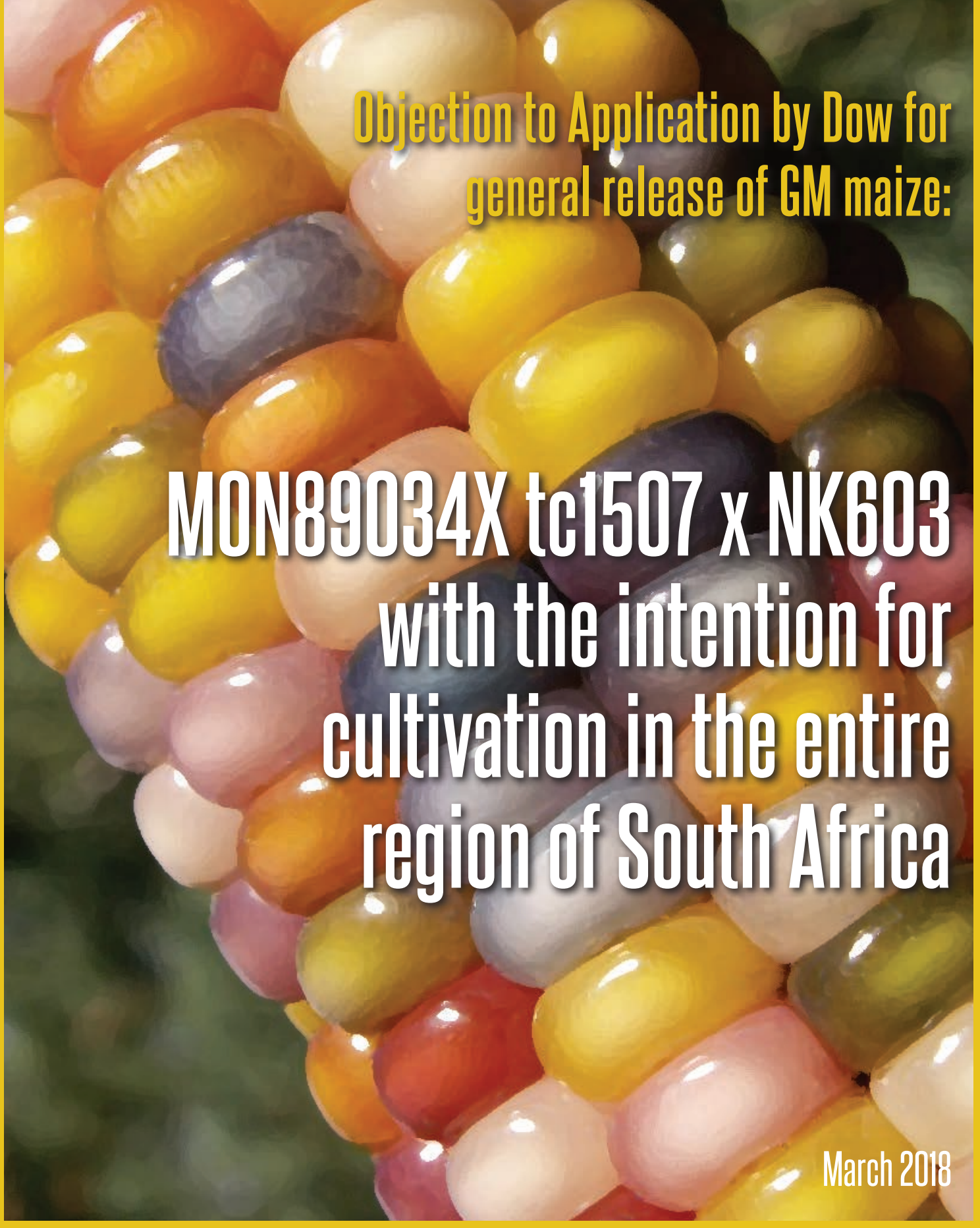


Objection to Application by Dow for general release of GM maize:

MON89034X tc1507 x NK603 with the intention for cultivation in the entire region of South Africa

March 2018

african centre for biodiversity
www.acbio.org.za

Contents

INTRODUCTION

The African Centre for Biodiversity (previously 'Biosafety') (ACB) was established in 2003 and registered in 2004. ACB carries out research, analysis, capacity and movement building, and advocacy, and shares information to widen awareness and catalyse collective action and influence decision-making on issues of biosafety, agricultural biodiversity and farmer managed seed systems (FMSS) in Africa. The ACB's work both informs and amplifies the voices of social movements fighting for food justice and food sovereignty in Africa.

The ACB has played an essential watch-dog role on new GMO permits in South Africa for a decade now, adding substantially to the discourse about the scientific assessment of GMOs as well as about issues of socio-economic impacts and democratic decision-making, through lodging substantive comments on at least 30 permit applications.

We are objecting to the general release of MON 89034 x TC1507 x NK603, due to concerns surrounding lack of safety to human and environmental health of this GM maize variety and its associated pesticides, glyphosate and glufosinate. This latest variety will serve to further increase exposure by the peoples of South Africa to yet more chemical pesticides, consolidate the corporate control of South Africa's already corporatized food systems and entrench inequities and food insecurity.

Under these circumstances, we urge the Department of Agriculture, Forestry and Fisheries to decline approval.

KEY CONCERNS

1. Molecular concerns

- There is lack of information included on the characterisation of the inserted transgenes. These transgenes have been made synthetically and therefore have no history of safe use. Independent studies document unintended changes in the sequences of parental line TC1507, suggesting potential genetic instability.
- Introduced genetic elements, such as the cauliflower mosaic virus and the nos 3' terminator sequences, introduce known hazards that may, in turn, introduce instability of the transgenes and/or production of novel nucleotide sequences. Such risks have not been tested for.
- Parental lines have been shown to have altered compositional profiles in peer-reviewed independent data. The applicant fails to mention this and provides information on techniques with limited sensitivity to confirm no alterations in transcriptome, proteome or metabolome has occurred.

