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# Benefits of biotechnology in agriculture: Review article

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**Abstract**
Biotechnology is one of the quickest developing areas in science that made an extraordinary improvement in different fields like agriculture, medicine, drug industry, and environment science. Modern biotechnology normally thinks about the natural processes of DNA replication, breakage, ligation, and repair. Inside agriculture, the key objective of current biotechnology is to work on the quality, quantity, nutrition, taste, and shelf life of produce, ultimately enabling stakeholders to obtain greater yield with reduced energetic costs. Biotechnologists accept that biotechnology resembles a miracle and could assist us with accomplishing supportability in agriculture. To accomplish such changes it is fundamental for specialists to reevaluate the connections between farmers, industry, consumers and universities.

**Keywords:** agriculture, biotechnology, genetic engineering, *Agrobacterium*

## Introduction
Biotechnology is a multidisciplinary field that significantly affects our lives. The innovation is known for a year which includes working with cells or cell-inferred particles for different applications. It has a wide scope of employment and is named "innovation of trust" which impacts human wellbeing, the prosperity of other living things, and our current circumstance. The expression "biotechnology" was authored by Hungarian designer Karl Ereky, in 1919, to indicate the science and technique that grant items to be created from unrefined components with the guide of living organic entities. Biotechnology is characterized as: "Biotechnology is the coordinated utilization of natural chemistry, microbial science, and designing sciences to accomplish the innovative (modern) use of the abilities of miniature organic entities, refined tissue cells." Biotechnology is the name given to the technique and methods that include the utilization of living organic entities like microorganisms, yeast, plant cells, and so on, or their parts or items as instruments (for instance, qualities and chemicals). They are utilized in a few fields, horticulture, pharmaceutics, food handling, and medication, among others (Horsch R.B *et.al.* 1985) [6].

## Objectives of biotechnology
- To see more with regards to the course of legacy and quality articulation
- To give better agreement and treatment of different infections, especially genetic problems.
- To create financial advantages, including further developed plants and organisms for horticulture and effective creation of important natural atoms.

## Scope and Importance of Biotechnology
Biotechnology is the controlled utilization of biological agents for beneficial use. It is incorporated the utilization of biochemistry, molecular biology, microbiology to achieve the technological application of the capabilities of biological agents. Along these, biotechnology has arisen as a science with enormous potential for human government assistance going from food handling, human wellbeing to climate security. The field of genetic engineering remaining parts a warmed subject of conversation in the present society with the advent of gene therapy, stem cell research, cloning, and genetically modified food.

## Industrial Applications of Biotechnology
This is a region wherein biotechnology was started for the enormous scope creation of liquor and anti-toxins by microorganisms. Indeed, even today, an assortment of drug medications and synthetics like lactic acid, glycerin, and so forth are being delivered by genetic engineering for

better quality and amount. Microorganisms are becoming significant instruments for modern cycles. Microorganisms are exceptionally helpful and appropriate for modern cycles on account of the accompanying reasons.

a) They can be created in huge numbers since they have high development and augmentation rates which can undoubtedly be controlled.
b) The capacity to increase and develop quick outcomes in more significant returns and explicitness of items than traditional cycles.

**Biotechnology in Medicine**

Creation of a monoclonal antibody, DNA, RNA probes for analysis of different infections; important medications like insulin and interferon have been integrated by bacteria for the treatment of human disease (Kim & Yang 2010) [7]. DNA fingerprinting is used for distinguishing proof of guardians and criminals. The advancement of recombinant vaccines like human hepatitis B and genetically engineered microorganisms incorporate the rundown of remarkable accomplishments.

