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USE OF PLANT BIOTECHNOLOGY IN CROP IMPROVEMENT AND GENETIC ENGINEERING

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Abstract
The power of genetic engineering has made it possible to modify the genetic makeup of agricultural plants. Transgenic technology, often known as recombinant DNA technology, is responsible for this. Plants in a crop may have a lot of desirable traits, but the presence of even a few undesirable traits might cause the crop's area and output to be severely constrained. Because of this, many farmers have been forced to switch to growing other types of food. Issues brought on by biotic and abiotic stressors may also be addressed with the use of recombinant technologies. There is always a chance to take stock of human endeavor in a given field and plot a course for the future because to the fluid nature of time. Researchers are required to respond to the dynamic global situation in which they work since science and technology cannot exist in a vacuum. Conclusion New plant features and varieties developed using plant biotechnology need to be mass-produced to be economically viable and to meet the needs of both commercial producers and the general public.
Keywords:*Plant biotechnology; crop improvement; genetic engineering; plant tissue culture.*

1. Introduction

For more than a century, plant breeding has played a significant role in raising agricultural productivity. Continued attempts have been undertaken to breed a single line or genotype with desired traits like as disease tolerance, greater yield, abiotic stress tolerance, etc. Crop development is based on the characteristics of originality, stability, uniformity, and usefulness, which a breeder accomplishes by combining the use of traditional breeding with biotechnology tools; this focus of plant biotechnology enhances breeding for crop improvement.

Crop plants have been in need of improvement for better yield, improved quality, and to meet altering human tastes ever since agriculture was first developed. This is becoming an increasingly pressing issue, particularly in developing nations where the population is continually rising.

No doubt, human-initiated genetic change of plants started about a long time back, when human farming exercises initially started, through the determination of novel sorts, and numerous helpful results were regularly the consequence of irregular or chance occasions. The revelation of the genetic regulations and the improvement of sub-atomic instruments for investigating plant science prompted the accessibility of particular crops since plant rearing turned into an arranged and unsurprising movement. To feed the world's growing population of 6.109 billion people, conventional plant breeding methods have proven fairly successful. Breeding efforts, together with the introduction of novel genes from wild species, have resulted in astounding diversity among existing crop species and the development of whole new crops like triticale. Current trends in agricultural production suggest that the increasing need for food, fiber, and fuel cannot be met by using just traditional practices. Yield gains for several staple crops have stalled or are falling behind the pace of population growth. Farmers in South and Southeast Asia must continually produce 30% more cereals to ensure food security and maintain current levels of nutrition. Closing the gap in yield improvement offers a challenging job for biotechnology. The availability of less land and water makes this task no less difficult. Feasible answers for these new difficulties might be created with the assistance of plant biotechnology and, later on, nanotechnology to support plant reproducing endeavors.

Biotechnological approaches

Vegetable quality and quantity have been improved using a variety of biotechnological techniques. Based on their understanding of DNA, scientists are effective in extracting the desired gene, transferring it, and integrating it into the host species. Improvements are made feasible by plant biotechnology that are not attainable via conventional crossing of related species alone. These strategies have been succinctly worked.

Genetic engineering

Vegetable crops may benefit from modern genetic engineering in terms of quality, production, and value. To create GM crops, which are grown commercially in many nations, it entails altering the genetic makeup of the host plant by introducing new genes for increased agronomic performance and/or enhanced nutrition. The production of vegetable crops with many advantageous and development qualities, such as flavors and fragrances, sizes, harvest durability, colors, tastes, resistance, etc., has also benefited greatly from genetic engineering.

Tissue culture

Tissue culture is the in-vitro regeneration of plants using only healthy plant components. By using a process known as micro-propagation, clones of a plant may be produced. Citrus, pineapple, avocado, mango, banana, coffee, and papaya are some examples of crops grown utilizing tissue culture.

2. Literature Review

2.1. Process of Plant Genetic Engineering

Genomic engineering represents a cutting-edge technique for modifying human DNA. It is the deliberate insertion of one or more foreign genes into an organism's DNA. A gene contains the data that will determine an organism's traits. The restrictions of conventional plant breeding are not applicable to genetic engineering. The genes for one or more features are physically transferred into another creature by genetic engineering. There are five steps that must be accomplished before any genetic engineering may take place. DNA extraction is the underlying move toward the genetic engineering process. As per Berg and Mertz (2010), quality cloning is the second move toward the field of genetic engineering.

