Environment Significance of Genetically Modified Organisms (GMO)

- Biotechnology principally involves the industrial scale generation of biopharmaceuticals and other useful products by exploiting genetically modified microorganisms, plants and animals

- GMOs are those organisms in which the genetic material undergone alteration as a result of genetic engineering approaches.

- Genetic engineering recognized as the extension of conventional biotechnology, which involves the manipulation in the genetic composition of an organism so as to attain a intended as well as anticipated outcome.

- Genetic manipulation/modification has enable crops more tolerant to abiotic stresses; helped to decrease dependence on chemical pesticides; enhanced effectiveness towards mineral utilization by agricultural plants; assisted in decreasing post harvest losses as well as increased nutritional value of food, e.g., “Vitamin A” supplemented golden rice.

Example of genetically modified plant (GMP)

Bacillus thuringiensis (Bt) toxin gene has been cloned from bacteria and expressed in plants so as to provide resistance against pests like insects and termed as biopesticides. For instance, Bt cotton and so on.

- ✓ Cry protein is a class of crystalline proteins formed by strains of Bt and engineered into agricultural plants so as to provide resistance towards insect pests.

- ✓ The cry proteins are toxic to some categories of insects, however not detrimental to mammals as well as most useful insects.

- ✓ Human beings have exploited cry proteins toxicity for their own benefit by introducing the cry gene for cry protein into commercial and foodr crop that are vulnerable to insect attack, for instance, cotton, corn, tobacco.

- ✓ The abovementioned plants transformed to insect resistant plants that saves the unnecessary utilization of chemical insecticides and, thus make water as well as soil free from pollution.

- ✓ Bt cotton form protein crystals that possess a toxic insecticidal protein. These crystals exist as inactive protoxins, however as soon as insect ingest the inactive toxin, it is converted to an active type of toxin owing to the alkaline pH of the gut that solubilize the crystals. The activated toxin binds to the surface of midgut epithelial cells and develops pores followed by swelling of cells as well as lysis and finally death of the insect like Lepidopterans, Dipterans as well as Coleopterans.

- **Golden Rice** is a variety of rice (*Oryza sativa*) that has been developed by genetic engineering.

- Golden rice produce the precursors for beta carotene (pro Vitamin A) in the edible parts of rice, the endosperm.

- ✓ The *Oryza sativa* can produce beta carotene naturally that is carotenoid pigment, which presents in the leaves and found to take part in photosynthesis.

- ✓ Nevertheless, the plants do not usually synthesize the pigment in the endosperms as phtosynthesis does not occur in the endosperm.

- ✓ Golden rice was developed as afortified food to be used in areas in which there is scarcity of dietary Vitamin A.

- **Benefits of development of GMP or genetically modified crop (GMC):**

✓ More tolerant towards abiotic stresses like drought, cold, heat, etc.

✓ Assists towards reduction in post harvest losses.

✓ More nutritional value can be introduced into crops as a result of genetic engineering, for instance, Vitamin A enriched rice is developed (Golden rice).

✓ Capable to utilize minerals more effectively.

✓ Gene technology offer one of the best solutions for overcoming the issue of world hunger. It can enhance crop productivity and reduce the price of food.

- **Impact of GMP/GMC on Environment or Drawbacks of development of GMP/GMC:**

- ✓ GM crops may contaminate other crops through pollen being blown by wind from one field to another.

- ✓ Sometimes GM crops depicts allergenic effects.

- ✓ Pest may acquire resistance towards GM crops, which have been targeted to kill them.

- ✓ GM crops may cause harm to the wealth and welfare of organisms, for instance, it can produce ecological side effects (Monarch butterflies).

- ✓ The more the gene technology is used, the worse the environment will be.

Example of genetically modified microbes (GMM)

- ✓ In 1983, an American company, Eli Lillyproduced the first genetically engineered human insulin and termed as Humuline.
- ✓ The transgenic bacterium *E. coli* is used to generate insulin to treat diabetes. Insulin hormone is composed of two polypeptide chains namely chain A as well as chain B.
- ✓ The two DNA sequences corresponding to chain A and chain B of human insulin are produced by genetic engineering.
- ✓ The aforementioned two sequences are incorporated into the plasmids of *E. coli* that generates two chains of insulin.
- ✓ Chain A as well as chain B are generated independently and they are extracted followed by combination through disulphide linkages to form insulin hormone.

- ❖ The first GMM towards the bioremediation was developed in USA by Dr. Ananda Chakrabarty.

- ✓ This GM was *Pseudomonas* that was able to disintegrate 2,4,5-trichlorophenoxyacetic acid.

- ✓ The aforementioned bacterium associated with two plasmids, each furnishing a distinct hydrogen degradative route. claimed

- ✓ This strain was claimed towards efficient treatment of oil spills.

