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Q16

How can biotechnology help to improve the living standards of farmers?

UPSC Civil Services Mains 2019 · GS III · 15 marks · Crops, Irrigation and Marketing

Major crops - cropping patterns in various parts of the country; different types of irrigation and irrigation systems; storage, transport and marketing of agricultural produce and issues and related constraints; e-technology in the aid of farmers.

Core demand of the question

- Show how biotechnology can raise farmers' living standards
- Cover seeds, **Bt cotton**, bio-inputs, livestock, diagnostics, and caution on GM and monopoly
- Name DBT, **GEAC**, **Biotech-KISAN**, ICAR

Revision summary

Marker breeding, tissue culture, and bio-inputs can raise yield and cut chemical cost without every crop being transgenic.

Bt cotton raised many incomes but later met resistance and high seed prices.

Livestock vaccines, sorted semen, and disease kits protect the dairy and fish household.

DBT, BIRAC, **Biotech-KISAN**, ICAR, and **GEAC** are the public machinery.

Living standards rise only if net income rises and public seed keeps traits affordable.

Introduction

Biotechnology is the use of living systems - **markers, tissue culture, microbes, vaccines, and genetic modification** - to make a farm more productive or less risky. For an Indian farmer, living standards rise if **yields are steadier, pesticide and feed bills fall, animals survive, and a better price is not eaten by seed royalties**. The tools exist. Whether they raise the smallholder's life depends on **public breeding, biosafety, and access**, not only on a laboratory success.

Body

Crop biotechnology

- **Marker-assisted selection** and genomic breeding speed up conventional varieties for drought, flood, salinity, and disease without always using transgenic methods. **ICAR** and State universities already put such lines into the seed chain.
- **Tissue culture** gives disease-free banana, sugarcane, potato, and horticulture planting material; a small nursery enterprise can be a rural livelihood.
- **Bt cotton** is India's only widely commercialised **genetically modified** crop. It cut bollworm sprays and raised output in many years, which lifted some farm incomes. Secondary pests, **pink bollworm resistance**, and high **seed cost** later showed that one gene is not a permanent living-standard guarantee.

- **Biofortified** varieties (iron, zinc, protein) - often from conventional plus marker breeding - raise household nutrition, which is part of living standards, not only the mandi price.
- **Biofertilisers and biopesticides** (Rhizobium, Trichoderma, nuclear polyhedrosis virus) cut chemical bills and fit organic and residue-sensitive export markets.

Livestock, fisheries, and diagnostics

- **Vaccines** (for example foot-and-mouth disease programmes) and **diagnostics** stop herd wipe-outs that push a household into debt.
- **Embryo transfer, sex-sorted semen, and genomic selection** in cattle, if publicly priced, raise milk yield per animal - the main dairy path for small farmers, especially women.
- Fish and shrimp **hatchery genetics** and disease kits protect coastal and inland aquaculture income.
- **Soil and pathogen kits** let extension advise instead of a blind spray.

Institutions and schemes

- **Department of Biotechnology (DBT)** and **Biotechnology Industry Research Assistance Council (BIRAC)** fund translation.
- **Biotech-KISAN** hubs link scientists to clusters of farmers so the lab is not only a paper.
- **Genetic Engineering Appraisal Committee (GEAC)** under the environment ministry is the biosafety gate for GM organisms. Public debate on **GM food crops** (mustard, brinjal) remains unresolved; living standards cannot ignore **choice, labelling, and liability**.
- Public seed systems (**National Seed Corporation**, State corporations) must keep **non-GM and public GM** options so a private trait fee does not tax every acre.

How this becomes a better life - and how it fails

- Higher **net income** (yield minus seed, chemical, and credit cost) is the channel. A costly seed that fails in a dry year is a poverty trap.
- **Less spray** is health for the farmer as well as rupees saved.
- Climate-resilient traits are insurance in a drought-prone district.
- **Failures: monopoly traits**, fake Bt seed, weak extension, and ignoring **agronomy and markets**. Biotechnology does not replace MSP, storage, or a working mandi.
- **Recommendations**: public investment in **orphan rainfed crops**, farmer-saved seed rights where law allows, strict **quality control** of bio-inputs, livestock vaccine coverage, and a transparent **GEAC** process. Pair biotech with **soil health cards, micro-irrigation, and FPO marketing** so the extra quintal actually sells.

Flow diagram

Biotechnology -> Markers tissue culture Bt
 Biotechnology -> Biofertiliser biopesticide
 Biotechnology -> Vaccines semen diagnostics
 Markers tissue culture Bt -> Net farm income
 Biofertiliser biopesticide -> Net farm income
 Vaccines semen diagnostics -> Net farm income
 Seed monopoly pest resistance -> Net farm income

Conclusion

Biotechnology can raise farmers' living standards through better seed, less pesticide, tissue-culture enterprises, livestock vaccines, and diagnostics. **Bt cotton** showed both the income gain and the later pest-and-price catch. Public ICAR-DBT breeding, **Biotech-KISAN**, honest **GEAC** oversight, and cheap quality inputs decide whether the smallholder gains - or only the trait owner does.

Facts & figures

Bt cotton

India's main commercial GM crop; reduced bollworm sprays for years, later challenged by resistance and seed cost.

GEAC

Genetic Engineering Appraisal Committee: Union biosafety authority for environmental release of GM organisms.

Biotech-KISAN

DBT scheme of farmer-centric biotech hubs that take lab tools to agricultural clusters.

Marker-assisted selection

Breeding that uses DNA markers to speed traits such as disease or drought tolerance without necessarily inserting a foreign gene.

FMD vaccination

Mass livestock vaccination against foot-and-mouth disease; a biotech-enabled public good that protects small dairy assets.

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