

## Present and past projects supported by BSA

- [BSA Summary of project 08-001JvB.pdf](#)

BSA 08-001: Studies on the effects of Bt maize on selected arthropods, amphibians and annelids

Summary of project:

The effect of Bt maize on non-target organisms is not well understood and prior to this study, no research has been conducted in South Africa other than field monitoring of species diversity and abundance. The main aims of the project were to study the effects of Bt maize on non-target organisms, to investigate gene-flow between target pest populations and lastly to develop research capacity. Below you will find the main results of the research project, how it advanced our current knowledge and understanding of relevant biosafety issues and the how the outcomes of the project will impact on current biosafety policy and management practices.

- [BSA Summary of project 09-011HS.pdf](#)

BSA 09-011: Evaluation of the allergenicity of DKC78-15B maize pollen

Background:

A maize farmer living in the Hartswater region (Northern Cape, South Africa) was reported as being allergic to pollen of a specific GM maize hybrid cultivated in the area. His local general practitioner referred him to an allergy specialist in Cape Town for further assessment. Subsequent skin prick tests with pollen extracts confirmed a marked positive reaction to the pollen of the specific GM maize cultivar. The aims of this project were therefore to (i) verify the initial sensitisation, (ii) compare the potential allergenicity of pollen from various GM and non-GM cultivars, (iii) determine if the allergic reactions are clinically relevant, (iv) ascertain whether this is an isolated incident and (v) identify the specific allergen(s) responsible for the reactivity.

- [BSA Summary of project 09-005EB.pdf](#)

BSA 09-005: Evaluation of alterations at the transcriptome, proteome and metabolome levels of two Bt maize lines with their corresponding non-Bt counterparts, as a result of genetic modification, natural variation or environmental variation.

Executive summary:

The objective of this study was to use three omics' technologies to test for unintended effects that could be derived from the modification of two maize cultivars with the same Bt gene. The four maize cultivars (two Bt and the corresponding no-Bt counterparts) were grown in the same plot in a randomized block design, in two locations and in two consecutive years. The transcriptomics technology used was RT-PCR and it tested developing embryos (25 Days After Planting) and mature kernels. It was used for the targeted analysis of 17 genes that have been reported in the literature to be expressed at different levels in some GM and non-GM maize. No differential expression was however found in this study for these genes in the cultivars tested. Three housekeeping genes were also included and the zein gene was found to be the one that was stably expressed in both embryos and kernels and not dependent on the developing stage of the maize plant.

- [BSA Summary of project 09-009HL.pdf](#)

BSA 09-009: The efficacy of containment methods of abalone in a contained use GM facility.

Executive summary:

Genetic modification of aquatic organisms is being employed for a number of purposes (e.g. to improve yields), but the potential benefits of genetically modifying abalone to improve growth are accompanied by potential risks to both the environment and to human health. Accordingly South Africa has developed a regulatory framework to enable the safe use of GMOs. Currently there are no standardised strategies to ensure containment of GM abalone within commercial production systems. The study investigated the efficacy of biological, chemical, and mechanical containment methods to contain genetically modified (GM) abalone (*Haliotis midae*).

- [BSA Summary of project 09-010JK.pdf](#)

BSA 09-010: Development of technology to enable cis-genesis in sugarcane.

Executive summary:

Crop genetic engineering relies on the introduction of foreign DNA into plant genomes. Recently strategies have been developed to genetically engineer plants by transforming them only with their own DNA (cisgenic plants). The aim of this study was to produce cisgenic sugarcane with down-regulated UMP synthase in combination with exclusively sugarcane sequences for promoters, coding sequences, terminators and selection genes.

A SH2 sugarcane promoter sequence from the ADP-glucose pyrophosphorylase subunit SH2 transcriptional regulator was isolated and fused to a GFP reporter gene. Sugarcane callus was bombarded with this construct and transient GFP expression was observed. However, no GFP expression was detected in the mature transgenic sugarcane plants. Numerous other attempts to isolate potential functional sugarcane promoters, based on available sequence data from other plant species and screening of sugarcane BAC libraries, were unsuccessful.

For the cisgenic selection regimes, two plant genes were targeted. The first target gene was acetolactate synthase (ALS). For this, the sensitivity of sugarcane callus towards herbicides from the sulfonylurea and imidazolinone classes was tested. Callus growth was most affected by sulfonylurea herbicides, particularly chlorsulfuron. Herbicide-resistant transgenic sugarcane plants containing mutant forms of a tobacco als gene were obtained following biolistic transformation. Post-bombardment, putative transgenic callus was selectively proliferated on nutrient medium and 3.6 µg/l chlorsulfuron. Thirty vigorously growing putative transgenic plants were successfully ex vitro acclimatized. Glasshouse spraying of putative transgenic plants with 100 mg/l chlorsulfuron dramatically decreased the amount of non-transgenic plants that had escaped the in vitro selection regime. PCR analysis showed that six surviving plants were also-positive and that five of these expressed the mutant als gene. This research work is the first to describe a selection system for sugarcane transformation that uses a selectable marker gene of plant origin targeted by a sulfonylurea herbicide.