**Biotechnology and Agriculture**

A cycle to create a genetically modified plant by eliminating genetic information from an organism, controlling it in the research facility, and afterward moving it into a plant to change sure of its attributes **(**Rommens, CM. 2007) [12]. In Nutshell it's the control of plants to serve humanity. Genetic engineering methods are used to create transgenic plants with advantageous qualities like disease resistance, herbicide resistance, the increased shelf life of fruits, etc. and so forth Additionally, molecular breeding has rushed the course of crop improvement for example molecular markers like RFLP, SSRs give useful tools to aberrant choice of both qualitative and quantitative attributes and for concentrating on genotypic diversity (Nadeem MA *et.al.* 2018) [10] (Sharma, HC. 2002) [14].

**Biotechnology and Environment**

Ecological issues like contamination control, depletion of natural resources for non-renewable energy, conservation of biodiversity, etc are being dealt with using biotechnology. For example, microscopic organisms are being used for detoxification of modern effluents, in fighting oil slicks for treatment of sewage, and in biogas creation (Dash, A 2016) [3]. Bio-pesticides give a naturally more secure option in contrast to synthetic pesticides for the control of insect pests and diseases.

**Genetic engineering for crop improvement**

The exchange of genes between plant species has assumed a significant part in crop improvement for a long time. Plant improvement whether because of normal determination or the endeavors of plant breeders has consistently depended upon after developing, assessing, and choosing the right combination of alleles. Valuable characteristics like resistance to disease, insects, and pests have been transferred to crop varieties from non-cultivated plants (Choudhary, K 2008) [1]. Beginning around 1970 quick advancement is made the developing the tools for manipulating genetic information in plants by recombinant DNA methods. The improvement of the different methods for plant recovery and change has empowered the creation (Stein A & Emilio RC. 2010) [16].

**Genetic transformation**

Genetic transformation offers direct admittance to an immense pool of valuable qualities not already available to plant breeders. Current genetic engineering techniques permit the synchronous utilization of a few advantageous qualities in a solitary occasion, subsequently permitting composed ways to deal with the presentation of novel qualities/attributes into the first-class foundation. The needs for applied transgenic research are like those of ordinary plant breeding, planning to specifically modify, add or eliminate a particular person to address territorial imperatives to usefulness. Genetic engineering additionally offers the chance of presenting a desirable character from intently related plants without related harmful qualities or from related species, which don't promptly cross with the harvest of interest or from totally disconnected species even in other ordered phyla. In numerous species, the improvement of fast, exceptionally productive, and routine change frameworks is as yet in progress and subsequently addresses a bottleneck in the advancement of stable high-yielding transgenic plants. The turn of events and arrangement of transgenic plants in a successful way is a significant essential for the practical and monetary utilization of biotechnology for crop improvement (Mittler, R & Blumwald, E 2010) [9]. Because of advances in genetic transformation and gene expression during the last decade, there has been fast advancement in utilizing genetic engineering for crop improvement as far as herbicide tolerance, pest resistance, and male-sterility frameworks. The capability of this innovation has now been generally perceived and widely taken on in plant breeding.

Plant genetic engineering arrangements with the exchange of the ideal quality from the source to the desired organism. Not all genetic engineering methods include embedding DNA from another organism (Lalitha SK. 1999) [8]. Plants may likewise be changed by eliminating or turning off specific qualities and genetic controls. When the code of the quality that decides the desirable characteristic is recognized, it tends to be chosen and transferred. Also, qualities that code for undesirable attributes can be taken out. Transgenic plants are developed by coordinating the utilization of recombinant DNA technology, gene transfer technique, and tissue culture technique. The term transgene is utilized to address the moved gene and the genetic transformation in plants is extensively alluded to as transgenic plants.

With traditional plant breeding, there is almost no assurance of acquiring a specific quality mix from the large numbers of crosses produced. Unfortunate genes can be moved alongside desirable genes or while one desirable gene is acquired conversely, genetic engineering permits the immediate exchange of one or only a couple of genes, between either intently or remotely related organisms. genes found in any organism can be utilized to further develop crop production Current genetic engineering techniques permit segments of DNA that code genes for a particular characteristic to be chosen and independently recombined in the new living being.

