Little
surprise,
then, that the world's
academies of science have mostly
come out in support of the use of GM crops.
"Food from GM crops are more extensively tested than any other," reads a statement in the ASSAf report. "They have been shown to be as safe as, or even sometimes safer than, foods derived from the corresponding conventional plants." These sentiments have been echoed by WEMA, whose researchers also promised that any field tests would be conducted under the strictest supervision. Even the Pontifical Academy of Science of the Catholic Church gave its provisional blessing to GM crops.

## The cons

Some are not convinced. The African Centre for Biosafety, for example, has been outspoken in its opposition to GM crops. It talks of multinational business interests, notably that of Monsanto – a major player in WEMA – and others. "It is clear that the real beneficiaries of this GMO deluge have been the multinational biotechnology and agribusiness corporations," it says. It also argues that these corporations and the GMO industry is "wreaking havoc on the climate, on human health, and on the peasant farmers who still provide 70% of the food eaten in the world".

A report by the Environmental Biosafety Cooperation Project (EBCP), a partnership between South Africa and Norway, also came to worrying conclusions.16 That report suggested, most notably, that some insects may be developing resistance to Bt maize, with a number of factors contributing to that growing immunity. It also cautioned of unwanted and unpredicted side effects of genetic engineering in human food or animal feed. So, for instance, there is a risk of the production of a known allergen (for early weaned pigs) in GM maize.

## And the maybes

The International Assessment of Agriculture, Knowledge, Science and Technology for Development (IAASTD) study, a three-year global study, also pointed out concerns. These, it noted, are typically around gene flow beyond GM crops, reduction in crop diversity, increases in herbicide use, herbicide resistance, loss of farmer's sovereignty over seed, ethical concerns on origin of transgenes, and lack of access to intellectual property rights held by the private sector.17 It also notes that while there have been positive economic benefits from GMOs for large-scale producers, there is "less evidence" that such crops have benefitted small producers in developing countries.

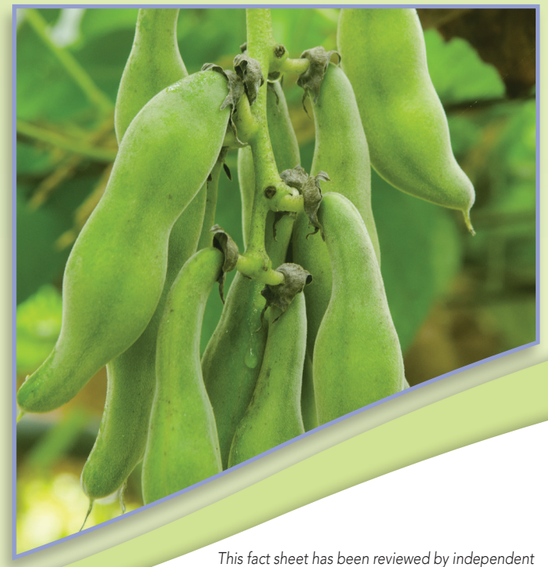
The study is at pains to observe that there is "little consensus" among the assessments. One study speaks of the benefits of GMO crops, the report says, while others question such gains. The study also concludes that the safety of GMO foods and animal feed is controversial because there is limited data available on the subject, notably around the long-term effects of consumption and chronic exposure.

Food safety is a major issue in the GMO debate, notes the study, with concerns over the changes made to the nutritional quality of foods, toxicity, antibiotic resistance, and allergenicity from consuming GM foods.

There
appears to be some
consensus that the approval process of GM crops is inadequate. And for those with a bent towards organic foods, there are further worries as the cultivation of GMO crops near organic crops can threaten organic certification due to the risk of cross-pollination and genetic drift.

## So what lies ahead?

It's clear that both supporters and detractors will keep a close eye on developments with WEMA. Even the IAASTD had a few hedged words of support. "Increasing investments in agricultural research, innovation, and diffusion of technology by for-profit firms," it says, "can also make major contributions to meeting development and sustainability goals."17 The multinationals may also be able to play its part. "Private firms (large and small) have been and will in the future continue to be major suppliers of inputs and innovations to commercial and subsistence farmers." And while they may not do it out of the goodness of their hearts, concludes the study, there may well be knock-on benefits. "They will not provide public goods or supply good and services for which there is no market, but there could be spillovers from private suppliers of technology to farmers and consumers."