2. Safety assessment

- The applicant claims safety based on assessment of parental lines, without conducting assessment on the final stacked event. This fails to take into account any combinatorial/synergistic effects that may occur in a stacked event with multiple transgenes.
- 'History of safe use' cannot be claimed for this crop. The inserted Cry toxins are modified and significantly different to their natural counterparts. As such, they should be treated as novel pesticides. Safety tests were, however, not performed on the whole plant material, but on the individual toxins derived from bacteria, instead of the GM plant.
- No toxicity feeding studies were performed in laboratory animals to confirm safety for human consumption.

3. Environmental assessment

- No risk assessment data is presented on potential effects on non-target organisms.
- The applicant fails to acknowledge any need for risk monitoring for potential

adverse effects beyond weed and insect resistance. This is a complacent approach that goes against recommendations of the Cartagena Protocol on Biosafety for risk monitoring.
- Very little training is envisioned for local farmers' understanding of resistance management measures. It remains unclear how any such measures will be implemented.

4. Weed and insect resistance

- Weed resistance to glyphosate is rapidly making glyphosate tolerant crops redundant. Insect resistance to Bt toxins is already present in South Africa and well documented. The recently introduced fall armyworm is already resistant to multiple Bt toxins. Any potential weed and insect management benefits of this crop will be short lived.

5. Pesticide toxicity

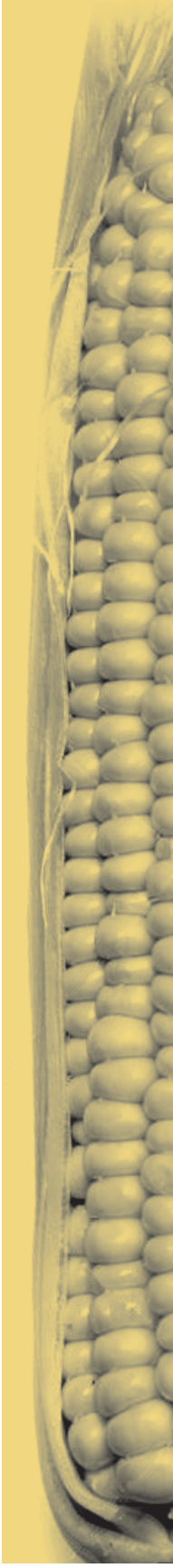
- Glyphosate and glufosinate are linked to serious adverse health effects, including cancers, neurotoxicity and reproductive problems. This crop will serve to expose the South African population to yet more toxic chemicals.

6. Socio-economic considerations

- Food safety and nutrition have not been adequately addressed, which is especially concerning for a staple food.
- Farm workers will bear the impact of increased pesticides sprayed onto crops.
- The cost of GM varieties is substantially higher than conventional varieties and stacked varieties are even more expensive. Smallholders will suffer these increasing prices, made more worrisome in a context of corporate concentration and decreased farmer choice for maize seed.
- Large-scale corporate production of maize is impacting on the environment, locking out smallholders from competing in the market and contributing to nutrition insecurity.

7. Conclusions

- MON 89034 x TC1507 x NK603 has not been adequately tested for human and environmental safety and many biosafety concerns remain unaddressed. Under the precautionary principle of the UN Cartagena Protocol on Biosafety, this event should not be approved in order to avoid negative effects to people and the environment.
- GM seed sold for insect protection and herbicide tolerance are detrimental to long-term sustainability of South African agriculture and serve to further corporate control. We urge a shift to agroecological methods that support smallholder farmers, food security and long-term health of the people and environment of South Africa.



SUMMARY OF THE APPLICATION

The crop event is summarised in Table 1.

Table 1 Summary of crop event

Crop event	Traits of interest	Genes introduced
MON 89034 x TC1507 x NK603	Glyphosate and glufosinate tolerance, insecticidal activity	c4-epsps (2 copies), pat, Cry1A.105, Cry2Ab2, Cry1F (2 copies)

This crop is a 'stacked variety', where two or more GM varieties are combined, from traditionally crossbreeding the GM parental lines together; in this case MON 89034 with TC1507 and NK603.

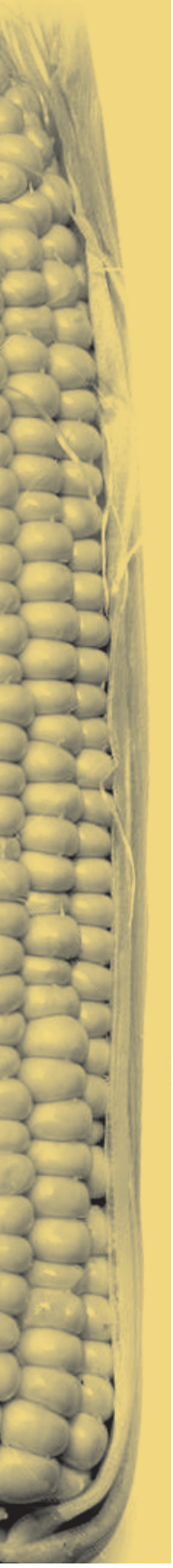
MON 89034 is a stacked Bt crop, containing two Bt toxins, Cry2Ab2 and Cry1A.105. Cry1A.105 (also known as CS-cry1A.105 3.53) is not one Bt toxin, but a protein comprised of Cry1Ab, Cry1F, and Cry1Ac proteins. The gene Cry1A.105 is a chimeric gene comprising four domains from other Cry genes previously used in transgenic plants. Bt insecticidal toxins were modified from the bacterium *Bacillus thuringiensis* subsp. *kurstaki* strain HD-1 and *Bacillus thuringiensis* subsp. *kumamotoensis*.

