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Gm sugarcane: A long way from commercialisation?

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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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Contents

Acronyms

ACB	African Centre for Biosafety
BMP	Best Management Practice
BP	British Petroleum
BSI	Better Sugarcane Initiative
CEF	Central Energy Fund
CSIR	Council for Scientific and Industrial Research
EC	Executive Council: GMO Act
EIA	Environmental Impact Assessment
GM	Genetically Modified
GMO	Genetically Modified Organism
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
IDC	Industrial Development Corporation
IFC	International finance corporation (World Bank)
IPB	Institute for Plant Biotechnology (University of Stellenbosch)
ISAAA	International Service for the Acquisition of Agri-biotech Applications
PANGEA	Partners for Euro-African Green Energy
RR	Round-Up Ready
RTRS	Round Table on Responsible Soy
SADC	Southern African Development Community
SASRI	South African Sugar Research Institute
SASA	South African Sugar Association
SMRI	Sugar Milling Research Institute
TNC	Trans-National Corporation
UKZN	University of KwaZulu Natal
UN	United Nations
UNICA	Brazilian Sugarcane Industry Association
USDA	United States Department of Agriculture
WWF	World Wildlife Fund

Key Findings

Numerous research projects are currently focussed on GM sugarcane in South Africa, with field trials having commenced as far back as 2001. However, there appears to be no immediate or even medium term prospect of the commercial cultivation of GM sugarcane in South Africa. The number of GMO permits granted by the Executive Council: GMO Act for sugarcane is miniscule when compared to those granted for other GM food crops.

Several research projects in South Africa are currently underway, with the stated aims of increased sucrose and biomass content. The leading players are the South African Sugar Research Institute (SASRI), the Institute for Plant Biotechnology (IPB) at the University of Stellenbosch and PlantBio (a branch of the Department of Trade and Industry).

While research scientists foresee the commercial cultivation of GM sugarcane in South Africa within the medium to long term, industry lobby groups such as the Better Sugarcane Initiative (BSI) remain sceptical of this. However, this reticence should not be interpreted as an ideological opposition to GM sugarcane, but merely a pragmatic appraisal. The manner in which the Round Table on Responsible Soy (RTRS) has been commandeered by industry interest groups should serve as a warning as to their 'sustainability' credentials.

Globally, the last few years have seen a flurry of activity within the biotech industry in regard to both sugarcane and sugar beet. In 2009 GM sugar beet became the fastest adopted GM crop in North America. Field trials for GM sugarcane are currently underway in Australia and Brazil.

Numerous partnerships have been established in Africa, and linkages have been established between South African and Brazilian industry and research groups.

Brazil is currently pushing for agrofuels produced from sugarcane to feature heavily in international climate change mitigation strategies. As yet there is no commercial cultivation of transgenic sugarcane in Brazil, although BASF, Bayer, Alellyx and CTC are conducting field trials in Brazil involving several GM traits: herbicide tolerance, virus resistance, drought resistance, Bt and higher sugar content.

Background

Globally, sugarcane accounts for approximately 80% of the global sugar crop, with sugar beet being grown at more temperate latitudes predominantly in Europe and North America, making up the balance.[1] Sugarcane is a major agricultural commodity in South Africa. In 2008/09 the gross income of sugarcane producers was over R4 billion,[2] while production of sugarcane over the same period was 19.26 million tons.[3] The sugarcane industry directly or indirectly employs over 400,000 people.[4]

The first experiment with GM sugarcane was conducted as far back as 1992, by Professor Robert Birch, at the University of Queensland in Australia.[5] However, to date, GM sugarcane is not grown commercially anywhere in the world.