During DNA extraction, the whole DNA in a creature is eliminated without a moment's delay. Researchers use quality cloning to make a great many duplicates of a solitary quality by detaching it from an enormous assortment of different qualities. In the wake of cloning a quality, the following stage for genetic specialists is to change the quality with the goal that it could be utilized in an alternate creature. Assuming that the DNA succession is known however no duplicates of the quality exist, it is possible to integrate one (Liang et al., 2011).

The changed quality is prepared for the subsequent stage all the while, change or quality inclusion. It would be challenging to insert a transgenic copy into each of the millions of cells that make up a plant. Tissue culture is used to multiply callus, which is composed of many undifferentiated plant cells (Byrne, 2014). James (2013) records numerous normal strategies, including the quality cannon, agrobacterium, microfibers, and electroporation.

Gene gun: Transgene parts are covered on little gold or tungsten pellets and shot at high speeds into plant cells or tissues utilizing this strategy. The DNA part from the pellet may once in a while clear its path through the cells and in the long run get integrated into a plant chromosome in the core. (Byrne, 2014).

Agrobacterium tumefaciens: The soil-dwelling bacteria Agrobacterium tumefaciens serves as the organic vector in this method; it transmits a portion of its DNA to plants and has been linked to the development of coronary nerve disease in humans. The infectious potential of this DNA transfer method has been reduced by geneticists. Gene transfer may be facilitated by co-cultivating bacterial and plant cells in a petri dish. Although this method allows for more controlled gene insertion than the gene cannon, not all plant species respond positively to it (James, 2013).

2.2. Crop enhancement via the use of genetic engineering

Generating insecticide and insecticide resistance in crops was the first and most profitable application of GM. Incorporating environmental stressor tolerance into crop cultivars is a hot topic right now as farmers try to keep yields stable in the face of unpredictable weather and other factors. In an attempt to fight hunger in underdeveloped countries and cater to the dietary preferences of naturalists, a number of transgenic cultivars with enhanced nutritional properties have been made public. Crop development with chemicals has also been successful to some extent.

Plants are used as hosts for medicinal goods and as a component of industrial value (Singh and Singh, 2014). Water and supplement pressure, high temperatures, and compacted soils with high impedance essentially decrease crop creation, which must all be survived assuming we are to accomplish practical agriculture and feed the world's growing populace. In this review, we talk about these developments and how the information they have created might be used to the development of efficient methods for genetically or genome-editing crops (Lopez-Arredondo et al., 2015).

3. Genetic Engineering Of Crops

Generating insecticide and insecticide resistance in crops was the first and most profitable application of GM. Incorporating environmental stress tolerance into crop cultivars has recently attracted a lot of research in an effort to maintain production under changing environmental circumstances.

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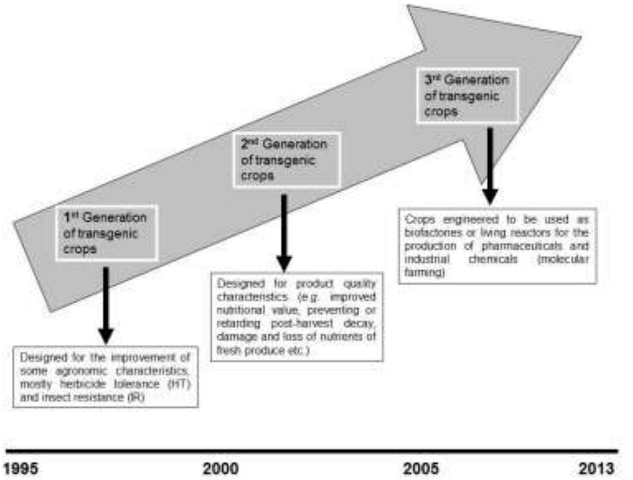

Figure 1: Genetically modified crop research and development.