*This fact sheet has been reviewed by independent experts and has followed SAASTA's Scientific Editorial Process.*
*www.saasta.ac.za*

*Last updated in January 2014*

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

# GMOs in South African Agriculture

## GMOs – a potted introduction

### What is a GMO?

A genetically modified organism (GMO) is an organism – be it plant, animal, bacterium or virus – whose genetic makeup has been altered for a particular purpose. For example, a plant can be modified to carry an additional gene taken from another organism (such as a bacterium) to protect that plant against insect pests. Typically, this involves taking genetic material, usually encoding a desirable trait, from one species and inserting it into another.11 An example would be the introduction into plants of the gene from the bacterium Bacillus thuringiensis (Bt), which is toxic to certain insects; and in so doing protecting the plant against those insects. Scientists are attempting other such GM crops, for example producing a GM banana in Uganda resistant to Banana Xanthomonas wilt disease by introducing genes from a sweet pepper plant.

### What kinds of biotechnologies are used in GMOs?

Recombinant DNA technology is the most typical means of transferring genetic material from one species to another. In the case of GMOs, strands of DNA from two different species are combined to form a modified or artificial DNA molecule.1

Chemicals are another biotechnology that can be employed with GMOs. Here chemicals – such as sodium azide and ethyl methyl sulphonate – are used to induce mutations in plants.1

However, some plant genes are more easily mutated by radiation. The most widely used means of doing this is gamma radiation.1 This irradiation of seeds speeds up the natural process of evolution of the plant's DNA, and so new varieties of crops can be produced with the desired characteristics.

### So just how common are GMOs in SA and African agriculture?

South Africa cultivates three GM crops:

**Cotton:**

Insect resistant cotton was the first GM crop grown in South Africa in 1997. Now herbicide tolerant cotton and double-stacked herbicide tolerant/ insect resistant cotton are also grown. Statistics in 2012/2013 showed that virtually no conventional cotton is grown in South Africa. The double-stacked herbicide tolerant/insect resistant cotton accounts for more than 95% of cotton planted.

**Maize:**

Insect resistant maize was first grown in South Africa in 1998. Now herbicide tolerant and double-stacked herbicide tolerant/insect resistant maize are grown in South Africa. Statistics of 2012/2013 showed that 86% of maize cultivated in South Africa is GM maize. The double stacked herbicide tolerant/insect resistant maize accounts for the greatest proportion of GM maize grown, at 49%, with the insect resistant Bt maize accounting for 35% of all GM maize.

**Soybean:**

Herbicide tolerant soybean has been grown since 2001. In 2011, it accounted for approximately 85% of total area of cultivated soybean. 2012/2013 figures estimate that 90% of the season's soybean plantings were herbicide tolerant soybean.

According to 2007 numbers, 51% of yellow maize, 62% of white maize, 80% of soybeans and 90% of cotton produced in the country were GM crops. By 2009, those numbers had grown to 63% of yellow and white maize, 85% of soybean and 98% of cotton. In 2011, numbers were up to 72% of yellow and white maize, 85% soybean and practically all cotton. The latest statistics of 2012/2013 show increases in total percentages of GM crops, with 81% of white maize, 93% of yellow maize and 90% of soybean being GM crops.

There are suggestions that other crops could follow. Research is underway on GM cassava – a starchy root – that is resistant to the Cassava Mosaic Virus (CMV) in Kenya and Uganda, and bio-fortified Cassava in Nigeria, as well as in South Africa. South Africa has also started to dabble in research on GM

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**The mandate of PUB is to promote a clear, balanced understanding of the potential of biotechnology and to ensure broad public awareness, dialogue and debate about biotechnology and its current and potential applications.**
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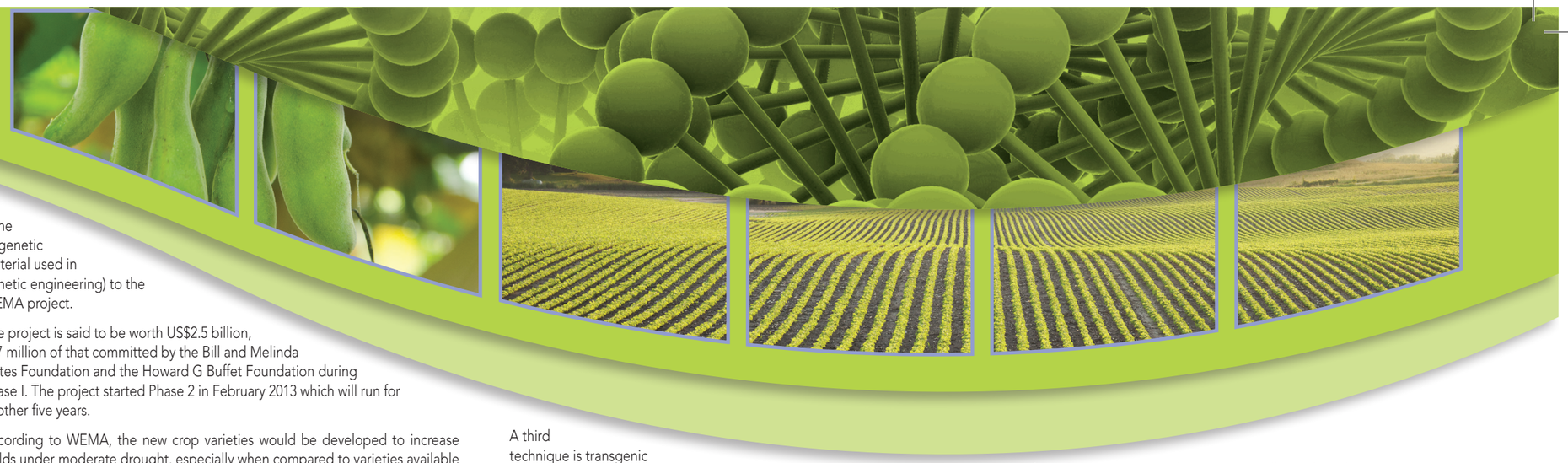

