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NEWS LETTER

ON

DEPARTMENT OF ENVIRONMENTAL SCIENCE, UNIVERSITY OF KALYANI, NADIA, WEST BENGAL

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INSTRUCTIONS TO CONTRIBUTORS

ENVIS Resource Partner on Environmental Biotechnology publishes two volumes (4 Nos.) of news letter in a year (**ISSN: 0974 2476**). The articles in the news letter are related to the thematic area of the ENVIS Resource Partner (see the website: **http://deskuenvis.nic.in**).

The format of the article as follows:

1. Font should be Times New Roman and font size to be 12 in 1.5 spacing with maximum of 3-4 typed pages.
2. Figures and typed table should be in separate pages and provided with title and serial numbers.
3. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

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EDITORIAL

The rapid increase in human population has become a major threat to resource availability and food security. Agriculture is the core source for food security in India. The development in agriculture also helps for poverty alleviation, sustainable development and nutritional security. Agriculture is regarded as a primary occupation of the individuals in rural areas of India. To feed the increasing population, it is essential to introduce modern and innovative techniques in the agricultural sector. New technologies are required to encourage the yield frontiers to an advanced stage, make use of the inputs resourcefully and diversify to a more sustainable and higher value cropping patterns. Making the significant enhancement of agricultural productivity in the next several decades, efforts of recent developed 'agrobiotechnology' have been concentrated on creating technologies that can increase crop yields. It is use of scientific and engineering principles in the biological materials processing of agents in order to provide goods and services for human use. There has been a strong tie between its existence and societal development.

(Ashis Kumar Panigrahi)

IN THIS ISSUE:

Introduction

The increasing demand of resource for the rapidly growing global population can be solved by applying morden technology, innovative approaches and application of biotechnology. The Agro-biotechnology provides important tools for the development of agriculture, fisheries and forestry which can be meet the food, cloth and selter requirement of rising human civilization. Biotechnology has major applications in many areas such as industrial, including health care (medical), crop production and agriculture, non food (industrial) uses of crops and other products (e.g. biodegradable plastics, vegetable oil, biofuels), and environmental uses (Fig-1). Application of Biotechnology in agriculture involves scientific techniques such as Genetically Modified Organisms, Bt Cotton, Pest Resistant Plants, plant breeding to raise and stabilize yields; to improve resistance to pests, diseases and abiotic stresses such as drought and cold; and to enhance the nutritional content of foods. It also helps in modifying plants, animals, and microorganisms and improvetheir agricultural productivity.

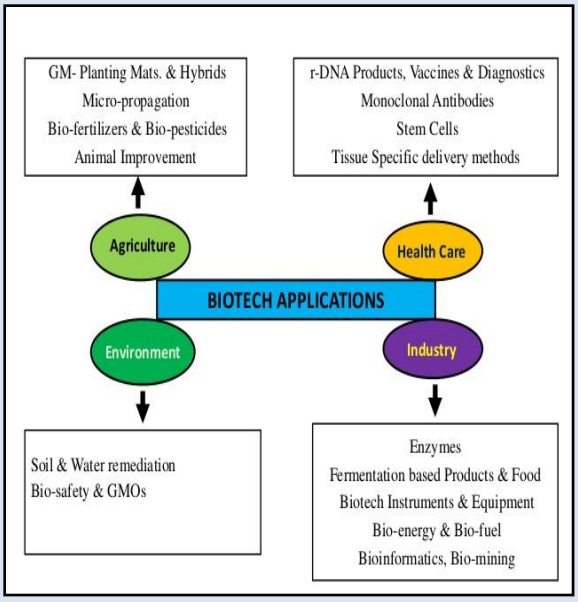

Fig: 1 Biotechnology and its application
Source:https://www.vedantu.com/

Agricultural biotechnology is a collection of scientific techniques and also known as agritech. This is used to improve plants, animals and microorganisms by using the scientific tools and techniques, including genetic engineering, molecular markers, molecular diagnostics, vaccines, and tissue culture. This technology is used to modify living organisms such as plants, animals, and microorganisms to enhances breeders' ability.

Crop biotechnology is one aspect of agricultural biotechnology which has been greatly developed upon in recent times. Desired trait are exported from a particular species of Crop to an entirely different species. These transgene crops possess desirable characteristics in terms of flavor, color of flowers, growth rate, size of harvested products and resistance to diseases and pests (Fig-2).