Malnutrition in underdeveloped nations may be reduced by consuming one of many transgenic strains that have increased nutritional content and are now available to the public. Improvements have been made in both the cultivation of plant-based medicines and their usage as medicinal product hosts.

3.1. Field Crops

The majority of crops grown by American ranchers are transgenic strains developed to generate higher profits. Half and half corn has been known for quite some time because of its excellent productivity. Processed oils (high in lauric, myristic, and oleic acids) are currently 79%, 70%, 32%, and 24% effective against pests and infection control (papaya ring spot infection, cucumber mosaic infection, and zucchini yellow mosaic), respectively. % ranked. Infection, watermelon mosaic infection, potato scroll infection, and) potato infection Y) and male sterility (barnase/barstar). These crops are grown in 4–17 different countries. Unfortunately for plants, most of the phosphorus (P) in soil is insoluble. A technique to overproduce citric acid in tobacco plants (Nicotianatabacum L.) has been shown to enhance the plant's ability to incorporate insoluble phosphorus into the soil. Researchers are endeavoring to further develop photosynthesis in C3 plants by overexpressing C4-cycle proteins with an end goal to support yield, however more work is expected to accomplish this objective. A new exploration has shown the capability of the transgenic innovation in expanding rice creation by distinguishing various elements that might be addressed to create transgenic for business reception and development. The qualities for an iron-restricting protein and a chemical that makes iron open have been acquainted into rice with produce genotypes with expanded iron substance. The nutritional value of several crops has been studied extensively, with variable degrees of success. Scientists have worked to improve the quality of many different types of crops by altering their genetic makeup in order to make them more resistant to disease, more delicious, and more nutritious.

Table 1: Examples of transgenic crops that target a certain trait or characteristic to boost crop yield.

Scientific name	Common name	Trait/quality	Target gene product/gene/source
Beta vulgaris	Sugar beet	Herbicide tolerance (glyphosate)	5-Enolypyruvylshikimate-3-phosphate synthase (EPSPS), CP4 strain of Agrobacterium tumefaciens
Glycine max L	Soybean	Herbicide tolerance (glufosinate ammonium) Carotenoids and vitamin E Fats and oil Protein Heat shock protein	Phosphinothricin acetyltransferase (PAT), Streptomyces viridochromogenes Alpha-tocopherol Omega-3-fatty acid; increased oleic acid Methionine enriched glycinin P5CR-Increased proline accumulation
Gossypium hirsutum L.	Cotton	Insect-resistance Increased ethanol production	cry1F gene, from Bacillus thuringiensis var Aizawa ADH (Alcohol dehydrogenase)
Helianthus annuus	Sunflower	Herbicide tolerance (imidazolinone) Fats and oil	By selection of a naturally occurring mutant Docosahexaenoic

3.2. Pharmaceutical Crops

Recombinant proteins, such as industrial and therapeutic proteins, and other secondary metabolites have been demonstrated to be producible in plants via genetic modification studies. Although several compounds have been developed in transgenic plants and are currently undergoing clinical trials, none of them have been approved for use in humans as of 2012. The main Plant Made Drug (PMP) was created in carrot tissue and given the go-ahead by the US Food and Medication Organization for use in treating the uncommon genetic illness Gaucher. A few plants are presently in different progressive phases as unrefined components for the creation of drugs or biologics with applications in the conclusion, treatment, and counteraction of illness in the two people and creatures.

Recent studies suggest that transgenic plants might be used to safely produce complex therapeutic mammalian proteins in huge quantities at cheap cost. Various plant and crop seeds were used to establish the pharmaceutical and agricultural business. Saklani and Kutty provide a detailed review of the preliminary clinical status of herbal compounds, with a particular focus on herbal anticancer therapies. Incorporating plants as bioreactors is a successful way to address frontier problems, especially in clinical settings.

Table 2: Plant-made medications for human consumption are in various levels of regulatory approval.

