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Genetic Pollution: A Safe or Risky Bet?

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Abstract | **Review Article**

Genetic pollution is undesirable gene flow into wild populations. The term is usually associated with the gene flow from a genetically engineered (GE) organism (or genetically modified organism - GMO) to a non GE organism. Genetic pollution and collateral damage from GE field crops already have begun to wreak environmental havoc. Wind, rain, birds, bees, and insect pollinators have begun carrying genetically-altered pollen into adjoining fields, polluting the DNA of crops of organic and non-GE farmers. Once released, it is virtually impossible to recall genetically engineered organisms back to the laboratory or the field. Genetic Engineering is a very useful technique as per the agricultural or animal breeding aspects. We can modify the genes of an organism to improve or change its properties. This modification sometimes undesirably spreads into the neighbouring species via pollination or cross breeding which might either improve or deteriorate the properties of the organisms. This unwanted deterioration of natural organisms due to genetically tailored one's cause genetic pollution. Genetically modified species have been extensively synthesized over recent years increasing the risk of genetic pollution more than ever.

Keywords: Genetic Engineering, Genetic Pollution, Animal Breeding, Deterioration.

INTRODUCTION

Genetic Pollution is the contamination of unaltered or natural organisms with modified genes from the genetically hybridized organisms. According to environmentalists and various groups, genetic pollution is an undesirable phenomenon [1]. Earlier it was described as the gene flow from domestic, non-native sub species to wild native population but lately it has been termed as the flow of genes from genetically engineered species to non-genetically engineered species. There are many terms given to this change like genetic deterioration, genetic aggression, genetic mixing but none has been collectively agreed upon. Hence, the definition of genetic pollution remains a dispute as far as now.

The first genetically modified plant was an antibiotic tobacco plant which was introduced as the first genetically modified organism (GMO) in 1983. The history of genetic pollution goes back to 1854 when an Austrian monk, Gregor Johann Mendel discovered the theory of inheritance through experiments involving breeding of pea plant. Mendel was able to explain the very basic form of inheritance and assumed that some heritable material is present in the pea plant which is able to transmit its traits to the offspring plant. About a century later, in 1962 Francis Crick and James Watson won the Nobel Prize in medicine for deciphering the structure of DNA which is till date the basis of inheritance.

Genetic Modification

The DNA molecule consists of two chains that twist around each other forming an antiparallel double helix structure. The discovery of DNA was due to the idea of its sequence which carries all the genetic information of any organism. Some nitrogenous bases called pyrimidines and purines are arranged in a specific in the DNA molecule itself in order to create a code which is transferred into a protein in the cell as a part of the creed of central biology. DNA is the basic unit of inheritance among the other larger units. One of those large units is gene which has the code for some product protein. The main idea behind Genetic modification is to find such genes within an organism which can be modified and then transmitted which can be modified and then transmitted into target organism to finally get the desired characteristic bearing species. It can be seen as an argument with the fundamental facts of nature which has its ill effects at very microscopic level summing up to genetically derived pollution.

Genetic Engineering has made possible to modify plants and other organisms [2-4]. In order to acquire desirable properties, new genes from any other species can be inserted into the subject species. These inserted genes are known as Transgenes [5]. In few cases, the gene of the subject specie is taken out in order to compare the nature and properties of the organism. Various changes are made genetically to study the changes in behaviour and characteristics. This change that takes place due to genetic modification has been termed as undesirable by organisation such as Greenpeace [6] and Traffic [7]. US, Brazil, Argentina, India and Canada are the countries producing 90% of genetically modified food products.

Genetic Pollution in Plants and Animals

Gene flow can take place undesirably from genetically tailored organism to non-genetically modified one. This flow of genes may occur via cross pollination, water pollination or animal pollination. Seeds of the genetically modified organism may reach the non-modified organisms through animals, water or cross pollination. Genetic pollution can also occur through the mating of wild and modified organisms, producing hybrids. This undesired mixing might cause genetic pollution by interfering with the genetics of the other organisms.

The process of gene flow for animals is about same as plants although it is not very common as the genetic pollution in plants. The gene flow from one animal to other can cause genetic pollution by altering certain properties of the animal. Genetic pollution in animals is a very serious issue as it can pose harmful effect on that particular breed of organisms and sometimes can make them extinct.

Table 1: Genetically engineered crops in this table include the crops that have insect-resistant traits or crops that have herbicide tolerance traits, or both [8]

Year	GE corn		GE soybeans		GE cotton	
	Million acres planted	Percent of corn acres	Million acres planted	Percent of soybean acres	Million acres planted	Percent of cotton acres
2000	19.89	25	40.1	54	9.47	61
2001	19.68	26	50.37	68	10.88	69
2002	26.82	34	55.47	75	9.91	71
2003	31.44	40	59.46	81	9.84	73
2004	38.04	47	63.93	85	10.38	76
2005	42.53	52	62.67	87	11.25	79
2006	47.78	61	67.21	89	12.68	83
2007	68.27	73	58.91	91	9.42	87
2008	68.79	80	69.66	92	8.15	86
2009	73.42	85	70.48	91	8.05	88
2010	75.85	86	71.99	93	10.21	93
2011	81.21	88	70.46	94	13.25	90
2012	85.5	88	71.79	93	11.58	94
2013	87.64	90	72.29	93	9.23	90