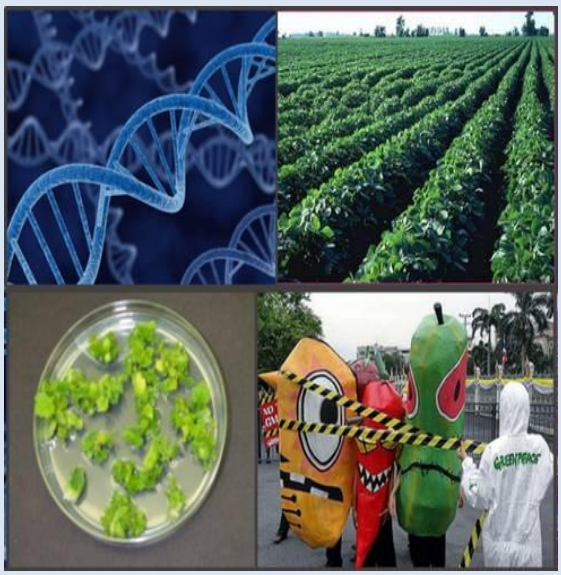

Fig: 2 Biotechnology in Agriculture
Source:https://www.canr.msu.edu

Agrobiotechnology in India

India has a significant role in the emerging economies of the world. It is estimated that India's bio-agriculture sector is currently reached to US$7.8 billion (including genetically modified (GM) crops productiontechnology). Bio agriculture yields better results than traditional techniques while maintaining the stability and fertility of soil. Highyielding seeds significantly enhance the productivity

potential and provide resistance from adverse environmental stress such as drought and salinity (Fig.-3). They are particularly effective and relevant for a country like India that suffers from water scarcity and drought every year. High-yielding seeds also protect crops from diseases and insects. Biotechnologyoffers multiple innovative techniquesto develop high-yielding crops that cancounter the biotic and abiotic stressassociated with Indian agriculture. India's agri-biotech development from cotton and brinjal (eggplant) to other crops as well as relevant trade concerns is growing in importance within a global context.

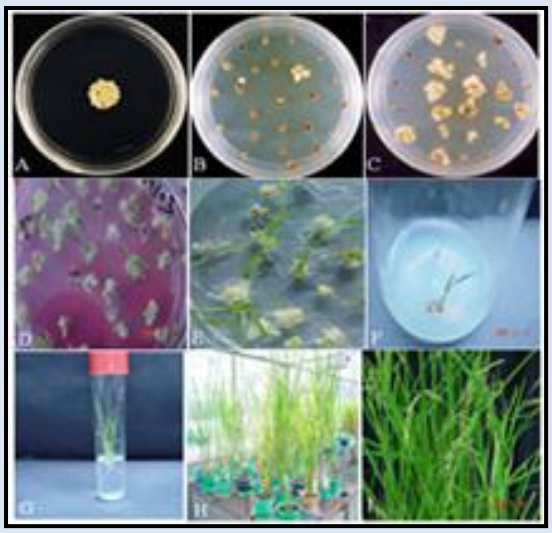

Fig: 3 Biotechnology in Indian agriculture
Source: http://dbtindia.nic.in

In India, Bt cotton, the only GM crop allowed forcommercial cultivation, has witnessed an impressiveadoption rate. Since its commercial release Bt cotton hybrids have been developed and 7.2 millionfarmers have adopted this technology on 11.1m ha area,accounting for 91% of total cotton area in the country.There is a stream of studies showing positive impacts ofBt technology.

The application of biotechnology has spread fromagriculture tochemical and drugs industry. This area of science has great importancein applied research, andin most casesthe new discoveries and innovationshas find direct application to the society. Innovations,techniques, and tools that have emerged andrevolutionized modern biotechnology includegenetic engineering, cell fusion technology,bioprocess technologies, and structure-basedmolecular designs including drug development (Fig-4).

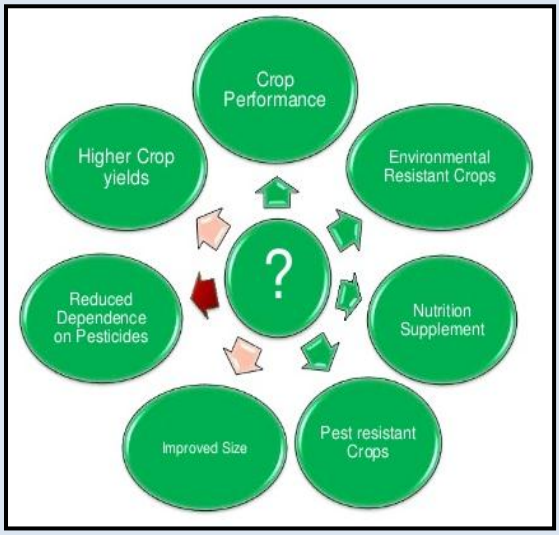

Fig: 4 Benefits of biotechnology in agriculture
Source:https://www.slideshare.net/ruchipriya

Types of Crop Modification Techniques

✓ Traditional breeding

Traditional crossbreedinghas been used for centuries to improve crop quality and quantity. Typically, pollen from one plant is placed on the female part of the flower of another, leading to the production of seeds that are hybrids of the two parents. For example, the honeycrisp apple exhibits a specific texture and flavor due to the crossbreeding of its parents.