Product	Crop	Class	Application	Status	Organization
Glucocerebrosidase ELELYSO/UPLYSO	Carrot cell culture	Therapeutic enzyme	Gaucher's disease	US FDA approved, May, 2012	Protalix
Alpha-galactosidase (PRX-102)	Carrot cell culture	Therapeutic enzyme	Fabry's disease	Phase I/II	Protalix
Acetylcholesterase (PRX-105)	Carrot cell culture	Therapeutic enzyme	Biodefense	Phase I	Protalix
Apo-A1Milano	Safflower	Therapeutic protein	Cardiovascular disease	Preclinical	SemiBioSys Genetics
Human serum albumin	Flax	Therapeutic protein	Maintenance of blood plasma pressure	Preclinical	Agragen

Production of antibodies in which abrupt volume increases are of the utmost importance. A large variety of species suitable for use in bioreactors may also be found in plants. The yield of recombinant protein from tobacco, maize, soybeans, and alfalfa has reached 20 kg/ha. New plant expression methods allow for rapid turnover and high yield molecular farming in a closely regulated environment in suspension-cultured cells of duckweed, moss, algae, and higher plants. Plants might be changed with mammalian glycosyltransferase or held in the endoplasmic reticulum to deliver plant-determined antibodies with carb profiles that are viable with those of people. These progressions recommend that plant articulation could supplant expensive and dangerous microbial or mammalian frameworks, particularly for the production of enormous amounts of recombinant multimers.

4. Current Status Of Genetically Engineered Crops

In the US, transgenic crop creation and appropriation are managed by the Creature and Plant Wellbeing Examination Administration (APHIS). APHIS classifies phenotypic characteristics as follows: a) agronomic qualities; b) resistance to bacteria; c) resistance to fungi; d) tolerance to herbicides; e) resistance to insects; f) resistance to marker genes; g) resistance to nematodes; h) other characteristics; i) product quality; and j) resistance to viruses. APHIS awarded 2192 licenses in total for various phenotypic features. The category was led by other characteristics (OO), herbicide tolerance (HT), and agronomic qualities (AP), which each contributed 34.53, 21.94, and 20.12 percent. More than 75% of the permits granted were for permits for other qualities. Every phenotypic category may comprise one or more features, and each phenotype category may have several phenotypes. According to FAO statistics, there are thousands of distinct GMOs in various stages of commercialization in developing nations.

Transgenic crop planting has increased at a far faster pace in underdeveloped countries than in industrialized countries since 1996. Assuming the latest developments continue, by 2015 he will have more than 40 countries adopting his GM crops.

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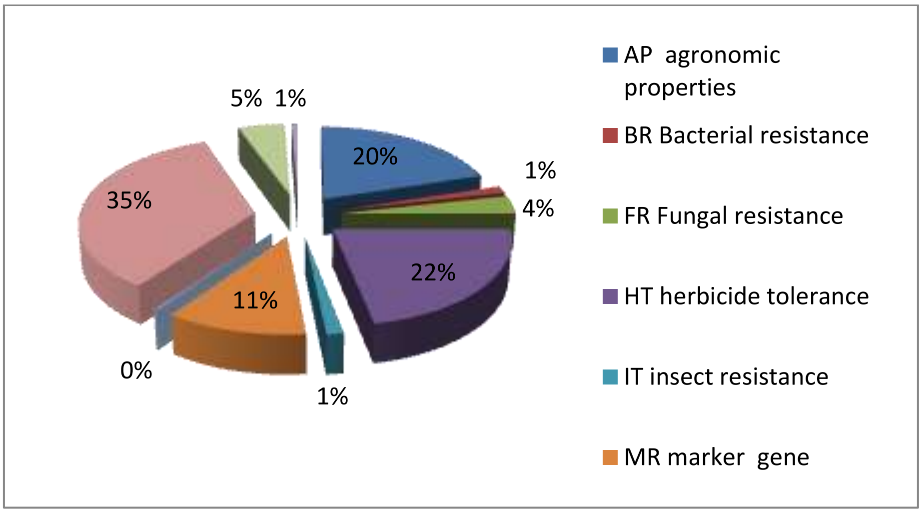

Figure 2: Total number of transgenic crop licences awarded in the United States by phenotypic

Table 3: The prevalence of GMOs at various phases of development in emerging nations

