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News: Genetically Modified (GM) crops

- Recently, the Government of India told the Supreme Court that Genetically Modified (GM) crops such as mustard will make quality edible oil cheaper for the common man and benefit national interest by reducing foreign dependency.
- The Genetic Engineering Appraisal Committee (GEAC) has approved the environmental release of Dhara Mustard Hybrid-11 (DMH-11), a genetically-engineered variant of mustard.

Genetically Modified Crops

- Genetic modification aims to transcend the genus barrier by introducing an alien gene in the seeds to get the desired effects. The alien gene could be from a plant, an animal or even a soil bacterium.
- In India, the Genetic Engineering Appraisal Committee (GEAC) is the apex body that allows for commercial release of GM crops.
- In 2002, the GEAC had allowed the commercial release of Bt cotton. More than 95% of the country's cotton area has since then come under Bt cotton.
- Use of the unapproved GM variant can attract a jail term of 5 years and fine of Rs. 1 lakh under the Environment Protection Act, 1986.

- Advantages of GM Crops include Higher Yields, Enhanced nutritional value, Longer shelf life, Increased resistance to droughts, Increased resistance to insects, pests & locusts and increased resistance to herbicides.
- Disadvantages of GM crops are it may cause allergies, Antimicrobial resistance and may lead to Cancer.

BT Brinjal

- BT Brinjal is a genetically modified Brinjal by **inserting a crystal protein gene (Cry1Ac) from the bacteria Bacillus thuringiensis.**
- It gives **resistance against lepidopteron insects & Shoot Borer.**
- Mahyco, an Indian company has developed Bt Brinjal in **collaboration with Monsanto (American company).**
- There were concerns over potential health hazards & **terminator seeds** (which compel the farmer to repurchase seeds from the company every year).
- The **pest resistance was lost by years resulting in losses to farmers & farmer suicides** which prompted the government to ban GM Brinjal.

BT Cotton

- Cotton is genetically engineered to **combat bollworm**, a major pest that attacks cotton.
- In **2002**, the GEAC had allowed the commercial release of Bt cotton. **More than 95% of the country's cotton area has since then come under Bt cotton.**
- Bt Cotton is created through the addition of genes encoding toxin crystals in the Cry group of **endotoxin**.
- The **worms present on the leaves of Bt Cotton become lethargic and sleepy & causes less harm to plants.**
- It is also developed **by Mahyco, in collaboration with Monsanto.**
- Bt cotton is the **only genetic crop allowed to cultivate in India.**
- **New GM crop involves the addition of new gene; Cp4-Epsps is being used by farmers, but not being cleared by GEAC.**

Bt Cotton - Generations

- In case of cotton, the **first two generations of Bt** have seen the introduction of **'Cry1Ab'** and **'Cry2Bc'** genes from the **soil bacterium, Bacillus thurigiensis (Bt)**, into the cotton seed. This **makes the crop resistant to the attack of pink bollworm.**

- The third generation, i.e. **herbicide tolerant Bt (HtBt)** cotton variety saw the addition of ‘**Cp4-Epsps**’ gene from another **soil bacterium, Agrobacterium tumefaciens**, which produces a modified protein that **allows the plant to withstand herbicide glyphosate**.
- Farmers were not able to spray glyphosate on normal cotton **because the chemical does not distinguish between the crop and weed, but the herbicide tolerant Bt (HtBt) cotton remains unaffected by glyphosate**.
- Fears include glyphosate having a **carcinogenic** effect, as well as the unchecked spread of herbicide resistance to nearby plants through pollination, creating a variety of **superweeds**.
- While **Ht Bt is not approved for commercial release**, farmers in Gujarat, Andhra Pradesh and Maharashtra have been surreptitiously planting the crop using smuggled seeds.

GM Rubber

- World's first Genetically Modified rubber has been **planted in Guwahati**.
- The GM rubber has additional copies of the **gene MnSOD, or manganese containing superoxide dismutase, inserted in the plant, which is expected to tide over the severe cold conditions during winter** — a major factor affecting the growth of young rubber plants in the region.

- The plant was developed at the Kerala based Rubber Research Institute of India (RRII).
- Natural rubber is a native of warm humid Amazon forests and is not naturally suited for the colder conditions in the Northeast.

GM Soybean

- GM Soybean is one of the most widely planted modified plants in the world today.
- The GM soybean, also called as the Roundup Ready (RR) Soybean, was developed by Monsanto and made it commercially available to farmers in 1996.
- It was developed to make the plant survive the herbicide Roundup, which can kill conventional soybean plants.
- GM Soybean was developed by introducing a copy of a gene from the *Agrobacterium* sp, strain Cp4.
- Conventional soybean has a similar gene in its DNA but is sensitive to glyphosate, the active ingredient of the herbicide Roundup.
- The insertion added the resistance to Roundup herbicide.