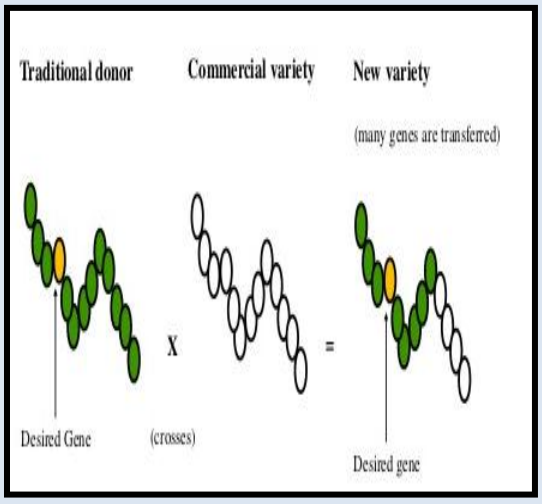

Fig: 5 Traditional Breeding technology
Source: https://www.slideshare.net

In this techniques pollen from one plant is placed on the female part of another,

which leads to a hybrid that contains genetic information from both parent plants. The plant breeders are carefully select the plants with the traits they're looking to pass on and continue to breed those plants. Crossbreeding can only be utilized within the same or closely related species (Fig.-5).

✓ Mutagenesis

Sudden change in nature is called mutation. New traits often arise through the spontaneous mutations.In mutagenesis techniques different mutagenic substances can be applied to induce random mutations to find out the desired trait. The scientists areoften used mutatgenic chemicals or radioactivity sources to generate random mutations in plants, and subsequently screening for new or desired traits (Fig. -6).

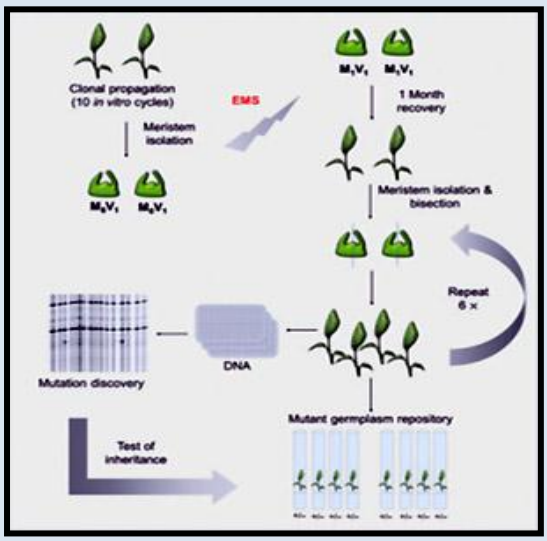

Fig: 6 Meristematicmutagenesis,

Source: http://www-naweb.iaea.org

✓ Polyploidy

Most species have 2 sets of chromosomes. Polyploidy is the occurrence of more than 2 sets of chromosomes. It can occur naturally, but polyploidy can also be induced through the use of chemicals. This crop modification technique is usually used to increase the size of fruits or to modify their fertility (Fig.-7).

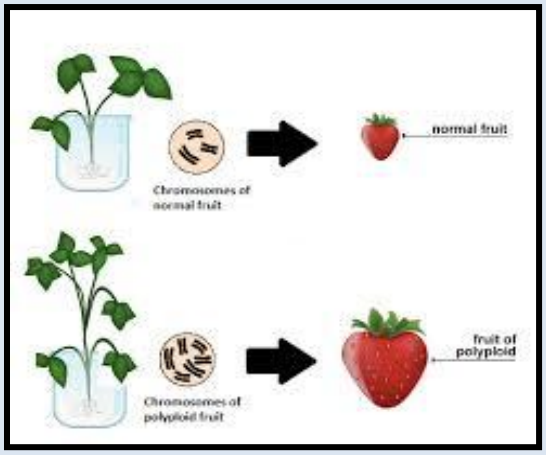

Fig: 7 Polyploid in case of strawberry
Source: http://www.ontrack-media.net/

✓ Protoplast fusion

The protoplast fusion is aartificial techniques to joining of cells or cell components to transfer traits between species and convert two cells into one. Beneficial traits can be moved from one species to another by fusing the protoplasts. For example, the trait of male sterility is transferred from radishes to red cabbages by protoplast fusion. This male sterility helps plant breeders make hybrid crops (Fig.-8).

