# Transgenic Florae: Frame of Mind an A Dilemmatical Sitch

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## Article Info

## Abstract

Throughout the history of mankind, we have developed more advanced techniques to cope with the challenges we face on the path of progression. It is no doubts that the most of problems are due to our greedy actions that ultimately led to a series of unforeseen consequences. One of them is the point of view on the use of genetically modified plants. The fact nowadays is that we may have been facing a very different scenario if these transgenic plants don't exist. Most of the world would've been starved to death by now due to the daily exponential increase in population. But the ethical and other concerns on the use of these plants are still a major hurdle in the path of development of these beneficial florae. This review summarizes the sum of possible problems and major situations related to transgenic plants according to modern research.

## INTRODUCTION

Modern biotechnology made it possible to transfer genetic material far efficiently that was thought impossible a couple of decades ago by using outdated conventional breeding techniques. The organisms that came into existence by this genetic material transfer process are called Genetically Modified Organisms (GMO's). These modified plants are enhanced in a manner that they show one way or other desirable characteristics of phenotype out in the field. This has been made possible because of the gradual technological evolution of old scientific equipment and techniques. Utilizing this technology, most of the crops produced in Mexico fields are transgenic. Furthermore, Mexico is the centralized station for all the crop origination economically so the record maintenance is necessary for the framework of action to remain balanced. The state also has very precise biosafety regulation procedures in action to keep a track of all the exported products that are approved by the FDA in advance. That's how they're protecting their plant diversity by utilizing strict regulation procedures between transgenic and wild type natural reserves. **(Garcia Ruiz, M. T.,** *et al.* **2018).**

GMOs may have their perks but the risk assessment of these organisms is a major concern based on several factors when they're released out in the environment. This assessment is considered crucial because of the unexpected environmental consequences posed by these modified varieties. They may alter and interfere with the naturally present wild type varieties. That's the reason why we must ensure that when these organisms are made free in the environment they do not disturb the environment or impact in any kind of way in human life. **(Khan, M. S.,** *et al.* **2016).**
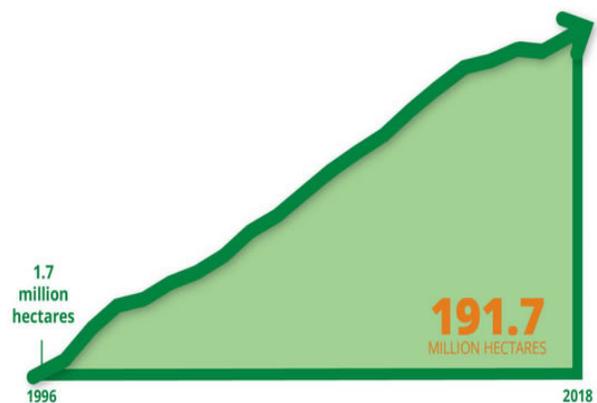


**Figure 1.** Global Area of Biotech Crops, 1996 to 2018. (ISAAA, 2018)

## Ecological Stability of Transgenic Plants

The modern process of genetic engineering allows us to transfer the genetic material extracted from any specie into plants genome to produce a particular phenotype. There are several examples of these like in most transgenic plants the character of weed resistance is a major modifi-

