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COMMERCIALIZATION OF GM CROPS: A THREAT TO THE ENVIRONMENT SAFETY AND SUSTAINABILITY?

SMITA SAHU*[1] AND NITYA SHARMA[2]

[1]*Assistant Professor, Amity Institute of Biotechnology, Amity University, NOIDA (UP), INDIA*
[2]*Junior Research Fellow, Amity University, NOIDA (UP), INDIA*

ABSTRACT

The introduction of GM crops on a large scale has inadvertently impacted the environment either through escapes or gene flow from such crops into the natural environment, or through the changes in agricultural practices. This paper extensively sensitizes the regulatory framework for commercialization of genetically modified crops and the environmental impact of GM crops and has outlined ways in which such crops may influence the biodiversity, genetic diversity and environmental components, and also raises further concern on what right we have to manipulate creation in this way highlighting the significance of biotechnology in revamping agro biodiversity scenario and whether or not the process of Genetic Modification itself is permissible and tantamount to play against the creation 'of the God' and ethical acceptance of patents associated with novel gm crops with respect to the correlation of intellectual property rights and commercial viability. There have been a lot of ethical, social and legal questions about the acceptability of genetic modification of nature and limitations in our current scientific levels of understanding clearly how, genetic modifications amounted to the complex natural entities with a 'blunt instrument' and that it would be impossible to predict the outcomes of such manipulations resulting in the unacceptable consequences.

KEYWORDS: GM Crops, Biodiversity Conservation, Environment Management, Sustainable Development, Genetic Modification, Risk Mitigation.

***Corresponding author**

SMITA SAHU
Assistant Professor, Amity Institute of Biotechnology, Amity University, NOIDA (UP), INDIA

INTRODUCTION

REGULATORY FRAMEWORK FOR COMMERCIALIZATION OF GENETICALLY MODIFIED CROPS: THE CONCEPTUAL OVERVIEW

Genetic engineering is an application of biotechnology involving the manipulation of DNA and the transfer of gene components between species in order to achieve stable inter-generational expression of new traits while maintaining the uniformity and stability. GM Crops are taking the centre stage in the emerging agribiodiversity and posing grave concern towards the environment safety, sustainability and biodiversity harmonization. The conventional practices of crop production are already changing and the farming practices adapted widely are likely to transform global food production and eventually cause an impact on the environment in dramatic ways [1]. 25,000 crops were field tried globally within a period of twelve years, from 1986 to 1997 with more than 60 crops; having 10 different traits from 45 countries [2.] The global arable land area devoted to transgenic crops increased by 4.5 folds initially being 2.8 million hectares during the year 1996 to 12.8 million hectares in 1997, and then no less to 30 million hectares by 1998. USA itself accounts for 64% of the total global acreage, followed by China and Argentina. There have been approximately 1,500 approvals for field testing transgenic crops (the private sector has accounted for 87% of all field tests since 1987), despite the fact that in most countries, stringent procedures are not in place to deal with environmental problems that may develop when engineered plants are released into the environment [4.] The main concern is the international pressure to gain market and earn profit which has resulted in the releasing of transgenic crops by the respective companies very frequently without any proper consideration of impacts on people or the ecosystem in a longer run [5.] The 1992 Convention on Biological Diversity (CBD) defined biotechnology as any technological application that uses naturally "occurring systems, living organisms and their derivatives, to make products and processes and modifies them for specific uses accordingly". The application of allied areas such as tissue culture, immunology, molecular genetics and recombinant DNA techniques in the fields of agricultural production and agro-industry is covered under biotechnology.

The ecological risks with degrees of seriousness due to the commercial-scale use of transgenic crops as outlined by Rissler and Mellon[[6] ; Krimsky and Wrubel[7] , appear to be

- Simplicity of cropping system threatens the genetic diversity and leads to genetic erosion
- The potential transition of genes from a transformed type such as pesticide resistant crops to wild or semi domesticated relatives may result in the creation of super weeds.
- The transformed varieties such as herbicide- or pesticide resistant crops become weeds in subsequent crops
- New variety of pathogenic bacteria may be created due to recombination and risk of Vector-mediated horizontal gene transfer
- Vector recombination may lead to generation of new virulent strains, more so in transgenic plants engineered with genes for viral resistance