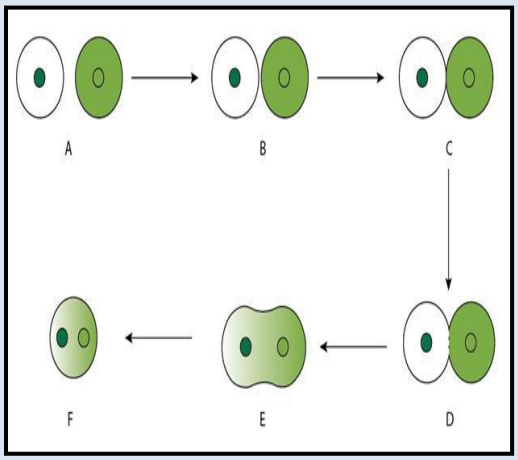

Fig: 8 Sequential stages in protoplast fusion.
Source: https://nptel.ac.in/courses

✓ Transgenics

Transgenicsis the process of insertion of a piece of DNA strand into another organism's DNA in order to introduce a new gene(s) into the original organism tocreates a new variety with desired traits.The desire traits of crops include insect resistance, herbicide tolerance, drought andsalinity tolerance etc. The

transgeniccropscan be created through insertion of genes from same or any other species because the genetic language is universal to all life on this planet (Fig.-9).

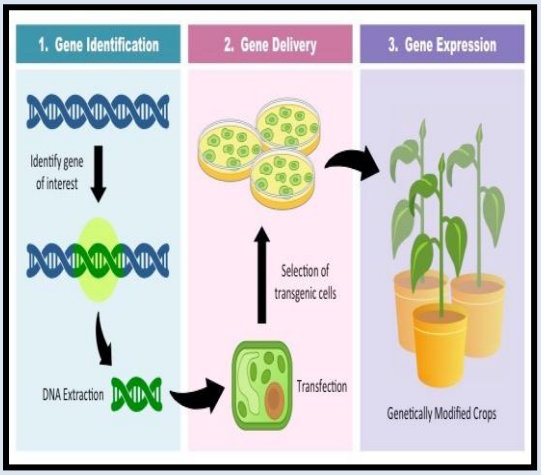

Fig: 9 Producing Transgenic Crops
Source: http://ib.bioninja.com.au

✓ Genome editing

Genome editing is the use of an enzyme system to modify the DNA directly within the cell. Genome editing was used to develop herbicide resistant canola to help farmers control weeds (Fig.-10).

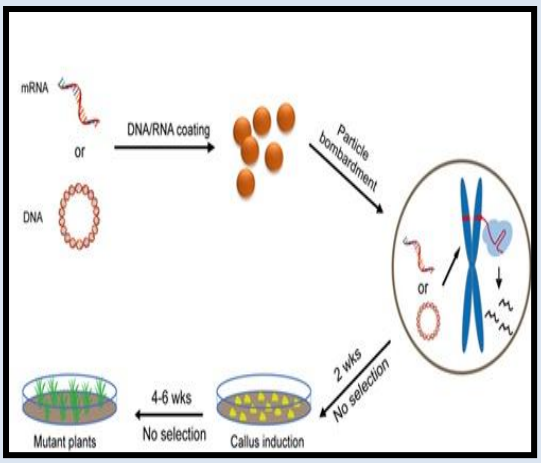

Fig: 10 Overview of the genome-editing methods
Source: http://english.genetics.cas.cn

Applications ofAgricultural Biotechnology

Genetic engineering: Genemoves from one organism to another is called genetic modification (GM), genetic engineering (GE) or genetic improvement (GI). This process allows the transfer of useful characteristics (such as resistance to a disease) into a plant, animal or microorganism by inserting genes (DNA) from another organism (Fig.-11).

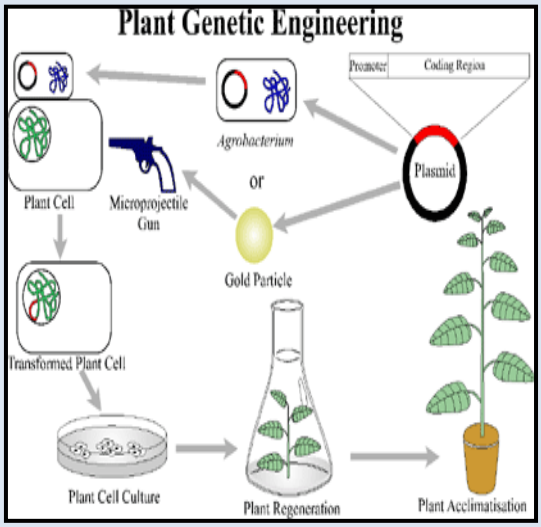

Fig: 11Plant genetic engineering
Source: https://biologyboom.com

Molecular markers: Molecular markers can be selected from plants of traditional breeding of individual plants or animals based on visible or measurable traits. Through analysis the DNA of an organism, scientists can use the molecular markers to select plants or animals that possess a desirable gene, even in the absence of a visible trait. For example, the International Institute of Tropical Agriculture has used molecular markers to obtain cowpea resistant to bruchid (a beetle), disease-resistant white yam and cassava resistant to Cassava Mosaic Disease, among others. The other use of molecular markers is to identify undesirable genes that can be eliminated in future generations (Fig.-12).