TC1507 contains a copy of pat gene from *Streptomyces viridochromogenes* that encodes tolerance to glufosinate-ammonium

herbicides, and a modified Cry1F Bt toxin from derived from B*acillus thuringiensis* var. *aizawai*.

NK 603 contains two copies of the CS-cp4 epsps gene from the bacterium *Agrobacterium tumefaciens* CP4, for glyphosate herbicide tolerance.

MON 89034 x TC1507 x NK603 was granted commodity approval in South Africa in 2012. Field trials in South Africa commenced in 2013–14 in various regions, including George, Bapsfontein, Lehau, Ohringstad, Settlers, Brits and Oudtshoorn. However, the precise locations remain confidential. The ACB previously launched an objection to the first trial in June 2013.



MOLECULAR CHARACTERISATION

Characterising the genetic modification is necessary at the level of the genome, to identify the location of the integration site of the transgene and the stability of the transgenes, as well as the number of copies of the transgene integrated into the maize genome. Any disturbances at the genomic level could have consequences for the transcriptomic, genomic or metabolomic activity of the plant.

Description of the recombinant DNA before and after modification

The transgenic material has been generated synthetically, and therefore has no history of safe use in nature. A detailed description of the sequence of the transgenes should, therefore, be provided. As stated in Annex I of Cartagena Biosafety Protocol, to which South Africa is a party:

> *It is important that a description of the nucleic acid introduced into the recipient organism be available. It provides information about all the genes including control elements that have actually been introduced...if there is introduced nucleic acid, then it will contain a number of elements with functions important to the production of a gene product; to the amount of gene product produced ...These are important in considering how the introduced genetic information may be expressed in the modified organism.*

The applicant claims that the "inserted sequences are genetically stable". However, there is no scientific literature available on the genetic construct and genetic stability of the stacked event in question, nor is it provided in the application. It also appears that no analysis of the stacked event has been performed, with the application stating:

> *Since the inserts present in MON 89034 × TC1507 × NK603 maize correspond to those of the parental lines as described in section 6.3.1 above, indicating stable integration of the stacked maize, it was then concluded that the MON 89034 x TC1507 x NK603 maize is a stable conventional cross between the three maize parental lines.*

Despite the lack of detailed sequence information provided by the applicant, a recent independent report found a single nucleotide polymorphism (SNP) in the promoter region of TC1507 maize (Morisset et al., 2009) that clearly contradicts the applicant's claim of genetic stability of the parent lines. **The detected SNP negatively affected the detection of this event, showing that genetic instability is not only a concern for expressional changes but also for detection purposes**.

As documented with NK603 (EFSA, 2003) and other GM lines (Aguilera et al., 2008; Aguilera et al., 2009), transgenic inserts have been shown to suffer rearrangements and instability.

The applicant should provide sequence data of the inserts and flanking genomic regions to substantiate claims of genetic stability. Such assessments should be conducted in several generations to prove long-term genetic stability.

Characterisation of the indel

The applicant does not provide any details on the specific location of the transgene. There is no sequence information or description of the flanking genomic DNA provided. The applicant, therefore, does not provide information to confirm a lack of disruption to endogenous maize genes or regulatory sequences. As stated by the Codex Alimentarius Commission (2003):

> *Unintended effects can result from the random insertion of DNA sequences into the plant genome which may cause disruption or silencing of existing genes, activation of silent genes, or modifications in the expression of existing genes.*

The CaMV 35S promoter

All three parental lines carry versions of the cauliflower mosaic virus 35S (CaMV 35S) promoter that has raised biosafety concerns, due to the presence of 1) a recombination hotspot and 2) viral gene VI within its sequence.

The presence of the recombination hotspot is a biosafety concern, due to its potential for increasing the risk of genetic rearrangements and horizontal gene transfer (Ho et al., 1999). **The applicant should provide sequence data on the integrity of the transgenes to confirm lack of genetic rearrangements**.

With regards to viral gene VI, a 2012 paper, entitled "Possible consequences of the overlap between CaMV 35S promoter regions in plant transformation vectors used and the viral gene VI in transgenic plants" raised concerns over the sequence overlap of the CaMV 35S promoter and gene VI, with gene VI potentially being expressed into the P6 protein (Latham et al., 2017). A proper retrospective risk assessment on the gene VI fragment showed that the gene product is toxic to plants probably through, among other things, the inhibition of gene silencing, a necessary function universal to plants and animals (see later); hence it is also likely to be toxic to animals, including humans. **The applicant has not mentioned this possibility, let alone checked for expression of this protein**.

T-nos terminator sequence

Analysis of the nopaline synthase (nos) terminator sequence in transgenic plants has shown that it does not reliably terminate transcription, leading to the generation of novel RNA variants. However, there is no mention of assessing for the absence of novel RNA variants in this application. As EFSA (2009) says:

> *(...) the data did demonstrate that an RNA species could be detected that likely initiated in the promoter of the NK603 insert and proceeded through the nos 3' transcriptional termination sequence continuing into the maize genomic DNA flanking the 3' end of the insert.*

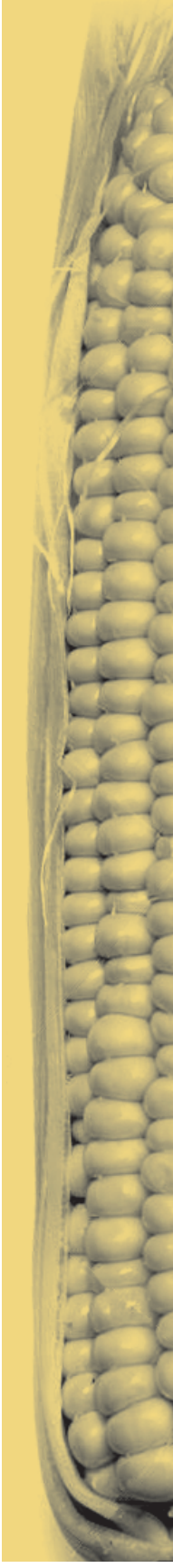
Other GM events carrying the nos terminator have also been shown to produce novel RNA and protein variants, such as MON 810 (Rosati et al., 2008).

