Highly hazardous pesticides and GMOs

SA government's legislative sleight of hand allows ongoing assault on our food system and people's health

AFRICAN CENTRE FOR BIODIVERSITY

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The African Centre for Biodiversity (ACB) is committed to dismantling inequalities and resisting corporate industrial expansion in Africa's food and agriculture systems.

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Abbreviations

CMR	Carcinogenicity, mutagenicity, and reproductive toxicity
EU	European Union
FAO	Food and Agriculture Organisation
GE	Genetically engineered
GHS	Globally Harmonized System of Classification and Labelling
GLA	Glufosinate-ammonium
GM	Genetically modified
GMOs	Genetically modified organisms
GS	Glutamine synthetase
HHP	Highly hazardous pesticides
LOC	Level of Concern
MOE	Margin of Exposure
PAN	Pesticide Action Network
PPE	Personal protective equipment
RA	Risk assessment
SAICM	Strategic Approach to International Chemicals Management
STOT	Specific target organ toxicity
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

About this paper

The legislative framework to regulate chemical remedies in South Africa is outdated, fragmented, and ineffective. Policy and regulatory reforms to date have taken place within a condemned and hopelessly antiquated framework and remain contradictory and untransparent. They maintain a system that consistently and systematically violates the human rights of all South Africans and undermines South Africa's 2010 Pesticide Management Policy.

A large and growing body of evidence points to the clear linkages between pesticide exposure and serious health effects on the skin, eyes, liver, and kidneys, as well as the cardiovascular, endocrine, and nervous systems (Orellana, 2023). This growing concern has resulted in globally agreed definitions and increased global commitments to phase out and eliminate highly hazardous pesticides (HHPs), along with prioritising alternatives to the use of hazardous chemicals in agricultural production. Despite regulatory reforms that specify the phase-out of HHPs, these regulations provide loopholes to sustain the continued and unconstitutional use of toxic HHPs.

We are now confronted with several published toxicological risk assessments (RAs), as part of applications for derogation of glufosinate-ammonium (GLA), in response to which we are submitting these objections. If approved, this will set the tone for future greenlighting of HHPs, flooding South Africans with more toxic chemicals, with no end in sight. Therefore, it is vital that these applications are rejected.

Summary

The legislative framework to regulate chemical remedies in South Africa is outdated, fragmented, and ineffective. Policy and regulatory reforms to date have taken place within a condemned and hopelessly antiquated framework and remain contradictory and untransparent. They maintain a system that consistently and systematically violates the human rights of all South Africans and violates South Africa's 2010 Pesticide Management Policy. Despite regulatory reforms that specify the phase out of HHPs, these regulations provide loopholes to sustain the continued and unconstitutional use of toxic HHPs. We are now confronted with several applications for derogation of GLA, an HHP targeted for phase out, out of 29 such chemicals, concerning which we are submitting these objections.

Glufosinate is a broad spectrum, non selective, post emergence, foliar applied herbicide used to control broad leaf, grass, and sedge weeds in a variety of industrial, agricultural systems, including crops, orchards, vegetables, and non crop sites. It is often referred to as glufosinate-ammonium (GLA) because the ammonium-salt formulations are the most commonly used. GLA (i.e. D, L-phosphinothricin – also known as 2-amino-4 (hydroxymethylphosphinyl) butanoic acid – is a herbicide with several unique characteristics, in particular, its mode of action as a natural amino acid that inhibits glutamine synthetase (GS), an enzyme essential for plant metabolism.

The Globally Harmonized System on Classification and Labelling of Chemicals (GHS) classifies GLA as aspiratory toxicity 2, acute toxicity 2 (inhalation), skin corrosion/irritation 2, eye damage/irritation 1, reproductive toxicity 1b (fertility), reproductive toxicity 2 (unborn child), specific target organ toxicity (STOT) single exposure 1 (nervous system), STOT repeat exposure 2 (nervous system), aquatic toxicity acute 2 and aquatic toxicity chronic 2 (BASF, 2024).

Since glufosinate irreversibly inhibits GS, leading to intracellular accumulation of ammonia, hyperammonemia is considered one of the main mechanisms of GLA toxicity in humans (Donthi and Kumar, 2022). It is a highly hazardous herbicide because it can cause reproductive toxicity, neurotoxicity, and cardiovascular effects. It is also capable of causing damage to developing foetuses. Studies report premature birth and intrauterine death and abortions in experimental animals and toxicity in human brains, which points to high risk to mammals (Donti and

Kumar, 2022). Due to its acute and chronic adverse health effects, it has been banned in 29 countries, including European Union (EU) member countries, Morocco, and the UK. It is also included in the Pesticide Action Network (PAN) International list of HHPs.

Based on the published toxicological RAs, which rely on the same data, resources, and conclusions being almost identical – with some variation (most notably the inclusion of GLA use as a potato desiccant in some) – our objections to the RAs and the applications for derogation are outlined below.

1. According to the Derogation Guidelines of 2024, the derogation will be granted only for a specific period and restricted uses. Yet only the toxicology RAs are available, and it is unclear why these derogations are being sought and for what period.

2. 1. The RAs focus primarily on occupational exposure, i.e. pesticide handlers and post-application (re-entry) workers, because their products will not be available to residential gardeners and the public. This fails to consider the diversity of farmers in South Africa, firstly, and secondly, ways of accessing dangerous chemicals through formal and informal networks, as highlighted in the recent evidence related to terbufos in South Africa's urban areas (see ACB et al., 2024).

3. Regarding occupational exposure, the RAs indicate the absence of a risk of health effects in operators involved in mixing, loading, and spraying, primarily due to the use of personal protective equipment (PPE), as indicated on the label. For post-application (re-entry) agricultural workers, they suggest negligible contact with pesticide residues: first, as the label suggests a gap of one day before re-entry; second, with little to no contact with areas sprayed, as harvested crops are not directly sprayed; and third, since GLA is volatile, inhalation exposure is excluded from the analysis.

   There are many concerns with these assertions and conclusions.

   a. When considering data used as a point of departure, new evidence describes epigenetic changes in mice at a dose of 0.2 mg/kg body weight, a dose much lower than the United States Environmental Protection Agency (USEPA)'s reference dose of 6 mg/kg used in the risk calculations (Ma et al. 2022). This study points to a very low dose that may influence the mode of action for possible toxicological changes in embryonic and offspring development. This highlights the concerns around the risk assessment (RA) use of a Margin of Exposure (MOE) approach.[1]

   b. The applicants rely on the fact that instructions on the label are followed correctly, yet this fails to take into account the reality of PPE compliance amongst farmers and farm workers and the precarious conditions of many women and seasonal farm workers in particular (Devereux, 2020; Orellana, 2023; Women on Farms and Solidar, 2024). As such, mitigation measures for exposure reduction cannot rely solely on PPE use promotion, where the reality for many farmers, farm workers, and those living near farms (farm dwellers, rural towns) is a lack of compliance, information, and ability to take precautions when using such agrochemicals. Instead, other strategies are required, such as the elimination and substitution of HHPs.

   c. The linkage between herbicide use and genetically engineered (GE) crops is completely neglected in the RAs. As an increasing number of herbicide-tolerant GE crops are being approved, both for commercial and general release, pesticides are applied to the harvested product indiscriminately, putting post-application workers increasingly at risk.

   d. As mentioned above, some indicate that GLA is and will be used for potato desiccation, suggesting this increases the risk to post-application workers. (See, for example, the toxicological RA provided by Villa Crop Protection.)

4. The impact of exposure through food consumption is mostly brushed off because pesticides are not sprayed on the "commodity" crop itself, and "translocation of GLA within various parts of the plant is insignificant".

   a. Yet, again, as some RAs imply, if GLA is used as a potato desiccant, there will be spraying on harvested crops, and the pesticide residues will have implications for consumers. No data is provided on dietary exposure related to potato desiccation. We, therefore, demand clarity on whether potato desiccation is linked to the proposed use of the GLA; the removal of the claim that harvested crops are not directly sprayed; and data provided regarding dietary exposure and risk.
   b. As GLA is hydrophilic, translocation varies

1 A comparison of the calculated exposure dose and the toxicity limit value of a particular health effect.

considerably according to environmental factors. Limited translocation may justify excessive spraying due to its limited herbicide effectiveness, with increased health and environmental implications. This is particularly concerning considering GLA-tolerant GE crop production, whereby the "commodity" crop can be indiscriminately and directly sprayed. This is not addressed anywhere within the RAs.

5. The RAs conclude that using GLA poses no ecological risks of concern for aquatic organisms.

   a. GLA is highly water-soluble and, therefore, has high to very high mobility. Being hydrophilic and mobile, GLA can rapidly dissolve in water, with impacts on water runoff if rain occurs shortly after application and potential impacts on aquatic species. GLA has a long half-life in fresh water, so it is ubiquitous in surface waters near farmland (Jia et al., 2019). GLA degrades at varying rates in aerobic and anaerobic soils. Degradation/recovery rates vary according to environmental factors and application amounts and rates. This has implications for aquatic environments and organisms regarding toxicity, residues, bioaccumulation, and biodegradation. Ultimately, little is known of the diverse environmental factors that respond differently to the amount and rate of application. This demands more investigation.

   b. The RAs rely on the findings and conclusions from USEPA's assessment, where USEPA did not recommend risk mitigation measures for birds, reptiles, and terrestrial-phase amphibians. Due to the impact on production of glyphosate-resistant weeds, and lower intake levels than those modelled, they do not suggest any reduced application rates. There are many concerns with this analysis.
   i. Ecological impacts are mostly brushed off without considering alternatives as necessary. Questions arise regarding the intake levels used in the analysis without providing the calculations and figures being modelled.
   ii. As glyphosate resistance is widespread, farmers are applying more toxic herbicides and cocktails of herbicides, with little knowledge of combined and cumulative effects.
   iii. Further, we are witnessing newer transgenic technologies for herbicide-resistant crops stacking multiple events, including glufosinate tolerance as one of their traits in most varieties. While fewer weeds have evolved resistance to GLA, there are examples where this has occurred.
   iv. Given the increased utilisation of GLA due to the global ban on paraquat and concerns regarding glyphosate and glyphosate weed resistance, and the increased production of GLA GM crops, the contamination of surface water by GLA residues and the risk to aquatic life are increasingly significant concerns. These should be given greater consideration.