grapevines. The research is focused on the development of fungal and viral resistant vines, vines better capable of resisting environmental stress and improved grape berry quality.

According to reports, the total area dedicated to GM crops grew by 8% in 2011/2012, to reach a total of 160 million hectares, grown by 16.7 million farmers in 29 countries.

In 2012, South Africa cultivated GM maize, soybeans and cotton on 2.9 million hectares of agricultural land, compared to 2.3 million hectares in 2011. Burkina Faso, Egypt and Sudan are the only other African countries cultivating GM crops. Burkina Faso first planted GM cotton in 2008, where it accounted for 2% of total cotton. Three years later, in 2011, GM cotton made up 58% of cultivated cotton. Egypt first planted GM maize in 2008 on 700 hectares. In 2011, 2800 hectares were planted. Sudan planted GM cotton on 20000 hectares for the first time in 2012.

Those nations' forays aside, Africa lags well behind other continents in the adoption of GM crops, despite the decline in its per capita food production. Countries like Zambia and Zimbabwe, for example, have banned GMO imports.

A major constraint to the development and adoption of GM crops in other African countries is the lack of regulatory frameworks that will lead to a comprehensive and balanced evaluation of GM products. With robust regulatory frameworks in place, GM crops are more likely to be widely adopted and accepted and the debates over safety concerns should hinder to a lesser extent the effort to use GM technology

For now, early adopter South Africa is leading the way, said to be the world's ninth-largest producer of GM crops. The United States remains the global leader.

## So you've heard of WEMA, the Water Efficient Maize for Africa Project?

Backed by the Bill and Melinda Gates Foundation and Howard G. Buffett Foundation, the Water Efficient Maize for Africa (WEMA) project has been billed as likely the most far-reaching initiative in agricultural development in Africa. Its founding can be traced back to 2008, when the Gates Foundation made its first WEMA grant to the African Agricultural Technology Foundation (AATF) in Nairobi. The aim of the project was to develop genetically engineered drought-tolerant and insect-protected African maize varieties for sub-Saharan Africa. Partnership institutes are based in five African countries – Kenya, Mozambique, South Africa (through the Agricultural Research Council), Tanzania and Uganda.

Other partners are the International Maize and Wheat Improvement Center (CIMMYT), a non-profit research and training centre with its roots and headquarters in Mexico but with projects and regional offices in 13 other countries; Monsanto, a US-based agricultural biotechnology multinational. Monsanto donated the technology and the drought tolerance (together with BASF, a German chemical company) and insect-pest protection transgenes (a gene or genetic material used in genetic engineering) to the WEMA project.

The project is said to be worth US$2.5 billion, $47 million of that committed by the Bill and Melinda Gates Foundation and the Howard G Buffet Foundation during Phase I. The project started Phase 2 in February 2013 which will run for another five years.

According to WEMA, the new crop varieties would be developed to increase yields under moderate drought, especially when compared to varieties available to farmers today. This would become increasingly important in the face of climate change. Modest yield gains could mean an additional two million tons of maize during drought years, a harvest that could feed 14 to 21 million more people.

## The piece of the puzzle that is maize

It's easy to understand the attention the project pays to maize, also known as corn.

It is the most widely grown staple crop in Africa, where it was first introduced in the 1500s.18 Over 300 million Africans are said to depend on the crop as their main food source. According to the International Institute of Tropical Agriculture, maize accounts for 30-50% of the expenditures of low-income households in Eastern and Southern Africa. Africa produces around 6.5% of the world's annual production of 785 million tons, harvesting 29 million hectares of maize. It also imports 28% of its requirements from outside the continent.

In developed countries, says the Directorate: Agricultural Information Services, maize is consumed mainly as second-cycle produce in the form of meat, eggs and dairy products. In developing countries, in contrast, maize is consumed directly.

