Chapter

Biosafety Aspects of Genetically Modified Crops

Ashutosh Kumar, Banshidhar, Priyanka Jaiswal and Harmeet Singh Janeja

Abstract

With the advancement in the field of agricultural biotechnology, many genetically modified crops like Bt- cotton, Bt- brinjal have been developed and commercialised to fulfil the need of the world population. Several biosafety concerns viz., risk to human health, risk to environment, ecological concern o has been raised after the rapid commercialization of GM crops every year across the world. As per Convention on biodiversity (CBD), Biosafety is a term used to describe efforts to reduce and eliminate the potential risk resulting from biotechnology and its product. Though many concerns being raised time to time, strict biosafety guideline must be followed before introducing a GM crop in public domain especially in resource poor developing countries.

Keywords: biosafety, GMO, Bt-cotton, CBD, health risk

1. Introduction

GM crops are one of the noble invention of 21st century that holds a good promise for better survival of humanity. These crops are developed through genetic engineering by altering the genetic make-up of the crops for enriching it with one or several economically important traits such as improved quality traits, reduction in anti-nutritional factors, herbicide tolerance, resistance to various biotic and abiotic stresses, etc. The GM crops have helped mankind to stand against various challenges arising out of high population growth, biodiversity loss and climate change but the process following which these crops have been developed may posed serious threat to the biodiversity which serve as the repository of raw materials for various biotechnological applications ranging from improved and processed foods, fibres and fuels, noble medicines and drugs, enzymes, etc. thus it is imperative that the biodiversity must be preserved satisfactorily to fully exploit the potential of this indispensable technology. In recent times, Biotechnological tool such as genetic engineering and recombinant DNA technology has proved its worth in achieving the sustainable development goals and enjoyed a great potential to mitigate the impact of climate change as well and opened new avenues for climate smart agriculture. However, while doing so we must take care of the ultimate stakeholder whether for the biodiversity or the technology i.e. the human beings and its environment. Fulfilling all these contradictory demands concurrently requires an elaborative and exhaustive framework involving robust protocols regarding safe designing, production, handling and transfer of GM crops. Keeping this in view, a series of meeting were held internationally to discuss the possible innovation or strategies to reduce the ill-effects

of these technological interventions and to develop effective strategies for conservation and preservation of biological resources. One of the practical outcome of these discussion fruits in form of "The Cartagena Protocol on Biosafety, 2000" [1, 2].

2. The Cartagena protocol on biosafety

The Cartagena Protocol on Biosafety (CPB) was adopted on 29 January 2000 in Montreal with the holistic approach to addresses the probable threats from the transfer, handling and use of living modified organisms (LMOs) under the umbrella of Convention on Biological Diversity, 1992 (**Figure 1**).

The term "Biosafety" describes the principles, procedures and policies to be adopted to ensure the environmental and personal safety. The convention directs its Contracting Party to take appropriate measures to regulate, manage or control the risks that may arise due to use and handling of LMOs that may pose some threats to biological and to ensure the safe handling, transport and use of LMOs. Recognising the need of biosafety in genetic engineering research, the Cartagena Protocol on Biosafety (CPB) was adopted with the following objectives:

1. To set up the procedures for safe trans-boundary movement of LMOs.

2. To harmonise principles and methodology for risk assessment and establish a mechanism for information sharing through the Biosafety Clearing House (BCH) [3, 4].

2.1 Guidelines of CPB

The CPB promotes biosafety through well-defined guidelines for the safe transfer, handling and use of LMOs or GMOs, with a specific focus on regulating transboundary movements of these organisms. These guidelines ensure comprehensive information to take decisions on scientifically sound risk assessments and on the precautionary approach in use of LMOs and/or GMOs.

2.2 India's initiative on biosafety

In India, Ministry of Environment & Forests (MoEF) plays the role of the nodal ministry for implementation of Cartagena Protocol and undertakes several initiatives to meet its obligations to the Protocol. It also organised various capacity building programmes to strengthen of the regulatory framework, particularly on transboundary movement of LMOs or genetically modified organisms, risk assessment and its management, training and human resource development and information sharing.

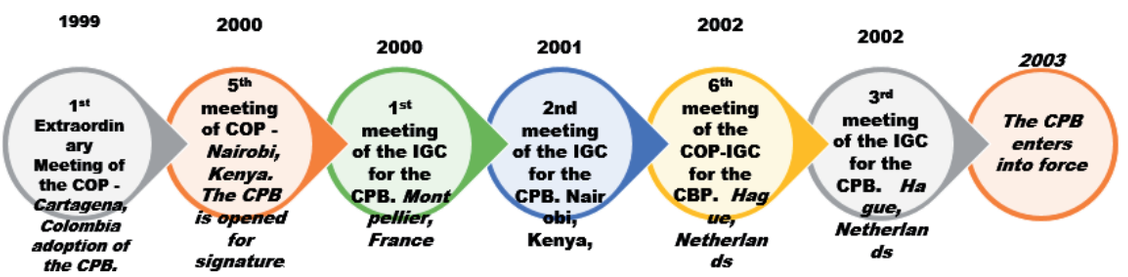


Figure 1.
Timeline of "The Cartagena Protocol on Biosafety". Key: COP: Conference of the parties; CPB: Cartagena protocol on biosafety; IGC: Intergovernmental committee.