***Agrobacterium* as a tool for plant genetic engineering**

During the beyond twenty years, we have seen a huge expansion in the number of reports on the fruitful Agrobacterium-mediated genetic transformation of different plant species, variants and cultivars. However, just in the beyond twenty years has the capacity of *Agrobacterium* to transfer DNA to plant cells been bridled for the reasons for

plant genetic engineering. Since the underlying reports in the mid-1980s utilizing *Agrobacterium* to produce transgenic plants, researchers have endeavored to work on this "natural genetic engineer" for biotechnology purposes (Sharma HC. 2001) [13]. A portion of these adjustments has brought about expanding the host scope of the bacterium to financially significant crop species (Dunwell JM. 2000) [4]. In any case, in many cases, significant upgrades included modifications in plant tissue culture change and transformation and regeneration conditions rather than control of bacterial or host genes. Agrobacterium-mediated plant transformation is an exceptionally perplexing and advanced interaction including genetic determinants of both the bacterium and the host plant cell.

**Molecular basis of Agrobacterium-mediated transformation**

**What Is T-DNA?**

The molecular basis of genetic transformation of plant cells by *Agrobacterium* is moved from the bacterium and combination into the plant nuclear genome of a region of a large tumor-inducing (Ti) or rhizogenic (Ri) plasmid resident in *Agrobacterium*. Ti plasmids are on the order of 200 to 800 kbp in size. T-DNA is a little, specific segment of the plasmid, about 24kb in size, and found incorporated in the plant nuclear DNA at a random site. This DNA portion is flanked by both ways borders. The T-DNA contains two groups of genes, the initial one is Oncogenes for the blend of auxins and cytokinin (phytohormones). The overproduction of phytohormones prompts the expansion of callus or growth development. Second, Opine synthesizes genes for the synthesis of opines (a product from amino acids and sugars emitted by the crown gall infected cells and used by *A. tumefaciens* as carbon and nitrogen sources). Along these opines go about as a wellspring of supplements for bacterial development, for example, Octopine, Nopaline. T-regions are characterized by direct repeats known as T-DNA border sequences (Right and Left border for example RB and LB of 25 bp each). These are not moved unblemished to the plant genome, be that as it may, are engaged with the transfer process. The RB is somewhat exact, yet the LB can shift by around 100 nucleotides. Deletion of the RB repeat abolishes T-DNA transfer, however, the LB is by all accounts unnecessary. The LB repeat has little exchange movement alone (Christou P and Harry K 2004) [2].

**DNA transfer into the plant genome**

Injured plant cell releases phenolics substances and sugars which are detected by vir A, vir An actuates vir G, vir G induces expression of vir gene of Ti-plasmid; vir gene produces all the vir - protein; vir D1 and vir D2 are associated with ssT-DNA production from Ti-plasmid and its product and the ssT-DNA (with related vir D1 and vir D2) with vir E2 are exported through transfer apparatus vir B; in plant cell, T-DNA coated with vir E2; different plant proteins impact the transfer of T-DNA + vir D1 + vir D2 + vir E2 complex and reconciliation of TDNA to establish nuclear DNA. (LB= left line; RB= Right line; pTi = Ti plasmid, NPC = nuclear pore complex) (Gupta P.K. 2004) [5].