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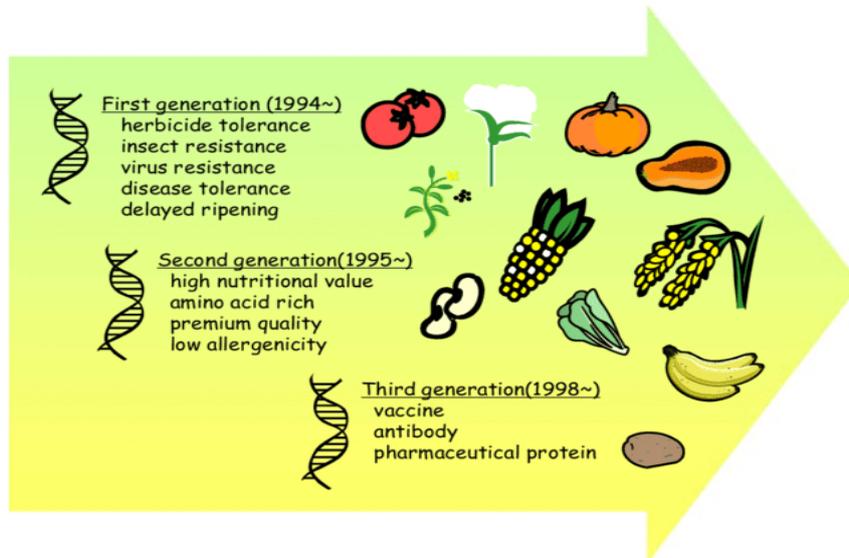
**Figure 2.** Generations of genetically modified plants. The traits of each generation are shown. **(Sakakibara, K.,** *et al.* **2006)**
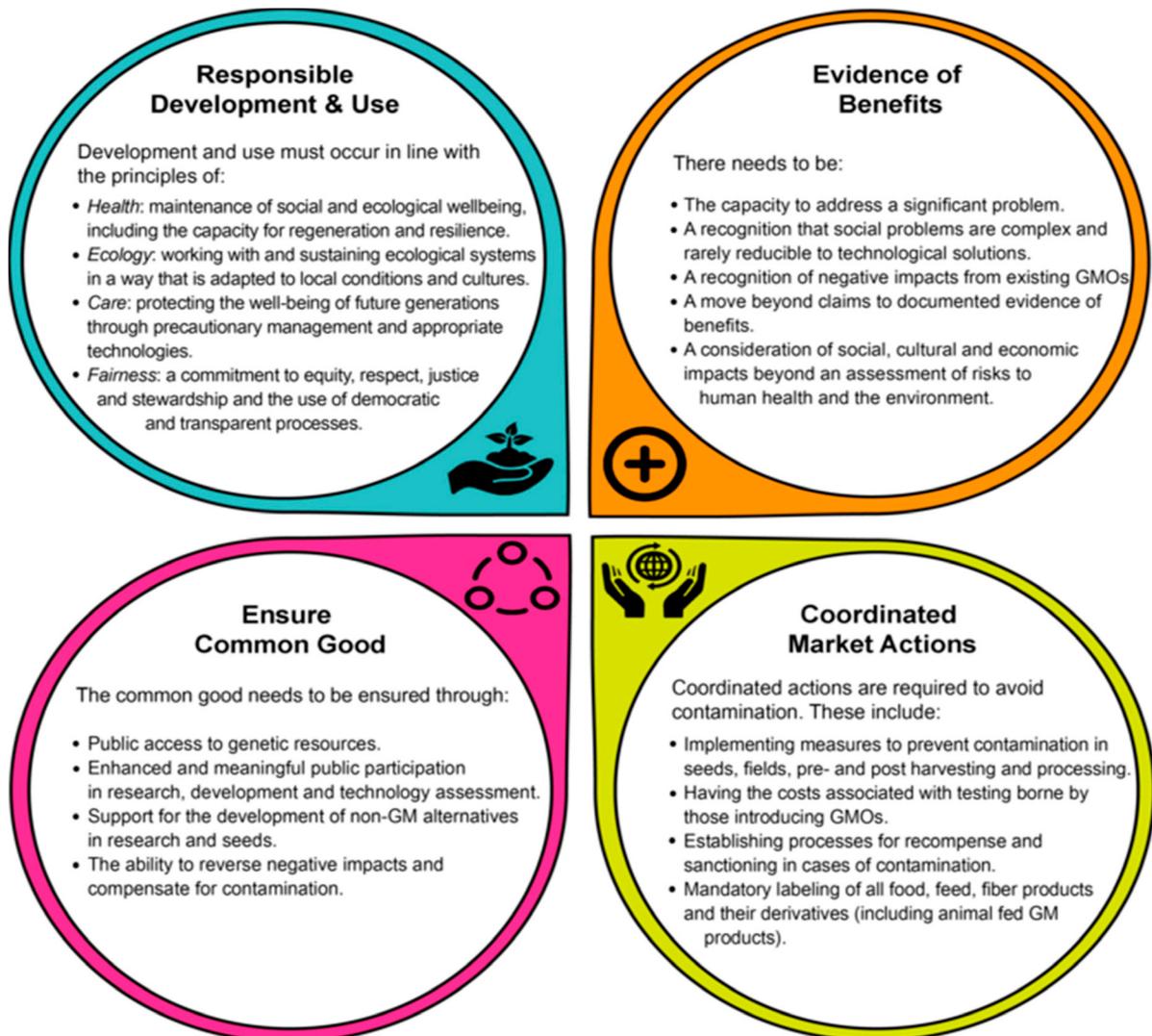


**Figure 3.** Summary of IFOAM requirements for GMOs. **(Wickson, F.,** *et al.* **2016)**

cation to protect the crop from harmful weeds. Similarly, insect resistance is another most common character to be found in modern-day genetic varieties.

However, the overall gene expression of plants can be modified by using a single unit change in the genome but this may result in unexpected outcomes and these outcomes can't be easily predicted even by using modern-day computational prediction analysis. DNA sequences in the genome can be altered by the processes of deletion, insertion, or by rearranging the whole DNA sequence. But these modifications have their risks like the genome instability or the interference phenomenon that involves automatic unintended alteration of other gene functions. The probable risks that may have a major concern are enlisted by World Conservation Union in 2004 which include whole native genome contamination, competition with wild types naturally occurring species, ecosystem alterations, inauspicious effects, deep-rooted effects, ecosystem aftermath, ethical concerns, substantial elimination due to adaptability process as well as horizontal allele transfers. Furthermore, there are some unexpected indirect effects like the action of GMOs on non-target hosts as well as with the main target hosts. One of the best studies on this indirect effect was made on the Monarch Butterfly decline tragedy induce by Cry1Ab gene modification acquired by *Bacillus thuringiensis* into genetically modified maize species. Monarch Butterfly larvae were very sensitive to a proper threshold concentration of CryA1b protein produces by maize Bt modified pollen in fields that eventually result in a decline in the overall population of the rare Monarch butterfly. **(Prakash, D., *et al.* 2011).** Similarly, Bt transgenic rice was another concern to the naturally existing wild type varieties of rice. Through regular observation interaction of several generations of GM plants with wild type mice, the transgenic ones were pushing the wild type out of the competition due to their better adaptation and survival capabilities. In general terms, this co-existence result in non-target action toward normal wild type rice.

