieties available in South Africa have only been incorporated in varieties developed for commercial farms. With Bt cotton, small farmers have well-developed marketing channels that enable them to profit from surpluses and, conceivably, pay for the technology fees charged for the GM trait. Andrew Bennett of Monsanto admits that this is not the case for small maize farmers, who mainly farm for subsistence with little access to markets: *"Without a good market for excess maize, it wouldn't make sense to introduce the biotech crop."* Pioneer Hi-Bred does run a Bt maize program for small farmers in the Eastern Cape, but the company does not have a specific breeding program for the area. According to Pioneer South Africa's manager, the company introduced the Bt hybrid maize *"for philanthropic reasons,"* as part of an effort to reduce the high incidence of cancer of the oesophagus in the region that they suggest is linked to stemborer infestation in the maize.

[61] Pretty and Hine, *op cit.*

[62] Martin Qaim, *op cit.*

[63] DeVries and Toeniessen, *op cit.*

[64] Clive James, "Global Review of Commercialized Transgenic Crops: 2001," *ISAAA Briefs* No. 24: Preview.

[65] PN Mwangi & A Ely, "Assessing risks and benefits: Bt maize in Kenya," *Biotechnology and Development Monitor,* No. 48, pp 6-9, 2001: http://www.biotech-monitor.nl/4803.htm

The lack of research into maize for small farmers is not confined to South Africa or to GM maize. Both the private sector and the public sector have done a miserable job producing hybrid varieties suitable to small-scale farming. In 1993, Rashid Hassan of the International Centre for Maize and Wheat (CIMMYT) told his fellow researchers that only two new varieties of maize have been produced over the last thirty years for the mid-altitude environment in Kenya, where small farmers produce 40% of Kenya's maize. KARI had not produced a single variety for that environment since 1970. As most formal sector breeding in Kenya targets the high potential lands, with the big commercial farms, Hassan says that small farmers are left with *"misplaced technologies."*[66] The situation is similar throughout Africa, and it is therefore not surprising that hybrids account for only 20% of the maize grown on the continent.[67]

This history does not appear to deter CIMMYT. With support from the Novartis Foundation, CIMMYT is working with KARI and the Zimbabwe Biotechnology Research Institute to develop Bt maize varieties for small farmers in Africa. According to the Director General of CIMMYT: *"By developing borer resistant varieties, we put more maize into the harvest basket of those farmers and their families who are too poor to purchase [pesticides]."*[68] But the technology has many hurdles to cross over before it can be of any potential benefit to small farmers in these two countries, where markets are the big problem, not technology. As noted by the Kenyan National Farmers Union, *"The major problem facing farmers in Kenya is that there are no markets and the middlemen are taking all the money."*[69]

"Both the private sector and the public sector have done a miserable job of producing hybrid varieties suitable to small -scale farming"

One of the big hurdles that the public institutes have yet to cross is that of the intellectual property associated with the project. Novartis has donated its Bt technology to the project, but only for *"research purposes,"* and there may be other patents involved that are owned by actors not associated with the project. Currently, ISAAA has commissioned intellectual property rights 'experts' to explore the situation. CIMMYT will likely appeal to the private institutions on humanitarian grounds to make their technologies available to small farmers. But this could lead to complications. For one, most African countries do not recognise patents on plants and any restrictions on Bt maize are likely to violate national intellectual property legislation. And second, although the markets may be small, seed TNCs do have an interest in Africa's maize markets. In Zimbabwe for instance, Monsanto, Pioneer, the Zimbabwe Seed Company and Pannar are applying to introduce Bt maize in the country.[70]

There are alternative means to deal with stemborers that avoid the complications of markets, intellectual property rights, biosafety testing, and enormous laboratory expenses. Farmers have developed ways to reduce infestation through cultural control techniques or direct applications of neem extract, pyrethrum marc, soil, ashes or chilli powder to infected maize plants.[71] Scientists at the International Centre of Insect Physiology and Ecology (ICIPE) have developed a *"push-pull system"* that not only prevents stemborer infestation, but also crop losses from *Striga*—a weed that can cause losses of between 20% and 80%. Knowing that stemborers were indigenous to East Africa long before maize was introduced and that the insect must have fed on another type of grass in the past, these ICIPE scientists identified varieties of grasses that the stemborers would feed on and then invited local farmers to select the ones they preferred. They chose napier and Sudan grass because they make good fodder. These grasses are grown in several rows outside the maize field to attract the stemborers while inside the field farmers plant molasses grass or silver leaf *Desmodium*, which repel the stemborers by their smell. In tests, the use

[66] Rashid Hassan, Regional Economist, CIMMYT (Kenya), Conference Proceedings from the *Workshop on Structural Transformation in Africa, Harare, Zimbabwe,* 1-3 June, 1993, p16: http://www.aec.msu.edu/agecon/fs2/ag-transformation/abf.pdf

[67] DeVries and Toeniessen, *op cit.*

[68] "New maize variety to boost harvests," *IPS*, 3 March, 2001.