Although there are many applications of genetic engineering in the field of agriculture, the current target of biotechnology is on developing herbicide tolerant crops and on pest and disease resistant crops. Transnational corporations such as Monsanto, DuPont, Norvartis, etc., which are the leading regulators of biotechnology view transgenic crops as a way to reduce dependence on inputs such as pesticides and fertilizers. What is ironic is the fact that the biorevolution is being brought forward by the same interests that promoted the first wave of agrochemically-based agriculture, but this time, with a promise of safer pesticides and reduced chemically intensive farming which would be responsible for a sustainable agriculture in the world by equipping each crop with new insecticidal genes.

SIGNIFICANCE OF BIOTECHNOLOGY IN REVAMPING AGRO BIODIVERSITY SCENARIO

To create broad international markets for a single product the conditions for genetic uniformity are being promoted and developed in rural landscapes, although the biotechnology has the capacity to create a greater variety of commercial plants. It has been observed that although a certain degree of crop uniformity may have certain economic advantage per say, it has two ecological drawbacks. First, history has shown us that a huge area planted to a single cultivar is very vulnerable to a new, matching strain of a pathogen or pest easily. And, second, the widespread use of a single cultivar leads to a loss of genetic diversity [8]. The cross-pollinating of genetically-engineered crops with other plants, can render them uncontrollable because of their migrating or mutating. A super weed could multiply and penetrate into the ecosystem, if a pest-resistant or herbicide-resistant strain spreads from crops to weeds, threatening the world food supply scenario. Evidences from the Green Revolution show that wide adoption of modern varieties has been the reason for the genetic erosion in ecosystems. Most of the local varieties were shunned and this adoption of MVs was massively promoted by the government campaigns to encourage the farmers [9]. The uniform increment in the areas sown with a smaller number of varieties has increasingly risked the farmers because the varieties are prone to disease and pest attack and thus mostly performed poorly in the marginal environments. The biotechnology industry claims it holds the answer to world hunger: high technology to increase production. But according to the United Nations Food and Agriculture Organization (FAO), this is misstating the issue and as such there is no shortage of food in the world. Per capita food production has never been higher. The real problem is that the poor or the developing countries are still exporting their food to the well-nourished developed countries even in a globalized economy. It has also been noticed that in around two decades since their first commercialization, genetically modified (GM) crops have gained ground on their conventional counterparts. The vast majority of GM crops are grown majorly in five countries, namely, USA, Brazil, Argentina, Canada and India. However, for many of the GM adopters the growth in the area planted with GM crops per year has slowed except for Brazil where the annual increase is 21%. [Figure 1][9] as in 2011.