## Whole Native Genome Contamination

This type of genetic contamination in the environment arises when the GMOs are deployed in a population with sexually compatible relatives. The next-generation hybrids that came into being will have a mutated hybrid genome of both the naturally existing wild type as well as the genetically modified type. These types of contaminations are usually irreversible and can take plenty of approaches to minimize the overall contamination. Similarly, if the resulting hybrid is dominant then it can change the whole native species requirement of proper and specific habitat as well as behavior toward pray and other factors of the environment. That's the reason this type of contamination is mostly avoided. The best example we can have here is of *Cercocarpus traskiae* plant species on the coast of California. These were native to the Catalina Islands on the coast but become endangered just because of the simple contamination and *Cercocarpus betuloides* hybrids that were produced are dominant and now occupy the whole island. **(Levin, D.A., *et al.* 1996).**

## GMOs Vs. Wild Types (Ecosystem Alterations)

The GMOs will have a lad in terms of better adaptations and survival in the environment than the natural wild types species of the ecosystem. This will eventually alter the balance of the ecosystem in such a way that as the time passes by the GMOs will eliminate the corresponding specie to a level of extinction and this damage won't be reversible after the critical point. The critical point is termed as that point where two competitive species exist in the environment at an equilibrium state. Recent studies have found that some of these transgenic plants affect the population of Rhizosphere residents i.e., Rhizobacteria. These bacterial species have become an indicator of the effect of GM plants on the chemistry of the soil. **(Filion, M., 2008).**

## Deep-Rooted Effects

The changes produced by GMOs are highly irreversible. This proves the long-term effects they have on the ecosystems or the habitat of other wild type species. For example, these newly introduced varieties may change the soil nutrient composition in such a way that it may become impossible for other wild types to grow in such a habitat. They may produce those compounds that are toxic to naturally existing types and in turn, may harm them and make their survival impossible. ERA or environmental risk assessment procedures are applied universally to keep an eye on all of these factors that are morphing due to the effects caused by GM plants on the soil. **(Wolt, J. D., *et al.* 2010).**

## Ethical Concerns

After the first introduction of FDA approved GM crops in the market, the topic of ethical concerns is still on the top. People have formed prejudices against these modified corps by using arguments like these products aren't as effective as the naturally occurring species, the contamination to natural environment problem as well as the health hazards related to these crops. But in-fact these crops are modified according to the needs of humanity and are more notorious than natural crops ever could be. **(Rastogi, V. S., 2013).**