6. The RAs argue that the registrar should grant the derogation of GLA and, therefore, allow for its sustained use. The argument is based on an interpretation that the realistic worst-case conditions are negligible: labelling and PPE are sufficient to prevent or control grave dangers to human health, while the risks to animal and environmental health are a sufficient price to pay for the need to use this HHP – in light of increasing herbicide tolerant weeds – based on Regulation 8(6) of the 2023 Regulations of Act 36. We believe these arguments and interpretations are false, dangerous, and misleading. They rely on outdated paradigms and data and perpetuate unjust labour practices and environmental racism.

7. Ultimately, the RAs rely on data from studies conducted in other parts of the world, not on crops and socio-economic and agroecological conditions in South Africa. The references are almost exclusively based on USEPA's analysis. The RAs essentially claim that USEPA's assessment is sufficient to transpose into a South African context. Yet the countries under study have fundamentally different social, ecological, and regulatory environments.

While the data and conclusions of the RAs must be questioned, it is more important to call out the illegitimate nature of the derogation procedures, which ultimately negate the progress made to eliminate dangerous HHPs from the agricultural landscape in South Africa, to ensure human and environmental health and safety. It is deeply concerning that – despite the government's commitment to reduce the use of HHPs – the government has, in essence, provided avenues for the persistent and sustained use of HHPs based on the interests of the agrochemical industry. This provides legal means to continue inherently illegal and unconstitutional practices. This questions the legality of such provisions articulated under Regulation 8(6). Such a provision is contradictory and subversive and sabotages the potential for not only reducing hazardous chemicals in our environment and our food but also preventing the ability to transition out of a chemical-dependent agricultural model that experts globally have increasingly called for and agreed upon in multilateral fora. This differs significantly from derogation applications, for example, in the EU, which are intended for use in an emergency rather than to greenlight HHPs. Ultimately, the derogation procedures negate the purpose of regulations to phase out HHPs under the guise of low risk under "realistic worstcase scenarios" and under false and perilous claims that the continued use of these HHPs is necessary to maintain/achieve food security.

Much remains unclear in terms of how decision-making is done regarding derogations as well as timeframes for decision-making, phase-out, criteria being used, and alternatives, amongst others. There are deep concerns that too much power is vested in the Registrar, who operates within the mandate of the Department of Agriculture, which ultimately serves the interest of agribusiness and commercial agricultural imperatives. There remain concerns around transparency and corporate capture, including in pesticide registration processes and the inability to access information. For example, Regulation 39 of the 2023 Regulations to Act 36 commits the Registrar – who oversees the registration, regulation, and prohibition of pesticides, among other functions – to provide an updated quarterly list of registered pesticides. Despite this, such a list is still not available.

Therefore, we urge the government to:

- Reject these applications, prioritising human and environmental health over business interests and false claims and prioritising alternatives to chemical-based agriculture, thus setting the tone for the future of agricultural production in South Africa.
- Maintain its commitments to phase out and ban HHPs. Linked to this, the criteria used for regulatory purposes must be made available, including how chemicals are identified for phase-out and related periods.
- Make available information regarding assessing the viability of using alternative products/techniques as the United Nations Special Rapporteur recommends.
- Urgently repeal Act 36 and its regulations. The incremental, contradictory, and delayed reforms that have taken place, including the 2023 Regulations, undermine the Constitution and the 2010 Pesticide Management Policy.
- Begin a process for a comprehensive and complete overhaul of the legislative framework governing agricultural remedies to reflect the realities of South Africa.
- Ensure the decision-making processes regarding agricultural remedies are transparent and adequately allow for public engagement. As part of a complete repeal and restructure of the pesticide regulatory framework in South Africa, an independent body should be established, made up of multidisciplinary experts appointed by the president, to make decisions regarding pesticide use, registration, renewal, etc., in the country. Currently, the decision-making structure is inherently unconstitutional as it does not guarantee fair administrative decision-making.
- In terms of regulating pesticides in the country, shift from a risk-based approach to a hazard-based approach. This recognises the property of the compound independent of exposure, following the example taken by the EU. This is better aimed at ensuring that the rights embedded in the Constitution are centred and realised.
- Ensure the smooth transition towards a socially just and ecologically sustainable food system, which considers South Africa's socio-economic, cultural, and ecological realities and shifts its current wholly inequitable food system towards one that recognises and aligns the agricultural and food system in South Africa with the rights enshrined in the South African Constitution.

1. Overview of pesticide regulation, phasing out of HHPs

In South Africa, agricultural remedies are regulated under the Fertilizer, Farm Feeds, Agricultural Remedies, and Stock Remedies Act (Act No.36 of 1947) (Act 36). The Pesticide Management Policy of 2010 was developed in response to this outdated legislation, which largely upheld historical environmental racism. The 2010 Policy aims to improve the legislative framework to reduce risk to environmental and human health and meet constitutional requirements; to comply with international agreements and shifts in global environmental governance and knowledge around pesticide management; increase transparency and public participation; as well as reduce dependence on chemical-based agricultural production (DAFF, 2010). The policy calls for the outdated Act 36 to be substantially revised or repealed. Following this, 19 chemicals were prohibited from sale and use, according to Notice 1116 of 2013 (DAFF, 2013). Of these, 17 were banned as of 2016 (DAFF, 2017). Thirteen years after adopting this policy, regulatory reforms were made to implement the policy's recommendations. Yet, **rather than delayed, incremental, and ineffective legislative reforms, the legislative framework governing agricultural remedies requires a comprehensive and complete overhaul.**

In April 2022, the Registrar of Act 36 formally announced the phase-out and banning of the use of active ingredients and their formulations that meet the criteria of carcinogenicity, mutagenicity, and reproductive toxicity (CMR) categories 1A or 1B under the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), by 1 June 2024 (DALRRD, 2022). Only 29 were identified for phasing out (see Annexure B) out of the 95 that fall within this category, including those partially banned in South Africa, based on the list developed by UnPoison (2023).[2] Even with this limited number, the Registrar published derogations procedures for companies to apply to continue using these under special circumstances, as discussed in further detail below. Pesticides with active ingredients and formulations that meet the criteria of CMR have been provided with different phase-out periods, with the final phase-out period being 30 June 2025 (PMG, 2024). While this is an important advancement, this process is now 15 years overdue.[3] As discussed below, different international bodies use different criteria to define HHPs. Therefore, the government must **make available the criteria used for their regulatory purposes and how they identify chemicals for phase-out and phase-out periods.** The Minister of Agriculture, responding to a question in Parliament, mentioned that the Department is currently assessing the viability of using alternative products/techniques before banning all HHPs, as recommended by the United Nations Special Rapporteur (Orellana, 2023; PMG, 2024). Further engagement with the Department is necessary to know what this entails, and where this process is.

Following this, regulations relating to agricultural remedies were published on 25 August 2023. The 2023 Regulations include the definition of a substance of concern as "any substance which has an inherent capacity to hurt humans, animals or the environment and is present or is produced in an agricultural remedy in sufficient concentration to present risks of such an effect" (DALRRD, 2023). Annexure A of the 2023 Regulations outlines the criteria by which substances would fall under this category. As such, a substance of concern is when agricultural remedy active ingredients and/or their formulations are classified under CMR categories 1A or 1B of the GHS and/or are listed under the Stockholm Convention or Montreal Protocol (except for dichloro diphenyl trichloroethane [DDT] used for malaria vector control by the Department of Health) (DALRRD, 2023; PMG., 2024). Additional regulatory reforms relate to public participation in the registration of substances of concern, applications, renewal of registration, labelling, access to information, and prioritising alternatives to substances of concern, amongst others. At the same time, many defects continue to exist, such as

2 According to UnPoison, 192 HHPs are still in use in South Africa, when including the WHO's categories 1a & 1b; GHS CMR categories 1a & 1b; and those falling under the Stockholm Convention, the Rotterdam Convention and Montreal Protocol.

3 The 2010 Policy states: "The Policy takes into cognisance the fact that special attention should be given to pesticides that pose an unmanageable risk, with an understanding that such pesticides should be considered for phase-out, sever restriction and bans. Those that will be considered include those with Endocrine Disrupting Properties (EDP), Persistent Organic Pollutants (POPs), carcinogenic and immunologic potential, formulations classified by WHO as Extremely Hazardous (class 1a) and Highly Hazardous (class 1b), as well as pesticides associated with frequent and severe poisoning incidents." (DAFF, 2010, page 4)

underwhelming penalties in the case of contraventions of the Act, limited public participation across the pesticide regulatory process, and untransparent decision-making processes, amongst others.