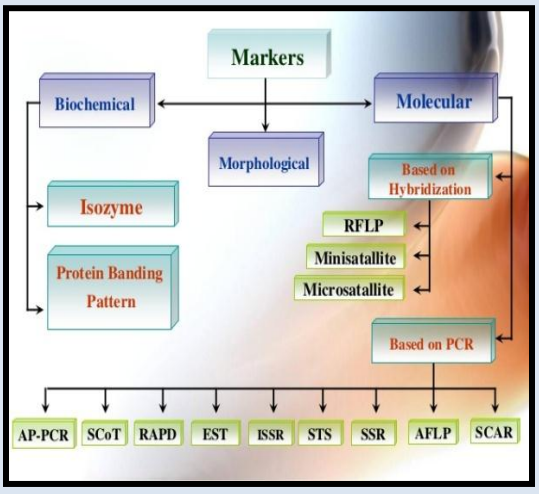

Fig: 12 Molecular marker
Source: https://www.slideshare.net/

Molecular diagnostics: Molecular diagnostics are methods to detect genes or gene products that are very precise and specific. Molecular diagnostics are used in agriculture to more accurately diagnose crop/livestock diseases (Fig.-13).

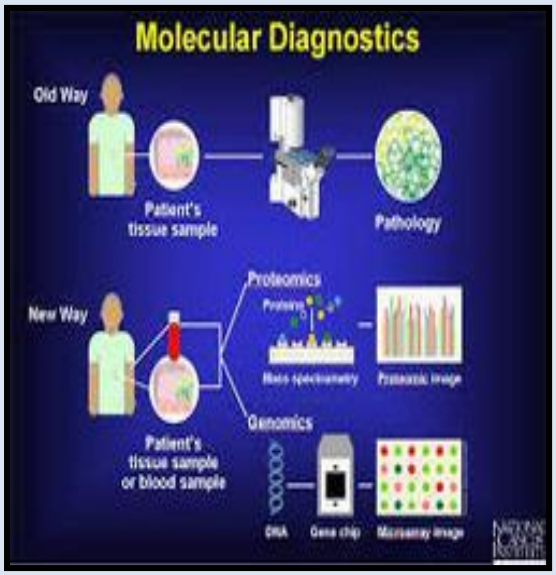

Fig: 13 Molecular diagnostics
Source: https://www.indiamart.com

Vaccines: Biotechnologically derived vaccines which used in livestock and humans are cheaper, better and/or safer than traditional vaccines. These vaccines canstable and store at room temperature, and do not need refrigerated storage; which have great advantage for smallholders in tropical countries. Some new vaccines are developed, which offer protection for the first time against some infectious illnesses. For example, in the Philippines, biotechnology has been used to develop an improved vaccine to protect cattle and water buffalo against hemorrhagic septicemia, a leading cause of death for both species.

Tissue culture: Tissue culture is the regeneration of plants in the laboratory from disease-free plant parts. This technique allows for the reproduction of disease-free planting material for crops. Examples of crops produced using tissue culture include citrus, pineapples, avocados, mangoes, bananas, coffee and papaya (Fig.-14).

Fig: 14Banana Tissue Culture Plants
Source: https://www.indiamart.com

Plant and Animal Breeding

To increading the efficiency of plant and animal traits through traditional agro-technique methods like grafting,cross-pollination, and cross-breeding isa tedious and time-consuming. The advance research in biotechnologythrough specific changes on a molecular level through over-expression or deletion of genes, or the introduction of foreign genes can used for developing superior traits of organisms for socitalbenifits.

Pest Resistant Crops

The microbe *Bacillus thuringiensis*, which produces a protein toxic to insects, in particular, the European corn borer, was used as dust for crop pest protection for years. To eliminate the application of dusting technology, scientists first developed transgenic corn expressing Bt protein, followed by Bt potato and BT cotton. Bt protein is not toxic to human, and transgenic crops make it easier and economic for farmers.The controversy emerged over Bt corn in the year 1999, because of a study that suggested the pollen migrated onto milkweed where it killed monarch larvae that ate it. Subsequent studies demonstrated the risk to the larvae was very small and, in recent years, the controversy over Bt corn has switched focus, to the topic of emerging insect resistance (Fig.-15).