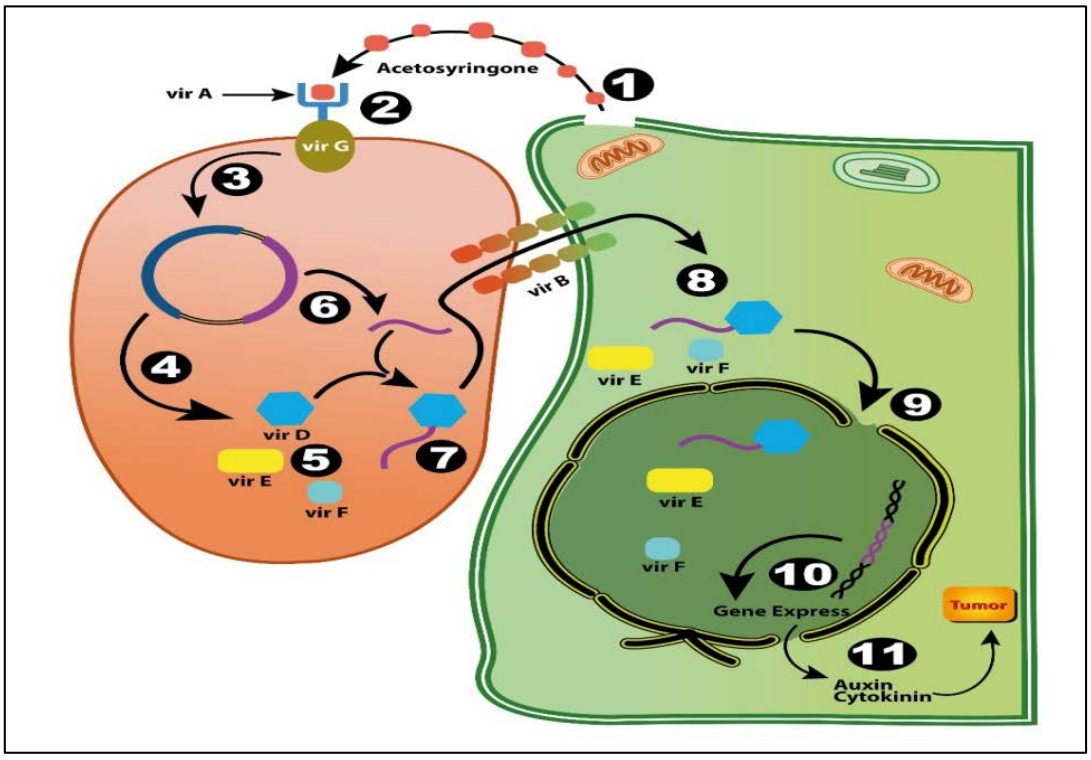


**Fig 1:** Major steps of the *Agrobacterium tumefaciens*-mediated plant transformation process**.**

**Signal acknowledgment by *Agrobacterium* spp.**

The injured plant cells discharge specific synthetic compounds, like phenolics and sugars. These synthetics are perceived by *Agrobacterium* as signs. This thusly brings about a succession of biochemical occasions in *Agrobacterium* that aide in the move of T-DNA of Ti plasmid.

**Attachment to plant cell**

Attachment of this bacterium to plant cells is a two-venture process. It includes an underlying connection by means of a polysaccharide (the result of att R locus). Thusly, a lattice of cellulose filaments is created by *Agrobacterium*. A few chromosomal virulence genes (chv qualities) are associated with the attachment of bacterial cells to plant cells.

**Induction of virulence gene**

vir A (a membrane linked sensor kinase) detects phenolics, (for example, acetosyringone) and autophosphorylates, accordingly phosphorylating and, along these lines, initiating vir G. This enacted vir G instigates articulation of harmfulness gene of Ti plasmid to produce the relating destructiveness proteins (D, D2, E2, B). It has been additionally distinguished that specific sugars (for example glucose, galactose, xylose and so forth) likewise incite virulence genes.

**Production of T-DNA strand**

The right and left border sequence of T-DNA are distinguished by vir D1/vir D2 protein complex and vir D2 produces single-stranded DNA (ss-T-DNA). Subsequent to nicking, vir D2 turns out to be covalently connected to the 5'end of ss-T-DNA strand and protects and exports the ss-T-DNA to plant cells. Transfer of T-DNA out the bacterial cell. The ss-T-DNA – vir D2 complex in relationship with vir E2 is exported from bacterial cells by a 'T-pilus' (a membrane channel secretary system).