According to Regulations 8(1)(d) and 10(3)(e), respectively, the Registrar (Act 36 of 1947) may not grant a new registration or renew an existing registration after 1 June 2024 if the product contains substances of concern or any other agricultural remedy banned in the Republic of South Africa. However, allowances exist for the sustained use of substances of concern, i.e. HHPs. According to Regulation 8(6), the Registrar may grant or renew a registration of an implicated agricultural remedy when the following conditions are met:

a. The risk to humans, animals, or the environment from exposure to the active substance in an agricultural remedy, under realistic worst-case conditions of use, is negligible; or

b. There is evidence that the active substance is essential to prevent or control a danger to human health, animal health, or the environment; or

c. Not approving the active substance would have a disproportionately negative impact on society compared to the risk to human health, animal health, or the environment arising from the use of the substance.

In these cases, approval of an agricultural remedy may be granted for a specific period and restricted uses following the publication of the RA report for public comment by the applicant. Annexures A, B, and C provide a list of pesticides already banned in South Africa, an additional list of pesticides currently being phased out (29), and two pesticides that were to be banned in November 2024, respectively.

2. Derogation procedures

In April 2024, the Registrar of Act 36 issued guidelines for the application for a derogation for an agricultural remedy identified as a substance of concern (DALRRD, 2024). This section briefly provides the procedure available to apply for derogation of substances of concern and public participation in this process, particularly those intended to be phased out.

Before applying for derogation of an agricultural remedy, an applicant must conduct an RA to evaluate the risks associated with using the remedy, according to the proposed uses for which a derogation is sought and to determine whether the associated risks can be sufficiently mitigated. The applicant needed to inform the Registrar of their intent to apply for a derogation before publishing the RA report for public comment or before 1 June 2024, whichever occurred first. The derogation application is product-specific and is granted for a specific period and restricted uses.

The following information must be provided to the Registrar: a) the name, active ingredient and registration of the agricultural remedy for which the RA has been or is being conducted; b) the final hazard classification of the remedy according to GHS or other classification resulting in the remedy being considered as a substance of concern; c) the intended use(s) for which a derogation is sought; and d) a copy of the RA report that will be published for public comment and where this report will be made available. If the RA report is not yet finalised at the time, proof that the study has been initiated must be submitted (i.e., confirmation from the specialist conducting the assessment that the study is in progress or in line to be conducted with an estimated timeframe for completion). Both a hard copy and electronic copy of the final report must be shared with the Registrar as soon as it is finalised.

The notification to the Registrar will be in the form of a formal letter, which may be submitted to the Registrar via email. The Registrar will acknowledge receipt of the notification of intent to apply for a derogation within 14 days. If the Registrar raises no prior objections, the applicant may go ahead and publish the RA report and notifications as proposed. This procedure may only commence once a hard copy of the RA report has been delivered to the office of the Registrar (Act no. 36 of 1947), where the report will be made available for public inspection.

According to the guideline for the application for a derogation for an agricultural remedy identified as a substance of concern (DALRRD, 2024), as the envisaged administrative action affects the rights of the public throughout the country, information concerning the administrative action must be published by way of notice in the Government Gazette, and a newspaper which is distributed, or in newspapers which collectively are distributed, throughout the Republic, as articulated under section 4(1) of the Promotion of Administrative Justice Act (Act no. 3 of 2000). According to Regulation 8(7) of the 2023 Regulations relating to agricultural remedies, the public is then invited to comment on the relevant RA report. A minimum of 30 days is provided for comments to be accepted. Following this, the application for derogation needs to be submitted to the office of the Registrar for evaluation within 30 days of the conclusion of the public participation process (DALRRD, 2024). If the Registrar is satisfied that the RA addresses the material concerns associated with the use of the remedy, and public comments do not reveal any additional unmanageable risks or concerns, the Registrar may approve the use of the agricultural remedy. If the remedy no longer complies with the conditions provided in Regulation 8(6), the Registrar will provide a reasonable phase-out period to deplete stock before cancelling the registration. The Derogation Guidelines do not specify when the Department must decide and respond to the applicant.

It is unclear how this decision-making process takes place regarding derogations, as well as more broadly regarding procedures around the registration and/or renewal of an agricultural remedy, criteria and timelines for phase-out, alternatives to substances of concern, etc., with deep concerns that too much power is vested in the Registrar who operates within the mandate of the Department of Agriculture, and ultimately serves the interest of agribusiness and commercial agricultural imperatives. As part of a complete repeal and restructure of the pesticide regulatory framework in South Africa, an independent body should be established, made up of multidisciplinary experts appointed by the President, to make decisions regarding pesticide use, registration, renewal, etc, in the country. Currently, the decision-making structure is inherently unconstitutional as it does not guarantee fair administrative decision-making.

It is deeply concerning that despite its commitment to reduce the use of HHPs, the government has provided avenues for the persistent use of these dangerous chemicals based on the interests of the agrochemical industry. **This provides legal means to continue inherently illegal and unconstitutional practices.** This questions the legality of such provisions articulated under Regulation 8(6). Such a provision is contradictory and subversive and sabotages the potential for not only reducing hazardous chemicals in our environment and our food but also preventing the ability to transition out of a chemical-dependent agricultural model that experts globally have increasingly called for and agreed upon in multilateral fora. The logic outlined under Regulation 8(6) assumes that risks can be identified and trumped by mitigation measures, even though these chemicals are already characterised as HHPs and targeted for phase-out and bans, with many already banned in other countries. This procedure differs significantly from derogation applications, for example in the EU, which are intended for use in the event of an emergency rather than to greenlight the use of HHPs.[4] Ultimately, the derogation procedures negate the purpose of regulations to phase out HHPs. This is biased toward industry interests under the guise of low risk under "realistic worst-case scenarios" and under false and perilous claims that the continued use of these HHPs is necessary to maintain/achieve food security.

The remainder of this report will unpack current derogation applications with regards to GLA, an HHP on the list for phase-out and bans in South Africa, circumventing the commitment to phasing out this HHP and entrenching GLA, and ultimately all HHPs, further into our agricultural and food system.

4 Interview with Peter Clausing, toxicologist, 2024.

3. The case of GLA: HHPs, derogation, illegalities, GM crops, and the trajectory of agriculture in SA

3.1. Background to GLA

Glufosinate (also referred to as racemic glufosinate comprised of D- and L-stereoisomers) is a broad-spectrum, non-selective, post-emergence, foliar applied herbicide used to control broad leaf, grass and sedge weeds in a variety of industrial, agricultural systems, including crops, orchards, vegetables, and non-crop sites. It is often referred to as glufosinate-ammonium (GLA) because the ammonium-salt formulations are the most commonly used. GLA (i.e. D,L-phosphinothricin, also known as 2-amino-4 (hydroxymethylphosphinyl) butanoic acid) is a herbicide with several unique characteristics, in particular, its mode of action as a natural amino acid, inhibiting glutamine synthetase (GS), an enzyme essential for plant metabolism (Dayan et al., 2019; Hoerlein, 1994), thereby killing plants by ammonia accumulation and accumulation on reactive oxygen (Donthi and Kumar, 2022).

Glufosinate is highly hydrophilic and does not translocate well in plants, generally providing poor control of grasses and perennial species. GLA often provides inconsistent performance in the field, attributed to several factors, including environmental conditions, application technology, and weed species (Takano and Dayan, 2020), ultimately resulting in far less area being treated with this herbicide than glyphosate. Glufosinate is a light-dependent herbicide and is more effective when sprayed in full sunlight compared to night application (Donthi and Kumar, 2022).

The area estimated to be treated with glufosinate globally was approximately 12 million ha per year in 2014 (Busi et al., 2018) following a substantial increase in the United States of America, particularly in areas where genetically modified (GM) glufosinate-tolerant crops are grown. This was in response to the ever-increasing number of glyphosate-resistant weeds due to the widespread use of glyphosate-tolerant GM crops grown in countries where this has been approved, including South Africa. After glyphosate and paraquat, glufosinate is the most popular herbicide in the world (Matshidze and Ndou, 2023). Glyphosate resistance is widespread, and weeds continue to evolve multiple resistance to other post-emergence herbicides, such as protoporphyrinogen oxidase (PPO) inhibitors and synthetic auxins (2,4-D and dicamba), as well as metabolic resistance to key preemergence herbicides (e.g. S-metolachlor). As such, we are witnessing newer transgenic technologies for herbicide-resistant crops stacking multiple events, including glufosinate tolerance as one of their traits in most varieties. While fewer weeds have evolved resistance to GLA, there are examples where this has occurred.[5] (www.weedscience.org).

Glufosinate is widely used in the Midwest and Southern United States where the majority of GM soybean and cotton are planted in North America. Rice, orchards, vineyards, minor crops, and non-agricultural areas also represent a large portion of glufosinate use in the Western United States and other parts of the world. Glufosinate is also widely used in South America due to large-scale GM soybean cultivation. In South Africa, GM crops that display tolerance to glufosinate have been approved for commodity clearance (food, feed, and processing) and general release since 2001 and 2003, respectively (See Annexures D and E). Glufosinate used to be registered for use in Europe until 2018, but it has not been reapproved by the European Commission (EC) due to toxicology concerns and has since been banned in 29 countries.

5 Lolium rigidum in Greece (grape, olive, orchards), Eleusine indica in Malaysia (vegetables, oil palm), Lolium perenne in New Zealand and the United States (grapes, orchards), Amaranthus palmeri in the United States (cotton), and Poa annua in the United States (non-crop sites).