Despite the confirmation by utilization of all the techniques that involve disciplines like proteomics, nutrigenomics, and genomic analysis bio-safety concerns casualties are still on the radar of ethical safety assessment. However, there are some threshold values of the ecosystem that define the extent of damage posed by any abnormal change in the factors that define the integrity of the ecosystem. EFSA of Europe has introduced a concept of Concern Limits of an ecosystem that is a really good measure to predict the response of ecosystem-based on the magnitude of the stimulus of change produced by the deployment of enhanced varieties in the habitat. This specific approach is considered highly feasible when dealing with a complex type of ecosystem. It's like solving problems with different individual parts and giving each part the proper concentration it needs from time to time and under the supply of technological resources. One of the major advantages is the time required to map the ecosystem. **(Dolezel, M., *et al.* 2017).**
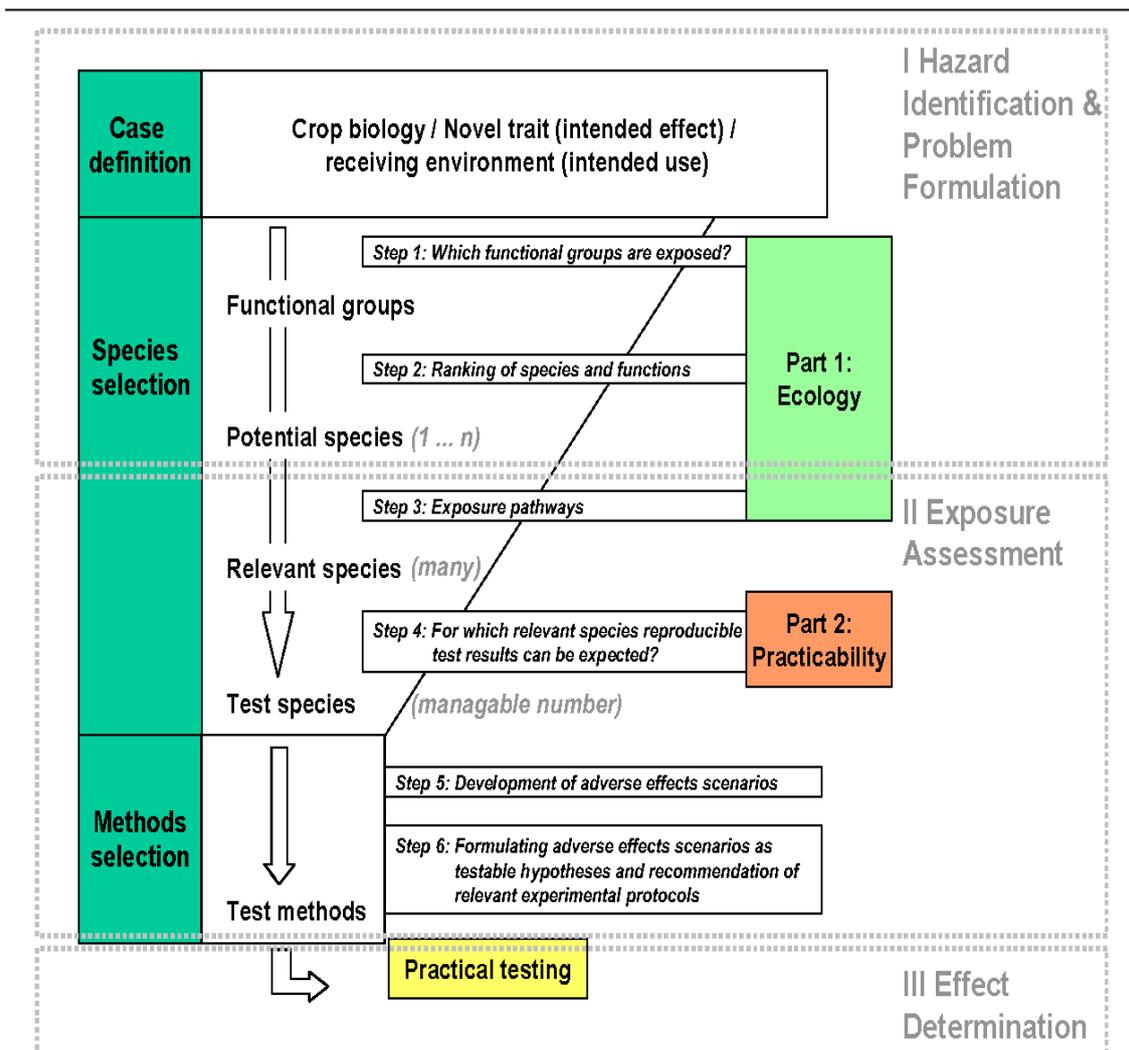
**Figure 4.** Scheme for the selection of testing species and developing relevant testing protocols. **(Hilbeck, A., et al. 2011)**

When the quantities of microelements in transgenic plants were put against the in naturally existing varieties, the obtained results were astounding. The level of microelements quantities in transgenic was health-friendly than that of normal wild type naturally occurring varieties. These studies prove the health friendliness of all the GM food corps. **(Yu, X., et al. 2018).** The same case is with GM modifies animal feed. On average, 80% of all the GM biomass is used as a general feed for Ruminants and other types of animals of the same category. But same concerns arise like when animal feed contain these GM corps, this maneuver harms the health of both animals that are feeding on it and human that eventually feed on that animal's mass. **(Giraldo, P. A., et al. 2019).**

In a similar modern approach, plants derived vaccines were of high ethical concerns between people despite its cost-effectiveness and several other advantages than a normally produces conventional vaccine. It was thought that this type of vaccine can produce a condition called Autism in kids who are administered with especially plant derive vaccines. Furthermore, countless other myths still reside in people's minds due to the prejudices against GM organisms. **(Guan, Z. J., et al. 2013). (Sánchez, M. A., et al. 2017).**

**Inauspicious Effects**

These GM crops may alter the natural course of pathogens, insects, and pests by gene transfer mechanisms. These types of gene transfers may have very adverse effects on the environment. Gene recipients may become resistant to chemicals we use for their elimination from the field. In this case, a more extensive type of research will be required for their removal. The most advanced type of research in this field is RNAi or RNA Interference mechanism to induce pests and insect resistance in plants. For example, *Planococcus citri* is a very common stem-hugger and phloem-feeder. By this nutrient sucking phenomenon, it significantly affects the crop quality and eventually effects the overall yield as compared to the normal yield. *Nicotiana benthamiana* is one of the victims of this cotton mealybug. When RNAi based Tobacco Mosaic Virus (TMV) was used to infect these plants, the phloem feeders die as a result of feeding on RNAi modified strain of TMV. **(Khan, A. M., et al. 2013).**