[69] Personal communication with Mwangi David, Nairobi, July 2001.

[70] ISNAR and IITA, *Biotechnology for Africa Crops,* study commissioned by the Rockefeller Foundation, January 1999.

[71] PN Mwangi and A Ely, "Assessing risks and benefits: Bt maize in Kenya," *Biotechnology and Development Monitor,* No. 48, pp 6-9, 2001. http://www.biotech-monitor.nl/4803.htm

of molasses grass reduced maize crop losses from 40% to 4.6%. *Desmodium* seems to be even better equipped for inter-cropping. As a legume it binds nitrogen and thus enriches the soil. It also keeps the soil moist, reduces erosion and can be used as fodder. But most important, *Desmodium* intercropped with maize suppresses the growth of *Striga* by a factor of 40 in comparison to monocropping of maize.[72]

ICIPE has developed other means to deal with the non-indigenous stemborers. The most aggressive species of stemborer in Africa is the spotted stemborer (*Chilo partellus*) which was introduced from South Asia to Africa some 70 years ago. ICIPE scientists went to the centres of origin of the stemborer and found that the pest was kept under control by several natural enemies. One of them is the little wasp *Cotesia flavipes cameron*, which tracks down the stemborer larvae deep inside the stem and lays its eggs into the pest. These hatch and consume the borer from within. After careful testing, this wasp was released on three sites in Kenya. The wasps are now well established and they not only go for the spotted stemborer, but for three other stemborer varieties. Results show that stemborer infestation can be reduced by 53%.[73]

"With the push-pull method, we have an integrated solution for the problems of stemborer and Striga. It's a system that is enhancing justice and sustainable agriculture"

According to ICIPE's Bill Overholt: *"Transgenic maize [may] be part of the solution in the far future. But what about the other problems? The interesting thing about the push-pull system is that it already exists and the farmers use it. It was developed together with the farmers. With the push-pull method, we have an integrated solution for the problems of the stemborer and Striga. We have protein-rich fodder, nitrogen fertiliser and good protection against soil-erosion. All this within one field. It's a system that's enhancing justice and sustainable agriculture."*[74]

But from the perspective of the industry, there is just one problem with the practices that Bill Overholt and African farmers are so happy with: there is no money to be made from them. And that is precisely why the corporations (and the scientists that work for them) are solidly pushing for genetic engineering. With the proper legislation and infrastructure in place, they can monopolise and control genes, privatise biodiversity, and spread their technologies under monoculture conditions throughout much of Africa. The gene as a commodity—and genetic engineering as the technology—perfectly serve the interests of industrialists, but do not address the needs of that vast majority of people in Africa.

Green Revolution, Gene Revolution ... or Farmer Revolution?

Transnational pesticide corporations are behind the push of genetic engineering into agriculture. They believe that genetically engineered crops will resolve certain profit constraints and op en the door to new markets and previously unimaginable profits. For this reason they have invested massively in agricultural biotechnology, buying up seed companies and securing control over R&D. Most governments and public research institutions in Africa have not challenged these developments. Rather, they have become industry allies, supporting and often leading the drive for commercialising GM crops.

The mistakes of the Green Revolution are being repeated all over again. With the Green Revolution and genetic engineering the focus is on trying to develop the perfect set of genes. The problem is that the 'perfect' plant needs the perfect conditions to be successful: which is entirely impossible for poor African farmers to duplicate, farming under the enormous range of ecological conditions and socio-economic constraints that they do. This approach brings disaster for farmers: pest and disease epidemics, low market prices, crop failures, health and environmental effects from pesticides, and so on. Moreover, it takes attention away from the more fundamental problems affecting small farmers.

[72] Antje Lorch, "Push and Pull: Biological control of stemborer and Striga," *Biotechnology and Development Monitor*, No. 43, p 22, http://www.biotech-monitor.nl/4308.htm

[73] Florianne Koechlin, "Natural Success Stories : The ICIPE in Kenya," June 2000, http://www.blauen-institut.ch/Pg/pF/pfNaturalSuccess.html

[74] *Ibid.*

Instead of resolving the problems of the Green Revolution, genetic engineering threatens to accentuate them. The environmental and health risks of GM crops are poorly understood and they are particularly dangerous in Africa where there are few resources for research into public safety and the enforcement of regulations. Africa's farmers, like all small farmers around the world, will be affected most directly by any consequences. Social and economic risks from GM crops are equally weighty. They will increase dependence on outside technologies, marginalise farmers from R&D, and consequently exacerbate the social and economic difficulties already affecting Africa's small farmers.