In South Africa, various research projects are underway involving transgenic sugarcane, with the South African Sugar Research Institute (SASRI) being the most active in this area. Between 2005 and the end of 2009 550 GMO permits were issued for trial or environmental release of GMOs by the Executive Council: GMO Act (EC), however, only 13 of these were for sugarcane. All 13 permits were issued to SASRI.[6]

In 2005 the African Centre for Biosafety (ACB) lodged 2 objections to the Registrar: GMO Act in response to two applications by SASRI for field trials of GM sugarcane in South Africa.[7] Our objections centred on concerns with the scientific data submitted by SASRI in its permit application. We also highlighted the 'behind the scenes' role played by Bayer Cropscience in bankrolling SASRI's research and in so doing, attempting to make early inroads into South Africa's sugarcane industry.[8]

GM sugarcane and sugar beet: International trends

The complex nature of the sugarcane genome is not conducive to genetic engineering[9] when compared to food crops such as maize and soyabeans. Nevertheless, there has been a spate of sugarcane and sugar beet collaborations involving research institutes and the largest multinational biotech companies in the last couple of years. Syngenta has been particularly busy on the sugarcane front: in June 2009 it entered into an exclusive world-wide research and commercial license agreement with Chromatin for the latter's proprietary gene-stacking technology in sugar cane.[10] During December of the same year, Syngenta announced its exclusive licensing agreement with CSR Sugar, a sugar and renewable energy company from Australia for its SugarBooster™ technology.[11] According to Marco Bochi, director of New Sugar Cane Technologies at Syngenta for Latin America "we are bringing innovation to sugar cane cultivation through 40 different projects, focused on agronomy performance, weed and bug control, and raising sugar content."

Researchers from SASRI are on record for stating that GM sugarcane will enable the ethanol yield to double from 6,000 litre/hectare to more than 12,000 litre/hectare within the next 15 years.[12] Approval for field trials for biotech sugarcane was granted in Australia in October 2009.[13] Meghan Sapp of Partners for Euro-African Green Energy (PANGEA), a European agrofuels lobby group whose members include the Better Sugarcane Initiative, are confident that researchers in Brazil and Australia can bring GM sugarcane to the market within 5 years.[14]

In 2009 Round-up Ready (RR) sugar beet was grown on 95% of the 485,000 hectares of sugar beets grown in the United States. In Canada the proportion was 96%, albeit on a much smaller total area of 15,625 hectares. Consequently, RR sugar-beet is now the fastest adopted commercialised biotech crop globally to date. According to the latest report of the ISAAA, the high level of demand for GM sugar beet 'probably has implications for sugarcane (80% of global sugar production is from cane), for which biotech traits are under development in several countries.'[15]

BASF is looking to gain market dominance in sugar beet, having recently entered into a commercial agreement with KWS sugar beet, which controlled 70% of the North American sugar beet market in 2009. The partnership aims to bring new varieties with 15% higher yields to the market from 2020 onwards.[16] In Europe, 6 separate environmental releases of GM sugar- beet

have already been granted this year.[17] Jens Kossmann of the Institute for Plant Biotechnology (IPB) at the University of Stellenbosch does not anticipate the commercial cultivation of GM sugar beet in South Africa as he does not think it will be possible to grow 2 crops of beet a year (which is standard practice). However, he did not rule out its cultivation in more tropical African countries.[18]

GM sugar beet is the latest in a long line of GM crops to stir considerable controversy. In September 2009, the North Californian district court ruled that the US Department of Agriculture (USDA) had illegally approved Monsanto's GM RR sugar beet, without first subjecting it to a full environmental impact assessment (EIA) by the US Animal and Health Inspection Service (AHPIS). Further, the court argued that it 'may cross pollinate with non-genetically engineered sugar beets' and that it 'may significantly affect the environment'.[19] This did not deter growers and suppliers from continuing to plant GM sugar beet in flagrant disregard of the ruling; all supported by intensive lobbying from US agribusiness.[20] This pre-emptive action resulted in the decision of US District Judge Jeffrey White **not** to grant a nationwide ban, citing economic factors. White did not rule out the possibility of a future ban, pending the outcome of the EIA. Further court dates have been set for the 9th of July, 2010.[21]

