



Role of Nuclear Technology in Global Food Safety

For Prelims: [Food irradiation](#), [Nuclear energy](#), [Food and Agriculture Organization \(FAO\)](#) [International Atomic Energy Agency \(IAEA\)](#), [nuclear technologies](#), [Polymerase Chain Reaction \(PCR\)](#), [intellectual property rights](#)

For Mains: Significance of Nuclear Energy in the food and processing sector.

Source: [FAO](#)

Why in News?

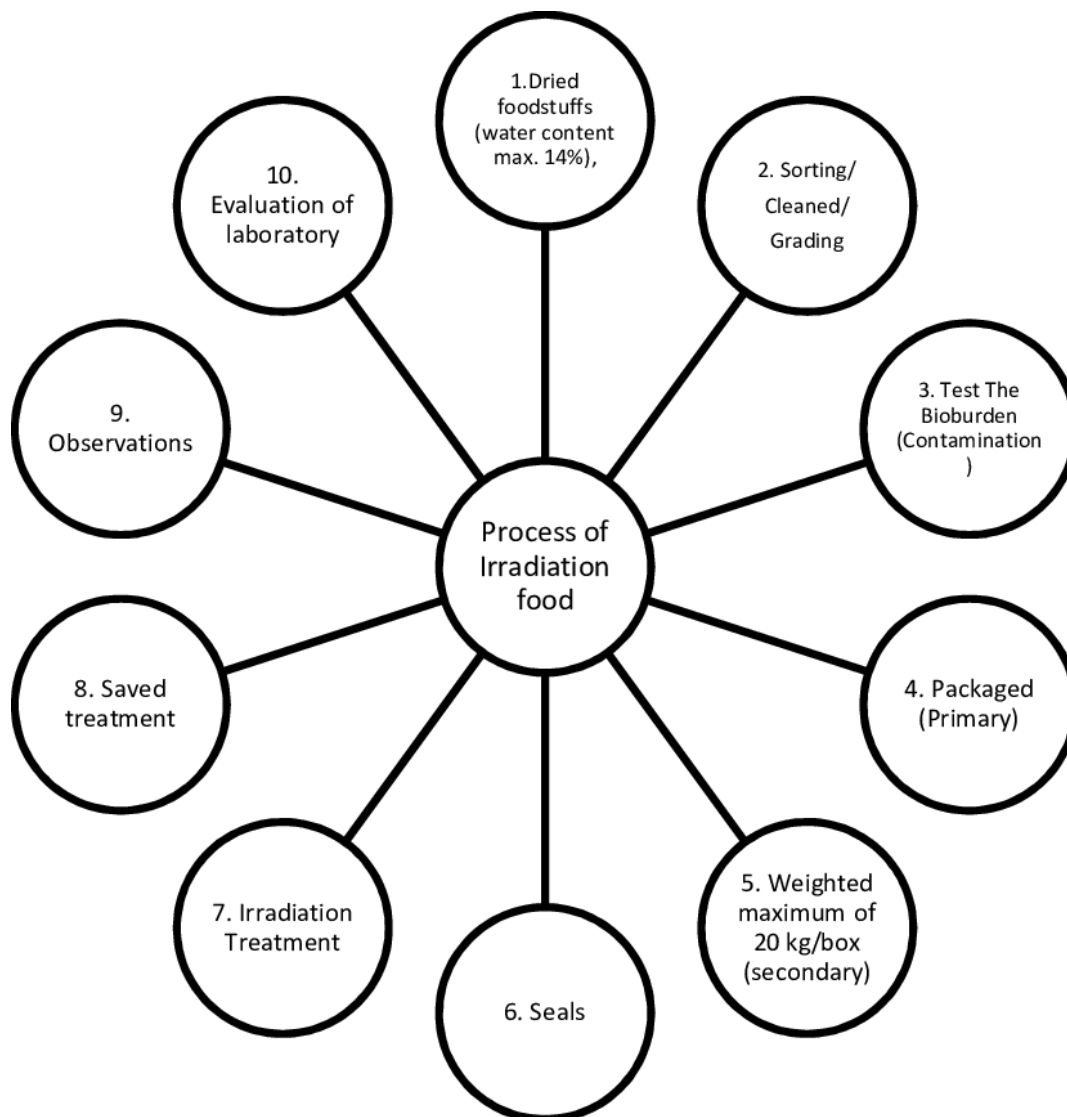
Recently, an International Symposium on "**Safe Food for a Better Life**", jointly organised by the [Food and Agriculture Organisation \(FAO\)](#) and the [International Atomic Energy Agency \(IAEA\)](#) emphasised the importance of [nuclear technologies](#) for measuring, managing and controlling food safety.

