GM Mustard

November 8, 2022

Manifest Pedagogy:

GEAC has recently approved the field trial of GM mustard. Though there are apprehensions associated with GM crops such as genetic contamination, threat to biodiversity and is considered ethically wrong. At the same time it can improve the yield, reduce usage of fertilisers and pesticides and ensure food security for the coming generation. India runs the risk of falling behind the rest of the world in terms of food yields, disease resistance, and shelf life by refusing to adopt genetic engineering technologies. Hence the government must involve all the stakeholders to explore the opportunities that will be provided with GM crops.

In News: Transgenic hybrid mustard DMH-11 that has been cleared by the Genetic Engineering Appraisal Committee for field trials.

Placing it in the Syllabus: Agriculture

Static Dimensions

- What is hybrid mustard?
- GM crops in India

Current Dimensions

- How has hybridisation been achieved in mustard?
- What has GEAC now done?
- Why did it take so long for GEAC to clear?
- Advantages of GMO crops

Content

The Genetic Engineering Appraisal Committee (GEAC) under the Union Ministry of Environment, Forest and Climate Change recommended the “environmental release” of the transgenic

hybrid mustard DMH-11 for seed production and conduct of field demonstration studies with respect to its effects, if any, on honey bees and other pollinating insects.

What is hybrid mustard?

- **Hybridisation** involves crossing two genetically dissimilar plant varieties that can even be from the same species.
- The **first-generation (F1) offspring** from such crosses tend to have higher yields than what either parent can individually give.
- Such hybridisation isn't easy in mustard, as its flowers have both female (pistil) and male (stamen) reproductive organs, making the plants largely self-pollinating.
- Since the eggs of one plant cannot be fertilised by the pollen grains from another, it limits the scope for developing hybrids – unlike in cotton, maize or tomato, where this can be done through simple emasculation or physical removal of anthers.

How has hybridisation been achieved in mustard?

- By genetic modification (GM). Scientists at Delhi University's Centre for Genetic Manipulation of Crop Plants (CGMCP) have developed the hybrid mustard DMH-11 containing two alien genes isolated from a soil bacterium called **Bacillus amyloliquefaciens.**
- The first gene **('barnase')** codes for a protein that impairs pollen production and renders the plant into which it is incorporated male-sterile.
    - This plant is then crossed with a fertile parental line containing, in turn, the second 'barstar' gene that blocks the action of the barnase gene.
    - The resultant **F1 progeny** is both high-yielding and also capable of producing seed/ grain, thanks to the barstar gene in the second fertile line.
- The CGMCP scientists have deployed the **barnase-barstar**

GM technology to create what they say is a robust and viable hybridisation system in mustard.

- This system was used to develop DMH-11 by crossing a popular Indian mustard variety **'Varuna'** (the barnase line) with an East European 'Early Heera-2' mutant (barstar).
- DMH-11 is claimed to have shown an **average 28% yield increase** over Varuna in contained field trials carried out by the Indian Council of Agricultural Research (ICAR).

What has GEAC now done?

- GEAC is a body responsible for appraisal of proposals relating to the "release" of GM organisms and products (ordinarily considered hazardous) into the environment.
- In this case, it has recommended the environmental release of DMH-11 "for its seed production and testing…prior to commercial release".
- It has given the green signal for commercial cultivation by farmers, with production of seed material being the first step.
- GEAC has also recommended the environmental release of DMH-11's parental lines (carrying the barnase and barstar genes) for them to be used to develop new hybrids. Such hybrids could give even higher yields than DHM-11.
- Mustard varieties in India have a narrow genetic base. The **barnase-barstar system** enables breeding of hybrids from a wider range of mustards, including those of East European origin such as '**Heera' and 'Donskaja**'.
- It is also possible to introduce new traits relating to resistance against disease (alternaria blight and stem rot fungus) or canola oil quality (zero/ low levels of erucic acid and glucosinolates, seen as negative from a health standpoint).

Why did it take so long for GEAC to clear?