Genetic Pollution in Plants and Animals

Genetic pollution is a controversial term for uncontrolled gene flow into wild populations. It is defined as "the dispersal of contaminated altered genes from genetically engineered organisms to natural organisms, especially by cross- pollination", but has come to be used in some broader ways. It is related to the population genetics concept of gene flow, and genetic rescue, which is genetic material intentionally introduced to increase the fitness of a population. It is called genetic pollution when it negatively impacts the fitness of a population, such as through outbreeding depression and the introduction of unwanted phenotypes which can lead to extinction. Gene flow can take place undesirably from genetically tailored organism to non-genetically modified one. This flow of genes may occur via cross pollination, water pollination or animal pollination. Seeds of the genetically modified organism may reach the non-modified organisms through animals, water or cross pollination. Genetic pollution can also occur through the mating of wild and modified organisms, producing hybrids. This undesired mixing might cause genetic pollution by interfering with the genetics of the other organisms [8, 11, 13, 14].

The process of gene flow for animals is about same as plants although it is not very common as the genetic pollution in plants. The gene flow from one animal to other can cause genetic pollution by altering certain properties of the animal. Common example of genetic pollution in animals is the breeding of farmed Atlantic Salmon with the wild Atlantic Salmon. Genetic

pollution in animals is a very serious issue as it can pose harmful effect on that particular breed of organisms and sometimes can make them extinct.

How Does Genetic Modification cause Pollution?

1. GMOs or Genetically modified organisms can cross pollinate and it becomes extremely impossible to clean the whole genetic pool.
2. A survey [9] in USA from 1996 to 2008 showed that a larger amount of herbicides and pesticides were required to use on the GMOs as compared to the non-GM plants. This may reduce the value of nutrients and increase the risk of 'superweeds' which are resistant of herbicides.
3. Genetically Modified crops and the extensive use of herbicides can harm birds, marine ecosystems, insects, amphibians and soil organisms. They reduce pollute water resources, biodiversity and are unsustainable. For example, GM crops are eliminating habitat for monarch butterflies, whose populations are down 50% in the US [10].
4. Contrary to the claim, the yield of the GMOs is less as compared to the natural products.

How to check the Ill Effects of Genetic Pollution?

1. While purchasing food products one should always look for genetically engineered free products in order to resist from consuming pollute food.
2. New age modification should be developed which is not transferable or contaminable to other crops or animals.
3. Extensive use of herbicides and pesticides will deteriorate the quality of both natural and modified crops which should be strictly avoided.
4. There should be a limit or restriction over the percent of modification done in the genes. The modification must only be done to improve certain properties lacking in the organism and not to completely modify it.

Few Facts

1. US, Brazil, Argentina, India and Canada are the countries producing 90% of genetically modified food products. The global area planted with GM crops has been increasing each year since they were first commercially cultivated in 1996, when just about 2.8 million hectares were cropped with GM crops. This number increased to 90 million hectares in 2005 and to 134 million hectares in 2009. The countries with major areas relying on GM crops in 2009 were the USA (64 million hectares), Brazil (21.4), Argentina (21.3), India (8.4), Canada (8.2), China (3.7), Paraguay (2.2), and South Africa (2.1 million hectares) [11].
2. 93% or more Soybean produced in US is bioengineered. There are only four major GM crops that dominate the market namely soybean, cotton, maize and canola. In terms of area cultivated, soybean is far more successful than any other GM crop. In 2009, more than three-quarters (77%) of the 90 million hectares of soybean grown globally were GM crops, while for cotton, almost half (49%) of the 33 million hectares were GM. Over a quarter (26%) of the 158 million hectares of globally grown maize were GM crops and 21% of globally grown canola (with a total area of 31 million hectares) [11, 12].
3. Herbicide tolerant genetically engineered crops have created weed resistance causing the pesticide use to increase by 70 million pounds within the period of 1996 to 2003.
4. The two dominant agronomic traits currently available are herbicide tolerance (HT) and insect resistance (mostly in the form of Bt crops). Herbicide tolerance is the prevailing trait that is deployed in all four dominant crops, while maize and cotton are the only two insect resistant GM crops currently commercially available [11].
5. Scientist from Taiwan has created a glow-in-the dark pig in 2006 by inserting the genes of jellyfish in the pig's embryo.

CONCLUSION

Genetic modification of plants and animals has been a boon in many ways but since everything has its advantages and disadvantages; genetic pollution became the ill effect of GMOs. Many new species have been derived by gene altering to improve the weak characteristics of organisms. The undesired cross pollination in plants and cross breeding in animals has brought about some unwanted changes in the field of genetic modification which is a challenge for the scientists. The contaminated species cannot be brought back to their natural self hence genetic pollution has become an irreversible process. There are very few steps take collectively to stop this unfortunate situation where many of naturally occurring species are on the verge of extinction. We must proceed with caution to avoid causing unintended harm to the human health and use this technique for the betterment of the humankind.

CONFLICT OF INTEREST

Authors declare that they have no conflict of interest.

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