The second plant target gene was protoporphyrinogen IX oxidase (PPO). For this, the sensitivity of sugarcane callus to diphenylether herbicides was tested. Callus growth was mostly affected by fomesafen and lactofen at 10 mg/l and cell death was also seen in exposed calli. To date a tobacco chloroplast ppo gene was isolated. Two mutations known to induce herbicide resistance in plant cells (Li et al. 2003) were introduced at amino acids Y426M and S305L. The mutated ppo gene is currently introduced into sugarcane. Attempts are also underway to isolate a native sugarcane PPO gene.

- [BSA Summary of project 11-001MG.pdf](#)

BSA 11-001: The Socio-Economic Consequences of Biosafety Regulation on Agricultural Trade: The Case of Maize Trade Between Zimbabwe and South Africa

Executive summary:

The project set out to study the socio-economic consequences of biosafety regulation on agricultural trade with focus on maize trade between Zimbabwe and South Africa. The study analysed the effects of complying with the Zimbabwean regulatory requirements, focusing on Zimbabwean consumers. The price effect of the added costs of complying with the regulation was considered to represent the costs of the regulation while the concerns of the consumers regarding GMOs, based on the government's concerns as implied and delimited by the regulations, were assumed to be indicative of the benefits.

The regulation has resulted in a dual maize grain import channel differentiating between GM and non-GM maize imports. As the only commercial producer of GM crops in southern Africa, South Africa supplies both channels. In the non-GM channel South Africa competes with Zambia, who only produces non-GM crops and has produced substantial surpluses in recent years. It was found that the GM grain import channel only officially functions during times of severe food shortages. The GM channel is characterised by an elaborate compliance process aimed at preventing the grain from being used as seed. The results of the cost analysis show that despite the purchase price of GM grain being significantly lower than non-GM grain the compliance procedures in the GM maize meal channel results in a more expensive consumer product. The study found that the regulatory cost effects have acted as a protectionist measure for local producers who sell at comparatively high government gazetted prices.

Analysis of risk and benefit perceptions of Zimbabwean consumers reveals that consumers are undecided about GMOs, as they perceive both high benefits and risks. The most perceived benefit is that GM crops can increase food supply while the major perceived risk surrounds impacts on human health. Generally, and based on these indications, it would appear as if the current provisions of the Zimbabwean National Biotechnology Act are aligned with the concerns of the consumers. However, the occasional acceptance of GM grain or food in times of severe food shortages is in contrast with the government's position and has resulted in considerable confusion among consumers.

- BSA project BSA 15-001 (ongoing)

Summary of the project to date:

The South African sugar industry is currently investigating the use of GM technology to address challenges experienced by South African farmers. This includes the development of GM sugarcane with *Bacillus thuringiensis* (Bt) crystal protein (Cry) genes to control lepidopteran stalk borers which cause annual losses of R900 million and investigating whether Ht traits could lead to more sustainable farming practices. Biosafety South Africa is currently funding a collaborative research project that looks to address various biosafety and sustainability issues associated with the development of a GM sugarcane line in South Africa. This includes projects focussing on the following topics :

- Insect resistance management is a key area to ensure sustainability of the Bt technology in GM crops. To this end, two aspects are under investigation: (1) which Cry insecticidal proteins and what level of exposure can be used to target lepidopteran stalk borers; (2) what proportion of a sugarcane farm should comprise of non-Bt cane (i.e. refugia plantings)? Progress has been made in assessing the performance of insects on artificial diets for insect species, the response of the insects to a concentration range of CryIAb protein in a pure form incorporated in an artificial diet and by feeding on maize tissue using *Busseola fusca* as a control has been evaluated. For predicting refugia proportions, it has been determined that existing agent-based models used previously to predict *Eldana* insect movement and mating are not be feasible to use and the focus will now be on simulation modelling using an approach known as cellular automation. A model using this approach has been developed and preliminary results have been obtained.
- As part of the assessment of any risks that may be associated with gene flow the likelihood of outcrossing of sugarcane with wild relatives was assessed. An assessment of *Saccharum* wild relatives was conducted based on prevalence, spatial overlap, proximity, distribution potential and flowering times. In addition phylogenetic data was generated to determine relatedness between *Saccharum* hybrids and its wild relatives. This aspect of the gene flow work has been completed and a manuscript has been submitted for publication.
- The objective of the ex-ante socio-economic impact assessment component is to shed light on the potential farm-level, industry-level and consumer level impacts of GM cane in South Africa. Research focussing on insect resistant and herbicide tolerant GM cane has commenced.