- Furthermore, the symposium highlighted the potential use of nuclear technology in ensuring food security.

What is the Application of Nuclear Technology on the Food Safety Standard?

- **Complementary to One Health Approach:**
 - The One Health approach recognises the interconnectedness of human, animal, and environmental health; nuclear techniques can be used to detect and monitor contaminants, pathogens, and toxins in food and the environment.
 - [Polymerase Chain Reaction \(PCR\)](#) tests is a molecular nuclear technique, to rapidly detect animal diseases in less than a day.
- **Food Irradiation:**
 - [Food irradiation](#) is a process of **exposing food to ionising radiation** to eliminate harmful bacteria, pathogens, and pests; nuclear technology helps to **extend the shelf life** of food products and ensure their safety for consumption.
 - **Stable isotope analysis** is a nuclear technique that is used to determine the origin and authenticity of food products and this helps to **detect adulteration and verify labelling claims**.
- **Improved Soil and Water Management:**
 - Past nuclear fallouts are actually helping scientists when it comes to measuring and assessing soil erosion, radioactive nuclides left behind after nuclear events can help scientists determine the [health of soils and rate of erosion](#).
- **Pest Control:**
 - Nuclear techniques, such as the **Sterile Insect Technique (SIT)**, are used for pest control in agricultural production systems.
 - This technique limits reproduction and suppresses insects and pests, thereby reducing the need for chemical pesticides, which can negatively impact food safety.
- **Plant Breeding and Genetics:**

- Nuclear technology applied in crop breeding facilitates the development of enhanced varieties capable of adapting to climate change.
- By subjecting seeds to irradiation by **gamma rays, X-rays, ions, or electron beams**, genetic alterations are initiated, expanding the genetic diversity available for breeding purposes.



What is the Need for Tech-Related Advancements in Food Security?

- **Climate Change:** Climate-induced challenges such as **droughts, floods**, and temperature fluctuations, can adversely affect crop production and food availability so **climate-smart agriculture (CSA)** needs to be promoted.
- **Food Waste:** According to the **FAO**, roughly **1/3rd of food** produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year and approximately **3.1 billion people** could not afford a healthy diet in 2020 (FAO, 2022).
- **Increasing Population:** The world's population is projected to reach **9.7 billion by 2050 (UN World Population Prospects, 2019)**, putting immense pressure on food production systems, thereby technological advancement is required.
- **Limited Resources:** With limited arable land and freshwater resources, technology can help maximise productivity through vertical farming, hydroponics, and efficient irrigation systems.

Note:

- **Atoms 4Food** is a joint initiative of the **International Atomic Energy Agency (IAEA)** and the **FAO** to tackle global hunger and enhance food security.

- It was showcased at the **2023 World Food Forum in Rome**.
- This project aims to leverage nuclear processes and cutting-edge technologies, tailoring solutions to address the specific needs of different countries.
- These technologies are employed to boost agricultural and livestock productivity, manage natural resources more effectively, reduce food losses, ensure food safety standards, improve nutritional value, and mitigate the challenges posed by climate change.
 - The **Joint FAO/IAEA Centre** of Nuclear Techniques in Food and Agriculture assists in safe and effective application of nuclear technologies for global food security and sustainable agricultural development.

What Challenges are Associated with using Nuclear Technology for Food Safety?