The applicant should be asked to provide data proving complete absence of novel RNA variants and potential novel polypeptides.

Description and characterisation of changes to the transcriptome, proteome and metabolome

There is a complete lack of acknowledgement of profiling techniques for testing, despite these techniques now being routinely employed to assess global changes in gene, protein and metabolite expression, and despite the fact that they would provide more detailed molecular characterisation of MON 89034 x TC1507 x N603.

The latest studies in relation to GM crops reveal that the genetic modification process has the potential to disrupt endogenous gene expression in the plant, which can introduce human and environmental hazards, as well as agronomic disturbances. Mesnage et al. (2016) used such techniques to analyse proteome and metabolome profiles of NK 603, detecting altered levels of proteins and metabolites indicative of oxidative stress, alterations in levels of enzymes involved in glycolysis metabolism, as well as alterations in TCA cycle involved in energy production. Metabolome alterations also included a 28-fold rise in polyamines, which play multiple



roles in cell growth, survival and proliferation; they can be either toxic or protective, depending on the context.

Further, with the inclusion of the nos-terminator and its known potential for generating novel RNA variants, such analyses become even more relevant.

The applicant should be asked to provide profiling results for MON 98034 x TC1507 x NK603, including analysis of novel RNA variants.

SAFETY ASSESSMENT

Establishing the food and feed safety of MON 89034 x TC1507 x NK603 is essential, considering that maize is consumed by humans and animals in South Africa and **is an important staple crop consumed on a daily basis**.

Claims of safety of MON 89034 x TC1507 x NK603 have been based on several assumptions.

First, no data is presented on the stacked event itself, making claims of safety based on the assumptions on tests done on the parental lines. **The applicant should be asked to provide safety tests based on whole plant material, not on individual toxins**.

This fails to address any combinatorial effects that may result from interactions between the novel trans proteins and metabolites produced in the stacked event. For example, multiple Bt toxins may have cumulative or synergistic effects on non-target organisms. This is the basis for the EU regulation that requires risk assessment of stacked traits, which defines a stacked event derived from conventional breeding of existing single event GM varieties as a "new entity" (Regulation [EC]No 1829/2003). It takes into account the possibility of stacked varieties showing disturbances in transgene and host genome stability, expression of novel proteins, and potential synergistic/combinatorial interactions between the individual modifications. Evidence from studies on off-target organisms suggests there may also be implications for human health, and stacked events should therefore be assessed (see Hilbeck & Otto, 2015).

'History of safe use'

The applicant states:

> *The Cry1A.105, Cry2Ab2 and Cry1F proteins are **functionally and structurally similar to Cry proteins that have a history of safe use**. Cry proteins have been used as components of microbial pesticides derived from Bt for over 45 years. They are generally recognized as non-toxic to humans and other mammalian species (Betz et al., 2000; EPA, 2001; OECD, 2007) when tested individually and in combination (e.g., Bt microbial formulations). **Cry1A.105 and Cry2Ab2 produced by MON 89034 are closely related to the Cry proteins that have been used as the active ingredients in existing Bt microbial pesticides and/or biotechnology-derived crops**.(Emphasis added)*

The applicant notably admits that the Cry proteins expressed in MON 89034 x TC1507 x NK603 are not identical to their naturally occurring, bacterially derived counterparts, making the claim of "history of safe use" unfounded. Indeed, there are critical differences between the modified versions of Cry proteins in GM crops and the natural Cry toxins, with some intended modifications made by the developers to improve their insecticidal properties, as well as additional unintended changes documented in various GM crop varieties. Key general differences include: 1) GM plant Cry toxins exist in soluble forms, unlike their natural counterparts, and 2) all GM crop Cry toxins are truncated versions of their natural counterparts. These two differences are understood to enhance and broaden the range of Cry toxicity (Latham et al., 2017). Indeed, insecticidal toxicity studies of the bacterially derived protein versus that of the GM plant revealed that the GM Cry1A.105 was twice as toxic to target insects (see Latham et al., 2017).

Further, there are various alterations in DNA sequence, amino acid substitutions, chimeric versions, and unintended modifications that have been documented (see Latham et al.,

2017 for detailed analysis of modified Cry toxins). Post-translational modifications have also been predicted to occur in various Cry toxins produced in GM plants. MON 89034 is one such crop that expresses a chimeric Cry protein, Cry1A.105, which is not found in nature. Cry1A.105 is a fusion of three partial proteins Cry1Ab10, Cry1Ac1 and Cry1Fa1. MON 89034 also shows the presence of additional putative Cry proteins produced in the plant, none of which have been characterised. Protein extracts show not only the polypeptide of the predicted weight (250 kDa), but also additional polypeptides of between 56 and 130 kDa in size. MON 89034 protein sequencing also suggests the potential of alternative post translational modifications, such as acetylation of protein, which can alter the properties of the protein, and thus alter its toxicity.

With the above documented intended and unintended modifications to GM Cry toxins, bacterially derived surrogates for safety assessments should only be used when they are scientifically indistinguishable from those produced in the GM plant. However, the above analyses reveal this to be clearly not the case. **Instead, Cry toxins produced in GM plants are novel insecticides with no history of safe use**.