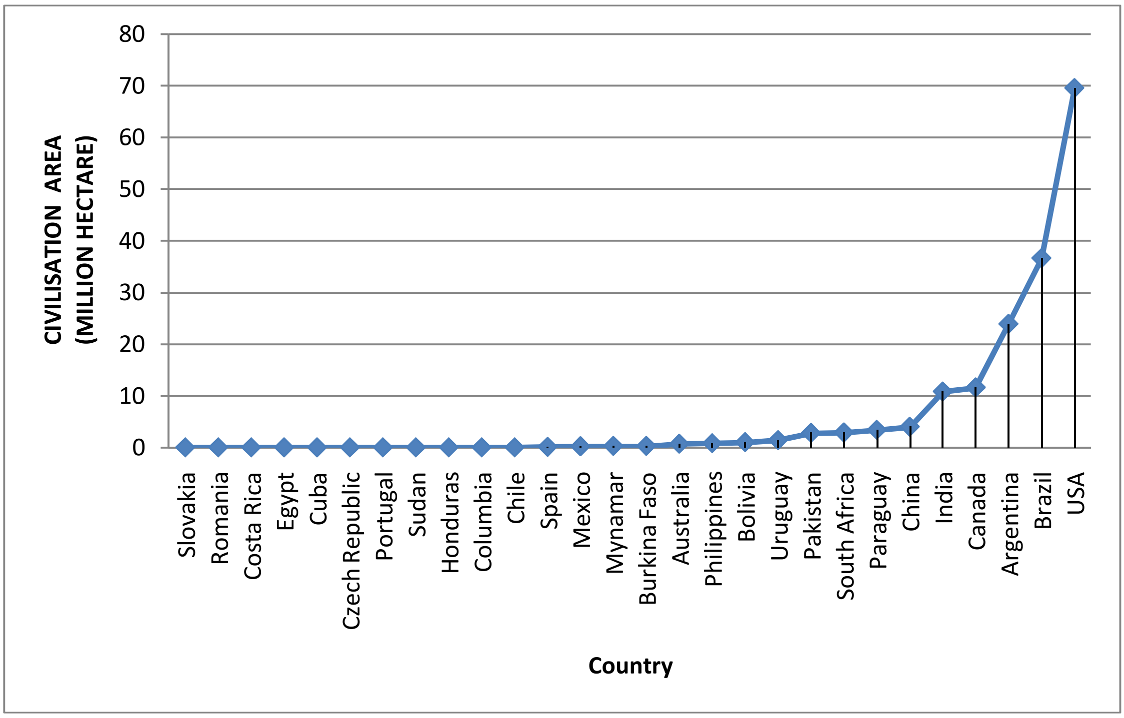

Figure 1
Graph to depict the area planted with GM crops in countries; data provided by the International Service for the Acquisition of Agri-biotech Applicaqtions.

In 2012, Genetically Modified soya bean, maize (corn), cotton and canola accounted for nearly all the GM crops grown. [Figure 2][9]

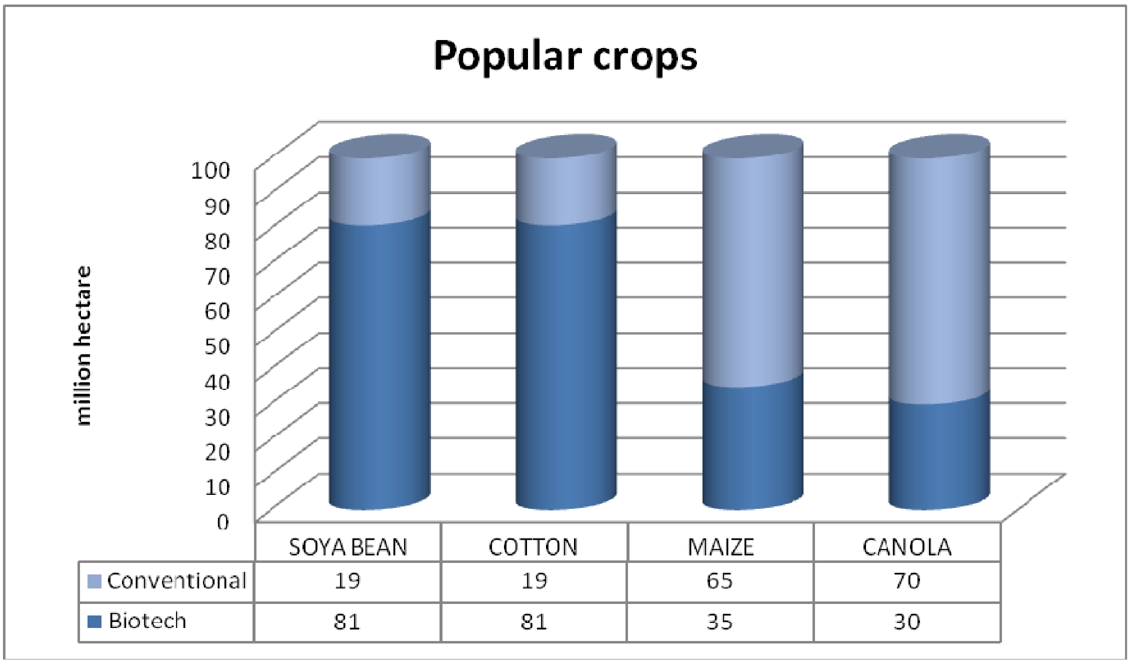

Figure 2
comparative analysis of the four crops grown by conventional and biotech methods and the area of land dedicated to each.