**Ecosystem Aftermath**

We have already seen the disastrous effects of GMOs on the factors that sustain an ecosystem. Furthermore, these impacts on the environment may expand
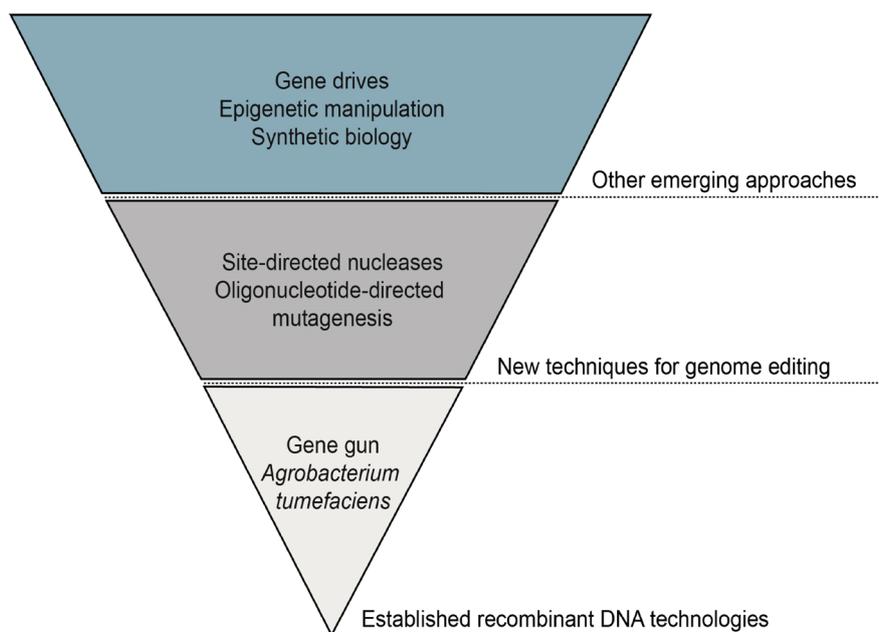
**Figure 5.** The development of tools for genetic modification. **(Wickson, F., *et al.* 2016)**

beyond the boundary of the ecosystem. The adaptation and survival ability make GMOs capable of entering other neighbor ecosystems and modify their habitats according to their requirements. In short, words, if we don't control the expansion, will grow their roots like cancer into the body of the ecosystem. In these cases, the SNP analysis between different mutants is performed to assess the extent or magnitude of damage and mutation over several courses of generation. **(Anderson, J. E., *et al.* 2016).** On the other hand, some researches and studies also show the toxic compounds that were naturally produced by wild type naturally existing varieties of plants like lectins, peptides, as well as other pore-forming toxins, have no competition against the GM modified plants. This resistance opens another door for the successful proliferation of GM plants in occupying the ecosystem. **(Dang, L., *et al.* 2015).**

**Substantial Elimination Conjecture**

After the invasion of GMOs on the ecosystem, the next major problem is the control and removal of all these hybrids. As we can assume, this is a very substantial process and require a great deal of research on the expansion behavior of hybrids and eventually contain them within a defined niche. Then, finally, the load on the environment or in short the environmental stress will be released. **(Dhillon S. S., 2004).** One of the best perspectives on these kinds of problems is to think about the single-unit level of species. Once we have completed enough research on the core specie that is causing the bloom to push the ecosystem sustainability to its edges, then we can deal with it as easily as to join simple pieces of the puzzle. But there's always a remainder defect in the equation that render the whole scenario incomplete. In short, we can't be sure that the elimination is 100% due to the deep unseen roots of specie in the ecosystem during the time of its bloom or expansion. The major case we can see is of secondary hybrids production that is difficult to identify due to their better survival capabilities

as compared to their parent generation. In that scenario, the case-by-case study of every single and minute factor that may help to control the population of hybrids will be necessary to be involved in every interventional approach of control. The competition can be more severe based on the type of enhancements made to the original parent species. For example, nowadays researchers are modifying all the plants to withstand the environmental stresses and can morph into those forms that'll help them to gain maximum advantage from the environment and enhanced protection and tolerance against the overall abiotic stresses of the environment. They may also develop reproductive characteristics in a scenario of danger to the parent specie that is the precursor of their whole progeny. **(Eckerstorfer, M. F., 2019).**