3.2. Genetically engineered crops and GLA

The rise in GE crops, particularly Roundup-Ready crops, i.e. those genetically engineered to withstand the broad spectrum herbicide glyphosate, has resulted in widespread glyphosateresistant weeds, also known as superweeds. Despite attempts and intentions to ban glyphosate, it remains widely in use after being categorised as a "probable carcinogen" by the International Agency for Research on Cancer (IARC) in 2015. In response to glyphosate resistance, farmers are applying more toxic herbicides and cocktails of herbicides with little knowledge of combined and cumulative effects (Benbrook, 2012; Soil Association and Pesticide Action Network UK, 2019). Biotech companies, such as Dow AgroSciences and Monsanto, are commercialising new crops engineered to tolerate glufosinate, 2,4-D, and dicamba, which are extremely toxic to human health and the environment. As such, newer transgenic technologies for displaying herbicide-tolerance stack multiple events, including glufosinate tolerance, as one of their traits in most varieties. Therefore, glyphosate resistance poses significant social and environmental concerns regarding the health, well-being, and sustainability of our agricultural and food systems and the environment (Bain et al., 2017).

Glufosinate-tolerant GM crops have been developed for various crops, including canola, corn, cotton, soybean, rice, and more recently wheat and sugarbeet. Glufosinate-resistant crops can metabolise glufosinate by expressing the phosphinothricin acetyltransferase (pat) gene, which is also known as bialaphos resistance (bar) gene (Takano and Dayan, 2020). Newer transgenic technologies tend to stack multiple events, including glufosinate resistance as one of their traits in most varieties for herbicide tolerance. Annexures D and E indicate the events approved in South Africa for general release and commodity clearance, respectively, which denote GLA tolerance. In addition to those stacked events, including glufosinate tolerance indicated in Annexure D, GLA-tolerant HB4 wheat trials are expected to begin in April 2025 to be released for cultivation (ACB, 2024).

There are numerous concerns regarding using GE crops for herbicide tolerance. Beyond the safety concerns surrounding the GE process and product, the prevalence of GE crops able to withstand direct herbicide spraying opens doors for various issues, including pesticide residues, with herbicides directly entering the food system and health implications for consumers. In areas where cultivation occurs, there are more localised health concerns, particularly for re-entry workers, who work directly with crops sprayed with pesticides, counter to the claims in the RAs, detailed below. This infringes further on the rights of workers, consumers, farm dwellers, and those living in rural areas. Unmitigated pesticide use also directly results in weed resistance. It is, therefore, vital that effective legislation, capacitation, and monitoring measures on pesticides – already recognised as woefully inadequate – are in place to prevent an inundation of pesticide use.

Effects on human and ecosystem health

GLA is an irreversible glutamine synthetase (GS) inhibitor, and its herbicide activity depends on the subsequent ammonium accumulation and oxidative burst of reactive oxygen species (Takano and Dayan, 2020). Inhibition of GS activity leads to the accumulation of glutamate and causes neurotoxicity (Lantz et al., 2014). Despite the lack of clarity surrounding the mechanisms of GLA toxicity in humans, acute high-dose exposure to GLA has been reported to cause convulsions, memory loss, and hippocampal pathology (Mao et al., 2012; Park et al., 2013). Different durations of exposure, concentrations or routes, and types of exposure lead to different GS responses. Male reproductive and developmental toxicity have been reported in mammals exposed to GLA (Ma et al., 2021; Laugeray et al., 2014). Aquatic animals exposed to GLA (2.5 mg/L) exhibit significant morphological abnormalities during early development, suggesting GLA is teratogenic in amphibians (Boccioni et al., 2022). Tadpoles exposed to GLA might suffer oxidative stress, hormonal disturbance (T4), and DNA damage. In zebrafish, for example, GLA causes spinal deformities, yolk sac edemas, and embryo mortality (Xiong et al., 2019). In reptiles, GLA induces hepatotoxicity and reproductive toxicity in male lizards via oxidative damage and disruption of the hypothalamic-pituitary-gonadal axis (Zhang et al., 2019).

From a human health perspective, there is evidence of acute and chronic toxicity (KEMI, 2002; Lapouble et al., 2002; Maillet et al., 2016; Matsumura et al., 2001). Studies report that glufosinate is harmful when inhaled, swallowed, or through skin contact, with serious health risks manifesting from repeated and prolonged exposure (Donthi and Kumar, 2022). Assessment of exposed patients shows that acute exposure causes convulsions, respiratory circulatory, and central nervous system damage (Donthi and Kumar, 2022). Chronic exposure studies note neurotoxicity (Fujii, 1997; Jeong et al., 2015; Kim and Min, 2018; Lantz et al., 2014; Lapouble et al., 2002; Lee and Kang, 2021; Mao et al., 2012; Mao et al., 2011; Nakaki et al., 2000; Watanabe, 1997; Watanabe and Iwase, 1996), reproductive toxicity (Ferramosca et al., 2021; KEMI, 2002; Zhang et al., 2019), and foetotoxicity/teratogenicity (Watanabe and Iwase, 1996). Potential damage to the brain, reproduction, and adverse effects on embryos can happen upon exposure. Simões et al. (2023) documented an association between residential exposure to glufosinate and low birth weight, and Ferramosca et al. (2021) provided evidence that glufosinate negatively affects the respiration efficiency of human sperm mitochondria, demonstrating the possible mode of action for the detrimental effects on fertility. There is no known antidote for glufosinate poisoning. Although glufosinate-containing herbicides are used worldwide, data on acute human glufosinate poisoning remains scarce (Mao et al., 2012).

Principally, proponents of the use of GLA suggest that any dangers to exposure are completely removed if procedures for use are followed according to the labels. This fails to consider the reality of many farm workers, particularly highly vulnerable seasonal and informal workers, farm dwellers, and rural inhabitants. There are many examples where preventative gear and methods of application are not followed for various reasons, exposing smallholder farmers, farm workers, and farm dwellers to unacceptable levels of dangerous and toxic pesticides. While the implications of occupational exposure are of primary importance, the ease by which toxic pesticides are accessed highlights concerns for acute toxicity, even with unintended usage (ACB et al., 2024).

Beyond this, impacts on food and consumption are also vital. Glufosinate is often used as a pre-harvest desiccant globally, with residues that can also be found in foods, including potatoes, peas, beans, corn, wheat, and barley. In addition, the chemical can be passed to humans through animals fed contaminated straw. The study by Watts indicated that flour processed from wheat grain containing traces of glufosinate retained 10–100% of the chemicals' residues (Watts, 2008). Yet, as GLA is considered

highly volatile, there is generally less concern and research on food residues. The herbicide is considered persistent and prevalent in spinach, radishes, wheat, and carrots planted 120 days after treatment (Donthi and Kumar, 2022). Its persistent nature can also be observed by its half-life, which varies from 3 to 70 days, with some studies showing its half-life over 300 days, depending on the soil type and organic matter content (Jia et al., 2019; Niu et al., 2010). Residues can remain in frozen food for up to two years, and the chemical is not easily destroyed by cooking the food item in boiling water (Donthi and Kumar, 2022). When pesticides are released into the environment, they may be degraded through chemical and biological degradation processes (Meng et al., 2022). GLA is degraded primarily through soil microbial activities and is not significantly degraded via the abiotic mechanisms of hydrolysis or photolysis.

GLA is highly water-soluble and, therefore, has high to very high mobility. Being hydrophilic and mobile, GLA can rapidly dissolve in water, with impacts on water runoff if rain occurs shortly after application, as well as potential impacts on aquatic species. Due to its high solubility in water, glufosinate can enter freshwater bodies through foliar spray or runoffs (Moon and Chun, 2016). Some studies have shown that glufosinate has a long half-life and slow degradation in buffer solutions and fresh water, with a half-life of over 300 days (Niu et al., 2010; Jia et al., 2019). Because of its high solubility (>500 g/L), foliar sprays and surface runoff allow GLA to contaminate surrounding freshwater bodies (Meng et al., 2022). GLA has a long half-life in fresh water, so it is ubiquitous in surface waters near farmland (Jia et al., 2019). In northern Italy, the annual average concentration of GLA in the rivers Musoncello (0.72 μg/L) and Teva (0.42 μg/L) exceeded the upper tolerable limit for Europe in river water (0.1 μg/L) for pesticides (Masiol et al., 2018). Similarly, the maximum observed GLA concentrations in China's agricultural surface waters sampled in summer and autumn was 13.15 μg/L (Geng et al., 2021). Most field investigations, however, have demonstrated that average surface water GLA concentrations are lower than the observed concentrations of glyphosate (Geng et al., 2021; Masiol et al., 2018).

By contrast, GLA is rarely detected in soils due to rapid degradation by soil microorganisms (Pelosi et al., 2022). There is conflicting evidence regarding GLA's persistence in soils. GLA degrades at varying rates in aerobic and anaerobic soils. Regarding impacts on soils, glufosinate is rapidly degraded by soil bacteria, resulting in no residual activity nor crop rotation restrictions, with studies indicating little impact on soils (Bartsch and Tebbe, 1989). Yet more recent studies indicate that due to glufosinate's strong water solubility, glufosinate sprayed on the surface of the soil may leach to the deeper soil with rain. During this process, GLA will be gradually adsorbed by clay particles in the soil (She et al., 2023).