Claims of lack of mammalian toxicity unsubstantiated

The applicant also claims that the trans proteins in MON 89034 x TC1507 x NK603 are "not acutely toxic" based on acute oral toxicity studies in mice. There are no details of the studies performed, making it impossible to verify such a claim.

However, three-month feeding studies submitted by industry to the European Union regulatory agencies revealed biosafety concerns that were raised by several member states, including France, Germany, Belgium and Austria, due to adverse effects on the bladder and kidney of exposed rats (Robinson, 2018). Effects included: bladder stones and "minimal" chronic progressive kidney disease or damage; minimal to moderate transitional cell hyperplasia (cell proliferation that can be a precursor to cancer of the urinary system); inflammation; and hydronephrosis (presence of water in the kidneys due to obstruction). Independent data has also repeatedly linked Cry toxins to immunogenic reactions in mammals. For example, Cry1Ac is known to enhance immune reactions and able to bind to epithelial cells in the intestine of mice (Vázquez-Padrón et al., 1999; Vásquez-Padrón et al., 2000), despite bioinformatics analysis by the producer showing lack of similarity to known allergens. The applicant should, therefore, provide further detailed experimental data to rule out the potential for the trans proteins to induce allergenic responses.

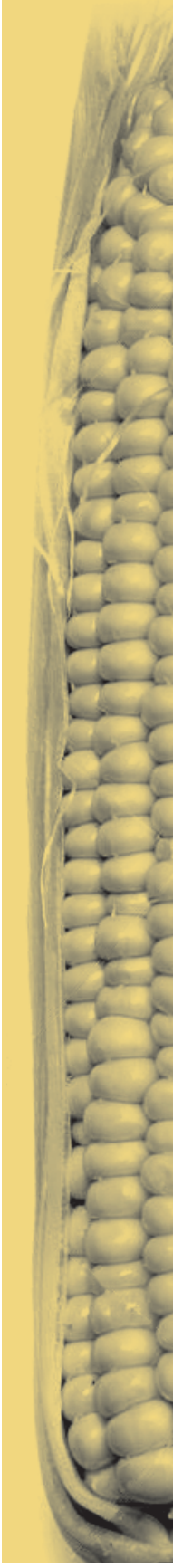
The applicant also makes assumptions on the lack of survivability of trans proteins, following mammalian digestion. This claim is not based on in vivo studies, but, instead, simulation assays of the digestive system. Independent data detecting Cry proteins in Canadian citizens (Aris & Leblanc, 2011) highlights the limitations of these assays and exposes the applicant's claims as assumption- and not evidence-based.

The applicant should be asked to conduct thorough, acute, sub-chronic and long-term mammalian feeding studies, using whole plant material to substantiate claims that this crop is safe for human consumption.

ENVIRONMENTAL RISK ASSESSMENT

Assessment of impacts on target organisms

The applicant fails to provide any data on field trials to show the efficacy of MON 89034 x TC1507 x NK603 against target organisms. The applicant claims that field trials showed a reduction in pest infestations but data is Confidential Business Information deleted CBI deleted. **CBI deleted data should not apply to trial data. We see no reason for protection of this information from the public that would help assess the risk of products to the environment, human health or food security**. This is of critical importance considering the complete lack of peer-reviewed data in the scientific literature on MON 89034 x TC1507 x NK603.



Assessment of impacts to non-target organisms

The applicant claims that MON 89034 x TC1507 x NK603 is not toxic to non-target organisms:

> *It has been established that the Cry1A.105, Cry2Ab2 and Cry1F proteins exhibit toxicity towards certain lepidopteran insects but are not active against other insect orders.*
>
> *To date, microbial pesticidal strains of* Bacillus thuringiensis *are virtually non-toxic to mammals, and generally show low toxicity to non-target terrestrial and aquatic species.*

Though there is a brief mention of a study performed in South Africa on effects to non-target organisms, there is no description of the study, or any results to substantiate claims that no harm to non-target insects has been scientifically established. Access to trial data was denied to ACB, preventing any independent analysis of such claims. As mentioned above, **CBI deleted data should not apply to trial data. We see no reason for protection of this information from the public that would help assess the risk of products to the environment, human health or food security**. No laboratory tests on key non-target organisms relevant to the South African environment appear to have been performed.

Further, claims of specificity to certain lepidopteran insects are based on references that are more than 15 years old. In contrast, more recent independent data indicates that Bt toxins are not so specific. Toxicity to a variety of non-target organisms has been reported, including important agricultural organisms, such as pollinators, pest predators, soil fungi, and earthworms, as well as aquatic organisms that can be exposed through agricultural runoff, having a potentially negative impact on aquatic biodiversity. Two meta-analyses of published studies documented that 30% of studies on predators and 57% of studies on parasitoids were adversely affected by Cry1Ab (present as part of the fusion protein Cry1A.105).

Lastly, the claim that Bt microbial sprays show low toxicity to non-target organisms ignores the critical differences between natural Bt toxins and modified versions in GM plants (see section 'History of safe use') that are understood to broaden and enhance their toxicity. Such claims of substantial equivalence are unfounded.

Lack of risk management and monitoring

The applicant states that the environmental risk assessment did not identify any adverse effects to human and animal health or the environment. As such, no monitoring or risk management beyond that of insect and weed resistance to Bt toxins and glyphosate herbicides, respectively, has been incorporated. Even in cases where no risks are identified (though this is not the case when considering independent data on human and environmental effects, as summarised in this objection), there is still need for general surveillance or monitoring to account for effects that were not anticipated in the risk assessment.