Around 30 traits are introduced into the genetically modified crops. However, it is seen that out of these the most popular are those that render herbicide resistance, insect resistance or both 'stacked' traits. [Figure 3][9]

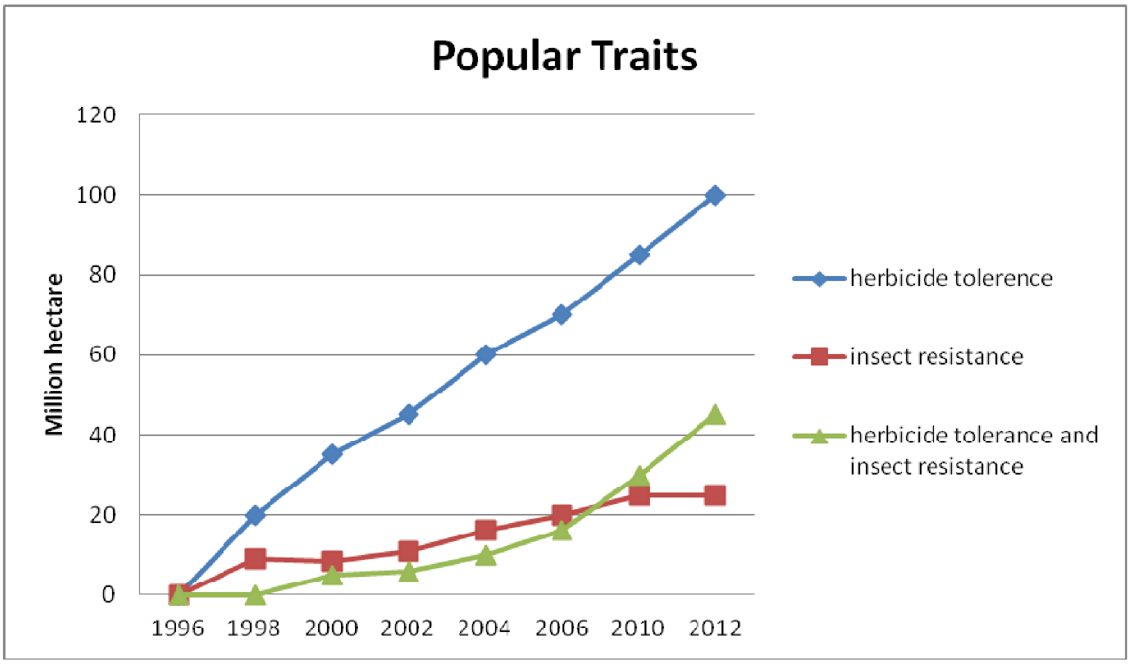

Figure 3
the graph depicts the trends in the popularity of the 3 major traits introduced in GM crops.

ETHICAL SOCIAL AND LEGAL (ELSI) QUESTIONS ABOUT THE ACCEPTABILITY OF GENETIC MODIFICATION OF NATURE

Fears are expressed consistently till date about the safety of GM crops with emphasis on the adoption of the 'precautionary principle' by the regulatory authorities and allow developing countries to balance their public health against economic profits. In particular, the grave concerns were expressed about the time-scale needed to assess the safety or otherwise of GM crops; dangers to human health though GM contamination of the food chains and food webs, the associated allergenic risks or the unexpected side-effects of introduced genes or their products. Biotechnologists' claim DNA technology deals with transfer of the new (exotic) genes into the transgenic plants; despite the fact that some scientists argue that genetic engineering is not different from conventional breeding. This transfer is mediated by vectors, derived from disease-causing viruses or plasmids thus narrowing down the species barriers so that they can transfer genes between a wide range of species thus infecting many other organisms in the ecosystem [10].

SAFEGUARDING CONSUMER CHOICES

There are grave concerns that labeling would not be sufficient to safeguard consumer choice. It was proposed that if widespread planting of GM food were permitted then cross-fertilization and natural hybridization would result in all foods containing genetic modifications within a short space of time. The need for buffer zones and the perceived inadequacy on current such zones need to be discussed extensively. It was noted that the large-scale planting of GM crops near borders could remove the choice to remain free of GM-crops from individual landholders, counties, regions or even countries. Some suggested that if GM crops were to become substantially cheaper for the consumer, then a subsidy should be provided for those who continue to grow conventional crops, so that consumer choice is safeguarded. Additional measures proposed to ensure consumer choice suggested that consumer education.