Region/(GMOs)	Experimental phase	Field trial	Commercial phase	Not specified
Asia (543)	453 786	221	44	86
Africa (94)	62	47	33	-
Latin America and Caribbean (474)	67	342	24	78
Europe (31)	20	4	3	3
Near East (46)	47	1624	3	3
Grand total 1188	723	451	43	64

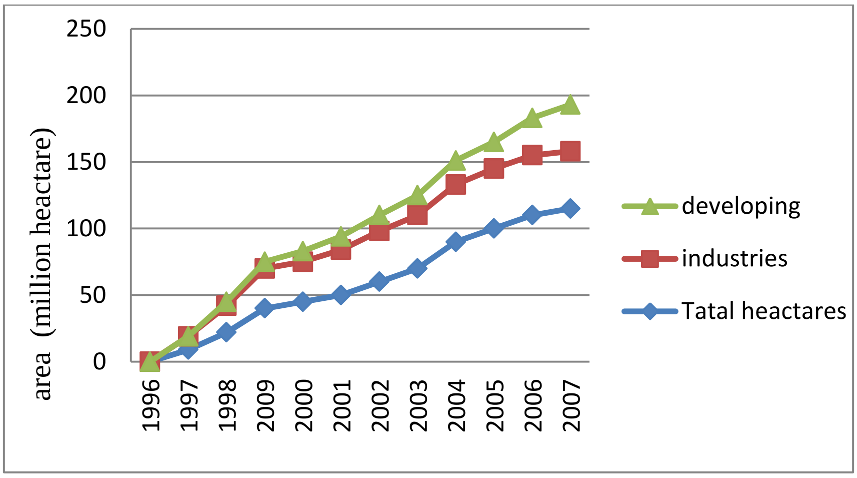

Figure 3: Comparison of the rising worldwide area planted with genetically modified crops in poor and developed nations

- **Strategies for Overcoming Obstacles in Genetic Engineering**

There is debate around the quick commercialization of transgenic technologies. Possibly adverse consequences on non-target creatures, quality stream into related wild species, and natural tirelessness of quality items are the super logical worries concerning transgenic crop utilization.

The transgenic technology industry is still developing and confronts several difficulties. First of all, the position and quantity of copies of the gene inserted cannot be precisely controlled by the techniques of gene insertion now in use. Due to the location's significant impact on gene expression, if a gene insertion is not done properly, this might lead to the "silencing" of the introduced gene or even the native genes. The instability of transgenic traits may have unintended consequences for plant fitness and utility metrics including fertility, yield, and others if they are passed down across several generations. The implanted

DNAs often include numerous stacked genes that might interact unfavorably with the host plant. Gene expression often takes the form of pleiotropy. As a result, a gene that is associated with a desirable feature may have unanticipated negative side effects. When soil moisture was a constraint, Soybean biomass and seed yields were shown to be reduced when glyphosate was applied for weed control.

There is concern that when BT crops are produced year after year, insect populations may become immune to cry proteins. This anxiety is understandable given that it has previously occurred after the repeated application of a pesticide. The only method to defeat the danger posed by insects' developed resistance is to incorporate new defensive mechanisms into the plant or construct several protection barriers. The two BT-quality cry1Ac and cry2Ab2 in Bollgard II cotton are excellent examples of a perturbed protective barrier that makes it difficult for insects to receive protection from two proteins simultaneously. Transgenic rearing, as customary reproducing, should be progressing notwithstanding inescapable nuisance attack of the obstruction.

5. Conclusion

For changing the genetic makeup of agricultural plants, genetic engineering has emerged as a potent tool. It is accomplished using recombinant or transgenic DNA technologies. The agricultural plants have a lot of desirable traits, but since they also have one or a few undesirable traits, their growth and output are constrained. Because of this, the farmers are compelled to switch to other crops. Recombinant technology is beneficial in addressing issues brought on by biotic and abiotic stressors.

The present moment always presents a chance to consider how people have behaved in a certain field and to choose a course of action for the future. Since science and technology cannot exist in a vacuum, researchers must adapt their work to the constantly shifting global environment in which they operate. We may draw the conclusion that plant biotechnology is an effective tool for creating novel plant features and varieties, and that these novel varieties must be generated in huge quantities in order to be successful commercially and to meet demand from producers and consumers as a whole.

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