Decoding Genetic Modification

This editorial is based on *"Understanding GM mustard: what is it, and how has it been achieved?"* ***which was published in The Indian Express on 27/10/2022. It talks about genetic modification crops and recently approved GM mustard.***

For Prelims: Biotechnology, Environment (Protection) Act 1986, Genetic Engineering Appraisal Committee (GEAC), Genetically Modified Mustard, Bt Cotton, Hepatitis B Virus Vaccine, Crude Jatropha oil (CJO), Bioethanol, National Policy on Biofuels, Gene banks.

For Mains: Regulations of GM Crops in India, Key Contributions of Genetic Modification Technique, Concerns Related to Genetic Modification.

Agricultural experiments in India have a long and dubious record, but **biotechnology** has added a new twist with genetically modified crops. The use of genetic engineering tools to **address agricultural vulnerabilities** is not just limited to India. A number of other countries are in line to deploy new genetic modified tools as well.

India, USA, Brazil, Argentina and Canada are **5 top GM growing countries,** together accounting for approx. **90% area of the Genetically Modified cultivation.** While proponents of genetic modification argue that **it has the potential to solve India's agricultural productivity problem,** opponents point to the **negative implications on environment and human health.**

It is therefore essential to conduct a more **thorough and comprehensive assessment of Indian agriculture's experiences with genetic modification.**

What is Genetic Modification?

- "Genetic modification" involves **altering the genes of an organism,** be it a plant, animal or microorganism.
- GM technology involves **direct manipulation of DNA** instead of using controlled pollination to alter the desired characteristics.
    - It is one the **approaches to** crop improvement, all of which aim at adding desirable genes and **removing undesirable ones to produce better varieties.**

How Genetic Modified Crops are Regulated in India?

- In India, the regulation of all activities related to **Genetically modified organisms** and products are regulated by the **Union Ministry of Environment, Forest and Climate Change(MoEFCC)** under the provisions of the **Environment (Protection) Act, 1986.**
    - **Genetic Engineering Appraisal Committee (GEAC)** under MoEFCC is authorised to

review, monitor and approve all activities including **import, export, transport, manufacture, use or sale of GMO.**
    - GM foods are also subjected to regulations by the Food Safety and Standards Authority of India (FSSAI) **under the Food Safety and Standards Act, 2006.**
- GEAC recently approved commercial cultivation of **genetically modified mustard.**
    - Before that **Bt cotton** was the only GM crop that was approved for commercial cultivation in 2002.
        - **'Bt'** is shorthand for ***Bacillus thuringiensis***, a bacterium found mainly in the soil that produces proteins toxic to some insects, especially the **cotton bollworm.**

What are the Key Contributions of Genetic Modification Technique?

- **Revolutionised Pharma Sector:** GM microbes and plants **revolutionised the production of complex pharmaceuticals** by enabling the generation of safer and cheaper vaccines and therapeutics.
    - Mass production of GM technology based **human insulin, vaccines, growth hormones** and other drugs has greatly facilitated the **availability and access to life saving pharmaceuticals.**
    - **For instance: Human hepatitis B virus vaccine** was prepared using antigen produced by **recombinant technology in yeast**
- **Herbicide Tolerance:** Genetic Modification has played a key role in **herbicide tolerance** and transformed crops to tolerate specific broad-spectrum herbicides, **which kill the surrounding weeds, but leave the cultivated crop intact.**
    - **For example: Soybean, maize, cotton and canola** are modified with herbicide tolerance character.
- **Climate Change Adaptation:** Genetic Modification is already being used to **help the plants adapt to the rapidly changing climate.** Researchers are developing strains of **rice, maize and wheat capable of withstanding longer droughts and wetter monsoon seasons.**
- **Salinity Tolerance:** Scientists have genetically modified plants **to tolerate high levels of salt offering a potential solution to growing food in salty soils.**
    - The researchers inserted a gene to **remove salt present in the form of sodium ions from water** before it reaches the leaves and also adjusts the ionic and osmotic balance of cells in roots.
- **Contributor to Food Security: Genetic Modification** has **improved crop yield, resulting in greater production of the target crop.** Scientists have also engineered pest-resistant crops, **helping local farmers better withstand environmental challenges** that might otherwise wipe out a whole season of produce.
    - **Genetic Modification in microbes** has also significantly contributed to food security for instance the **use of animal-based rennet for cheese production** has been replaced to the **extent of 80-90% by the enzyme chymosin produced by genetically modified microorganisms.**
- **Enhancing Biofuel Production:** A chemical modification was performed on the **crude Jatropha oil (CJO)** with the intention of improving the low thermal and oxidative stability, the **modified jatropha is considered as a viable bio-ethanol feedstock.**
    - Additionally, it is giving thrust to the 'National Policy on Biofuels' which aims for a **20% blend of ethanol in petrol by 2025-26.**