The maize varieties that WEMA plan to develop will use different breeding techniques. These include conventional breeding, in which the genes of a plant are changed by, typically, 'mating' two closely related plants to tap the most favourable traits of the respective plants. This, if it all pans out, will improve the plant's ability to adapt to different climate conditions or boost its nutritional value, etc.

WEMA will use advanced breeding or marker-assisted breeding, Rather than the slow process of directly targeting one or a number of genes that would, for example, make a plant more resistant to a certain pest, scientists use a shortcut, looking out for molecular or genetic markers closely linked to that gene or genes. (Find the marker, and more than likely the sought-after gene or genes will be present in the plant.) These markers can be based on either DNA or proteins.

A third technique is transgenic breeding, aka genetic modification.

According to WEMA, its first maize varieties – developed through conventional breeding techniques – could be available within the next couple of years. The timelines for the genetically modified drought-tolerant and insect-protected maize varieties would, it said, depend on results from its research and development projects.

WEMA has predicted that farmers could have access to these drought-tolerant maize varieties in six to seven years. The first five years of the project – up to 2013 – would be committed to research: its "breeding development" and "biotechnology trait development" periods. Extensive field testing is scheduled from year six onwards, with final products scheduled for delivery by years nine and 10.

The transgenic varieties, they also pledge, would be made available royalty-free – no additional fees – to smallholder farmers in Africa through local seed companies.

The public perception of WEMA and its technologies remains a concern, however, said the collaboration in its 2011 social audit report.

## That's good, right?

Not everyone is convinced that WEMA will deliver on its promises.

The African Centre for Biosafety (ACB), for example, has argued that WEMA is threatening Africa's food sovereignty and opening new markets for Monsanto. The Centre claims that WEMA is little more than a front for the breakthrough into Africa that biotechnology and seed industries have been after for two decades.

Others have picked up on the Centre's cues. In 2010, members of the Lutzville community in the Western Cape were reported to have objected to trials of Monsanto's GM maize in the area. The Centre also points out that the Gates Foundation had, not-so conspicuously, bought half a million shares in Monsanto.

Its science is also shaky, said the ACB.2 WEMA's scientific claims have been "hotly disputed", and research suggests that conventional breeding had already outstripped WEMA's ambitious yields, according to the Centre.

In addition, added the ACB, Monsanto and the BASF were being disingenuous about some of its intentions. Most of the 1,600 patent documents lodged worldwide between June 2008 and June 2010 relating to flood-, drought-, heat- and salt-tolerance are owned by Monsanto, DuPont and BASF. Many of these patents, apparently, involve traits found in African heritage crops such as cassava, millet and sorghum.

The ACB also argues that there is no evidence, despite claims to the contrary, that GM crops benefit either the poorest consumer or small-scale farmers, and rather took decision-making powers – to go GM or not – away from farmers. Instead, it was seed and chemical companies, along with the agribusiness sector, which profited most from the introduction of GM crops. In addition, the price of GM maize seed has gone up; although this does not necessarily suggest that farmers pay the increased prices as discounts can be offered.

Furthermore, says the ACB, three of Monsanto's GM maize varieties had failed to pollinate in 2009, leaving over 200,000ha of South African maize fields barren. And there is growing concern that insects have built up resistance to Bacillus thuringiensis (Bt) maize.

## The pros and the cons

### The pros

From South Africa's widespread adoption of GM crops, it's become clear that the country has embraced – more or less – the use of GM biotechnology in agriculture, and has become the frontrunner on this front on the continent. Many in the academic community have also come out in support of GM crops. At a scientific workshop, titled GMOs for African Agriculture: Opportunities and Challenges, hosted by the Academy of Science of South Africa (ASSAf) in 2009, experts from seven different countries spoke on the opportunities – and challenges – of GM technology. While noting those challenges, it would appear that most favoured the introduction of GM crops in agriculture.

GM technology presents "an exciting opportunity" to help solve the continent's food and nutrition security problem, said ASSAf in that report. Research results showed, it continued, that GM technologies could increase crop yields, improve the storage potential of harvest crops, and improve the protein content of starchy foods, among other benefits.

In addition, GMOs offer the opportunities to build plants' resistance to plant virus infections. There's a rogues' gallery of such plant diseases that are of economic importance to African agriculture. This includes the likes of maize streak virus, a major pathogen that is said to have made maize production "virtually impossible" in some parts of Africa.1 Similarly, cassava mosaic virus (CMV) disease and cassava brown streak virus (CBSV) disease have, together, had a dramatic impact on the production of cassava in East and Central Africa. And more recently banana bunchy top virus (BBTV) has become a threat to banana production – and no small threat at that as some 70 million people in 15 countries in sub-Saharan Africa depend on bananas for their livelihood and food supply.

GM crops, says WEMA, could as a result lead to a decrease in pesticide use as it reduces farmers' needs for such products to protect their crops.