RISK MITIGATION – CAPACITY BUILDING TO ENSURE ENVIRONMENT SUSTAINABILITY

The 'GM debate' has involved a wide range of stakeholders and there is skepticism about the transparency and power of the current regulatory system. Factors such as the organism's natural history, complex interactions among the specific genetic modification(s), and the properties of the ecosystem in which the GM crop is released play a pivotal role in determining the risks associated with a Genetically Modified crop. As the area planted with the GM crops increases these complexities are compounded because the risks and benefits associated with a specific crop change and become more difficult to assess. The regulating agencies should hence concentrate on strengthening the national capabilities of research and integrating application as an element of agricultural research, therefore aiming at increasing and sustaining agricultural production, including marginal conditions per say. Training in biotechnology should have as its objective the resolution of actual constraints and the exploitation of real objectives. As per the international guidelines adopt assistance in capacity building in biosafety, inclusion of risk assessment, abidance monitoring and related issues, should be included.[11] The biosafety assessment of genetically modified organisms (GMOs) is required for their environmental impact and also for health of the consumers. It has been demonstrated many times that unauthorized and potentially unsafe GM products may sometimes be found in the market. Altogether unauthorized GMOs pose a significant socioeconomic risk through their potential effects on trade and trust in industry and authorities, as well as potentially to human and animal health, and the environment. Therefore, several countries have implemented labeling thresholds for unintentional mixing of GM crops; defined as 0.9% in the European Union, 1% Brazil, Australia, New Zealand, 3% in Korea and 5% in Taiwan and Japan.[12] Hence, for regulatory compliance on GM labeling and identification of genetic trait, the need for easy and reliable detection methods for these GM crops is necessary. Detection methods, which are reliable, are important for detection of unauthorized GMOs as well as form the first step in labeling control. Such detection is useful for monitoring of crop production during the growing season based on transgenic DNA or its expressed proteins.

Some of the parameters to ensure sustainability and mitigate risk include:

- Prevention of Gene Flow as far as possible to nearby plant species
- Preventing the entry of GMOs into the food chain
- Preventing the persistence of GMOs in the field altogether
- Biosafety risk evaluation
- Survival, multiplication and dissemination of GMOs in contained/ open environment in a broader aspect
- Interaction of GMOs with biological systems per say

The main objective of the development of GM crops was to introduce or modify the traits of the crops as per requirements. However, it is seen that even the most commonly introduced modifications have adverse effects on the environment or ecosystem of the particular region. It is high time to take into account various risks associated with each of the modifications and their impact on the ecosystem lest irreparable damages shall be done to the environment. [Table 1] [13.]

Modifications Introduced in GM crops	Advantages	Risks Associated
Herbicide resistance in cotton, maize and other such crops	Reduction in the use of chemical herbicide	Reduction in the in-field biodiversity which may in turn reduce the ecological services provided by agricultural ecosystems.
Maize with *Bt* toxin	Pesticide use is reduced. Fewer non-target organisms are killed as compared to alternatives such as broad-spectrum pesticides.	Promotes the development of *Bt* resistance, which will eliminate *Bt* as a relatively safe pesticide. Killing of non-target caterpillars and butterflies, such as monarchs.
Virus resistance in small grains due to coat proteins.	Reduce insecticide use to control insect dispersers of pathogens.	Facilitation of the creation of new viruses. Movement of genes into non-agricultural ecosystems where the subsequent increase in fitness of weedy species could eliminate endangered species.
Terminator or other sterilizing traits in crops and ornamentals.	Prevents the movement of traits to non-target species. Prevents the movement of introduced species to other ecosystems.	Prevents farmers from developing their own seed supplies adapted to local conditions.
Synthesis of vitamin A or other nutrients.	Improvement in the nutrition intake of people who depend heavily on rice.	Disruption of local ecosystems if an ecologically limiting nutrient or protein is produced.
Nitrogen fixation by non-legumes.	Reduced energy is used in fertilizer production and application.	Adds to the excess N leaching from agriculture, degrading human health and reducing biodiversity.