Brazil

Despite Brazil being a world leader in the production of ethanol from sugar cane and the world's second largest grower of GMOs, [22] at the moment there is no commercial cultivation of transgenic sugarcane in Brazil. BASF, Bayer, Alellyx and CTC are currently running field trials testing for different traits (herbicide tolerance, virus resistance, drought resistance, Bt and higher sugar levels).[23]

Brazil is currently on a huge policy drive to put agrofuels at the centre of the global discourse on climate change mitigation. The Brazilian delegation to the recent United Nations (UN) climate change summit in Copenhagen was quick to deflect criticism of the disastrous impact the countries agrofuel drive has had upon vast swathes of land in the country, including areas of the pristine Amazon basin. Nevertheless, an official from the Brazilian ministry of science and technology let it be known that plans were currently underway to increase the area of land under sugarcane to a massive 64 million hectares, a tenfold increase on the present area.[24]

The ethanol industry in Brazil has been witness to a succession of eye-catching commercial deals within the last 12 months, including some of the biggest names from agribusiness, private equity and the oil industry.[25] In January, a joint collaboration between Brazilian state oil giant, Petrobras, and General Electric saw the world's first ethanol fuelled power plant open in the country.[26] Barely a month later Royal Dutch Shell signed a memorandum of understanding with Brazil's largest ethanol producer, Cosan, in a joint venture said to be worth $12 billion. According to the UK based Guardian newspaper, the deal will cement Brazil's position 'as the world's alternative energy super-power'.[27]

Brazil's South African and African collaborations

Several industry and research links have recently been forged between Brazil and South Africa. Researchers from the Council for Scientific and Industrial Research (CSIR) visited Embrapa (the Brazilian agricultural research corporation) in Brazil in October 2009 to discuss the potential for biotechnology in combating HIV/AIDS and agrofuels.[28] However, according to one of the CSIR visitors, GM sugarcane was not discussed during the visit.[29] The Brazilian Ministry of External Relations also hosted a recent biofuels seminar in Durban, as part of a 7 country tour of the SADC region by the agronomic giant to push for mandatory targets for blending agrofuels into national fuel supplies.[30]

Embrapa has established numerous linkages in the rest of Africa. Its main Africa office is located in Accra, Ghana, where it is currently engaged in sugarcane project to export ethanol to Sweden.[31] Late last year representatives from the Brazilian and Southern African agrofuels industry met in Mozambique to discuss investment opportunities in Mozambique. The county's close proximity to South Africa, its emerging ties with Brazil, and its tariff-free access to the Chinese[32] and European markets makes it an obviously attractive option. This came hot on the heels of the announcement in March last year of Mozambique's national biofuels strategy.[33] Barely a month after this the Mozambican government announced a $710 million investment by 3 foreign companies for ethanol production in sugarcane.[34] This deal was quickly surpassed in November 2009 by a deal with Brazil reported to be worth a staggering $6 billion.[35] So far GM sugarcane has not been mentioned, though this is likely to be subject to progress made in transgenic sugarcane research in Brazil and South Africa.

South Africa's flirtation with GM sugarcane

SASRI, the university of Stellenbosch, and PlantBio are all currently active in GM sugarcane research in South Africa. The Institute for Plant Biotechnology (IPB) at the University of Stellenbosch holds two patents related to transgenic sugarcane: Manipulation of VPPase activity in sugarcane to increase sucrose content (Patent number 2007/02680, filing date: 30 March 2007), and manipulation of sucrose content and cell wall composition in sugarcane. (Patent number 2006/07743, filing date: 15 September 2006).[36] The IPB receives funding from USAID and Bayer Cropscience, along with the South African National Research Foundation (NRF), SASRI and the Technology and Human Resources for Industry Programme (THRIP) (run through the Department of Trade and Industry).[37]