If governments are serious about addressing the needs of small farmers, they need to look elsewhere—at land distribution, market constraints, and affordable technologies and practices that work with on-farm resources, such as soil and water management, biodiversity conservation strategies, and mixed cropping. African farmers are skilled and knowledgeable and are responsible for the vast majority of agricultural innovation that has succeeded in Africa. The low levels of productivity that are often cited in reference to African agriculture are the result of poverty, displacement, war, colonialism, and environmental challenges. Africa's small farmers do not need the false promises of genetic engineering; they need concrete measures that will attack the root causes of poverty and enable them to farm according to their capabilities.

Annex 1: GM crop research in Africa

Country	Crop	GM trait	Institution	Status
Cameroon	Cowpea		IARD*	Laboratory
Egypt	Barley	Abiotic stress tolerance	AGERI	Laboratory
	Cotton	Heat and salt stress tolerance Bt	AGERI	Laboratory
	Maize	Bt	AGERI/Pioneer	Laboratory
	Melon	Virus resistance	AGERI	Field test
	Potato	Tuber moth resistance	AGERI	Field test
	Squash	Virus resistance	AGERI	Field test
	Tomato	Virus resistance	AGERI	Field test
	Wheat	Salt and drought tolerance	AGERI	Laboratory
Ethiopia	Noog		Addis Ababa University	Laboratory
	Tef		Addis Ababa University	Laboratory
Kenya	Cotton	Bt	KARI/Monsanto	Laboratory
	Maize	Bt	KARI/CIMMYT/Novartis	Application
	Maize	Herbicide resistance	KARI/CIMMYT	Laboratory
	Sweet Potato	Virus resistance	KARI/Monsanto	Field test
Morocco	Tomato			Field test
Nigeria	Cowpea	Virus and insect resistance		-
South Africa‡	Barley	Malting	CSIR	-
	Cotton	Bt cotton	Monsanto	Commercial
	Cotton	Herbicide resistance	Monsanto	Commercial
	Maize	Disease resistance, drought tolerance	University of Cape Town	Laboratory
	Maize	Bt	Monsanto	Commercial
	Maize	Disease resistance, drought tolerance	ARC Roodeplaat°	Field test
	White Maize	Disease resistance	CSIR	Field test
	White Maize	Bt	Monsanto	Commercial
	White Maize	Bt	Pioneer, Pannar	Field test
	Millet	Lysine and methionine content	CSIR	Laboratory
	Ornithogalum	Virus resistance	ARC Roodeplaat	-
	Potato	Virus resistance, drought tolerance	ARC Roodeplaat	Field test
	Sorghum	Enhanced protein	CSIR	Laboratory
	Soya bean	Drought tolerance	ARC Roodeplaat	-
	Soya bean	Herbicide resistance	Monsanto	Commercial
	Sweetpotato	Disease resistance	ARC Roodeplaat	-
	Tomato	Delayed ripening, virus/disease resistance	ARC Roodeplaat	-
	Wheat	Herbicide resistant	Monsanto	-
Tunisia	Potato			-
Uganda	Banana	Black sigatoka disease, nematode, and weevil resistance	NARO/IITA§	Field test
	Cassava	Starch content	Makerere University	Laboratory
	Cotton	Bt	Monsanto	Application
	Maize	Drought tolerant and striga resistant	NARO	Laboratory

‡ Crops not listed in the table that South Africa is pursuing GE research on include lupins, sunflowers, sugarcane, cucumbers, ornamental bulbs, cassava, apricot, strawberry, peach, apple, table grapes and banana.
* Institute of Agricultural Research for Development
° Agriculture Research Centre Roodeplaat
§ National Agricultural Research Organisation/International Institute of Tropical Agriculture

Annex 1: GM crop research in Africa (cont'd)

Country	Crop	GM trait	Institution	Status
Zimbabwe	Cassava	Shelf-life	University of Zimbabwe	Laboratory
	Cotton	Bt	Monsanto/Quton	Field test
	Cowpea	Virus resistance	University of Zimbabwe	Laboratory
	Cowpea	Herbicide resistance	University of Zimbabwe	Laboratory
	Maize	Bt	Monsanto	Application
	Maize	Bt, drought tolerance	University of Zimbabwe, CIMMYT	Laboratory
	Sorghum	Metabolites	University of Zimbabwe	Laboratory
	Soyabean	Herbicide resistance	Monsanto, Zimbabwe Seed Co	-
	Tobacco	Disease resistance	University of Zimbabwe	Laboratory