Therefore, the residual amount of glufosinate in the surface soil is greater than the residual amount in deeper soil. As such, the risk of leaching into drinking water and groundwater and the ecological risks to aquatic organisms remain unclear. Some studies suggest GLA will degrade fast and completely in soil and surface water or have high adsorption and low desorption rates, giving no scope for residues joining groundwater (Tayeb et al., 2019). As the toxicological threshold levels for all the non-target organisms tested are well above the potential exposure levels, developers claim this does not reflect any hazard for non-target organisms in the ecosystem. Yet increasing evidence points to unacceptable risks due to spray drift, overflow runoff, and exposure to surface water, posing potential risks to drinking water and aquatic organisms (Geng et al., 2021). Degradation/recovery rates vary according to environmental factors and application amounts and rates. This has implications for aquatic environments and organisms regarding toxicity, residues, bioaccumulation, and biodegradation.

There is mixed evidence on the environmental impacts of GLA in terms of its volatility, mobility, persistence in soils and waters, impacts on groundwater, and terrestrial and aquatic organisms. Ultimately, little is known of the diverse environmental factors that respond differently to the amount and rate of application and, therefore, the situation demands more investigation (Zhang et al., 2023).

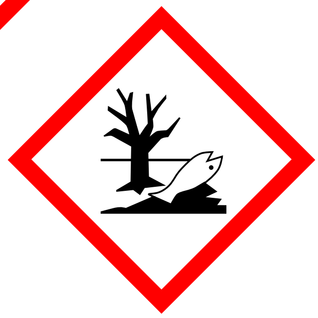
3.3. Classification of glufosinate-ammonium as a highly hazardous chemical

Since glufosinate irreversibly inhibits GS, leading to intracellular accumulation of ammonia, hyperammonemia is considered one of the main mechanisms of GLA toxicity in humans (Donthi and Kumar, 2022). It is a highly hazardous herbicide because it can cause reproductive toxicity, neurotoxicity, and cardiovascular effects. It is also capable of causing damage to developing foetuses. Studies report premature birth and intrauterine death and abortions in experimental animals and human brain toxicity, pointing to high risk to mammals (Donti and Kumar., 2022). Due to its acute and chronic adverse health effects, it has been banned in 29 countries, including EU member countries, Morocco, and the UK. It is also included in the PAN International list of HHPs.

Following European Union (EU) Regulation 1107/2009 (European Commission, 2009), based on the precautionary principle, the EU has declared a ban on all CMR pesticides from categories I and II. Glufosinate is banned in the EU because pesticides classified as category 1A/1B for CMR are not allowed for marketing in the EU. Glufosinate is classified as a reproductive toxin (GHS code H360Fd – may damage fertility and the unborn child) based on evidence in laboratory animals as provided by the regulatory toxicity studies conducted as required for registration. According to the European Chemicals Agency, glufosinate is classified as acute toxicity category 4, reproductive toxicity category 1b, specific target organ toxicity (STOT) single exposure category 1, STOT repeat exposure category 2, and both acute and chronic aquatic toxicity category 1.[6] Some variation occurs, such as aquatic toxicity, which is considered a category 2 from BASF, but the same pictograms are used for labelling purposes (BASF, 2024).

Health hazard[8]

Exclamation mark[7]



Environmental hazard[9]

According to BASF, the GHS classifies GLA as aspiratory toxicity 2, acute toxicity 2 (inhalation), skin corrosion/irritation 2, eye damage/irritation 1, reproductive toxicity 1b (fertility), reproductive toxicity 2 (unborn child), STOT single exposure 1 (nervous system), STOT repeat exposure 2 (nervous system), aquatic toxicity acute 2 and aquatic toxicity chronic 2 (BASF, 2024). This differs from the World Health Organisation (WHO) Recommended Classification of Pesticides by Hazard and Guidelines to Classification, which considers GLA a class 2, moderately hazardous pesticide (JMPR, 2012; WHO, 2019).

While these classifications are useful entry points, they are outcomes of multilateral fora, which are heavily influenced by agribusiness. As such, criteria used locally must not rely solely on these confusing and potentially dangerous reference points. Developing criteria that ensure pesticide regulations abide by and align with the South African Constitution and context is vital.

6 https://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/discli/notification-details/35913/1524179
7 An immediate skin, eye or respiratory tract irritant, or narcotic.
8 A cancer-causing agent (carcinogen) or substance with respiratory, reproductive or organ toxicity that causes damage over time (a chronic, or long-term, health hazard).
9 Chemicals toxic to aquatic wildlife.

International guidelines and standards regarding HHPs

International recognition of the impact of HHPs on human and environmental health is well established. The WHO Recommended Classification of Pesticides by Hazard was first published in 1975, classifying pesticides in one of five hazard classes according to their acute toxicity. In 2002, the GHS was introduced, which, in addition to acute toxicity, also provides the classification of chemicals according to their chronic health hazards and environmental hazards (FAO and WHO, 2016).

Concerns around health and environmental hazards led to establishing the Stockholm Convention on Persistent Organic Pollutants and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. The Stockholm Convention agrees on the phasing out persistent pesticides and other chemicals listed under its Annex A. The Rotterdam Convention promotes shared responsibility and cooperative efforts in the international trade of certain hazardous chemicals to protect human health and the environment.

In 2006, the Strategic Approach to International Chemicals Management (SAICM) was adopted. This voluntary agreement, under the auspices of the United Nations Environmental Programme (UNEP) recognised the need for action to reduce dependency on pesticides worldwide, including phasing out highly toxic pesticides and promoting safer alternatives. In 2006, the UN's Food and Agriculture Organisation (FAO) Council endorsed FAO participation in the SAICM. It noted that the International Code of Conduct on the Distribution and Use of Pesticides was to be considered an important element of the SAICM process. The Council suggested that the activities of FAO could include pesticide risk reduction, including the progressive banning of HHPs (FAO, 2006). This request resulted in the formulation of criteria that define HHPs by the Joint FAO\WHO Meeting on Pesticide Management (JMPM). In October 2007, JMPM was launched, and developed eight criteria to meet the definition of an HHP:

- **Criterion 1:** Pesticide formulations that meet the criteria of classes Ia or Ib of the WHO Recommended Classification of Pesticides by Hazard; or
- **Criterion 2:** Pesticide active ingredients and their formulations that meet the criteria of carcinogenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or
- **Criterion 3:** Pesticide active ingredients and their formulations that meet the criteria of mutagenicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or
- **Criterion 4:** Pesticide active ingredients and their formulations that meet the criteria of reproductive toxicity Categories 1A and 1B of the Globally Harmonized System on Classification and Labelling of Chemicals (GHS); or
- **Criterion 5:** Pesticide active ingredients listed by the Stockholm Convention in its Annexes A and B, and those meeting all the criteria in paragraph 1 of Annex D of the Convention; or
- **Criterion 6:** Pesticide active ingredients and formulations listed by the Rotterdam Convention in its Annex III; or
- **Criterion 7:** Pesticides listed under the Montreal Protocol; or
- **Criterion 8:** Pesticide active ingredients and formulations that have shown a high incidence of severe or irreversible adverse effects on human health or the environment.

The criteria and definition encompass a broader range of pesticides than those addressed by the Conventions. The International Code of Conduct on Pesticide Management (2014, p. 4) defines HHPs as: "Pesticides that are acknowledged to present particularly high levels of acute or chronic hazards to health or environment according to internationally accepted classification systems such as the WHO or the GHS or their listing in relevant binding international agreements or conventions. In addition, pesticides that appear to cause severe or irreversible harm to health or the environment under conditions of use in a country may be considered to be and treated as highly hazardous."

HHPs then became a special focus area in the programme of work for the FAO Pest and Pesticide Management Group. In 2015, the SAICM International Conference on Chemicals Management adopted a resolution that recognised HHPs as an issue of concern and called for concerted action to address HHPs, with emphasis on promoting agroecologically based alternatives and strengthening national regulatory capacity to conduct risk assessment and risk management (SAICM, 2015). Over the years, more emphasis has been placed on the impact of hazardous chemicals on human and environmental health. Most notably, in 2023, the fifth International Conference on Chemicals Management (ICCM5) adopted the Global Framework on Chemicals (GFC) as a successor to SAICM and committed to phasing out HHPs by 2035.[10] Resolution V/11 of the GFC agreed on establishing a Global Alliance on HHPs to progress towards the phase-out of HHPs (GFC, 2024). In March 2024, the UN Environment Assembly (UNEA) supported this engagement by agreeing on a resolution that calls for action to phase out HHPs globally by 2035 (UNEP, 2024).

From a regulatory perspective, the EU took the lead when, in November 2009, it shifted from a paradigm based on an assessment of pesticide risks only,[11] with Regulation 1107/2009/EC, to one that emphasises the need to consider the intrinsic hazards of pesticides.[12] Accordingly, Reg. 1107/2009 stipulated that pesticide substances (active ingredients) proven to be carcinogenic, mutagenic, toxic for reproduction, and endocrine disruptors shall not be authorised in the EU (PAN, 2024). However, despite this, double standards exist whereby the EU continues to export pesticides banned for use on EU soil, including GLA. Despite shifting discourse on HHPs, the paradigm of assessing chemicals based on RA remains largely the same globally.