SASRI has established partnerships with the IPB[38] and PlantBio, which was established in 2004 as one of the Department of Trade and Industry's national innovation centres for plant biotechnology. It has research partnerships with a variety of South African and overseas research bodies, both public and private.[39] SASRI's partnership with PlantBio is for the development of tissue-specific promoters for transgenic improvement of sugar-cane and other crop species. In the initial research phase several genes expressed in leaves and roots were identified. The next step will be to use these identified gene sequences to verify the specific tissues, where the genes are found, and to quantify the levels of expression in each.[40] In addition, SASRI's own variety

improvement programme includes studies into sucrose content and metabolism, and inducing herbicide tolerance.[41]

SASRI's collaboration with the IPB was established in 1998, and is expected to continue 'indefinitely'. Several research projects are currently underway at IPB, focussing on higher sucrose content and increased biomass, some of which are at an advanced stage.[42] The South African sugar industry also funds research carried out by SASRI and the SA Sugar Milling Research Institute (SMRI), and members are represented on the respective boards of the institutes.[43]

In December 2009, Minister of the Department of Science and Technology, Naledi Pandor, announced the formation of a strategic sugarcane research platform, to be based in Pietermaritzburg. The centre, which will be mandated by the PlantBio Trust, is the result of an approach made by the SMRI, SASRI and the University of KwaZulu Natal (UKZN).[44] No public mention has been made of GM sugarcane in the initiative, and when contacted by the ACB the organisations involved were reluctant to expand on what has already been publically announced. However, the fact that the PlantBio Trust will oversee all projects involved indicates that biotechnology will play some kind of role. The first project funding awards are expected to be announced at the end of March 2010.[45]

The Executive Council (EC): GMO Act granted 5 permits for the trial release of GM sugarcane in 2009.[46] No permits have yet been granted in South Africa for 2010.[47] When contacted by the ACB, the South African Sugarcane Research Institute (SASRI) directed us to the Registrar: GMO Act, who was unwilling to divulge any information regarding future plans around GM sugarcane.[48] The Registrar: GMO Act has since revealed that no applications have been made to them by SASRI or PlantBio so far this year.[49] Professor Jens Kossmann, who is head of the Institute for Plant Biotechnology at Stellenbosch, thinks that the commercial cultivation of GM sugarcane in South Africa will be a realistic possibility in the medium to long term.[50] These views are echoed by professor Hussein Shimelis at the African Centre for Crop Improvement, UKZN.[51] The sugar industry in South Africa appears less optimistic of this however. Stan Rau, of Illovo Sugar, believes that it will be at least another 8-10 years before GM sugarcane becomes commercially cultivated.[52]

The GMO-Agrofuel Nexus in South Africa

In December 2007, the South African Department of Minerals and Energy published its Biofuels industrial strategy paper. This called for a 2% penetration level of agrofuels into the national liquid fuel supply within 5 years, or 400 million litres. Due to concerns over food security, maize was excluded, leaving sugarcane, sugar beet, canola and soya as the key crops.[53] As stated earlier, researchers at SASRI have previously acclaimed the potential for GM sugarcane to improve ethanol yields.

Several large scale projects involving the Central Energy Fund (CEF) and the Industrial Development Corporation (IDC) were earmarked across the country for the cultivation of sugarcane for ethanol.[54] In August 2009, yet another Brazilian – South African partnership was formed, between the Brazilian state development bank (BNDES) and the IDC. The agreement covers technology sharing, strategy formulation and the joint financing of capital projects in South Africa.[55] The nation's largest sugar companies have also been expanding their operations in the agrofuel sphere, at home and in the rest of Africa. Illovo is currently working on a R1.4 billion ethanol plant,[56] while Tongaat-Hulett CEO Peter Staude has stated that the companies focus is likely to change in the coming years towards ethanol production.[57]

Presently the major focus of agrofuels in South Africa, and other large sugar producing nations, is on conventional sugarcane. As yet no large scale GM sugarcane projects for agrofuels have been put forward. However, all the architecture is being put in to place for a massive agrofuels push, and should GM sugarcane become commercially feasible (as believed by many in the research sphere), the potential for a switch in agrofuel production to GM ingredients would more than likely be based on commercial incentives than worries over biosafety or biodiversity.