**Appraisal Of Potential Risks**

The overall assessment of every potential risk is highly necessary because GMOs may result in those kinds of situations that may be unavoidable later due to poor initial assessment. Good quality and quantity of all the GMO products depend upon these appraisals that are completed at the start of every process of GMO release. This will eventually end in better remodeling that this crucial for extracting the maximum amount of benefits in less time. **(Key, S., *et al.* 2008).** All of these assessments of risks are managed by the International Plant Protection Convention (IPPC). It is based on several approach criteria that extensively utilize statistical data analysis, assessment of all the protocols information of a GMO, audit of final results as well as involves all the research from national and international relevant centers. **(Karalis, D. T., *et al.* 2020).** When a GMO is released into the environment, the number of possibilities of risk is infinite based on considering all the factors. But most of them have a very low probability as compared to the major and normally observable risks. This is the reason we need several understandable appraisals to map the ove-
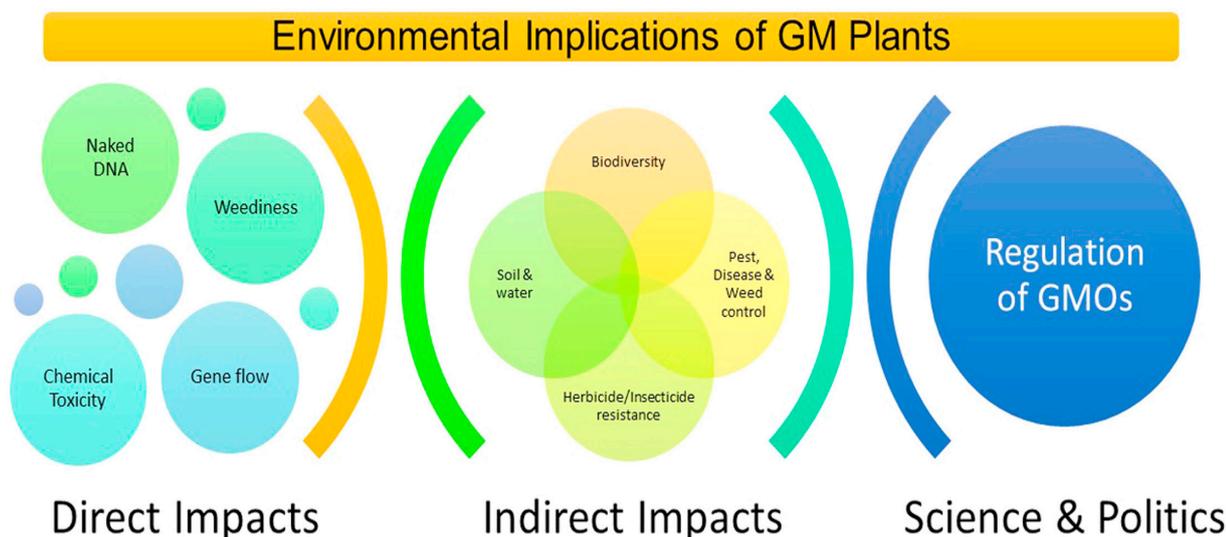
**Figure 6.** Environmental Implications of GM Plants. **(Tsatsakis, A.,** *et al.* **2017)**

rall situation. **(Prakash, D.,** *et al.* **2011).**

Man has discovered the ways of conventional artificial breeding recordings 10,000 years back in the past. Since then, the techniques evolved vigorously in a minute time of decades as compared to thousands of years. Nowadays, GMOs ' food use increasing at an annual rate of about 9.92% which shows the adhesion of people toward better and sustainable technology. Alongside these advancements and breakthroughs, controversial researches and events are still in the way as always. One of the worst incidents reported in history was 2012's Seralini affair that progressed to the partial ban on the use of GMOs in several countries. **(Raman, R., 2017).** Anyhow, we know that the food-related casualties will eventually increase due to the problem of population blooms all over the world. It is already estimated by several researchers that the population of Earth will increase up-to an approximation of a staggering 9 Billion people. This much stress will push agriculture to its peak alongside with of course other consequences. So, to keep up the pace, our only option will be the extensive use of GM crops and foods. Otherwise, everything will ultimately end in jeopardy and anarchy. **(Oliver, M. J., 2014).**

## Menace Administration

Ethical, sociological, and economical types of iterations in the equation of management of potential risks are always considered pivotal. An overall balanced framework based on all these aspects must be deployed to deal with all the possible casualties. An ideal framework includes the following qualities of management. Utilization and development of all the available innovatory technology and equipment, ultimate decision-making power, sharp initial efforts with effective biosafety protocols. Alongside with all of these factors, the political influence is in the way of proper management as always. This specific type of influence ultimately produces biasedness and defects in decision making power at the end of the appraisals. One crucial key point of all these processes is that some of the most important and secret information is kept confidential due to reason like it can produce anarchy and dispersion in public. Such mat-

ters are handled by keeping the overall process under the radar and it is a good measure to do the good but quietly. **(Prakash, D.,** *et al.* **2011).** The assumption analysis is another-way of obtaining results of an intervention when we are dealing with a multi specie model of ecosystems. It has been proved that multi-specie assumption analysis generates better and explainable results than by using normal and conventional techniques. The results can be further processed based on the percentage deviation from the ideal graph line they are showing. **(Rocca, E.,** *et al.* **2017).** One of the main hindrances is the way is the diverging point of views of both political parties and societal groups. To be more and more productive in our agricultural evolution techniques, everyone should put more emphasis on humanity's common values and goals. Otherwise, we should always prepare for unforeseen consequences. **(Lucht J. M., 2015).**

## Merits And Demerits

Researchers are working on those types of GM plants that have an innate ability to prevent its consumer from that disease. One of the best examples we can take here is GM Banana. These genomes of type of fruits have been modified in such a way that when they mature, they produce natural vaccines as a product from their cells. It is a very interesting concept by far but still in research due to some research and technological limits. Similarly, some vegetables are enhanced with their natural property of the antioxidant formation. This concept is based on the potent action of antioxidants in the prevention of several types of cancers. Computational analysis of these antioxidant interactions with cancer cells supports this concept. On the downside, some studies show that by constantly utilizing GM foods, one can develop those diseases that are immune to all present antibiotics. These types of studies have very little proof of their assumptions yet we can conclude one thing for sure that these GM foods are new to us and there is not enough time for us to observe their long-term effects on the human body. This observational researches can take a couple of decades. **(Bawa, A. S.,** *et al.* **2013).** One of the less-studied phenomena that cause several problems with

- New traits : multiple stresses; new diseases; root architecture …
- Modelling and optimisation to define ideotypes
- High throughput PF

