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ADVANTAGES AND DISADVANTAGES OF POPULAR GENETICALLY MODIFIED PLANTS AND ANIMALS- A REVIEW

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ABSTRACT

A genetically modified organism (GMO) is an organism whose genetic material has been altered using genetic engineering techniques. Organisms that have been genetically modified include micro-organisms such as bacteria and yeast, insects, plants, fish, and mammals. In conventional livestock production, crop farming, and even pet breeding, it has long been the practice to breed select individuals of a species in order to produce offspring that have desirable traits. Combining genes from different organisms is known as recombinant DNA technology and the resulting organism is said to be 'Genetically modified (GM)' or 'Transgenic'. The principal transgenic crops grown commercially in field are herbicide and insecticide resistant soybeans, corn, cotton and canola. Other crops grown commercially and/or field-tested are sweet potato resistant to a virus that could destroy most of the African harvest, rice with increased iron and vitamins that may alleviate chronic malnutrition in Asian countries and a variety of plants that are able to survive weather extremes. There are bananas that produce human vaccines against infectious diseases such as hepatitis B, fish that mature more quickly, fruit and nut trees that yield years earlier and plants that produce new plastics with unique properties. Technologies for genetically modifying foods offer dramatic promise for meeting some areas of greatest challenge for the 21st century. Controversies and public concern surrounding GM foods and crops commonly focus on human and environmental safety, labelling and consumer choice, intellectual property rights, ethics, food security, poverty reduction and environmental conservation. What are the risks of recombinant technology or it is really beneficial. This review will also address some major concerns about the safety, environmental and ecological risks and health hazards involved with GM foods and recombinant technology.

KEYWORDS: Genetically modified foods, Recombinant DNA technology, Transgenes, Food Safety, intellectual property right, Allergenic foods,

INTRODUCTION

A genetically modified organism (GMO) is an organism whose genetic material has been altered using genetic engineering techniques. Organisms that have been genetically modified include micro-organisms such as bacteria and yeast, insects, plants, fish, and mammals (Johnson 2008). In conventional livestock production, crop farming, and even pet breeding, it has long been the practice to breed select individuals of a species in order to produce offspring that have desirable traits. In genetic modification, however, recombinant genetic technologies are employed to produce organisms whose genomes have been precisely altered at the molecular level, usually by the inclusion of genes from unrelated species of organisms that code for traits that would not be obtained easily through conventional selective breeding.

GMOs are produced using scientific methods that include recombinant DNA technology and reproductive cloning. Reproductive cloning technology generates offspring that are genetically identical to the parent by the transfer of an entire donor nucleus into the enucleated cytoplasm of a host egg. The first animal produced using this cloning technique was a sheep named Dolly, born in 1996. Since then a number of other animals, including pigs, horses, and dogs, have been generated using reproductive cloning technology. Whole-genome replacement, involving the transplantation of one bacterial genome into the "cell body," or cytoplasm, of another microorganism, has been reported, although this technology is still limited to basic scientific applications. GMOs produced through genetic technologies have become a part of everyday life, entering into society through agriculture, medicine, research, and environmental management. However, while GMOs have benefited human society in many ways, some disadvantages exist; therefore, the production of GMOs remains a highly controversial topic in many parts of the world. Applications of GMOs are diverse and include drugs in food, bananas that produce human vaccines against infectious diseases such as Hepatitis B (Kumar et al. 2005: Ma, J., et al.2003).

Production of GMOs

An organism can be a plant, animal, fungus, or bacteria and all of these can be, and have been, genetically engineered for almost 40 years. The first genetically engineered organisms were **bacteria** in the **early 1970s**. Since then, genetically modified bacteria have become the work horse of hundreds of thousands of labs doing genetic modifications on both plants and animals. Most of the basic gene shuffling and modifications are designed and prepared using bacteria, mainly some variation of E. coli, then transferred to target organisms. The general approach to genetically alter plants, animals, or microbes is conceptually pretty similar. However, there are some differences in the specific techniques due to general differences between plant and animal cells. For example, plant cells have cell walls and animal cells do not.