The Better Sugar Cane Initiative

The Better Sugar Cane Initiative (BSI) was founded in 2005 by the World Wildlife Fund (WWF) and the World Bank's International Finance Corporation (IFC). The BSI is based on the workings of other environmental 'round-tables', seeking to implement certification schemes, which ultimately aim to include the cultivation of sugarcane as part of international climate change agreements.[58] In the word of its website, the BSI's mission is "'to ensure that current and new sugarcane production is produced sustainably".[59] Recent new members include BP, Shell and Greenergy. The BSI steering committee is dominated by TNCs, including Cargill, Tate and Lyle, Coca Cola, British Sugar, as well as the WWF and Ethical Sugar. Joining the BSI steering committee costs US$25,000 and becoming a special advisor US$10,000. According to the Timberwatch coalition, "this is extraordinarily undemocratic and unheard of in any of the other roundtables". A number of BSI members, including BP, Shell and Cargill are involved in collaboration with or have investments in the largest biotech companies, including Monsanto, Du-Pont and Bayer.[60] The Brazilian national sugarcane industry association (UNICA) is also a member.[61]

BSI's project manager, David Willers, previously worked as an overseas representative for the South African Sugar Association (SASA). The BSI has held outreach meetings in the Noodsberg area of KwaZulu Natal, in the heartland of South Africa's sugarcane belt. According to Willers, the BSI has no position on GM, instead leaving it to its members "to use the most appropriate local BMP (best management practice) within the national laws to do so." Willers is dubious of the prospect of the commercial cultivation of GM sugarcane, owing to consumer attitudes in the biggest sugar importing countries such as Japan and the EU, and difficulties with segregation during transportation[62] (these concerns over the segregation of GM and non-GM sugarcane have been echoed by other sugar industry representatives).[63]

If the experience of the 'Round-Table on Responsible Soy' (RTRS) is anything to go by, the BSI's neutrality on GMOs is open to undue influence from its members. Prominent members of the RTRS took part in an aggressive lobbying campaign to get the EU to water down its GM policy, while biotech companies have used the forum as a giant PR stunt to promote 'climate friendly' agrofuels.[64] Non-till (NT) agriculture, much vaunted by the biotech industry, is another supposed climate solution. In a NT system, seeds are drilled directly into the ground, averting the need to till the soil. As the act of tilling the soil releases carbon dioxide into the atmosphere, in theory NT will prevent this release. However, the United Nations Framework on Climate Change (UNFCC) and the US Department of Agriculture are both skeptical of NTs true mitigation value. This has not stopped the biotech industry from intensive lobbying, through the UN Food and Agricultural Organisation (FAO) and the Conservation Technology Information Centre (CITC), for the inclusion of conservation agriculture in carbon offsetting schemes.[65]

Conclusion

Along with the BSI, Partners for Euro-African Green Energy (PANGEA) and Illovo Sugar South Africa are also skeptical of the future of commercially grown GM sugarcane in South Africa, citing consumer concerns. The divergence in opinion between industry groups and scientists as to the potential for the wide spread use of GM sugarcane is significant, and reflects the different constraints that the two groups operate under. However, as has been pointed out elsewhere, industry 'round-tables' are notorious for their propensity for quite unsustainable environmental 'solutions'.[66] [67] Given the collaborations between members of the BSI and some of the world's largest biotech companies,[68] and their recent spate of activity around GM sugarcane, a negative position on GMOs would seem extremely unlikely in the long term. The example of the hijacking of the Round Table on Responsible Soy by an 'agribusiness as usual' constituency should serve as a stark warning in this regard.

In South Africa trials of GM sugarcane have been going on since at least 2001,[69] with there being no possibility of a commercial release in the foreseeable future. The complex nature of the plant is no doubt a significant factor in this, but there are economic factors at play too. The most widely planted GM food crops, maize and soy, were developed predominantly in the US industrial agricultural system. Their substitution for commercially grown hybrid varieties in this existing system was thus much simpler. The promise of high economic returns also drove the research agenda within the increasingly consolidating biotech industry.