- ❖ Similarly, the increased capability towards sequestering of heavy metals like cadmium was attained through transfer of a mouse gene that found to encode matallothionein to *Ralstonia eutropha,* a bacterium naturally occur in soil.

- ✓ The expression of matallothionein occurs on the external surface of the cells of GMMs, i.e., *Ralstonia eutropha* and, thereby assist towards sequestration of toxic cadmium.

➢Impact of genetically modified microbes on Environment:

❖ *Ecological disruption:*

✓ Genetic manipulation of microbes might result towards the development of more improved forms that might better adjusted in a new environmental condition, might colonize it, therefore significantly upsetting the ecological balance, whether microbial/plant or animal.

✓ For instance, the toxigenic unicellular alga *Chrysochromulina polylepis* owing to anthropological activity like the discharge of nitrogenous compounds to sea, entered portion of North Sea as well as the English Channel, which result in significant human health issues since it generates toxic substances (Belsher et al. 2003).

❖ Spread of resistance:

✓ One threat of specific concern pertaining to GMM is the risk of horizontal gene transfer (HGT). HGT is the acquisition of foreign genes as a result of transformation, transduction and conjugation by organisms in diverse environmental conditions. It take place particularly in response to varying environments and offers organisms, specifically prokaryotes, with access to genes other than those that can be inherited.

- ✓ HGT of an introduced gene from a GMM can provide a new characteristic in another organism, which might be a basis of potential detriment for the health of people or the environment. For example, the transfer of antibiotic resistance genes to a pathogen has the potential to compromise human or animal therapy.

- ✓ HGT has been detected in various diverse bacteria, for various genes, and in many different environments. It would, therefore be a mistake to suppose that recombinant genes would not spread to other bacteria, unless precautions are taken. Recent evidence from the HGT technology confirms that transgenic DNA in GM crops and products can spread by being taken up directly by viruses and bacteria as well as plant and animals cells.

❖ Reduced ecological diversity:

The diversity plays a very significant role towards managing the ecosystem. The adoption of GMMs might decrease the genetic and ecological diversity of microbial flora. GMM might be more adapted in the environment and compete with the local strain within their genetic variant (Aslaksen and Myhr 2007).

❖ Health related issues

- ✓ Majority of microorganisms exploited in food, chemical industrials are usually not pathogenic. Nevertheless, genetic manipulation of such microbes might result in the formation of virulent type that might be pathogenic triggering diseases in human beings, plants as well as animals. Furthermore, genetic manipulation of pathogenic strains to less virulent types for the production of vaccines towards some diseases might develop to more virulent types. This is the case of tuberculosis vaccine in which US investigators produced a variant that was considerably more virulent over native strain, by trying to prevent the activity of a virulence gene in *Mycobacterium tuberculosis* (Shimono 2003).

- ✓ The issue is even more crucial when it comes to the development of biological weapons: in this case, the primary objective is the creation of new pathogens against which an army or an enemy country is not able to defend itself (New Scientist issue 2003).

Examples of genetically modified animals:

- ❖ At Hematech, a biotech company situated in USA, the cows are genetically engineered for generation of disease fighting human antibodies in the plasma of their blood.

- ✓ The clones of aforementioned cows with greater amount of human antibodies in their systems are hyper-vaccinated against specific diseases and, therefore the plasma from their blood can become human drugs.

- ❖ GM pigs are being exploited towards transplants of hearts, kidneys, livers as well as pancreas cells so as to cure diabetes into non-human primates.

- ✓ It will be utilized in future for human being trials as it is thought that pig organs as well as cells would be safer over human organ transplant as they would be free of HIV of hepatitis

Benefits of GM animals

- ✓ These GM animals are extremely helpful towards the production of valuable biological products like human antibodies, etc.

- ✓ These GM animals assist to investigate not only how genes are controlled but also how they influence the normal functioning as well as development of body.

- ✓ These GM animals are exploited for evaluating the vaccines before moving towards commercial exploitation.

- ✓ These GM animals assist in investigation towards how genes contributein the progress of disease such as cancer.

Impact of genetically modified animals on Environment

- ❖ This can be understand by taking one example from fisheries field, where most GMOs depict enhanced growth rates; thus, apprehensions regarding environmental threat focus more on predation, competition as well as genetic pollution.

- ✓ GM fish may pose risks to the environment as of their enhanced rates of feeding on prey species; their widespread environmental tolerances that enable them to occupy new territories as well as probably to displace local native populations; and their potential for genetic mixing with, and therefore the transforming of the composition of natural fish populations.

Overall Precautionary measures

- ❖ Cautionary actions like risk assessment, monitoring as well as management have been put in place by policy makers to ensure the safety of genetically modified microbes as well as their products. The efficiency of these measures will reliant upon the close partnership amongst scientist as well as policy makers in working together. However, it is encourage scientist in the arena of genetic engineering to work with the goal line of improving on the well-being of humans taking into account all the moral values of man in order to reduce damage (Godwill 2014).

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