Genetic engineering, then, is simply inserting a new DNA base sequence (usually corresponding to a whole gene) into the chromosomal DNA of the organism. Conceptually, it is straightforward, but technically, it is a little more complicated. There are many technical details to getting the right DNA sequence with the right signals into the chromosome in the right context that enables the cells to recognize it is a gene and use it to make a new protein.

There are four key elements that are common to almost all genetic engineering procedures:

1. First, a gene ; the physical DNA molecule with the particular base sequences is required which is inserted into a piece of bacterial DNA that is like a small chromosome (a plasmid) and, since bacterial replicate rapidly, as much of the gene as needed can be made;
2. The gene is placed in a DNA strand surrounded with the right surrounding DNA sequence to enable the cell to recognize it and express it. Principally, this means that a small DNA sequence called a promoter that signals the cell to express the gene is required;
3. In addition to the main gene that is to be inserted, often a second gene is needed to provide a marker or selection. This second gene is essentially a tool used to identify the cells that contain the gene.
4. Finally, a way is needed to deliver the new DNA (i.e., promoter, new gene, and selection marker) into the organism's cells.

Popular Genetically Modified Plants

Bt Cotton

Bt cotton is a genetically modified variety of cotton producing an insecticide. It is produced by Monsanto. It is supplied in India's Maharashtra state by the agri-biotechnology company, Mahyco, as the distributor. The lines were claimed to be “substantially equivalent” to parent lines (Berberich et al. 1996) in levels of macronutrients and gossypol.

The bacterium Bacillus thuringiensis (Bt) is a family of over 200 different proteins which naturally produce chemicals harmful to selective insects, most notably the larvae of moths and butterflies, beetles, cotton bollworm (Helicoverpa armigera) and flies, and harmless to other forms of life. The gene coding for Bt toxin has been inserted into cotton, causing cotton to produce this natural insecticide in its tissues. In many regions, the main pests in commercial cotton are lepidopteran larvae, which are killed by the Bt protein in the transgenic cotton they eat. This eliminates the need to use large amounts of broad-spectrum insecticides to kill lepidopteran pests (some of which have developed pyrethroid resistance). This spares natural insect predators in the farm ecology and further contributes to non-insecticide pest management.

However, Bt cotton is ineffective against many cotton pests such as plant bugs, stink bugs, and aphids; depending on circumstances it may still be desirable to use insecticides in prevention of such pests. A 2006 study done by Cornell researchers, the Center for Chinese Agricultural Policy and the Chinese Academy of Science on Bt cotton farming in China found that after seven years these secondary pests that were normally controlled by pesticide had increased, necessitating the use of pesticides at similar levels to non-Bt cotton and causing less profit for farmers because of the extra expense of GM seeds.

How Bt Cotton works

(Bt) cotton was created through the addition of genes encoding toxin crystals in the Cry group of endotoxin. When insects attack and eat the cotton plant the Cry toxins are dissolved. This is made possible due to the high pH level of the insects’ stomach. The now dissolved and activated Cry molecules bond to cadherin-like proteins on cells comprising the brush border molecules. The epithelium of the brush border membranes role is to separate the body cavity from the gut whilst allowing access for nutrients. The Cry toxin molecules attach themselves to specific locations on the cadherin-like proteins present on the epithelial cells of the midge and ion channels are formed which allow the flow of potassium. Regulation of potassium concentration is essential and if left unchecked causes death of cells. Due to the formation of Cry ion channels sufficient regulation of potassium ions is lost and results in the death of epithelial cells. The death of such cells creates gaps in the brush border membrane. The gaps then allow bacteria and (Bt) spores to enter the body cavity resulting in the death of the organism.

Bt Corn

Bt corn is a variant of maize that has been genetically altered to express one or more proteins from the **Bacillus thuringiensis** bacteria. The protein is poisonous to certain insect pests and is widely used in organic gardening. The European corn borer causes about a billion dollars in damage to corn crops each year. In recent years, traits have been added to ward off Corn ear worms and root worms, the latter of which annually causes about a billion dollars in damages.