What are the Concerns Related to Genetic Modification?

- **Compromising Nutritional Security:** Ironically, some **genetically modified foods have been reported to be void of nutritional value.**
    - As genetic modification tends to **focus more on increasing their** production, prolonging their lifespan, and **deterring pests,** the nutritional value of some crops is sometimes compromised.
- **Loss of Indigenous Variety:** Genetically modified production imposes **high risks to the disruption of ecosystem and biodiversity** because the better traits produced from engineering genes can result in the favouring of one organism. **Hence, it can eventually disrupt the natural process of gene flow and** affect the sustainability of indigenous variety.
- **Risk of Allergic Reactions:** Genetically modified food has immense potential of allergic reaction

because it is **biologically altered.** The sudden emergence of genetic modification may have a common side effect of allergic reaction for **humans who have adapted to the conventional variety.**

- **Threat to Wildlife:** Altering the genes of plants can also have serious effects on wildlife. For example, **genetically modified plants,** such as **tobacco or rice,** that are used to produce plastic or pharmaceuticals, can endanger **mice or deer who consume crop debris left in the fields after harvesting.**

What Should be the Way Forward?

- **Towards Bio-Safety:** There is a need to **prevent large-scale loss of biological integrity,** focusing both on **agricultural production as well as plant, animal and human health.**
    - Creation and use of genetically modified crops must be done in collaboration with **stewards of ecosystems** in order to **meet the needs of the environment, local populations, and the wider global community.**
- **Complementing Genetic Modification:** Genetic modifications are not the only solution for food security, it must be combined with improved **farming credit, better use of water** and reducing waste, to create better food options and sustainable crop management.
- **Technical Competency for Effective Regulation:** All regulatory bodies of gm crops, especially the GEAC, should be made technically competent.
    - Specific competence on **Risk Assessment and Risk Management of GM crops** including **Monitoring and Information Systems** skills are the need of hour.
    - Also, there is a need to create with immediate effect legally mandated District Level and Panchayat level Committees for **faster documentation, and analysis of GM crops.**
- **Bottom-Up Genetic Modification:** There should be a consultative and participatory process to prioritise crops and traits for genetic improvement through biotechnology with the **goal of addressing the needs of small farmers.**
- **Indigenous Gene Banks:** It is important to preserve the indigenous variety due to its ability to adapt to diseases and nutritional value.
    - **Gene banks** can be created that will **assist various research institutions** in conducting research as well as help in conserving indigenous crops.

Drishti Mains Question

Highlighting the key contribution of genetic modification in India, explain how genetic modified crops are regulat

UPSC Civil Services Examination, Previous Year Question:

Prelims:

Q. With reference to recent developments regarding 'Recombinant Vector Vaccines', consider the following statements: (2021)

1. Genetic engineering is applied in the development of these vaccines.

2. Bacteria and viruses are used as vectors.

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Ans: (c)

Q. How does the National Biodiversity Authority (NBA) help in protecting Indian agriculture? (2012)

1. NBA checks the biopiracy and protects the indigenous and traditional genetic resources.
2. NBA directly monitors and supervises the scientific research on genetic modification of crop plants.
3. Application for Intellectual Property Rights related to genetic/biological resources cannot be made without the approval of NBA

Which of the statements given above is/are correct?

(a) 1 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans: (c)