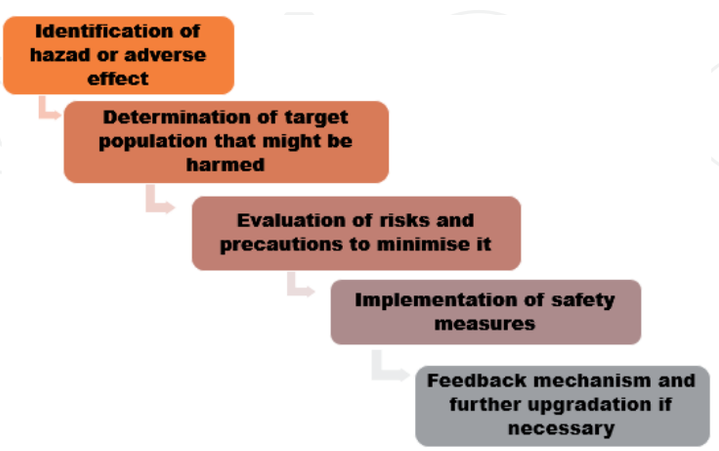
Authorities for implementation of regulations and guidelines in the country [5]

1. Recombinant DNA Advisory Committee (RDAC)
2. Review Committee of Genetic Manipulation (RCGM)
3. Genetic Engineering Approval Committee (GEAC)
4. Institutional Biosafety Committees (IBSC)
5. State Biosafety Coordination Committees (SBCC)
6. District Level Committees (DLC)

3. Risk assessment of GM crops

Risk assessment identifies potential hazards and/or adverse impacts of GM crops or derived product on non-target organisms and/or environment. This involves a number of coordinated steps like risk identification, risk characterisation and risk categorisation. The first and foremost practice i.e. risk identification involves identification of risk or possible hazard to the non-target species or the environment, if any, associated with release and use of transgenic or GM crops and associated products. This is followed by overall characterisation of risk i.e., whether its effect are direct or indirect, chronic or acute, immediate or delayed in action, etc. Finally, risk categorisation is done which involvves grouping of identified and well characterised risk under various categories *viz*., negative health effects on target population; adverse effect on non-target population, the evolution of resistance or resurgence in the targeted pest/pathogen population, flow of transgene to another species, etc. In the process of risk assessment if a potential risk is identified the appropriate measures are taken for its management .

3.1 Steps of risk assessment



4. Risk management in use of GM crops

Risk management involves strategic techniques to reduce the adverse effect of GM crops and associated products on non-target species or environment and also to reduce the chances of development of resistance in target pest population. Several

tactics *viz*. application of alternate or mix insecticides with different modes of action or use of refuge strategy could be effectively employed to minimise the risk of development of insecticidal resistance in insects. These techniques are also helpful in avoiding the problem of resurgence in insects. In Bt crops newer techniques *viz*. use of alternate or combined Bt toxin or refuge strategy are much rewarding in management of resistance. Similarly, weeds could develop resistance in them following various mechanism *viz*. modified site of action, detoxification and compartmentalisation. By doing so they rendered the herbicides or weedicides ineffective against them in long run. Thus, to minimise or to prevent the risk of development of herbicide resistant in weeds and evolution of super weed various techniques have been utilised. Rotation of herbicides or using them in combination effectively reduces chances of development of resistance against herbicides in weeds. Crop rotation is another technique that could be used to reduce this risk [6].

5. Conclusion

Modern advances in biotechnology has revolutionalised the way of living particularly in meeting the requirement of food, fodder, fibre and fuel by use of GM crops. However, a group of social activist and environmentalists are always in against of the use of GM crops because of its unprecedented effects on ecosystem and human health. Thus, a scientific debate has been continued for a long time in which the favouring statements are made based on risk assessment and its consecutive management as per the norms and protocols. In addition to this a number of initiatives have already been taken by national as well as international agencies to ensure safety measures in use, handling and transfer of these GM crops. Thus, basically these crops can be commercialised in public domain with adequate care following the defined biosafety measures.

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References

[1] Bawa AS, Anilakumar KR. Genetically modified foods: Safety, risks and public concerns—A review. Journal of Food Science and Technology. 2013;**50**(6):1035-1046

[2] Hilbeck A, Meier M, Römbke J, Jänsch S, Teichmann H, Tappeser B. Environmental risk assessment of genetically modified plants-concepts and controversies. Environmental Sciences Europe. 2011;**23**(1):1-12

[3] https://www.cbd.int/doc/publications/bs-brochure-02-en.pdf

[4] https://www.icgeb.org/wp-content/uploads/2019/01/2-The-Cartagena-Protocol-on-Biosafety-Julian-Kinderlerer.pdf

[5] https://ibkp.dbtindia.gov.in/DBT_Content_Test/CMS/Guidelines/20181115134719867_Regulations-Guidelines-for-Reocminant-DNA-Research-and-Biocontainment-2017.pdf

[6] Prakash D, Verma S, Bhatia R, Tiwary BN. Risks and precautions of genetically modified organisms. In: International Scholarly Research Notices. 2011