Such an approach to monitoring is recognised in the "Guidance on Risk Assessment of Living Modified Organisms" (UNEP/CBD/BS/COP-MOP/6/13/Add.1) developed under the Cartagena Protocol on Biosafety, to which South Africa is a Party. Where changes that could lead to an adverse effect are detected through general monitoring, possible causes for the observed changes are examined, and, where appropriate, a more specific hypothesis is developed and tested to establish whether or not a causal relationship exists between a GMO and the adverse effect, and can be followed up by case-specific monitoring or further research.

Further, there is also very little training envisioned in the application regarding local farmers' understanding and use of resistance management measures and refuges. It is also unclear who will bear the costs and responsibility of monitoring refuge implementation and compliance.

INSECT AND WEED RESISTANCE

The applicant claims that MON 89034 x TC1507 x NK603 confers protection against stem borers and other destructive Lepidoptera, including stem borers *B. fusca* and *C. partellus*, as well as other Lepidoptera species *Sesamia calamistis, Helicoverpa armigera, Spodoptera exempta* and the more recently introduced *S. frugiperda* (the recently introduced South American fall armyworm).

However, resistance to Bt toxins exposes the limited value of Bt traits as a long-term pest management strategy. Indeed, South Africa was one of the first places where resistance in the field was documented, and new research suggests that the country has the necessary environmental conditions for the spread of Bt pesticide resistance in corn borers, a major pest for South African farmers (Campagne et al., 2016). Field resistance has also been documented in the United States to Cry1A.105+Cry2Ab2, included in MON 89034 (Dively et al., 2016), which the authors concluded was due to factors such as high adoption rates and moderate expression of the Cry toxins that allowed for organisms with minor heterozygote resistance alleles to survive. It is only a matter of time before resistance is documented in South Africa.

The fall armywormis already resistant to most Bt traits, with resistance developing within three years (Fatoretto et al., 2017). **Fall armyworm resistance in Brazil was documented for MON 89034 x TC1507 x NK603 only one year after its approval was granted**. With the fall armyworm coming from these regions, if the South African population does not already carry the resistance mutations, current evidence suggests it will take very little time for resistance to occur, rendering this crop completely futile against this new and destructive pest.

Weed resistance to glyphosate is already a major global issue, and within South Africa three species of weeds have been documented to have evolved resistance, including Conyza, an economically important weed for maize farming. Glufosinate is often used as a substitute for glyphosate resistant weeds; however weeds that are resistant to glufosinate are now being documented, with six species recorded to have evolved resistance since 2009.

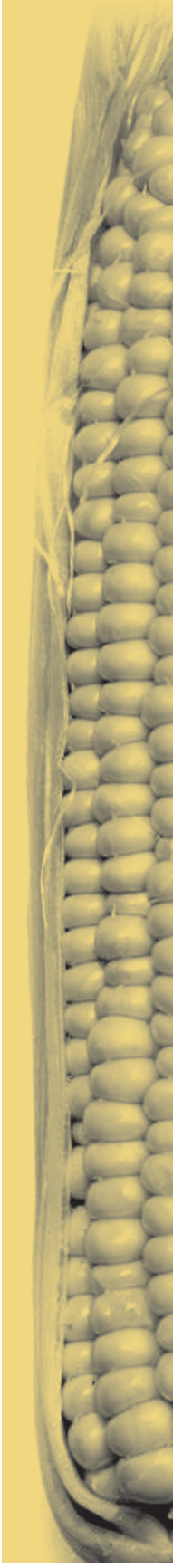
PESTICIDE TOXICITY

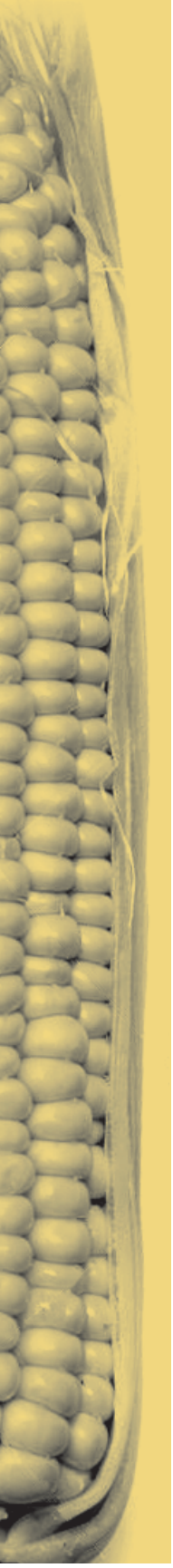
The cultivation of GM crops tolerant to herbicides has led to a sharp increase in pesticide use, with 15-fold rises documented in the United States (Benbrook, 2012) and an 858% rise documented in Argentina (Ávila-Vázquez, 2015). The rising use is being reflected in the pesticide burden on people. A new 2017 study shows that glyphosate levels in US citizens has risen dramatically from 1993 to 2016 (Mills et al., 2017) from a mean of 0.024 to 0.314 µg/ml in 70 participants. This can only be expected for the additional herbicide, glufosinate. Indeed, glufosinate has already been detected in urine of Canadian citizens (Aris & Leblanc, 2011).

As recently reported by ACB (2017), **there are no established safe levels** for these pesticides in foods. Conversely, evidence of toxicity of these pesticides and their metabolites is well documented in the scientific literature. Of critical importance to the South African context is that legal limits on pesticide residues for many food crops are yet to be established or fully regulated. **There appears to be no 'maximum residue level' (MRL) set for glufosinate in maize**, despite the cultivation of gludosinate tolerant crops in the country.

While safe levels are yet to be fully established, evidence of adverse effects of exposure to glyphosate and glufosinate pesticides is well documented. Glyphosate has been recently classified as a probable human carcinogen by the oncology arm of the WHO, the International Agency for Research on Cancer (IARC), forcing a delayed decision on its re-approval in the EU, yet to be resolved. Over 150 studies have shown adverse effects of glyphosate to humans and the environment (see Ávila-Vázquez, 2015, for a fully-referenced extensive review).