The Bt protein is expressed throughout the plant. When a vulnerable insect eats the Bt-containing plant, the protein is activated in its gut, which is alkaline (human guts are acidic). In the alkaline environment the protein partially unfolds and is cut by other proteins, forming a toxin that paralyzes the insect's digestive system and forms holes in the gut wall. The insect stops eating within a few hours and eventually starves. In 1996, the first GM maize producing a Bt Cry protein was approved, which killed the European corn borer and related species; subsequent Bt genes were introduced that killed the corn rootworm larvae.

European corn borer

The now-famous Bt corn controversy started with a laboratory study by Losey *et al*. (1999) in which the mortality of monarch larvae was reportedly higher when fed with milkweed (their natural food supply) covered in pollen from transgenic corn than when fed milkweed covered with pollen from regular corn. The report by Losey *et al*. was followed by another publication (Jesse & Obrycki, 2000) suggesting that natural levels of Bt corn pollen in the field were harmful to monarchs.

Debate ensued when scientists from other laboratories disputed the study, citing the extremely high concentration of pollen used in the laboratory study as unrealistic, and concluding that migratory patterns of monarchs do not place them in the vicinity of corn during the time it sheds pollen. For the next two years, six teams of researchers from government, academia, and industry investigated the issue and concluded that the risk of Bt corn to monarchs was "very low" (Sears *et al*., 2001), providing the basis for the U.S. Environmental Protection Agency to approve Bt corn for an additional seven years.

Genetically modified rice

Genetically modified rice are types of rice that have been genetically modified (also called genetic engineering) for agricultural purposes. The rice genome is usually modified using particle bombardment via the use of a gene gun or more commonly, a process known as agrobacterium mediated transformation. Rice plants can be modified in DNA to be herbicide resistant, resist pests, increase grain size, generate nutrients, flavours or even produce human proteins. The natural movement of genes across species, often called horizontal gene transfer or lateral gene transfer, can also occur with rice through gene transfer mediated by natural vectors. Scientists are genetically modifying rice for several purposes including making rice resistant to herbicides, diseases, and pests, increasing nutritional value, eliminating rice allergies, producing human blood protein, increasing yield; improving tolerance to drought and salinity; and enhancing nitrogen use efficiency.

BT rice is modified to express the **cry IA (b)** gene of the bacillus thuringiensis bacterium. The gene confers resistance to a variety of pests including the rice borer through the production of endotoxins. The benefit of this is that the farmers do not need to spray their crops with pesticides to control fungal, viral, or bacterial pathogens. Other benefits include **increased yield and revenue** from crop cultivation. **Human serum albumin (HSA)** is a blood protein in human plasma. It is used in treatment such as severe burns, liver cirrhosis, and hemorrhagic shock. More importantly, it is used in blood donations and thus is in short supply around the world. In China, the scientists modified brown rice as a cost-effective way to produce HSA protein. The Chinese scientists put recombinant HSA protein promoters into 25 rice plants using *Agrobacterium*. Out of the 25 plants, nine of them breed (brown rice plants), and contained the HSA protein. They confirmed that the genetically modified brown rice had the same amino acid sequence as human serum albumin. They called this protein **Oryza sativa recombinant HSA**. The modified rice were transparent compared to regular rice. Additionally, they tested this protein on the rats with liver disease. The rats showed improved liver function.

Bt Brinjal

The **Bt brinjal** is a suite of transgenic brinjals (also known as an eggplant or aubergine) created by inserting a crystal protein gene(*Cry1Ac*) from the soil bacterium *Bacillus thuringiensis* into the genome of various brinjal cultivars. The insertion of the gene, along with other genetic elements such as promoters, terminators and an antibiotic resistance marker gene into the brinjal plant is accomplished using *Agrobacterium*-mediated genetic transformation. The Bt brinjal has been developed to give resistance against lepidopteron insects, in particular the Brinjal Fruit and Shoot Borer (*Leucinodes orbonalis*)

When fruit and shoot borer larvae feed on Bt brinjal plants, they ingest the Bt protein Cry1Ac along with plant tissue. In the insect gut, which is alkaline with a pH >9.5, the protein is solubilized and activated by gut proteases. The Bt protein binds to specific receptor proteins present in the insect membrane, resulting in pore formation in the membranes. This leads to disruption of digestive processes, paralysis, and subsequent death of the fruit and shoot borer larvae.