Table 1
The table enlists the type of modifications introduced in some widely commercialized GMOs, the advantages that they have and the risks associated in each case.

HISTORY OF REGULATORY FRAMEWORK TOWARDS GM CROPS AND SUSTAINABLE DEVELOPMENT

Growth and commercialization of GM Crops recommends that the Government should plan to make regular post-commercialization monitoring of the impact of GM releases a general condition for all releases, with inspection of the results by regulatory bodies, public access to the monitoring results and provision for modification or revocation of consents if the monitoring results show that this is necessary, This monitoring should impinge the biodiversity. The leading business regulators (and others) hold such patents work in collective partnership with a consortium of appropriate international organizations as a whole. The scope and impact of developing and commercializing new plants meant for agricultural production and human consumption is of real significance. Given the central economic position of the agricultural sector and controversies involved over public acceptance of GE traits into the food chain, Monsanto has been at the centre of contention to show that the company's operations have low risk and that its products are thoroughly reviewed by regulators during development and prior to commercialization which is one of the false beliefs about Monsanto's products leading to acceptance by the market. A glimpse in to the successive regulatory frameworks and guidelines for ensuring and pursuing the objective of conservation and sustainable development of biological diversity based on the precautionary principle.

- Emergence of “pressure groups” in the sixties
- The Conference on the Human Environment and Development in United Nations (1972) –Famous as the Stockholm Conference it marked the beginning of modern political and public awareness for environmental problems globally. Following this conference, the global awareness about environmental issues increased dramatically, and so did international environmental law-making proper.

- ASILOMAR Conference (1975): On the possible biohazards and regulation of biotechnology, draws guidelines to ensure the safety of recombinant DNA technology, applying precautionary principle. The principles stated for dealing with the potential risks were: (i) that containment be made an essential consideration in the experimental design and, (ii) that the effectiveness of the containment should match, as closely as possible, the estimated risk. [14]
- The Brundtland Report: our Common Future (1987)- Formerly known as World commission on Environment and Development is to unite countries to pursue sustainable development together against deterioration of natural resources. [15]
- The Rio Earth Summit (1992)-emphasizes on conservation and sustainable use of biological diversity based on the precautionary principle.[16]
- Guidelines by Codex Alimentarius Commission-The Codex Alimentarius Commission (CAC) were formed in 1962 to implement the Joint FAO/WHO Food Standards Programme, its purpose being "to protect the health of consumers and ensure fair practices in the food trade. As, a)Assessment of possible allergenicity, b)Assessment of possible toxicity, c) Compositional analysis of key components, d)Food processing, e) Nutritional modification.[17]

CORRELATION OF INTELLECTUAL PROPERTY RIGHTS AND COMMERCIAL VIABILITY: ETHICAL ACCEPTANCE OF PATENTS ASSOCIATED WITH NOVEL GM CROPS

In the GM crop area, the implications of patents on important new technologies such as apomixes will depend largely on the licensing strategy of the companies involved. Plant genome sequencing programmes will accelerate the development of GM crops further. The identification of a wide range of genes in model species will allow the rapid identification of genes of economic importance in crop species in a whole. The large agrochemical and seed companies are also investing heavily in genome sequencing projects per say. The possibilities of patents being granted for partial gene sequences of unknown function increasingly alarmed many researchers. [18]

These concerns include or arise from uneasiness over the fact that biotechnology is seen by some as interposing the work of nature, and that it is a risk-taker for commercial profits eventually. However, in priority setting, all concerns must be properly leveled, respecting ethics but manifesting the actual and potential possibilities of increasing food supplies and alleviating hunger across the world over. Most of the ethics-related issues, such as "patents on life," etc., are now being debated in the context of IPR legislation. Since these issues are mainly related to ethics and to maintain the level of public perception and awareness, decisions on the use of such technologies should be made maintaining the respect of social and economic realities. [19] A few believed that the patenting of GM crops permitted the patenting of a discovery, rather than an invention, and that the creators of GM crops had not therefore been involved in an inventive step which deserved intellectual property protection to reap the benefits. In addition, such patents deprived all of those who had done earlier research in a relevant area from the right to share any resulting profits, or would restrict access to a ‘common inheritance’ as a whole. GM crops may threaten to reduce biodiversity and the holders of patents on GM crops could have an unfair monopoly over food production. As a result, the respondents suggested the owners make patentable inventions approachable to the developing countries on a non-exploitative terms. [20] Among the areas within biotechnology, the largest number of patents is related to protection in research areas like proteins (30%) and enzymes and bacteria (10%). The other categories include RNA and fermentation (9%), gene specific patents (6%) and vaccines (5%), while sequences and transgenics accounted for 5% and 3% of patents filed respectively. [Figure 4] [21.]