The latest study to raise serious biosafety concern to human health detected glyphosate in the urine of 90% of pregnant





American women, with **highest levels in urine correlating with significantly shorter gestational lengths**. This study builds on years of animal studies as well as physician reports in countries like Argentina, where vast regions of glyphosate tolerant crop plantations are associated with maternal reproductive toxicity and birth defects, as well as other serious illnesses. Even Monsanto's own data from decades ago revealed reproductive problems but was hidden and dismissed. **Now evidence from real-life exposure in people is confirming what independent and industry animal data has been warning us of for over 30 years**.

In light of the latest clinical evidence of glyphosate toxicity to people, it is of utmost importance that the government protects South African citizens from yet more exposure to chemical pesticides.

Glufosinate has also been shown in many studies to have adverse toxic effects on humans, such that its use was restricted in 2013 by the European Union. Toxic effects of glufosinate have been linked to its glutamate neurotransmitter-mimicking effects. This has been shown to disrupt brain signalling, resulting in learning and memory deficits, structural changes in the brain and impaired brain development in laboratory animals (Herzine et al., 2002; Calas et al., 2008; Meme et al., 2009; Lantz et al., 2014; Laugeray et al., 2014). In humans, paternal exposure has been linked to developmental defects in their children (García et al., 1998). The applicant claims (pg. 3) that glufosinate will not be used on this crop in South Africa, as it was used solely as a selection marker during the transformation process involved in generating the crop; however, how this would be regulated is unclear.

The above scientific evidence of pesticide toxicity, at the very least, highlights the lack of scientific consensus surrounding their safety, and at worst, reveals serious adverse health effects that are harming citizens, especially the most vulnerable of all: children. In line with the precautionary principle Cartagena Protocol, we urge the rejection of MON 89034 x TC1507 x NK603.

SOCIO-ECONOMIC CONSIDERATIONS

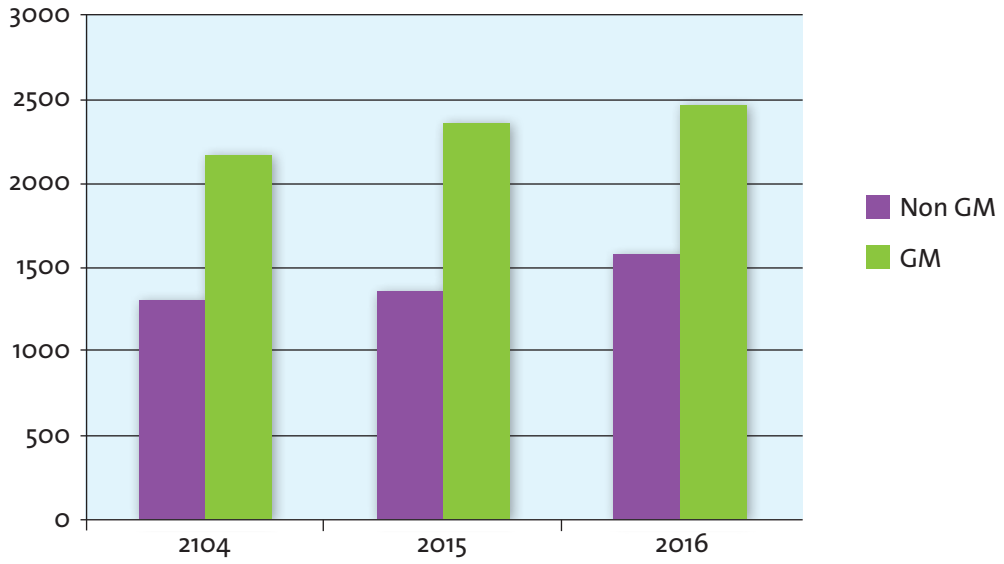
Food safety and nutrition

For a middle-income country that is categorised as food secure, South Africa has alarming levels of child stunting, micro-nutrient deficiency, household food insecurity and obesity (Shisano, O. et al., 2013). One of the key reasons for this state of affairs is that agriculture, health, nutrition and poverty are dealt with in silos by our government. It is also a function of a highly concentrated agro-food system that rewards the production of high volumes of calories with low nutritional level.

It is abundantly clear in the application under review that this maize seed is primarily bred for agronomic performance, with little consideration of it as a staple source of nutrition for the majority of South Africa's citizens. We have already pointed to Dow's lack of scientific rigour in terms of assessing the safety of consuming this variety, and the potential risks that have not been investigated. This event will introduce yet more novel genes and combinations of genes into our staple food. To date, there has been no monitoring of the impact of commercialised GM maize on the health of South Africans. Additionally, we have highlighted that South Africans may be exposed to new and more pesticide residues in their food, while South African authorities are yet to assess the potential impacts or ensure that the necessary regulations and processes are in place.

Unfortunately South Africans are force-fed genetically modified maize as there is no alternative GM-free maize available on the market that is affordable and accessible to all the people who consume maize as part of their staple diet. Dow's disregard for best biosafety practices and current scientific assessment tools is unacceptable.

Figure 1 Average price (Rand) of white maize seeds (60 000 kernels/bag) for the period 2014–16



Source: Compiled from Grain SA (2016)

Impact of pesticides on farm workers

The development of GM maize that is resistant to multiple herbicides will increase the volume and number of agrochemicals to be sprayed on crops. Farmers, farm workers and their families will bear the brunt of increased pesticide use. Farm workers are the most marginalised of the South African workforce, often paid below a living wage and surviving on precarious seasonal work. When farm workers fall sick they rarely receive workers' compensation, assistance with healthcare or paid sick leave.