10 Target A7: By 2035, stakeholders have taken effective measures to phase out HHPs in agriculture where the risks have not been managed and where safer and affordable alternatives are available, and to promote transition to and make available those alternatives.
11 Risk is the probability and severity of an adverse health or environmental effect occurring as a function of a hazard and the likelihood and the extent of exposure to a pesticide.
12 Hazard means the inherent property of a substance, agent, or situation having the potential to cause undesirable consequences (e.g. properties that can cause adverse effects or damage to health, the environment or property).

3.4. Derogation applications of GLA in South Africa

To date, we are aware of six applications for derogation for GLA.[13] The toxicological RAs are essentially the same across all applications, with few notable differences. One important difference is that some RAs include data on risks associated with potato desiccation, while others do not include these considerations. Some RAs conclude that contact with treated plants can take place between 12–24 hours after application of the pesticide, while others say after one day. Some of the RAs are identical (in some cases having the same typos), with all relying on the same data, resources, and conclusions. Beyond this, there are no indications of the proposed use or time being requested. These indications are meant to form part of the derogation application, and their absence makes it difficult for the public to comment adequately.

It must be noted that multiple applications that were submitted over Christmas and New Year are currently underway when many people are away from their desks and, therefore, , lack transparency. Further, if multiple applications for derogation are made for different brands, using the same active ingredient (although the RAs do not attend to co-formulants), this may overwhelm the system, flooding the Registrar with applications. This indicates an administrative problem with this approach, pointing to the structural problem with the legislative framework which is irredeemably unlawful.

3.4.1. Impact of exposure on human health

Based on the summaries of the RAs: "[brand name] is not intended for sale to residential gardeners; therefore, risks to health, associated with the herbicidal application of [brand name], are assessed only for occupational pesticide handlers and post-application (re-entry) workers."

The RAs focus primarily on occupational exposure, considering the dosage and response (toxicology assessment) as they claim that, since this product will not be available to residential gardeners and the public, only pesticide handlers and post-application workers are deemed valid for assessing risk exposure. This fails to consider the range of farmers and ways of accessing dangerous chemicals through formal and informal networks, as highlighted earlier.

In terms of occupational exposure, the RAs firstly note as part of the toxicology assessment that comparisons between the Margin of Exposure (MOE) and the Level of Concern (LOC)[14] indicate the absence of a risk of a health effect in operators involved in mixing, loading, and spraying, primarily due to the use of PPE, as indicated on the label.

For post-application (re-entry) agricultural workers, they suggest negligible contact with pesticide residues, firstly, as the label suggests waiting one day before re-entry, with little to no contact with areas sprayed as crops are not sprayed. Further, they state that since GLA is volatile, inhalation exposure is excluded from the analysis. There is some mention of potential post-application contact during potato desiccation in some of the RAs, but not all of them, stating "The only activities that might involve more-than-negligible contact with residues on weeds is weeding by hand, slashing and clearing of treated reeds in commercial or non-crop areas, and scouting and inspecting of desiccated potato plants." (Van Niekerk, 2024, p.25).

When considering data used as a point of departure, new evidence describes epigenetic changes in mice at a dose of 0.2 mg/kg body weight, a dose much lower than the USEPA reference dose of 6 mg/kg used in the risk calculations (Ma et al. 2022). While the histone modifications in mouse sperm described in this study are not classical toxicological endpoints, they indicate at a very low dose the mode of action for possible toxicological changes in embryonic and

13 Enviro Bio-Chem (Pty) Ltd; Villa Crop Protection (Pty) Ltd; Kwelenga (Pty) Ltd; UPL South Africa (Pty) LTD; AECI Limited; Sharda International Africa (Pty) Ltd.

14 The toxicology assessment relies on an MOE approach, i.e. a comparison of the calculated exposure dose and the toxicity limit value of a particular health effect. If a calculated MOE is higher in value than the LOC associated with the point of departure used for the MOE calculation, a risk to health under the assessed exposure conditions is highly unlikely and excluded for all practical purposes. Conversely, if the calculated MOE is lower than the associated LOC, a risk to health cannot be excluded. A point of departure is a data point or an estimated point that is derived from observed dose-response.

offspring development. This highlights the concerns around the RA use of an MOE approach.

The applicants rely on the fact that instructions on the label are followed correctly, yet this fails to consider the reality of PPE compliance amongst farmers and farm workers and the precarious conditions of many women and seasonal farm workers in particular (Orellana, 2023; Women on Farms and Solidar, 2024). It has been found that (Devereux, 2020):

- More than two-thirds of seasonal workers (69%) are exposed to dangerous pesticides within an hour after vineyards have been sprayed, with exposed workers reporting negative impacts on their health, such as skin rashes, nasal and eye problems, breathing difficulties, and headaches.
- An even higher proportion of seasonal workers (73%) are not provided with protective clothes by the farmer.
- Only one in five women in the Northern Cape (21%), less than one in five seasonal farm workers (18%), and less than one in ten domestic market workers (7%) have been informed by the farmer about what pesticides are used and their possible side-effects.
- Nearly two-thirds of workers (63%) who work with pesticides do not have a separate wash facility in the workplace, meaning that they wash at home, thereby potentially exposing their families to hazardous pesticides. Furthermore, while pesticide handlers are mostly men, women at home wash the clothes covered with pesticides and have no protective gear. Beyond this, in some cases, farm workers live within the farm compound, and many people live close to farms sprayed, with no or little warning that sprays will take place.

As such, mitigation measures for exposure reduction cannot rely solely on PPE use promotion, where the reality is a lack of compliance, information, and ability to take precautions, as is the case for many farmers, farm workers, and those living near farms (farm dwellers, rural towns) using such agrochemicals. Instead, other strategies are required, such as eliminating and substituting HHPs and altering application methods. Exposure prevention is key, rather than shifting blame towards the end-user.

In addition, and crucially important, is the linkage between herbicide use and GE crops, something entirely neglected in the RAs. As an increasing number of crops are approved both for commercial and general release, post-application workers are at increasing risk as pesticides are applied indiscriminately to the harvested product.

The RAs conclude that: "The results of the health risk assessment indicated that there are no reasons for concern, including reproductive/developmental toxicity effects, in agricultural operators handling the product, mixing or applying the product, or in contact with treated crops after 12 to 24 hours post-application."

Despite GLA being characterised as having high reproductive toxicity, based on GHS classification and BASF itself, the RAs completely eradicate any concerns around the hazard itself, based on apparent real-life situations, with adherence to the information on the labels. Yet this risk-based approach fundamentally contradicts the commitment to phase out HHPs so that derogation procedures undermine this process entirely. The paradigm by which these RAs are oriented dilutes the hazardous nature of the chemicals themselves and the precautionary principle and is, therefore, outdated.

According to the RAs: "Dietary exposure of consumers or treated produce is highly unlikely and not an issue of concern, firstly because the herbicide is never applied directly to the commodity to be harvested. Secondly, the translocation of glufosinate-ammonium within the various parts of the plant, e.g., root-to-fruit, is insignificant."

The impact of exposure through food consumption is mostly brushed off because pesticides are not sprayed on the crop itself. There are two problems with this statement. Firstly, as some RAs indicate, GLA is and will be used in potato desiccation (and perhaps other crops). Therefore, GLA is used directly on harvested crops. Secondly, GLA is used in conjunction with multiple and growing GM crops. As mentioned, this is not discussed in the RAs. The RAs report significant dietary risks of exposure to drinking water resulting from using GLA on rice. Yet, since rice is not produced in SA, they claim this is not applicable.

3.4.2. Impact on the environment

The RAs report that: "The USEPA (2013) preliminary risk assessment did not identify risks of concern for aquatic plants, fish, or aquatic invertebrates, except for the use of glufosinate-ammonium on rice. Considering that the use of glufosinate-ammonium on rice is not relevant in South Africa, it can be concluded that the use of glufosinate-ammonium poses no ecological risks or concerns for aquatic organisms." This raises the concern of risk not being adequately considered in other production chains due to limited research.

The assessment concludes that GLA does not translocate. Yet research is still underway. As GLA is hydro-philic, translocation varies considerably according to environmental factors (Takano et al., 2020). Limited translocation may justify excessive spraying of plants due to its limited herbicide effectiveness, with increased health and environmental implications. This is particularly concerning in light of GLA-tolerant GM crop production.

The RAs report that: "Although ecological risks to mammals and birds foraging in treated weeds cannot be totally excluded, reducing either the single application rate or the number of applications on glufosinate labels is not contemplated. Such reductions could have an impact on growers (and food production) that outweighs the potential decrease in chronic risk to mammals."

The RAs rely on the findings and conclusions from the USEPA assessment, where USEPA did not recommend risk mitigation measures for birds, reptiles, and terrestrial-phase amphibians. In particular, the RAs do not suggest any reduced application rates, based on the impact on production, due to lower intake than those modelled and due to the growing glyphosate-resistant weeds. There are some concerns with this analysis. Firstly, it brushes off ecological impacts without considering alternatives as necessary. Questions arise regarding the intake levels used in the analysis, particularly since the RAs talk to section 9.5 (assumingly of the RA), which does not exist in any of the RAs, to confirm these calculations and figures being modelled. Secondly, the RAs also do not consider the likelihood and examples of GLA weed resistance, as stated above (Minnesota Department of Agriculture, n.d.).