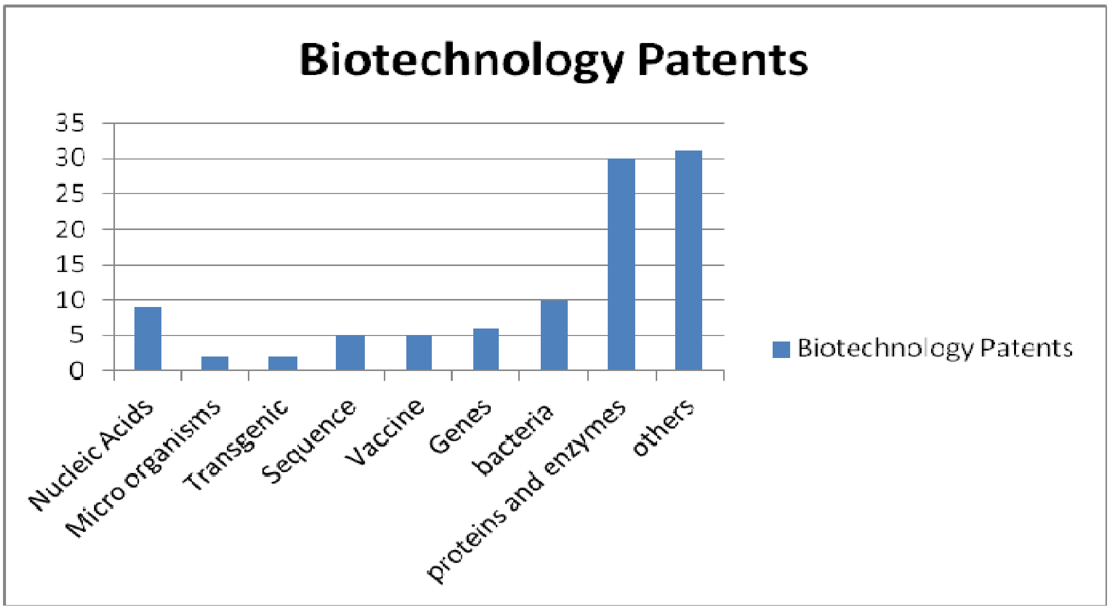

Figure 4
graphical representation of the percent of total biotechnology patents filed in biotechnology areas

CONCLUSION

In conclusion, we reaffirm the view that GM crops today represent an important new promising technology which ought to have the potential to do much good in the world provided that proper safeguards are maintained or introduced. People involved in developing the new technology, whether they are researchers from the public sector, in agrochemical or agricultural businesses or farmers, food manufacturers or retailers; everyone needs to realize and accept a wide range responsibility to the public in the line with the enshrined precautionary principle of sustainable development. [22] There is a need to take into consideration the ethical, social and legal concerns by them, and that their new inventions and products are safe enough for human consumption and avoid further irreversible threat to the environment, that the GM technology is capable enough to harness earnestly and meet the most urgent food needs of the growing world population as well as the legitimate commercial benefit is given due respect along with the strengthening of the framework. For sustainability in the current GM crop cultivation focus needs to be put on a few factors: first, their impacts on planet and environment impacts of which would include areas such as: production efficiency (including yields, fertilizers, biocides and energy), soil and water conservation, biodiversity and climate change. Second, profit with respect to parameters like farm income, national income, economic welfare distribution, and financial and other risks (including institutional risks).And third, the impact it has on human resource involved in and their labour conditions (including wage levels, occupational health, employment opportunities, and child and forced labour), land rights, community rights and rights of indigenous people, freedom of choice, competition with food production, and contribution to livelihood of producers and local communities. [23]

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