New trait assessment

Screening of genetic resources

Mapping gene/QTL

- Access to wild relatives and genetic resources
- SNP availability : SNP array, GBS, resequenced genomes
- QTL mapping/GWAS

- Marker assisted-selection
- Genomic selection
- Gene editing

Manipulation of candidate gene

Gene/allele discovery

- Fine mapping
- Map-based cloning
- MBS/QTL seq
- RNAseq/proteome
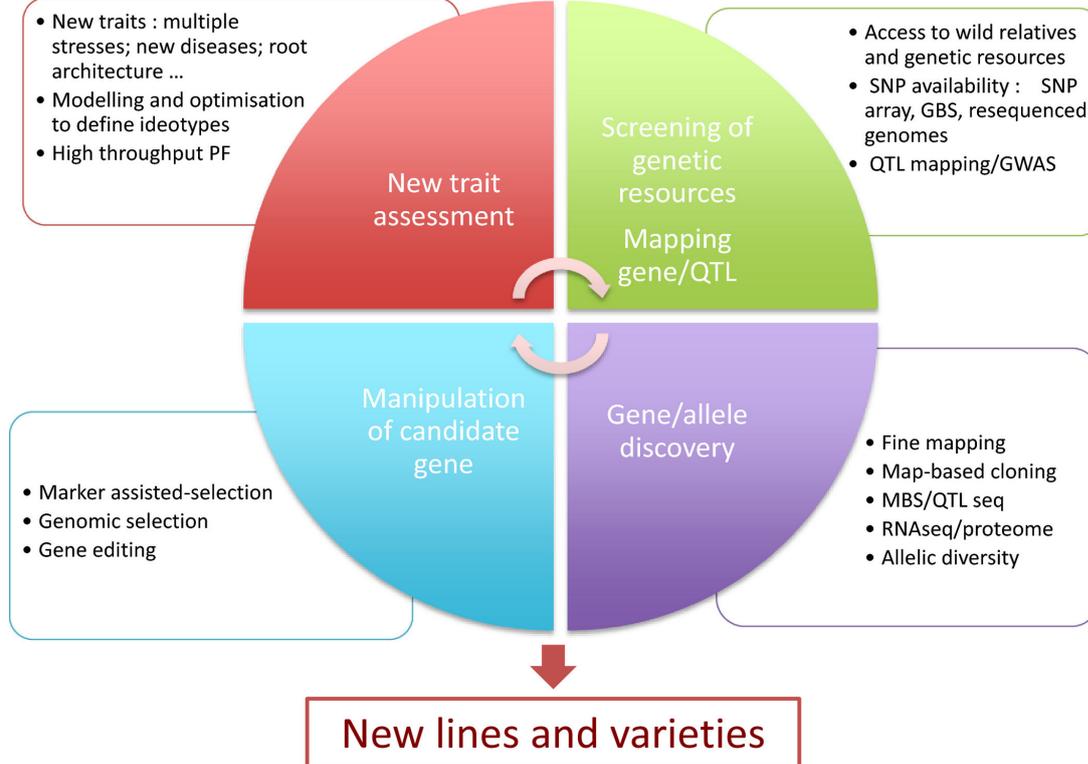- Allelic diversity

New lines and varieties

**Figure 7.** General strategy to breed a new trait of interest. (**Rothan, C.,** *et al.* **2018**)

plant genome while enhancing and modifying them by utilizing genetic engineering is Pleiotropy. As we already know that it is the effect of a single gene whether it is entered as a transgene or pre-existing one in the genome affects multiple traits and phenotypes expressed by other genes on the plant. The overall consequences of pleiotropy may be positive or negative yet there are a lot of factors that researchers have to deal with while developing a GM plant. One of the best examples of pleiotropic interaction we can take here is of the most common crop of *Triticum aestivum.* There is a gene on the location termed as the *Lr34* gene that is responsible for the transfer of metabolites through membranes in the cells through different diverse pathways of a unified metabolism.

The main region of that specific gene location encodes a transporter termed as ABC transporter that controls the overall migration process of these metabolites. These specific alternative pathways of metabolites provide a barrier to several wheat diseases. Surprisingly, it has a negative effect on the aging process of plant leaf when the overcrop isn't affected by the disease. It means that if the proper threshold of diseases isn't present on the modified GM wheat then it'll have negative consequences and effects on the over yield of the crop. Similarly, the consequences were even worse when this gene is transferred to the genome of other crops causing sterility and very poor growth over the normal phases of development. Furthermore, these unsought circumstances can be avoided if researchers have enough knowledge in the database of proteomics and genomics that gives them ultimate control over the prediction of protein-encoding mechanisms and probabilities followed by genes. (**Mueller, S., 2019**). One the other there is a well-known phenomenon of Soma-Clonal Variations (SCV). In these modern methods, epigenetic enhancements in plant tissues that are in pre-developmental phra-

ses are introduced. These enhancements trigger those kinds of mutations that are unpredictable and so are novel. These methodologies have been applied to crops like barley to increase malting quality. Normal wild type barley produces very poor quality during the malting process with annual losses of about 50% overall yields.