Popular Genetically Modified Animals

Transgenic Sheep

The first reports of transgenic sheep were published by **J.P. Simons** (1988) of Edinburgh. The first transgenic sheep developed was **Dolly** which was a female domestic sheep, and the first mammal to be cloned from an adult somatic cell, using the process of nuclear transfer. The cell used as the donor for the cloning of Dolly was taken from a mammary gland, and the production of a healthy clone therefore proved that a cell taken from a specific part of the body could recreate a whole individual.

Dolly was born on 5 July 1996 and had three mothers (one provided the egg, another DNA and a third carried the cloned embryo to term). She was created using the technique of **somatic cell nuclear transfer**, where the cell nucleus from an adult cell is transferred into an unfertilised oocyte (developing egg cell) that has had its cell nucleus removed. The hybrid cell is then stimulated to divide by an electric shock, and when it develops into a blastocyst it is implanted in a surrogate mother. Dolly was the first clone produced from a cell taken from an adult mammal. The production of Dolly showed that genes in the nucleus of such a mature differentiated somatic cell are still capable of reverting to an embryonic totipotent state, creating a cell that can then go on to develop into any part of an animal. Dolly's existence was announced to the public on 22 February 1997. It gained much attention in the media. A commercial with Scottish scientists playing with sheep was aired on TV, and a special report in TIME Magazine featured Dolly the sheep. *Science* featured Dolly as the breakthrough of the year. Even though Dolly was not the first animal to be cloned, she gained this attention in the media because she was the first to be cloned from an adult cell.

Transgenic Sheep - Dolly

Recombinant DNA technique can also be used to increase the ability of sheep for wool growth. For this purpose genes essential for synthesis of some important amino acids found in keratin proteins of wool, have been cloned and introduced in embryos to produce transgenic sheep. For instance, genes (cysE and cysM) for two enzymes (serine acetyltransferase and O-acetylserine sulphydrylase) involved in cysteine biosynthesis, were isolated from bacteria and cloned in a vector. These genes were introduced in sheep cells, ultimately leading to the production of transgenic sheep, where these genes are expressed. Growth hormones (GH) genes have also been introduced and can be used to promote body weight. Other genes involved in wool production have also been cloned and will be used for transgenesis, thus increasing the potential of wool production through genetic engineering.

Transgenic goats

Transgenic goats were successfully produced during 1990s by groups headed by **John McPherson** and **Karl Ebert** both in USA. These transgenic goats expressed a heterologous protein (a variant of human tissue-type plasminogen activator = LAtPA) in their milk. This protein is used for dissolving blood clots i.e. for treatment of coronary thrombosis. A CDNA representing LAtPA was linked with either the murine whey acid promoter (WAP) or a β casein promoter in an expression vector and used for injecting early embryos obtained surgically from the oviducts of super ovulated dairy goats. These injected embryos were either immediately transferred to the oviducts of recipient females (surrogate mothers) or cultured for 72 hours before transferring to the uterus of recipient females. Of 29 off-springs from 36 recipients, one male and one female contained the transgene. The transgenic female delivers 5 off-springs, one of which was transgenic showing expression of LAtPA at a low level of few milligrams per litre of milk. In another case of transgenic goat, few grams of LAtPA per litre of milk could be obtained. At this concentration, the dairy goat may become an economically viable bioreactor for human pharmaceuticals.