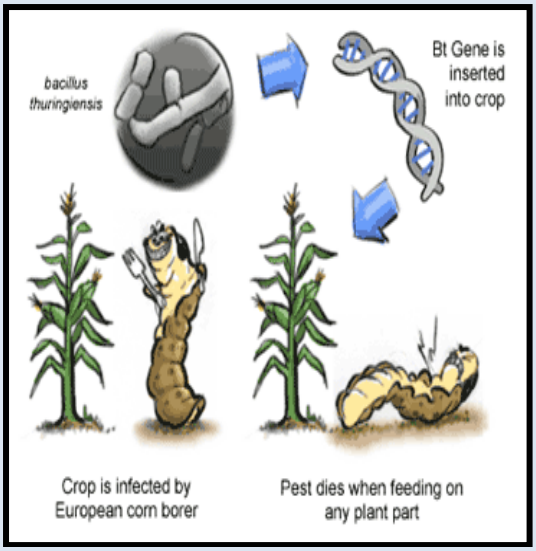

Fig.-15 Pest resistance mechanism
Source: https://www.independent.com

Pesticide-Resistant Crops

The pesticide resistant plants are allowing farmers to killsurrounding selectedweeds of cultivated field without harming their crop. The well known example of this is the Roundup-Ready technology, developed by Monsanto.This was first introduced in 1998 as GM soybeans. The Roundup-Ready plants are unaffected by the herbicide glyphosate, which can be applied in copious quantities to eliminate any other plants in the field. The benefits to this are savings in time and costs associated with conventional tillage to reduce weeds, or multiple applications of different types of herbicides to eliminate selectivespecies of weeds. The possible drawbacks include all the controversial arguments against GMOs(Fig.-16).

Fig.-16 Pest-resistant crops
Source:https://insectcop.net/pest-resistant

Nutrient Supplementation

In an effort to improve human health, particularly in underdeveloped countries, scientists are creating genetically altered foods that contain nutrients known to help fight disease or malnourishment. An example of this is Golden Rice, which contains beta-carotene, the precursor for Vitamin A production in our bodies. People who eat the rice produce more Vitamin A, an essential nutrient lacking in the diets of the poor in Asian countries. There are 3 genes involved in 'golden rice', two from daffodils and one from a bacterium, capable of catalyzing four biochemical reactions, were cloned. The name comes from the color of the transgenic grain due to overexpression of beta-carotene, which gives carrots their orange color (Fig.17).

Fig. -17 Genetically modified, golden rice grains (left) are a deep yellow. At right, white rice grains.

Abiotic Stress Resistance

Less than 20% of the earth is arable land but some crops have been genetically altered to make them more tolerant of conditions like salinity, cold, and drought. The discovery of genes in plants responsible for sodium uptake has lead to the development of knock-out plants able to grow in high salt environments. Up- or down-regulation of transcription is generally the method used to alter drought tolerance in plants. Corn and rapeseed plants, able to thrive under drought conditions, are in their fourth year of field trials in California and Colorado, and it is anticipated that they'll reach the market in 4-5 years (Fig.18).

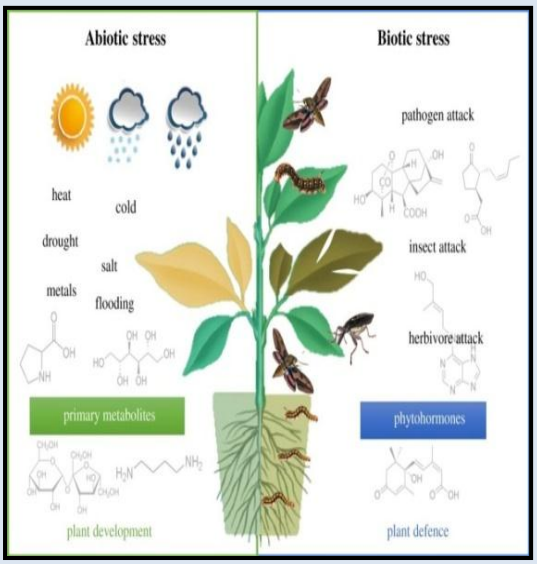

Fig.-18 Responses of a plant against Abiotic
Source: https://orbitbiotech.com

Phytoremediation

Phytoremediation is the process of pollutant removal from environment through plants. Genetic modified transgenic plants may be grown to pollutants remediation from soils and waste water. Plants have already been genetically transformed to mitigate the persistent pollution problem of mercury contamination of soils by converting the highly toxic organic mercury into less toxic elemental volatilemercury. Plants are already capable of accumulating more than 1% of their biomass as mercury through the phytoremediation process. The crop improvement techniques, including genetic engineering, may be applied to increase that phytoremediation efficiency.