- **Geographical and Regional Variations:**
 - **Diverse agro-climatic regions** and farming practices, can pose challenges in the uniform application and adaptation of nuclear techniques across the globe.
 - The application of **isotopic techniques** for soil and water management may require **region-specific calibration** and adaptation due to variations in soil types, climatic conditions, and irrigation practices.
- **Limited Funding and Investment and Technology:**
 - The development of **irradiation facilities** for food preservation and pest control requires significant capital investment, which may be a challenge due to budget constraints.
 - Accessing advanced techniques like **accelerator-based mutation breeding** or specialised analytical equipment for food traceability may be difficult due to **technology transfer restrictions or high costs**.
- **Regulatory Challenges:**
 - The use of nuclear technology in agriculture is subject to strict regulations and guidelines to ensure safety and security obtaining necessary approvals, licences, and compliance with regulatory requirements can be a **lengthy and complex process**.
 - Various factors, including **intellectual property rights** and **technology transfer barriers**, hinder the adaptation.
- **Lack of Allied Infrastructure:**
 - Lack of specialised laboratories and research facilities, to effectively utilise nuclear techniques in agriculture and shortage of trained personnel and expertise in this field, limiting the widespread application of these techniques.

What is Nuclear Energy?

- It is a form of energy released from the **nucleus or core of atoms**.
- It is known for its high energy density, meaning a **small amount of nuclear fuel can produce a large amount of energy**.
 - There are two primary methods for harnessing nuclear energy:
- **Nuclear Fission:** This process involves splitting the nucleus of an atom into two **smaller nuclei**, releasing a **large amount of energy**.
 - Nuclear power plants primarily use this method, **utilising uranium-235 or plutonium-239 as fuel**. When the nuclei of these heavy isotopes are bombarded with neutrons, they become unstable and split into smaller nuclei, releasing additional neutrons.
 - This chain reaction generates significant heat, which is used to produce steam, drive turbines, and ultimately generate electricity.
- **Nuclear Fusion:** This process involves combining the **nuclei of two light atoms to form a heavier nucleus**, which is the process that powers the sun and other stars.
 - While nuclear fusion holds great potential for providing clean and virtually limitless energy, achieving controlled nuclear fusion on Earth remains extremely challenging.

What is the Food and Agriculture Organization (FAO)?

- FAO is a specialised agency of the [United Nations](#) that leads international efforts to defeat hunger.
- [World Food Day](#) is celebrated every year around the world on 16th October to mark the anniversary of the founding of the FAO in 1945.
- With 194 member countries (including India) and the European Union, FAO works in over 130 countries worldwide.
- It is one of the UN food aid organisations based in Rome (Italy). Its sister bodies are the [World Food Programme](#) and the International Fund for Agricultural Development (IFAD).

Way Forward

- **Developing Infrastructure and Facilities:** Allocate funds and resources to set up **irradiation facilities, analytical labs**, and equipment for nuclear technology, such as a food irradiation facility to **preserve perishable produce**, reduce losses, and ensure food safety.
- **Regulatory Reforms and Streamlining Processes:** Create guidelines for the **safe handling, transport, and disposal of radioactive** agricultural materials and form a regulatory body to oversee the approval and commercialization of radiation-induced mutant crops.
- **Promoting Public-Private Partnerships:** Promote collaborations between **research institutions, the private sector, and the industry** for nuclear technology transfer, and offer incentives for companies to invest in developing and commercialising nuclear-based agricultural products.
- **International Cooperation and Knowledge Sharing:** Foster international collaborations, such as partnering with the **Joint FAO/IAEA** Centre for expertise and technology transfer.

Drishti Mains Question:

“Technology has the potential to significantly contribute to the growth and sustainability of Indian agriculture by improving crop yields, farmer incomes, and the ability to withstand challenges faced by the agricultural sector.” Critically analyse.

UPSC Civil Services Examination Previous Year's Question (PYQs)

Prelims:

Q. Consider the following statements: (2019)

1. According to the Indian Patents Act, a biological process to create a seed can be patented in India.
2. In India, there is no Intellectual Property Appellate Board.
3. Plant varieties are not eligible to be patented in India.

Which of the statements given above is/are correct?

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

Ans: (c)

Mains:

Q. What are the present challenges before crop diversification? How do emerging technologies provide an opportunity for crop diversification. (2021)

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