Science & Technology · GS - III

How does nanotechnology offer significant advancements in the field of agriculture? How can this technology help to uplift the socio-economic status of farmers?

EXAM YEAR	PAPER	SUBJECT
2025	GS - III	Science & Technology

MARKS	WORD LIMIT
15	~250 words

Answer Hint

Nanotechnology, nano-fertilisers, nano-pesticides, precision agriculture, soil health, nutrient-use efficiency, water efficiency, productivity, input costs, Nano Urea

Model Answer

Introduction

Nanotechnology manipulates materials at the nanoscale to create products with enhanced properties. In agriculture, it can improve the precision and efficiency of inputs while reducing environmental externalities.

1. Agricultural applications

Nanotechnology can facilitate:

1. Nano-fertilisers for controlled and efficient nutrient delivery.
2. Nano-pesticides for targeted pest management and reduced chemical usage.
3. Nanosensors to monitor soil moisture, nutrients, diseases and crop stress.
4. Nano-enabled seed treatment for improved germination and resilience.
5. Precision delivery of micronutrients and agrochemicals.
6. Improved packaging and preservation of agricultural produce.

For example, nano-urea has been promoted in India as a means of improving nitrogen-use efficiency and reducing conventional fertiliser requirements.

2. Socio-economic benefits

Higher input-use efficiency can reduce production costs and improve farm profitability. Early detection of pests and nutrient deficiencies can reduce crop losses, while precision irrigation can conserve water.

Higher productivity and quality can increase farmers' marketable surplus and potentially improve incomes. Reduced chemical use can also lower environmental and health risks.

3. Challenges

High technology costs, limited farmer awareness, uncertain long-term ecological impacts, regulatory requirements and the need for field-level validation remain concerns.

Conclusion

Nanotechnology can support climate-smart and precision agriculture, but its benefits will become inclusive only when supported by affordable access, extension services, scientific validation and appropriate regulation.

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