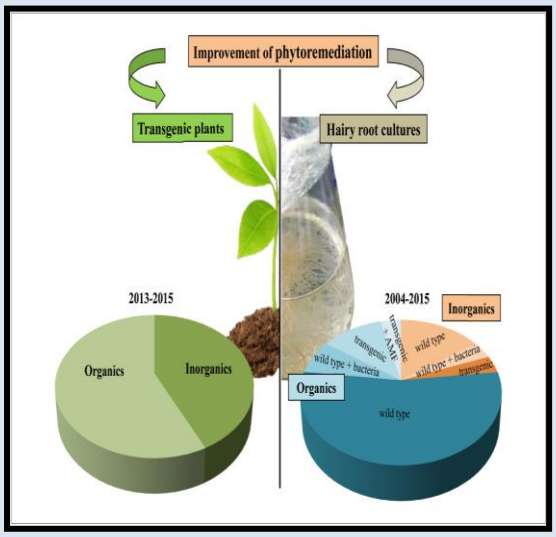

Fig.-19 Transgenic plants for phytoremediation
Source: https://www.sciencedirect.com

Biofuels

The agro industry plays a great role in the biofuels production sector, providing the feedstocks for fermentation and refining of bio-oil, bio-diesel, and bio-ethanol. Genetic engineering and enzyme optimization techniques are being used to develop better quality feedstocks for more efficient conversion and higher heat energy outputs of the resulting fuel products. Using of high-yielding and energy-dense crops can minimize relative costs associated with harvesting and transportation (per unit of energy derived), resulting in higher efficiency fuel products.

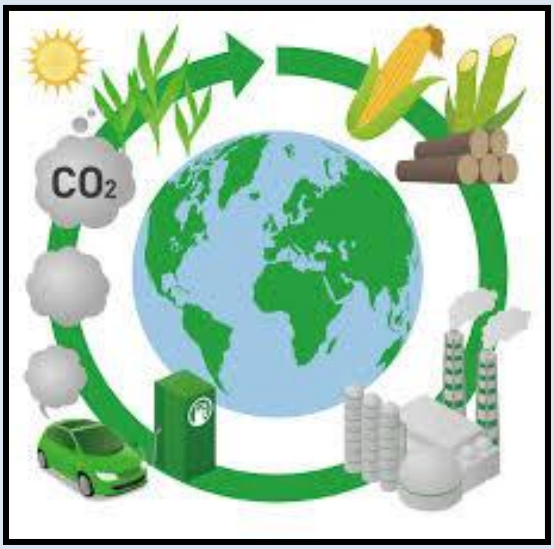

Fig.-20 Biofuel from agricultural waste
Source: https://edgy.app/consumers-pay-extra

Major Successes

1. In wheat, new hybrids developed were demonstrated to have tolerance to heat and high grain filling efficiency attributed to stay green habit & chlorophyll retention.
2. For wide hybridization for developing heat tolerant wheat germplasm, Aegilopsspeltoids accessions evaluated extensively and observed to possess very high level tolerance to heat with no effect of increasing temperature on plant growth and maturity.
3. Twenty five putative transgenic hill banana plant lines exhibiting resistance against Banana Bunchy Top Virus (BBTV) have been developed and 8 of

these plants exhibited high degree of resistance against BBTV and they remained free from bunchy top symptom at the end of 6th month.

4. Phytase gene encoding cloned from *Aspergillusniger* is being used for developing micronutrient rich transgenic maize lines for use in poultry feed.

5. In sorghum, three stable charcoal rot resistance QTLs were successfully introgressed from E36-1 into M35-1 and SPV86 varieties. Its BC3F3 progenies carrying various QTLs combination were field evaluated. Based on multi-season and location phenotypic data, QTLs for stay-green, water use efficiency (deltaC) and yield related traits were mapped. Three stable QTLs for stay-green and one for deltaC were introgressed into M35-1, SPV86 and SPV570. Their BC3F2 plants are being genotyped. Four superior RILs including the one tolerant to shoot fly (30% incidence) have been identified. Three Fusarium wilt resistant superior lines have entered multi-location trial and 16 other resistant lines were in station trial (http://www.dbtindia.nic.in)