Smallholder farmers and input prices

The cost of maize seed has been steadily rising over the years. In 2004/05 a South African maize farmer would have spent, on average, roughly 6% of their overall costs on seed. By the 2010/11 season, this figure had more than doubled, to 13%. Seed makes up about 10–12% of production costs. The prices of different varieties vary considerably. For example, GM maize is sold at double the price of popular hybrids, and five times the price of popular open pollinated varities (OPVs) (Fischer et al., 2015). The average price of stacked GM maize seed on the market was around 42% higher than single trait GM maize. In 2008, just over 5% of the maize planted in South Africa was stacked. By 2016/17 the figure stood at 61%.

Major seed companies appear to be increasing the prices of their single Bt varieties quicker than for their stacked varieties. The ACB has previously documented this phenomenon: from 2008 to 2011 the average price of single gene Bt white and yellow varieties increased by 42% and 43% respectively, compared to increases of 28% and 23% for yellow and white stacked varieties respectively. This is a common tactic that has been used elsewhere to 'encourage' farmers to stop purchasing the older varieties and start purchasing their latest products.

For South Africa's 21 200 small-scale commercial farmers and approximately one million households who carry out subsistence farming, the ever increasing price of seed could be catastrophic. This is especially so in a context where monopolies in the maize seed sector are reducing competition and farmers' choices.

The impact of corporate concentration

Current levels of concentration in the global seed and agrochemical markets can officially be categorised as an oligopoly. The world's three leading seed and agrochemical companies (Monsanto, DuPont Pioneer and Syngenta) control 55% of the commercial seed market and 51% of the agrochemicals market (Syngenta, Bayer Crop Science and BASF) (ETC Group, 2015). In South Africa,

according to Grain SA, "Four companies dominate ownership of maize seed varieties, with 68% between them. These companies are Monsanto SA, Pioneer Hi-Bred, Pannar and Klein Karoo Seed". (Grain SA does not explain that Monsanto and Syngenta are merging, while Pannar is now owned by Du Pont/Pioneer). The lack of competition in the agribusiness sector is impacting on farmer and consumer choice and further entrenching the tendency towards highly processed, standardised, input-intensive staple crop varieties, resulting in the loss of nutrients and agricultural diversity (IPES-Food, 2016).

We believe that it is time for our government to open the debate about the domination of these massive corporations in the agricultural sector and the socio-economic impact they have on smallholder producers. While the rationale of producing at economy of scale is to produce cheaper, more affordable food, we note that this has not been the case, to date. The August 2017 Pietermaritzburg Agency for Community Social Action (PACSA) reported that 25 kg of maize meal has been subjected to a 39.6% year-on-year (YoY) increase, while the National Agricultural Marketing Council's (NAMC) food price monitoring report suggests that 5 kg of maize meal increased as much as 43.7% between January 2015 and January 2016. Increased grain prices have implications for other value chains, most notably animal production and the costs of poultry and beef. Food price inflation is particularly impactful on low-income consumers.

CONCLUSIONS

We urge the government to reject the approval of MON 89034 x TC1507 x NK603 for general release in South Africa on biosafety and socio-economic grounds.

The precautionary principle of the UN Cartagena Protocol requires commitment to the idea that full scientific proof of a causal link between a potentially damaging operation and a long-term environmental impact is not required, in order to take action to avoid negative effects on health and the environment. There is a lack of information available in the scientific literature on genetic stability; potential mammalian toxicity of multiple, modified Cry toxins; pesticide residues; and lack of long-term safety data. We find that these uncertainties warrant further research and advise the government to apply the precautionary principle and deny the marketing of MON 89034 x TC1507 x NK603 until more scientific understanding has been published.

We are particularly concerned that novel genes and novel combinations of genes, which are poorly understood and assessed, continue to be loaded into South Africa's staple food. This is even more egregious in a context where consumers have no choice but to eat these highly controversial foods due to saturation in the maize value chain. Additionally, we are alarmed that farmers, farmworkers and consumers must bear the brunt of increasing herbicide use, due to stacked herbicide tolerant (HT)-tolerant crops.

We believe that it is time to develop a food system that supports both producers and consumers, instead of one that creates and perpetuates risk and vulnerability, where only the strongest and most competitively advantaged survive. We need to shift away from simply increasing production through high-yielding, high calorie staple crops, towards improving food quality and nutritional content; and to address the structural and systemic issues that create persistent poverty, inequality and unemployment – the root causes of hunger and malnutrition. A transition away from industrialised agriculture towards agroecological methods is recommended by many recent reports, including the UN International Panel on Sustainable Food Systems (IPES-FOOD, 2016) to be the most efficient and sustainable way to improve food security, nutrition and climate change.

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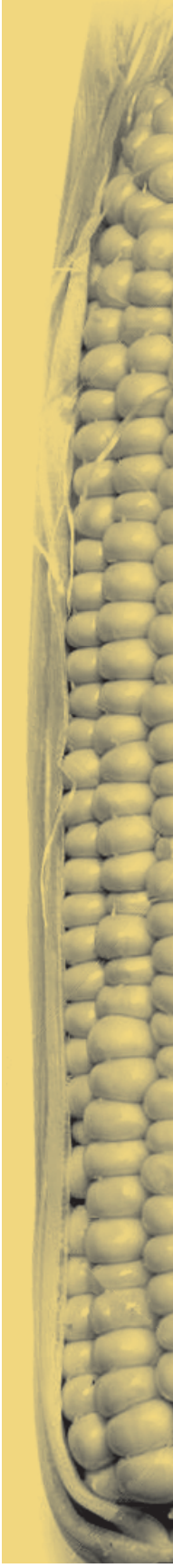

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