UNIT IV

ECOLOGICAL DIVERSITY AND AGRICULTURE

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

GM CROPS AND THEIR IMPACTS ON THE ENVIRONMENT

GM CROPS - Genetically Modified (GM) Crops

The term genetically modified (GM), as it is commonly used, refers to the transfer of genes between organisms using a series of laboratory techniques for cloning genes, splicing DNA segments together, and inserting genes into cells. Collectively, these techniques are known as recombinant DNA technology.

Other terms used for GM plants or foods derived from them are genetically modified organism (GMO), genetically engineered (GE), bioengineered, and transgenic.

'Genetically modified' is an imprecise term and a potentially confusing one, in that virtually everything we eat has been modified genetically through domestication from wild species and many generations of selection by humans for desirable traits.

The term is used here because it is the one most widely used to indicate the use of recombinant DNA technology. According to USDA standards for organic agriculture, seeds or other substances derived through GM technology are not allowed in organic production.

Genetically modified crops (GM crops) are plants used in agriculture, the DNA of which has been modified using genetic engineering methods. In most cases, the aim is to introduce a new trait to the plant which does not occur naturally in the species.

Genetic modification (GM) technology allows the transfer of genes for specific traits between species using laboratory techniques.

GM crops were first introduced in the U.S. in the mid-1990s. Most current GM crops grown in the U.S. are engineered for insect resistance or herbicide tolerance. Corn, soybeans, and cotton are the three largest acreage GM crops.

GM crops grown in Colorado include corn, alfalfa, sugar beet, soybeans, and canola.

Potential future applications of the technology include nutritional enhancements, stress tolerance, disease resistance, bio fuel efficiency, and remediation of polluted sites.

GM crops are regulated at the federal level by the U.S. Department of Agriculture (USDA), the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA), each with authority to oversee specific aspects of the crops and their products.

Examples in food crops include resistance to

Certain pests

Diseases

Environmental conditions

Reduction of spoilage

Resistance to chemical treatments (e.g. resistance to a herbicide)

Improving the nutrient profile of the crop.

Examples in non-food crops include production of pharmaceutical agents, bio-fuels, and other industrially useful goods, as well as for bioremediation.

Farmers have widely adopted GM technology. GM maize outperformed its predecessors: yield was 5.6 to 24.5% higher with less mycotoxins (−28.8%),

A 2014 meta-analysis concluded that GM technology adoption had reduced chemical pesticide use by 37%, increased crop yields by 22%, and increased farmer profits by 68%. This reduction in pesticide use has been ecologically beneficial, but benefits may be reduced by overuse. Yield gains and pesticide reductions are larger for insect-resistant crops than for herbicide-tolerant crops. Yield and profit gains are higher in developing countries than in developed countries.

Each GM food needs to be tested on a case-by-case basis before introduction. The legal and regulatory status of GM foods varies by country, with some nations banning or restricting them, and others permitting them with widely differing degrees of regulation.

However, opponents have objected to GM crops on grounds including environmental impacts, food safety, whether GM crops are needed to address food needs, whether they are sufficiently accessible to farmers in developing countries and concerns over subjecting crops to intellectual property law.

Methods

Genetically engineered crops have genes added or removed using

Genetic engineering techniques

Originally including gene guns

Electroporation

Microinjection

Agrobacterium.

Gene guns (also known as biolistics) "shoot" (direct high energy particles or radiations against) target genes into plant cells. It is the most common method. DNA is bound to tiny particles of gold or tungsten which is subsequently shot into plant tissue or single plant cells under high pressure. The accelerated particles penetrate both the cell wall and membranes. The DNA separates from the metal and is integrated into plant DNA inside the nucleus. This method has been applied successfully for many cultivated crops, especially monocots like wheat or maize, The major disadvantage of this procedure is that serious damage can be done to the cellular tissue.

Agrobacterium tumefaciens- mediated transformation is another common technique. Agrobacteria are natural plant parasites. Their natural ability to transfer genes provides another engineering method. To create a suitable environment for them, these Agrobacteria insert their genes into plant hosts, resulting in a proliferation of modified plant cells near the soil level (crown gall). The genetic information for tumor growth is encoded on a mobile, circular DNA fragment (plasmid). When Agrobacterium infects a plant, it transfers this T-DNA to a random site in the plant genome. When used in genetic engineering the bacterial T-DNA is removed from the bacterial plasmid and replaced with the desired foreign gene. The bacterium is a vector, enabling transportation of foreign genes into plants. This method works especially well for dicotyledonous plants like potatoes, tomatoes, and tobacco. Agrobacteria infection is less successful in crops like wheat and maize.

Electroporation is used when the plant tissue does not contain cell walls. In this technique, "DNA enters the plant cells through miniature pores which are temporarily caused by electric pulses."

Types of modifications

Transgenic

Transgenic plants have genes inserted into them that are derived from another species. The inserted genes can come from species within the same kingdom (plant to plant), or between kingdoms (for example, bacteria to plant). In many cases the inserted DNA has to be modified slightly in order to be correctly and efficiently expressed in the host organism. Transgenic plants are used to express proteins, like the cry toxins from B. thuringiensis, herbicide-resistant genes, antibodies, and antigens for vaccinations.

Transgenic carrots have been used to produce the drug Taliglucerase alfa which is used to treat Gaucher's disease. In the laboratory, transgenic plants have been modified to increase photosynthesis (currently about 2% at most plants versus the theoretic potential of 9–10%). This is possible by changing the rubisco enzyme (i.e. changing C_3 plants into C_4 plants), by placing the rubisco in a carboxysome, by adding CO
2 pumps in the cell wall, or by changing the leaf form or size. Plants have been engineered to exhibit bioluminescence that may become a sustainable alternative to electric lighting.

Cisgeni

Cisgenic plants are made using genes found within the same species or a closely related one, where conventional plant breeding can occur. Some breeders and scientists argue that cisgenic modification is useful for plants that are difficult to crossbreed by conventional means (such as potatoes), and that plants in the cisgenic category should not require the same regulatory scrutiny as transgenics.

Subgenic

Genetically modified plants can also be developed using gene knockdown or gene knockout to alter the genetic makeup of a plant without incorporating genes from other plants.

Multiple trait integration

With multiple trait integration, several new traits may be integrated into a new crop.

Impacts:

Powerful scientific techniques have caused dramatic expansion of genetically modified crops leading to altered agricultural practices posing

Direct and

Indirect environmental implications.

Despite the enhanced yield potential, risks and biosafety concerns associated with such GM crops are the fundamental issues to be addressed.

The current state of knowledge reveals that GM crops impart damaging impacts on the environment such as modification in crop pervasiveness or invasiveness, the emergence of herbicide and insecticide tolerance, transgene stacking and disturbed biodiversity, but these impacts require a more in-depth view and critical research so as to unveil further facts.

The consumption of GM plant products are safe for consumption to a greater extent with few exceptions.