A Transgenic Goat

Transgenic Cows

Scientists have created cows that have been genetically modified to produce milk which is healthier for humans. Researchers have revealed that they have successfully created a calf whose milk could be drunk by people suffering from lactose intolerance and a second animal whose milk contains high levels of "healthy" fat found in fish. The cows are part of a growing effort by scientists to make food and drink products from livestock healthier by genetically altering the animals. Transgenic cows are genetically modified (GM) cows. They have an extra gene or genes inserted into their DNA. The extra gene may come from the same species or from a different species. The extra gene (transgene) is present in every cell in the transgenic cow. However, it's only expressed in mammary tissue. This means that the transgene's protein will only be found in the cow's milk and can only be extracted from there.

First, the gene for the desired product is identified and sequenced. Then a gene construct containing this desired gene is created using DNA cloning, restriction enzyme digests and ligation. The gene construct is then introduced into female bovine (cow) cells by transfection. Transgenic bovine cells are selected and fused with bovine oocytes that have had all of their chromosomes removed. Once fused with the oocyte, the transgenic cell's chromosomes are reprogrammed to direct development into an embryo, which can be implanted into a recipient cow. After a 9-month gestation period, a female calf is born. She will only express the transgene in her milk during lactation after her first calf is born. This is because expression of the transgene is controlled by a promoter specific to lactating mammary cells lactating mammary cells.

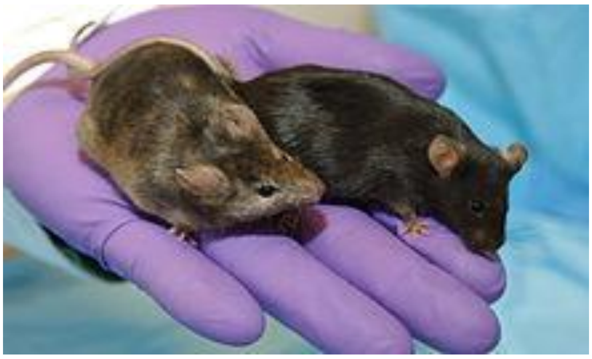
A Transgenic Cow

Transgenic herds live on special farms with their own milking sheds. They are kept separate from regular herds. Transgenic cows look identical to normal cows. Researchers use ear tags and microchips to identify transgenic cows and their calves. One of the aims of the research programme is to show that transgenic cows pass on their transgenes to subsequent generations. If a transgenic cow is mated with a transgenic bull, she will have a higher chance of having transgenic offspring. However, if a transgenic cow is mated with a non-transgenic bull, her offspring will have a 50% chance of being transgenic, as offspring inherit half of their chromosomes from their mother and half from their father.

Transgenic Mice

A **genetically modified mouse** is a mouse that has had its genome altered through the use of genetic engineering techniques. Genetically modified mice are commonly used for research or as animal models of human diseases.

There are two basic technical approaches to produce genetically modified mice. The first involves pronuclear injection into a single cell of the mouse embryo, where it will randomly integrate into the mouse genome. This method creates a transgenic mouse and is used to insert new genetic information into the mouse genome or to over-express endogenous genes. The second approach, pioneered by Oliver Smithies and Mario Capecchi involves modifying embryonic stem cells with a DNA construct containing DNA sequences homologous to the target gene. Embryonic stem cells that recombine with the genomic DNA are selected for and they are then injected into the mice blastocysts. This method is used to manipulate a single gene, in most cases "knocking out" the target gene, although more subtle genetic manipulation can occur (e.g. only changing single nucleotides).



A genetically modified mouse in which a gene affecting hair growth has been knocked out (left), shown next to a normal lab mouse.

Genetically modified mice are used extensively in research as models of human disease. The most common type is the knockout mouse, where the activity of a single (or in some cases multiple) genes are removed. They have been used to study and model obesity, heart disease, diabetes, arthritis, substance abuse, anxiety, aging and Parkinson disease. Transgenic mice generated to carry cloned oncogenes and knockout mice lacking tumor suppressing genes have provided good models for human cancer. Hundreds of these oncomice have been developed covering a wide range of cancers affecting most organs of the body and they are being refined to become more representative of human cancer. The disease symptoms and potential drugs or treatments can be tested against these mouse models.