New SCV modifies barley, on the other hand, produces superior quality marks with a very low percentage of reported annual losses in yield. Anyhow, the overall prediction of whether pleiotropy occurs or not and whether SCV enhancements produce positive novel changes depends upon the technological boundaries in metabolomics' prediction analysis of gene protein-encoding mechanisms. The reason why we have a high uncertainty rate in predictions is because of the limitations of modern technology that are still in the phase of everlasting development. To produce more consistent results, we should focus on the accuracy of the magnitude of all the factors involved. (**Ladics, G. S., et al. 2015**).

The type of risk assessments that are specific to the case holds and accounts for the following elements as crucial in their procedure deployment.

i. Natural characteristics of the modified trait.
ii. Clear hazards enlisted that are possible as a result of modification introduced.
iii. Recently collected data from the modification.
iv. Molecular differentiation of the genome.
v. Any modification that wasn't present in the pre-planned modification record.
vi. A modification that is away from the target and may result in severe phenotypic abnormalities.
vii. Phenotypic characters differentiation for aftermath assessment.

All of these safety assessment protocols if followed properly will leave very low margins or percentage of er-
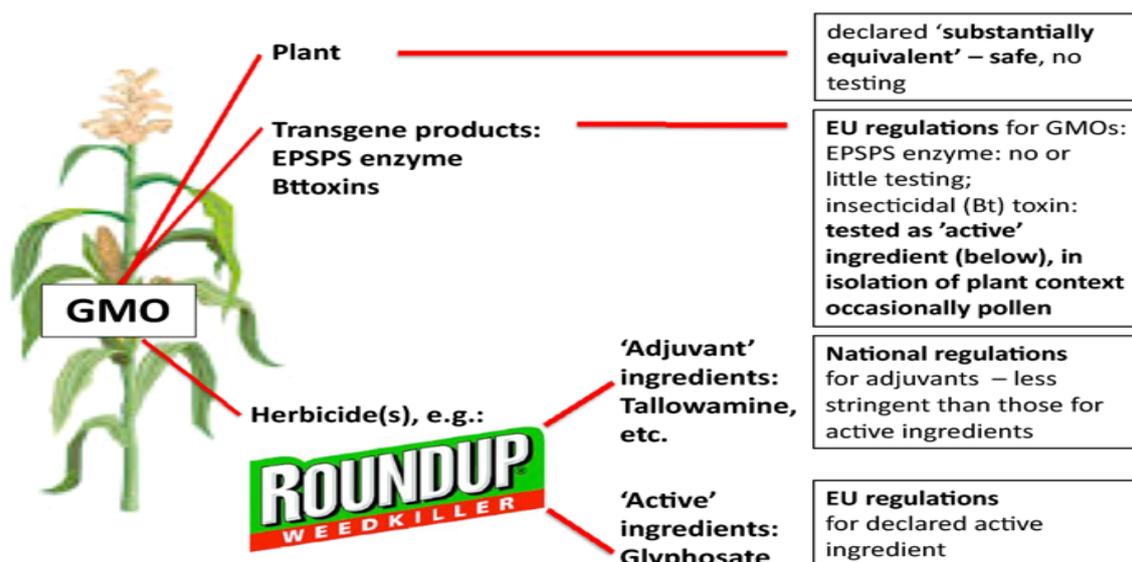
**Figure 8.** Reductionism in the environmental risk assessment of GM crops (e.g., HT and Bt): GM HT Bt plant package divided into individual components, assessed in isolation from each other under different national and EU regulations. **(Hilbeck, A., *et al.* 2020)**

ror that could have been present if not followed. Once this assessment is complete all of the other protocols and procedures can be applied to generate statistical analysis result data that'll eventually help in drawing suitable and effective conclusions.

## CONCLUSIONS

Humans have evolved exponentially since the last ice age and we have tackled many of our problems very efficiently through gradual evolution. Talking of GMOs, there are numerous discoveries and inventions are lying ahead in the way of future development. GM crops have shown highly promising results to deal with worldwide malnutrition as well as world hunger. Melinda-Gates foundation is constantly supporting those organizations that are facing financial problems in the way of their research. This foundation is also funding to tackle the major food famine in Africa is constantly evolving in the past recent years and effecting millions of African families. Alongside these, several other supporting organizations are constantly funding the research hoping to see promising results in the future. As the time is passing by, more and more novel methods of treating the problems from a different angle are emerging and all of these feats and innovations that we have achieved today weren't possible if the researchers and scientists do not have performed their duty with love and passion. One thing that has to be changed for a foreseeable future is the public perception of GMOs. Once we have achieved this victory than local, national, and international participation will boost the overall research towards the solution of humanity's problems by several folds.

Though scientific and public ways of perception about genetic engineering are very divergent yet from overall observation we all can see that genetic engineering is the future of food management all over the world. The public may have its concerns with GM organisms but scientists and researchers have to contemplate not only the concerns of a small group of people that are creating dispersion but

about the conditions arising from an ever-increasing population of the world. If further concerns may sprout in the future then the case-by-case study of all the possible casualties caused by stumbling blocks in the way will eventually help.

## CONFLICTS OF INTEREST STATEMENT

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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