Already by 2000, and in spite of huge marketing campaigns by the biotech industry promoting GMOs, ordinary South African citizens questioned about GMOs expressed concerns over what they perceived to be some negative impacts of GMOs in agriculture.[70] South Africa remains one of only three African countries to have planted GM crops,[71] and the only country in the world that has allowed the planting on a commercial scale of a GM staple food. Nevertheless, the decision by the EC to reject an application for the trial release of GM potatoes at the end of 2009 came about after a groundswell of public and civil society opposition.[72] In the European Union, which in 2008 imported 38% of South Africa's agricultural exports[73], a 2008 Eurobarometer survey found that 58% of respondents are 'personally opposed' to biotechnology.[74]

Sugarcane is not grown in the industrial north and its counterpart, sugar beet, is only just beginning to establish itself as a GM food crop. However, the current fixation with agrofuels as a carbon mitigating strategy in the industrial north could very well provide the economic incentive for a more concerted push by the biotech industry into GM sugarcane. The South African government launched an industrial agrofuels strategy in December 2007,[i] with several large-scale projects centered on the Eastern Cape's supposed 'marginal' lands.

Ongoing research into GM sugarcane in South Africa, coupled with a general laissez faire attitude to genetic engineering at the policy level, indicates that commercial GM cultivation cannot be ruled out. The African Centre for Biosafety will continue to monitor the situation and engage with the main actors involved.

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i. For more details see the ACB publication 'Agrofuels in South Africa: projects, players and poverty'. http://www.biosafetyafrica.org.za/index.php/20090128191/Agrofuels-in-South-Africa-projects-players-and-poverty/menu-id-100027.html

Annexures

GM Sugarcane permits granted 2009

Applicant	Organism	Trait	Foreign supplier/ receiver	Volume / quantity	purpose	status
SASRI 012 (Feb)	Sugarcane NCo310	Alternative sugar	-	-	Trial release	Trial release
SASRI 010 (April)	Sugarcane NCo310	Alternative sugar	-	-	Trial release	Trial release
SASRI 013 (Nov)	Sugarcane pASNI	Growth rate/yield &altered sucrose content	-	-	Trial release	Trial release
SASRI 014 (Nov)	Sugarcane pSVPPase	Growth rate/yield & altered sucrose content	-	-	Trial release	Trial release
SASRI 015	Sugarcane pAUGdf510	Growth rate/yield & altered sucrose content	-	-	Trial release	Trial release

Source: Department of Agriculture, Forestry and Fisheries. 2010

NB. There were no GMO permits granted related to GM sugarcane by the Executive Council in 2007 or 2008

GM Sugarcane permits granted 2006

Applicant	Organism	Trait	Foreign supplier / receiver	Volume / quantity	Purpose	status
SASRI 005	Sugarcane	Viral resistance	-	5 lines	Field trials	Trial release
SASRI 008	Sugarcane	-	local	126 plants	Trial release	Trial release
SASRI 009	Sugarcane	Anti-microbial	Local	5 transgenic lines	Field Trials	Trial release
SASRI 006	Sugarcane	-	local	91 lines	Trial release	Trial release

Source: Department of Agriculture, forestry and fisheries. 2010

GM Sugarcane permits granted 2005

Applicant	Organism	Trait	Foreign supplier / receiver	Volume / quantity	Purpose	status
SASRI 005	Sugarcane 1-2-3-3	-	RSA	48 stalks	Export for contained use	Export
SASRI 004	Sugarcane 1-2-3-3	-	RSA	Several transformed lines	Field Trial (Fast track)	Trial release
SASRI 003	Sugarcane pleurocidin	Antimicrobial	-	5 lines	Field Trials (Extended permit)	Trial release
SASRI 003	Sugarcane BT	Insect R	-	77 lines	Field Trials (Extended permit)	Trial release

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