Transgenic Fish

Genetically modified fish (GM fish) are genetically modified organisms. The DNA of the fish has been modified using genetic engineering techniques. In most cases the aim is to introduce a new trait to the fish which does not occur naturally in the species. GM fish are used in scientific research, and while they are being developed for use in aquaculture food production

Some GM fish that have been created have promoters driving an over-production of "all fish" growth hormone. This resulted in dramatic growth enhancement in several species, including salmonids, carps and tilapias.

A genetically modified Atlantic salmon known as the **Aqu Advantage salmon** has an increased growth rate and size over the wild type Atlantic salmon from which it was derived, up to doubling its weight with a reduced time of growth to maturity.

Transgenic Salmon and Normal Salmon

Genetically modified organisms or GMOs are a product of a form of scientific farming, where crops are administered with chemicals to increase their sizes and yields. It is becoming more and more common in many types of food we see every day. But due to its concept, it has been a topic in heated debates around the world, with proponents and opponents pushing their arguments. Health risks associated with GM foods are concerned with toxins, allergens, or genetic hazards. The mechanisms of food hazards fall into three main categories (Conner and Jacobs 1999). They are inserted genes and their expression products, secondary and pleiotropic effects of gene expression and the insertional mutagenesis resulting from gene integration.

Advantages and Disadvantages of GM Plants

Advantages

1) Developments of new kinds of crops that can be **grown at extreme climates**, for example, dry or freezing environments (like deserts). For example, scientist developed a type of tomato that grows in salty soil.
2) **Less pesticide** is **needed** to be used due to insect pest resistant plants.
3) More **economically friendly** as pesticides do not go into the air, soil, and wat (especially freshwater supplies). Their production hazards to the environment also decreases.
4) Higher crop yields.
5) **Decrease in food prices** due to lower costs and higher yield. As people in poor countries spend over half of their income on food alone, lower food prices mean an automatic reduction of poverty.
6) Enhancement of the taste of food and the quality of food.
7) GMO crops **last longer**. This decreases the amount of wasted crops and foods.
8) **Reduced energy** needs to produce GMO crops.
9) Less machinery requirements.
10) Due to reduced costs of production, prices can be further reduced.

Disadvantages

1) Environmental- possibility of unintended harm to other organisms: They can pose a threat to the insects that are important to the ecosystem. Potential risk of harm to non-target organisms, e.g. a pest resistant crop that produces toxins that may harm both crop-damaging and non-crop-damaging insects E.g. The pollen of BT corn on milkweed is thought to affect (*slow or kill*) the larvae of Monarch butterflies. Further studies are underway.

2) Pesticides become less effective as pests become resistant to modified crops. Different varieties and strengths of pesticides will be needed once weeds have adapted to the existing effective pesticides.

3) They would make plants that leave unwanted residual effects to remain in the soil for a long period of time. The process of growing GMOs includes the addition of new genetic material into a crops genome, and similar to bacterial genetic engineering in agricultural ecology, this means the introduction of new genes in crops, like corn.

4) They threaten crop diversity: While the chance that the strain of one genetically modified crop could pollinate an already existing non-GM crop is unpredictable and unlikely, as there are certain conditions to be met for cross pollination to occur, a large-scale plantation has the ability to release a GM strain during pollination, thus increasing the risk. As a result of the cross pollination to non-GM plants, hybrid strains are created, which means there is a greater chance of ecological novelty to occur. New artificial strains will be introduced into the ecosystem that can potentially decrease the level of biodiversity through competition.

5) They are believed to change the field of agriculture in a negative way. Research on the effects of growing GM crops on a large scale has sparked various concerns, specifically those regarding ecosystems with GMO strains. According to scientists, these strains have the potential to change agriculture in a negative way.

6) It has trade issues. In other countries and regions in the world, there may be problems regarding trade matters, such as tariff and quota.