And finally, ecological impacts are somewhat dismissed in the RAs. Given the increased utilisation of GLA due to the global ban on paraquat, concerns regarding glyphosate and glyphosate weed resistance, and the increased production of GLA GM crops, the contamination of surface water by GLA residues and the risk to aquatic life raises significant concerns, which should be given greater consideration. This said, environmental impacts are not cut-offs for the use of any pesticide, based on the commitment by the Registrar in 2022 or Regulations 8(1)(d) and 10(3)(e) of the 2023 Regulations of Act 36.

| 4. Concluding remarks

According to the Derogation Guidelines, derogation will be granted only for a specific period and for restricted use. Yet only the toxicology RAs are available, and it is unclear why these derogations are being sought and for what period. The arguments presented in the RAs provide reasons why the Registrar may grant or renew a registration of a defined substance of concern based on its interpretation that the realistic worst-case conditions are negligible and that labelling and PPE are sufficient to prevent or control grave dangers to human health. Concomitantly, the risks to animal and environmental health are a sufficient price to pay for the need to use this HHP in light of increasing herbicide-tolerant weeds, based on Regulation 8(6) of the 2023 Regulations of Act 36. We believe these arguments and interpretations are false, dangerous, and misleading. They rely on outdated paradigms and data and perpetuate unjust labour practices and environmental racism.

Ultimately, the RAs rely on data from studies conducted in other parts of the world and not on crops and socio-economic and agroecological conditions in South Africa. The references are almost exclusively based on USEPA's analysis, essentially claiming that USEPA's assessment is sufficient to transpose into a South African context. Yet these countries have fundamentally different social, ecological, and regulatory environments. While the data and conclusions of the RAs must be questioned, more importantly, it is necessary to call out the illegitimate nature of the derogation procedures provided for, which ultimately negate the progress made to eliminate dangerous HHPs from the agricultural landscape in South Africa to ensure human and environmental health and safety. This makes the regulatory reforms null and void.

Further to this, the United Nations Special Rapporteur on the Implications for Human Rights of the Environmentally Sound Management and Disposal of Hazardous Substances and Wastes, Marcos Orellana, released a report recommending that all hazardous pesticides that have been banned in countries of origin should also be banned in South Africa (Orellana, 2023). There remain concerns around transparency and corporate capture, including in pesticide registration processes and the inability to access information. To date, a list of registered pesticides in South Africa is only able to be accessed through CropLife South Africa, an association representing agrochemical companies, for a fee, despite the new regulations on pesticides committing the Registrar, who oversees the registration, regulation, and prohibition of pesticides among other functions, to provide an updated quarterly list of registered pesticides as per Regulation 39 of the 2023 Regulations to Act 36. This illustrates how regulatory duties are being flouted.

The commitment to ban HHPs and the publication of the new regulations are progress toward meeting objectives spelt out in the 2010 policy and creating an effective legislative framework to regulate agricultural remedies in South Africa. However, provisions under Regulation 8(6) undo much of this progress by creating legal avenues to continue business as usual. Other regulatory gaps remain, such as around public participation in the renewal of pesticides, mechanisms for the traceability of pesticides, and penalties, amongst others. Regulations remain contradictory and untransparent, maintaining a system that consistently and systematically violates the human rights of all South Africans. There must be a complete overhaul of the legislative framework overseeing pesticides and agricultural remedies, including the establishment of a unique regulatory authority to oversee the entire process, including bans and phasing out.

Additionally, as much relies on pesticide labelling, this should be in languages accessible to workers, include clear specifications on buffer zones, non-target areas, and aerial spraying, and ensure people can comprehend labels. Yet, preventing exposure and misuse of HHPs cannot rest on labels alone, and rather, the government should stick to its commitment to eliminate and prevent exposure in the first place. Using a risk-based approach neglects the reality of smallholder farmers, marginalised farm workers, farm dwellers, and those living in rural towns, with impacts on the environment and human health beyond the site of spray. **Rather, a hazard-based approach, i.e. the property of the compound independent of exposure, following the example taken by the EU, is better aimed at ensuring the rights embedded in the Constitution are centred and realised.**

We urge the government to maintain its commitments to phase out and ban HHPs and extend the list already provided rather than diminish the meaning and impact of these commitments. To support this, we need a global phase-out and ban on HHPs.

Further, we call for an inquiry and public hearings into transitioning out of industrial agriculture by unpacking the systemic drivers of food insecurity in South Africa, as well as the necessary transitions towards alternative modes and models of production and consumption. Experts have united globally, calling for an end to chemical-based agriculture. Such chemicals are intrinsically dangerous.

Agribusiness has repurposed chemical warfare from World War 2 to attack our food sources. Risk mitigation has no place in agricultural production that relies on chemicals known to be detrimental to human and ecological health. Therefore, we call on the South African government to ensure the smooth transition towards a socially just and ecologically sustainable food system that considers South Africa's socio-economic, cultural, and ecological realities. It is in the government's power to transition South Africa's current, wholly inequitable agricultural and food system towards one that recognises and aligns with the rights enshrined in the South African constitution.

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Annexes

Annexure A: Pesticides that are banned or restricted for use in the Republic of South Africa

(Source: Steenhuisen, 2024. https://pmg.org.za/files/RNW1472-241108.docx)

AGRICULTURAL REMEDY	STATUS	REGULATION/REFERENCE DOCUMENT
Aldicarb	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Aldrin	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Arsenic	All uses of any inorganic arsenic-containing compound on plant material (except on citrus) were banned in 1983.	Government Notice No. R. 384 of 25 February 1983.
Atrazine	Withdrawn from use on heavy clay soils (Springbok Flats) in 1977. Industrial use was withdrawn on 31 March 1995.	Use is not supported, as per the label.
Azinphos-ethyl	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
BHC (mixture of various isomers)	Banned in 1983.	Government Notice No. R. 384 of 25 February 1983.
Binapacryl	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Camphechlor (CLC)	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Captafol	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Chlordane	Banned in 2005.	Government Notice No. R. 834 of 26 August 2005.
Chlordimeform	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Chlorobenzilate	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Chlorpyrifos	Banned for household and garden use in 2010.	Government Notice No. R. 375, of 14 May 2010.
2,4-D (dimethylamine salt)	Banned in parts of the magisterial districts of Camperdown, Pietermaritzburg and Richmond. Aerial application in Natal was banned in 1991.	Government Notice No. R 2370 of 27 September 1991.
2,4-D esters	Withdrawn from all agricultural uses in the Western Cape in 1980. Banned in Natal in 1991.	Use is not supported, as per the label. Government Notice No. R 2370 of 27 September 1991.

2,4-DB (sodium salt)	Banned in parts of the magisterial districts of Camperdown, Pietermaritzburg and Richmond. Aerial application in Natal was banned in 1991.	Government Notice No. R 2370 of 27 September 1991.
Dicamba	Banned in parts of the magisterial districts of Camperdown, Pietermaritzburg and Richmond. Aerial application in Natal was banned in 1991.	Government Notice No. R 2370 of 27 September 1991.
DDT (dichlor-diphenyltrichloroethane)	Banned in 1983.	Government Notice No. R. 384 of 25 February 1983. (Except for the control of malaria vectors by the government).
Dibromochloropropane	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Dieldrin	Banned in 1983.	Government Notice No. R. 384 of 25 February 1983.
Dinoseb	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Dinitro-ortho-cresol (DNOC)	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Endosulfan	Banned in 2012.	Government notice No. 853 of 26 Oc-tober 2012.
Endrin	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Gamma-BHC (lindane)	Banned in 2009.	Government Notice No. R. 592, of 29 May 2009.
Heptachlor	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Hexachlorobenzene	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Kepone	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Leptophos	Withdrawn in 1980.	Voluntarily withdrawn.
MCPA (dimethylamine salt)	Banned in parts of the magisterial districts of Camperdown, Pietermaritzburg and Richmond. Aerial application in Natal was banned in 1991.	Government Notice No. R 2370 of 27 September 1991.
MCPA (potassium salt)	Aerial application was banned in Natal in 1991.	Government Notice No. R 2370 of 27 September 1991.
MCPB (sodium salt)	Aerial application was banned in Natal in 1991.	Government Notice No. R 2370 of 27 September 1991.
Mercury compounds	Banned for use on seed, bulbs, tubers, stalks, or other vegetative matter in 1983.	Government Notice No. R 384 of 25 February 1983.
Methyl bromide	Withdrawn, expect for Critical Use Nomination, quarantine and pre-shipment applications only as from 31 March 2015.	Voluntarily withdrawn.
Monocrotophos	Banned in 2005.	Government Notice No. R 154 of 25 February 2005.
Nonylphenol and Nonylphenol ethoxylates (NPEs)	Withdrawn in 2010.	Voluntarily withdrawn.

Parathion	Withdrawn for use on deciduous fruit and vineyards in 1992. Withdrawn for use on beans, coffee, cotton, groundnuts, mangoes, and ornamentals, as well as for the control of short-horned grasshoppers on various crops in June 1993.	Use is not supported, as per the label.
Phosphamidon	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
Propham	Banned in 2016.	Government Notice No. 862, of 29 July 2016.
2,4,5-T	Withdrawn in 1989.	Voluntarily withdrawn.
Triclopyr	Aerial application in Natal was banned in 1991.	Government Notice No. R 2370 of 27 September 1991.
TDE (Tetrachlorodiphenylethane).	Withdrawn in 1970.	Voluntarily withdrawn.
Vinclozolin	Withdrawn in 1995.	Voluntarily withdrawn.