- There has been opposition to GM crops in general, from assorted green groups and.In GM mustard, there have been two specific concerns voiced as well.
- The first is the presence of a third 'bar' gene, which makes GM mustard plants tolerant to the spraying of glufosinate ammonium, a chemical used for killing weeds.
    - This, the opponents allege, will cause displacement of manual labour engaged in weddings by promoting use of chemical herbicides.
    - The DMH-11 developers, however, say that bar is only a marker gene. It is used to identify those plants that have been genetically modified; the non-GM ones cannot withstand application of the herbicide – and are necessary for large-scale seed production.
    - The GEAC has recommended the "usage of any formulation of herbicide exclusively for hybrid seed production", while not permitting the same "for cultivation in the farmer's field under any situation.
- The second concern is over GM mustard threatening or undermining the population of honey bees. Mustard flowers are a source of nectar for honey bees and many other pollinator insects.
    - The GEAC has cited the report of an **expert committee under Department of Biotechnology scientist Sanjay Kumar Mishra and director of the Indian Agricultural Research Institute A K Singh**, which stated that "based on the examination of scientific evidences available globally-it seems unlikely that the bar, barnase and barstar system will pose an adverse impact on honey bees and other pollinators".
- The GEAC has, at the same time, recommended that the applicant (CGMCP) should conduct "field demonstration studies with respect to the effect of [GM mustard] on

honey bees and other pollinators" post the environmental release, "to generate scientific evidence in [the] Indian agro-climatic situation and as a precautionary mechanism".

GM crops in India

- **Bt cotton:**Bt cotton, the only GM crop that is allowed in India, has two alien genes from the soil bacterium Bacillus thuringiensis (Bt) that allows the crop to develop a protein toxic to the common pest pink bollworm.
    - On the other hand, Bt cotton is derived with the insertion of an additional gene, from another soil bacterium, which allows the plant to resist the common herbicide glyphosate.
- **Bt Brinjal:**In Bt brinjal, a gene allows the plant to resist attacks of fruit and shoot borer.
    - In Bt brinjal, a gene permits the plant to resist attacks of fruit and shoot borers.
    - Previously, the government has put on hold the commercial release of genetically modified (GM) mustard due to stiff opposition from anti-GMO activists and NGOs.
- **Global variants:**
    - Across the world, GM variants of maize, canola and soybean, too, are available.

Advantages of GM crops

- **Production**-It improves production and raises the farmer's income.Reduced maturation time.
- **Pesticide**-It reduces the use of pesticide and insecticide during farming that might be great moves for the betterment of the food supply.
- **Food security**-It can feed a rapidly increasing population because it shows dramatically increased yields.

- **Efficiency**-It can produce more in small areas of land.
- **More nutritious and tastier**.May be possible to produce medicines or even vaccines.

Issues associated with GM crops

- **Genetic contamination**-Since a GMO is artificially created, its breeding with the other crops in the natural ecosystem can result in genetic contamination.
- **Affecting species diversity**-Bt. crops can harm non-target insects thereby affecting species diversity. In the case of Bt. Corn, Monarch butterflies feeding on wild milkweed that grows near cornfields may be harmed.
- **Super weeds**-GM technology could also allow the transfer of genes from one crop to another, creating "super weeds", which might be immune to common control methods.
- **Commercialisation**-Corporate control over farming is facilitated by GM technology (with accompanying Intellectual Property Rights), giving them control over the food supply.
    - From an economic standpoint, this poses a risk to long-term food security by creating dependence on a single or limited number of suppliers.
- **Increased use of chemicals:**Though GM Cotton was supposed to be more resistant to pests, chemical usage (including pesticides) in India's cotton cultivation has actually increased.
- **Inadequate Safety Assessments:** The current safety assessments are inadequate to catch most of the harmful effects from the GM crops. Moreover, the regulatory regime in India about GM crops has never been assessed thoroughly about the GM risk assessment in Indian conditions.

Wayforward

- The challenges linked to GM crops need to be addressed by governments, especially in the areas of safety

testing, regulation, industrial policy and food labelling.

- Academia should come forward and help in guiding public perception and building confidence in the appropriate processes and products of GM technology.
- Any decision on introduction of GM technologies must be taken on the basis of scientific evidence.
    - A participatory approach should be adopted in order to bring together all stakeholders to develop regulatory protocols. This would ensure trust in the entire process.
- GM crops can play a major role in ensuring food security for the coming generation.
- There is a need to strengthen, conserve and preserve traditional seeds that would ensure food security.

Mould your thoughts

1. GEAC has recently given approvals for field trials of GM mustard. In this light discuss the significance and challenges associated with GM crops in India (250 words)

Approach to the answer.

- About GM crops.
- Field trials of GM mustard
- Significance of GM crops
- Challenges associated
- Suggestions
- Wayforward and conclusion