- The studies showed that rats fed with the modified crops led to higher risk of them developing liver and kidney problems. This health risk may not be transferable to humans, but it reveals the unpredictable nature of GM crops.
- GM Soybean is not approved by the Genetic Engineering Appraisal Committee.
- The union ministry recently, banned the import of GM Soybean.
- Recently, the farmers from poultry industry are seen urging the Centre to allow import of GM Soybeans, which is a major ingredient of poultry feed.
- Government has decided to allow the import of crushed genetically modified (GM) soybean.
- However, environmental activists have raised concerns about the permission given for something derived from a genetically modified plant to enter the human food chain, given that India's regulatory system has yet to approve GM foods.

GM Mustard

- The Genetically Engineered Mustard DMH-11 has been developed by University of Delhi.

DMH – 11

- DMH–11 is a **hybrid variant of mustard** developed by researchers at The Centre for Genetic Manipulation of Crop Plants, at the **University of Delhi**.
- The University of Delhi authorities asserted that **DMH – 11 was developed without transgenic technology**.
- DMH – 11 is a result of a **cross between two varieties: Varuna and Early Heera–2**.
- Such a cross **wouldn't have happened naturally** and was **done after introducing genes from two soil bacterium called barnase and barstar**.
- **Barnase in Varuna induces a temporary sterility because of which it can't naturally self-pollinate. Barstar in Heera blocks the effect of barnase allowing seeds to be produced**.
- The result is DMH 11 (**where 11 refer to the number of generations after which desirable traits manifest**) that **not only has better yield but is also fertile**.
- DMH–11 is a **transgenic crop because it uses foreign genes from a different species**.

Benefits of GM Mustard

- Indigenously developed seeds, the **patent remains with government** unlike with cotton it remains with corporates.
- India Plans for **food fortification** to achieve SDG, this will help to achieving its goal.
- Yields are expected to **rise by up to 30 per cent**.
- India imports 15 million tonnes (Mt) of edible oils worth almost \$11 billion annually, **Mustard oil production from this variety of crop will save a lot on Foreign exchange exchequer**.
- The **GEAC initially cleared DMH - 11 for commercial cultivation, however, they retracted their approval upon deciding that more tests**, and additional data concerning the **effect of DMH - 11 on insect pollinators, in particular honeybees**, and on soil microbial diversity was needed prior to commercialisation.

Reason for the controversy behind GM Mustard

- There are **two main reasons why transgenic mustards are a topic of debate**.
- The **use of genes that are foreign to the species** is one and secondly, the **preparation of mustard hybrids require the use of another gene, called the bar gene, that makes it tolerant to an herbicide called glufosinate–ammonium**.

- Activist groups allege that the GM mustard hasn't been evaluated as an herbicide tolerant crop posing potential risks. Finally, they allege, **GM mustard plants may dissuade bees from pollinating the plant and this could have knock-off environmental catastrophes.**

Genetically Modified (GM) Mosquitoes

- Genetically Modified (GM) Mosquitoes are **mass-produced in a laboratory to carry two types of genes.**
- **A self-limiting gene that prevents female mosquito offspring from surviving to adulthood.**
- **A fluorescent marker gene that glows under a special red light.** This allows researchers to **identify GM mosquitoes in the wild.**
- **GM mosquitoes produced in the laboratory lay eggs.** These eggs carry the self-limiting and fluorescent marker genes.
- GM mosquito eggs that carry the self-limiting gene are released into an area. **Once they have hatched and develop through to the adult stage, they are available to mate with wild females. The genes are passed on to offspring.**

- The male mosquitoes have a protein (the tTAV-OX5034 protein) that prevents female offspring from surviving when male OX5034 mosquitoes mate with wild female mosquitoes.
- The female offspring die before they become adults. The expected result is that the number of *Aedes aegypti* mosquitoes in the area decreases.

Related Concerns

- Genetically modifying insects to control their population to curb the spread of a disease is not a novel idea. Similar efforts began a decade ago, with scientists now attempting to engineer ticks to prevent diseases.
- The concerns ranged from the modified mosquitoes harming people, its impact on mosquito-eating species and other unintended consequences such as the emergence of a deadly virus.
- Experts also believe that reducing the population of the virus spreading mosquito is not enough to curb a potential outbreak.