Annexure B: Pesticide formulations to be phased out that meet the criteria of carcinogenicity, mutagenicity, and reproductive (CMR) toxicity categories 1A or 1B of the Globally Harmonized System (GHS) of classification and labelling of chemicals

(Source: Steenhuisen, 2024. https://pmg.org.za/files/RNW1472-241108.docx)

ACTIVE INGREDIENT	TYPE	INTENDED USE
Arsenic acid	Fungicide	Wood preservative
Benomyl	Fungicide	Agriculture
Boric Acid /Borax	Fungicide	Wood preservative
Brodifacoum*	Rodenticide	Rodenticide
Calcium arsenate	Plant Growth Regulators	Agriculture
Carbendazim	Fungicide	Agriculture
Chlorthal-dimethyl	Herbicide	Agriculture
Chromium trioxide	Fungicide	Wood preservative
Coumatetralyl	Rodenticide	Rodenticide
Cyproconazole	Fungicide	Agriculture
Difenacoum	Rodenticide	Rodenticide
Dimethomorph*	Fungicide	Agriculture
Epoxiconazole*	Fungicide	Agriculture
Ethylene dibromide	Insecticide	Agriculture
Fluorochloridone	Herbicide	Agriculture
Flusilazole	Fungicide	Agriculture
Glufosinate-ammonium	Herbicide	Agriculture
Halosulfuron-methyl	Herbicide	Agriculture
Ipconazole	Fungicide	Agriculture
Linuron	Herbicide	Agriculture

Mancozeb*	Fungicide	Agriculture
Mineral oil (hydrotreated light paraffinic) *	Insecticide, Adjuvant	Agriculture
Propiconazole*	Fungicide	Agriculture
Quizalofop-P-tefuryl*	Herbicide	Agriculture
Spirodiclofen	Insecticide	Agriculture
Thiacloprid	Insecticide	Agriculture
Thiodicarb*	Insecticide	Agriculture
Topramezone	Herbicide	Agriculture
Triadimenol	Fungicide	Agriculture
*Applications for reclassification by some registration holders were submitted. Reclassification may be affected if some products may be banned.		

Annexure C: Pesticides scheduled for banning in November 2024

(Source: Steenhuisen, 2024. https://pmg.org.za/files/RNW1472-241108.docx)

ACTIVE INGREDIENT	TYPE	INTENDED USE
Chlorpyrifos	Insecticide	Agriculture
Cartap hydrochloride	Insecticide	Agriculture

Annexure D: Outline of glufosinate-ammonium GM crops in South Africa for general release

(Sources: DALRRD, n.d. GMO activities approved for general release under the genetically mod-ified organisms act 15, 1997 https://old.dalrrd.gov.za/doc/General%20Release%20Approvals%20%20_GMO%20Act%2015%201997.pdf [accessed February 2025] and ISAAA https://www.isaaa.org [accessed February 2025]

CROP	EVENT	YEAR APPROVED
Soybean	DAS 44406-6 (glufosinate, glyphosate and 2,4-D herbicide tol-erance)	2022
	DAS 81419-2 x DAS 44406 (glufosinate, glyphosate, and 2,4-D herbicide tolerance, lepidopteran insect resistance)	2022
Maize	Bt11 (Glufosinate herbicide tolerance, Lepidopteran insect resistance)	2003
	Bt11 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance)	2010
	Bt11 x MIR162 x MON89034 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance, mannose metabolism)	2021

Maize	Bt11 x MIR162 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance, mannose metabolism)	2021
	TC1507 (glufosinate herbicide tolerance, lepidopteran insect resistance)	2012
	TC1507 x MON 810 (glufosinate herbicide tolerance, lepidopteran insect resistance)	2014
	TC1507 x MON 810 x NK603 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance)	2014
	MON89034 x TC1507 x NK603 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance)	2018
	MON89034 x TC1507 x NK603 x DAS 40278-9 (glufosinate, glyphosate, and 2,4-D herbicide tolerance, lepidopteran insect resistance)	2019
	MON89034 x TC1507 x MIR162 x NK603 x DAS 40278-9 (glufosinate, glyphosate, and 2,4-D herbicide tolerance, lepidopteran insect resistance, mannose me-tabolism)	2023

Annexure E: Outline of glufosinate-ammonium GM crops in South Africa for commodity clearance

(Sources: DALRRD., n.d. GMO activities approved for commodity clearance under the genetical-ly modified organisms act 15, 1997. https://old.dalrrd.gov.za/doc/Commodity%20Clearance%20Approvals%20_GMO%20Act%2015%201997.pdf [accessed February 2025] and ISAAA., https://www.isaaa.org [accessed February 2025]

CROP	EVENT	YEAR APPROVED
Soybean	A2704 -12 (glufosinate herbicide tolerance)	2001
	DAS 44406-6 (glufosinate, glyphosate and 2,4-D herbicide tolerance)	2013
	DAS 68416-4 x MON 89788-1 Stacked HT (glufosinate, glyphosate and 2,4-D herbicide tolerance)	2016
	DAS 81419-2 (glufosinate herbicide tolerance and lepidopteran insect resistance)	2016
	DAS 81419-2 x DAS 44406 Stacked HT + IR (glufosinate, glyphosate, and 2,4-D herbicide tolerance, lepidopteran insect resistance)	2021
	MON 87708-9 x MON 89788-1 x A5547-127 Stacked HT (glufosinate, glyphosate and dicamba herbicide tolerance)	2018
Maize	Bt11 (glufosinate herbicide tolerance, lepidopteran insect resistance)	2002
	Bt11 x MIR162 x TC1507 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance, mannose metabolism)	2011

Maize	Bt11 x MIR162 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance, mannose metabolism)	2011
	Bt11 x MIR162 x MIR604 x GA21 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance, man-nose metabolism)	2011
	Bt11 x MIR604 x GA21 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance, man-nose metabolism)	2011
	Bt11 x MIR604 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance, man-nose metabolism)	2011
	Bt11 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance)	2011
	Bt11 x MIR162 x MIR604 x TC1507 x GA21 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance)	2014
	Bt11 x MIR604 x TC1507 x 5307 x GA21 (glufosinate and glyphosate herbicide tolerance, multiple insect resistance)	2014
	Bt11 x 59122 x MIR604 x TC1507 x GA21 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance, mannose metabolism)	2014
	Bt11 x MIR162 (glufosinate herbicide tolerance, lepidopteran insect resistance, mannose metabolism)	2015
	3272 x Bt11 x MIR604 x TC1507 x 5307 x GA21 (glufosinate and glyphosate herbicide tolerance, multiple insect resistance, modified alpha amylase, mannose metabolism)	2016
	Bt11 x TC1507 x GA21 (glufosinate and glyphosate herbicide toler-ance, lepidopteran insect resistance)	2016
	3272 x Bt11 x MIR604 x GA21 (glufosinate and glyphosate herbicide tolerance, coleopteran and lepidopteran insect resistance, modi-fied alpha amylase, mannose metabolism)	2016
	Bt11 x MIR162 x MON89034 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance)	2018
	Bt11 x MIR162 x MIMR604 x MON89034 x 5307 x GA21 (glufosinate and glyphosate herbicide tolerance, multiple insect resistance , mannose metabolism)	2018
	3272 x Bt11 x MIR162 x TC1507 x 5307 x MIR604 x GA21 (glufosinate and glyphosate herbicide tolerance, multiple insect resistance, modified alpha amylase, mannose metabolism)	2022
	3272 x Bt11 x MIR162 x GA21 (glufosinate and glyphosate herbicide tolerance, lepidopteran insect resistance, modified alpha amylase, mannose metabolism)	2023
	T25 (glufosinate herbicide tolerance, antibiotic resistance)	2001
	GA21 x T25 (glufosinate and glyphosate herbicide tolerance, antibiotic resistance)	2015

Maize	NK603 x T25 (glufosinate and glyphosate herbicide tolerance, antibiotic resistance)	2016
	NK603 x T25 x DAS 40278-9 (glufosinate, glyphosate and 2,4-D herbicide tolerance, antibiotic resistance)	2021
	DP 4114 (glufosinate herbicide tolerance, coleopteran and lepidopteran insect resistance)	2016
	DP202216 (glufosinate herbicide tolerance, enhanced photosynthesis)	2023
	DP202216 x NK603 x DAS 40278-9 (glufosinate-ammonium, glyphosate and 2,4-D herbicide tolerance, , Enhanced Photosynthesis/Yield)	2023
	MON87427 x MON89034 x TC1507 x MON87411x DAS59122 x MON87419 (glufosinate, glyphosate and 2,4-D herbicide tolerance, coleopteran and lepidopteran insect resistance)	2018
	MON87427 x MON89034 x MON87419 x NK603 (glufosinate, glyphosate and dicamba herbicide tolerance, lepidopteran insect resistance)	2018
	MON89034 x TC1507 x MIR162 x NK603 x DAS 40278-9 (glufosinate, glyphosate and 2,4-D herbicide tolerance, lepidopteran insect resistance, mannose metab-olism)	2020
	MON87427 x MON89034 x MON810 x MIR162 x MON87419 (glufosinate, glyphosate and dicamba herbicide tolerance, coleopteran and lepidopteran insect re-sistance, antibiotic resistance, mannose metabolism)	2020
	MON87427 x MON89034 x MIR162 x MON87419 x NK603 (glufosinate, glyphosate and dicamba herbicide tolerance, coleopteran and lepidopteran insect re-sistance, mannose metabolism)	2020
	MON87427 x MON87419 x NK603 (glufosinate, glyphosate and dicamba herbicide tolerance)	2020
Wheat	HB4 wheat (Drought stress tolerance)	2022

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