**Transfer T-DNA into a plant cell and integration**

The single-stranded T-DNA–vir D2 complex and other vir proteins cross the plant plasma membrane. In the plant cells, T-DNA gets covered with vir E2. This covering of Vir E2 helps in the protection of ss-T-DNA from debasement by nucleases. vir D2 and vir E2 interact with a variety of plant proteins which impact the T-DNA transport and integration. The T-DNA – Vir D2 – Vir E2 – plant proteins complex enters the nucleus through nuclear pore complex (NPC). Figure 1 shows the major steps of the Agrobacterium-mediated plant transformation process. In the nucleus, T-DNA gets integrated into the plant genome by an interaction alluded to as 'ill-conceived recombination. This process is unlike homologous recombination as it does not depend on an extensive region of sequence similarity.

Through many technical innovations, *A. tumefaciens* can now be used to engineer the genomes of many plants well beyond their natural host range.

**Direct Gene Transfer**

The term direct exchange of gene is utilized when the foreign DNA is directly introduced into the plant genome. Direct DNA transfer techniques depend on the conveyance of naked DNA into the plant cells DNA transfer by particle bombardment utilizes actual cycles to accomplish the transformation of crop plants. Particle bombardment is the best strategy for gene transfer and the making of transgenic plants.

The Particle bombardment device, otherwise called the gene gun, was created to enable penetration of the cell wall so that genetic material containing a gene of interest can be transferred into the cell. Today the gene gun is utilized for the genetic change of numerous living beings to present a different range of desirable traits (Ranjan, A, & Khokhani, D 2017) [11].

Plant transformation utilizing particle bombardment follows a similar layout as the Agrobacterium-interceded technique. The means taken include: 1) isolate the genes of interest from the source organism; 2) develop a functional transgenic construct including the gene of interest; promoters to drive expression; codon modification, if needed to increase successful protein production; and marker genes to facilitate tracking of the introduced genes in the host plant; 3) incorporate into a useful plasmid; 4) introduce the transgenes into plant cells; 5) regenerate the plant's cells; and 6) test trait performance or gene expression at the lab, greenhouse, and field level.

The particle bombardment technique begins with coating tungsten or gold particles (microprojectiles) with plasmid DNA. The covered particles are covered on a large-scale shot, which is sped up with gaseous tension and shot into plant tissue on a Petri plate.

A perforated plate is utilized to stop the macro-projectile while permitting the microprojectiles to go through to the cells on the opposite side. As the microprojectiles enter the cells, the transgenes are let out of the molecule surface and may incorporate into the chromosomal DNA of the cells. Selectable markers are utilized to distinguish the cells that take up the transgene. The changed plant cells are then regenerated into entire plants utilizing tissue culture (Singh BD. 2018) [15].

Particle bombardment likewise assumes a significant part in the transformation of organelles, for example, chloroplasts, which empowers the engineering of organelle-encoded herbicide or pesticide resistance in crop plants and to study on photosynthetic cycles. Limits to the particle bombardment method comparative with Agrobacterium-mediated transformation incorporate a continuous mix of numerous duplicates of the transgene at a solitary inclusion site, a reworking of the embedded qualities, and a fuse of the transgene at various addition locales. These multiple copies can be linked to the silencing of the transgene in subsequent progeny.

**Conclusion**

Agriculture biotechnology applications are useful in supporting food production. Biotechnology is a supplement not a substitute for some spaces of conventional agriculture research. It offers a variety of devices to work on our arrangement and the board of genetic resources for food and agriculture. Agriculture biotechnology is a field of agricultural science that utilizes cell and molecular biology tools to work on genetic makeup and agronomic management of crops and animals. There are numerous biotechnology techniques utilized by scientists and researchers in this discipline, which incorporate genetic engineering, marker-assisted selection, hybridization as well as plant tissue culture. Subsequently, a large portion of the utilization of these biotech instruments can possibly work on the occupations of individuals living in regions that are reliant chiefly on agribusiness.

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