Examples of GMOs from Agricultural Biotechnology

Genetically Conferred Trait	**Example Organism**	**Genetic Change**
Approved Commercial Products		
Herbicide tolerance	Soybean	Glyphosate herbicide (Roundup) tolerance conferred by expression of a glyphosate-tolerant form of the plant enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) isolated from the soil bacterium *Agrobacterium tumefaciens*, strain CP4
Insect resistance	Corn	Resistance to insect pests, specifically the European corn borer, through expression of the insecticidalprotein Cry1Ab from *Bacillus thuringiensis*
Altered fatty acid composition	Canola	High laurate levels achieved by inserting the gene for ACP thioesterase from the California bay tree *Umbellulariacalifornica*
Virus resistance	Plum	Resistance to plum pox virus conferred by insertion of a coat protein (CP) gene from the virus
Products Still In Development		
Vitamin enrichment	Rice	Three genes for the manufacture of beta-carotene, a precursor to vitamin A, in the endosperm of the rice prevent its removal (from husks) during milling
Vaccines	Tobacco	Hepatitis B virus surface antigen (HBs Ag) produced in transgenic tobacco induces immune response when injected into mice
Oral vaccines	Maize	Fusion protein (F) from Newcastle disease virus (NDV) expressed in corn seeds induces an immune response when fed to chickens
Faster maturation	Coho salmon	A type 1 growth hormone gene injected into fertilized fish eggs results in 6.2% retention of the vector at one year of age, as well as significantly increased growth rates

Source: https://www.nature.com

Current News

1. ICRISAT and NIAB, UK join hands to develop cereals that use nitrogen efficiently for higher yields

A team of researchers from India and the United Kingdom have come together to develop new cereal crop varieties that use nitrogen efficiently that in turn will reduce greenhouse emissions and make farming more profitable and sustainable. The partnership will explore natural variations of cereals and basic research in model plants to deliver new varieties of cereals with enhanced nitrogen use efficiency.

Source:https://economictimes.indiatimes.com

2. Mahyco Monsanto seeks stay on formation of Bt cotton pricing panel

Mahyco Monsanto Biotech, a joint venture between US agriculture company Monsanto and Maharashtra Hybrid Seeds Company, sublicenses biotechnology to seed companies. The notification it challenged was issued on January 27, setting out the constitution of a nine-member committee to recommend the maximum sale price of Bt cotton seeds to the government, said sources.

Source: https://economictimes.indiatimes.com

3. Govt go ahead for field trials of transgenic silkworms

Multi-locational field trails of transgenic silkworm have been initiated in "contained facilities" after the approval of Review Committee of Genetic Manipulation (RCGM) at four locations.

The trials are being conducted at Central Sericultural Research and Training Institute (CSR&TI), Mysore, CSR&TI, Berhampore, CSR&TI, Pampore and Andhra Pradesh State Sericulture Research and Development Institute (APSSRDI), Hindupur.

A transgenic animal is one that carries a foreign gene that has been deliberately inserted into its genome.

https://economictimes.indiatimes.com

The Future of Agricultural Biotechnology

✓ **An Inventory of New Transgenic Crops:**

These products have the potential to not only improve agronomic performance but also increase the nutritional value of grains consumed by humans and livestock, eliminate allergens and antinutritional factors, improve the shelf life of fruits and vegetables, and increase the concentration of vitamins and micronutrients.

✓ **Improved Agricultural Characteristics**

Genetically engineer crop plants that are more tolerant to drought, salinity, and other abiotic stresses (see below); that are able to grow more efficiently in the acidic, aluminum-containing soils found in tropical areas; that can compete more effectively with weeds; that can reproduce in a shorter time; and that can potentially fix their own nitrogen.

✓ **Improved Postharvest Processing**

Phytic acid stores phosphorus in the developing seed.Much of this mineral complex is not digested by livestock, so it ends up in the waste stream. Ultimately, it is released into ponds and lakes, where the phosphorus can create algal blooms. Several molecular approaches, including genetic engineering, are being applied to reduce the phytate content of corn.

✓ **Mitigation of Environmental Pollution**

Transgenic plants contribute to removing or detoxifying heavy metal pollutants in contaminated soils (“phytoremediation”). A particular problem in some locations is mercury. Plants have already been created that can accumulate mercury. Thus, growing such plants is a potential solution for cleaning up mercury pollution at despoiled sites

FORTHCOMING EVENTS		
Events	**Date**	**Place & Correspondence**
International Conference on Environmental, Food, Agriculture and Bio-Technology(ICEFABT - 2019)	20th January, 2019	Indore, Madhya Pradesh, India http://irfconference.org/Conference2019/1/Indore/2/ICEFABT/
Renewable Energy and Resources Theme: Cutting-edge Information on Renewable Energy Technologies and Innovations	February 22-23, 2019	San Francisco, USA https://renewableenergy.conferenceseries.com/
9thWorld Convention onWaste Recycling and Reuse|	March 11-12,2019	Holiday Inn Atrium, Singapore https://recyclingsummit.conferenceseries.com/
International Conference on Green Energy	April 01-02, 2019	Amsterdam | Netherlands https://greenenergy.conferenceseries.com/netherlands/
8th World Climate Congress	May 08-09, 2019	Phuket, Thailand https://climatecongress.conferenceseries.com/
9thInternational Conference on Environment and Climate Change	November 4th-5th, 2019	Johannesburg, South Africa https://environmentclimate.conferenceseries.com/

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