7) "Superweeds": They can produce more weeds and can threaten the lives of animals. Engineered plants are found to function as mediators to the transfer of genes to wild plants and the creation of weeds. To keep them under control, scientists are inventing new herbicides that were not necessary for non-GMO weeds and are toxic to various animals that feed on GMO crops, such as cows. Tests have shown the uptake of these herbicides having toxic consequences on certain organisms and the ecosystem in general. (Mortensen et al 2012) gene transfer to non-target species where herbicide tolerant plants crossbreed with weeds potentially creating herbicide resistant weeds (Duke & Powles, 2009).

8) Human health risks: Introducing a gene into a plant *may* create a new allergen or cause an allergic reaction in susceptible individuals, For example, inserting genes from a nut into another plant could be dangerous for people who are allergic to nuts. In addition, newly expressed enzymes may cause metabolites to diverge from one secondary metabolic pathway to another (Conner and Jacobs 1999). Ethical concerns are also important, that a particular technology is in some way "tampering with nature", or that unintended effects are unpredictable and thus unknown to science (Miles and Frewer 2001).

9) Economic Hazards: Elimination of competition, GM seeds are patented (must buy each year),This presents problems for poor farmers in both the developed and developing worlds, The most influential factor in consumer-perceived risk from these foods is concern about health (Martinez- Poveda et al. 2009).

10) Suicide seeds: Plants with sterile seeds that are infertile are created, Farmers are forced to buy seeds every year

Advantages and Disadvantages of GM Animals

Advantages

1) Transgenic animals are used for the study of regulation of gene expression – They provide a true in vitro environment for the study of gene expression and its regulation in the adult and during development;

2) In Biomedical Research- They are used as models for the study of causes and remedy of human diseases. Eg. the **oncomouse** (a transgenic mouse) for cancer. They are used as bioreactor for the production of pharmaceuticals and other useful products. Eg. Transgenic cows to produce disease-fighting human antibodies in the plasma of their blood. Used as donors for organ transplant in humans. Eg. Transgenic pigs are used for transplants of hearts, kidneys cells etc. since pig organs and cells would be safer as they would be free of HIV or hepatitis.

3) As food- Transgenic animals have been developed which are fast growing, contain leaner meat, convert food more efficiently and resist diseases. These are therefore suitable as food.

Disadvantages

Usually leads to breeding problems, Low survival rate of transgenic animals. Can lead to mutagenesis and functional disorders, For transgenic pigs, the pollutant phytase is discharged, Transgenic sheep is a difficult and expensive procedure, Expensive, some changes in environmental cycles (Insects not being able to eat their usual food and needing to find new food sources), Is a lengthy process, Can lead to injury to the organism's legs due to being heavier than they are intended to be, Transgenic animals could escape into natural environment (Salmon choose their mate based on size. If a four hundred pound transgenic salmon fish escapes to the natural environment it would reproduce rapidly. This is bad because transgenic salmon have decreased life expectancies due to decreased swimming ability)

CONCLUSION

While GMOs offer many potential benefits to society, the potential risks associated with them have fueled controversy, especially in the food industry. Many skeptics warn about the dangers that GM crops may pose to human health. For example, genetic manipulation may potentially alter the allergenic properties of crops. However, the more-established risk involves the potential spread of engineered crop genes to native flora and the possible evolution of insecticide-resistant "superbugs." In 1998 the European Union (EU) addressed such concerns by implementing strict GMO labeling laws and a moratorium on the growth and import of GM crops. In addition, the stance of the EU on GM crops has led to trade disputes with the United States, which, by comparison, has accepted GM foods very openly. Other countries, such as Canada, China, Argentina, and Australia, also have open policies on GM foods, but some African states have rejected international food aid containing GM crops. The use of GMOs in medicine and research has produced a debate that is more philosophical in nature. For example, while genetic researchers believe they are working to cure disease and ameliorate suffering, many people worry that current gene therapy approaches may one day be applied to produce "designer" children or to lengthen the natural human life span. Similar to many other technologies, gene therapy and the production and application of GMOs can be used to address and resolve complicated scientific, medical, and environmental issues, but they must be used wisely.

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