# NANOTECHNOLOGY IN AGRICULTURE

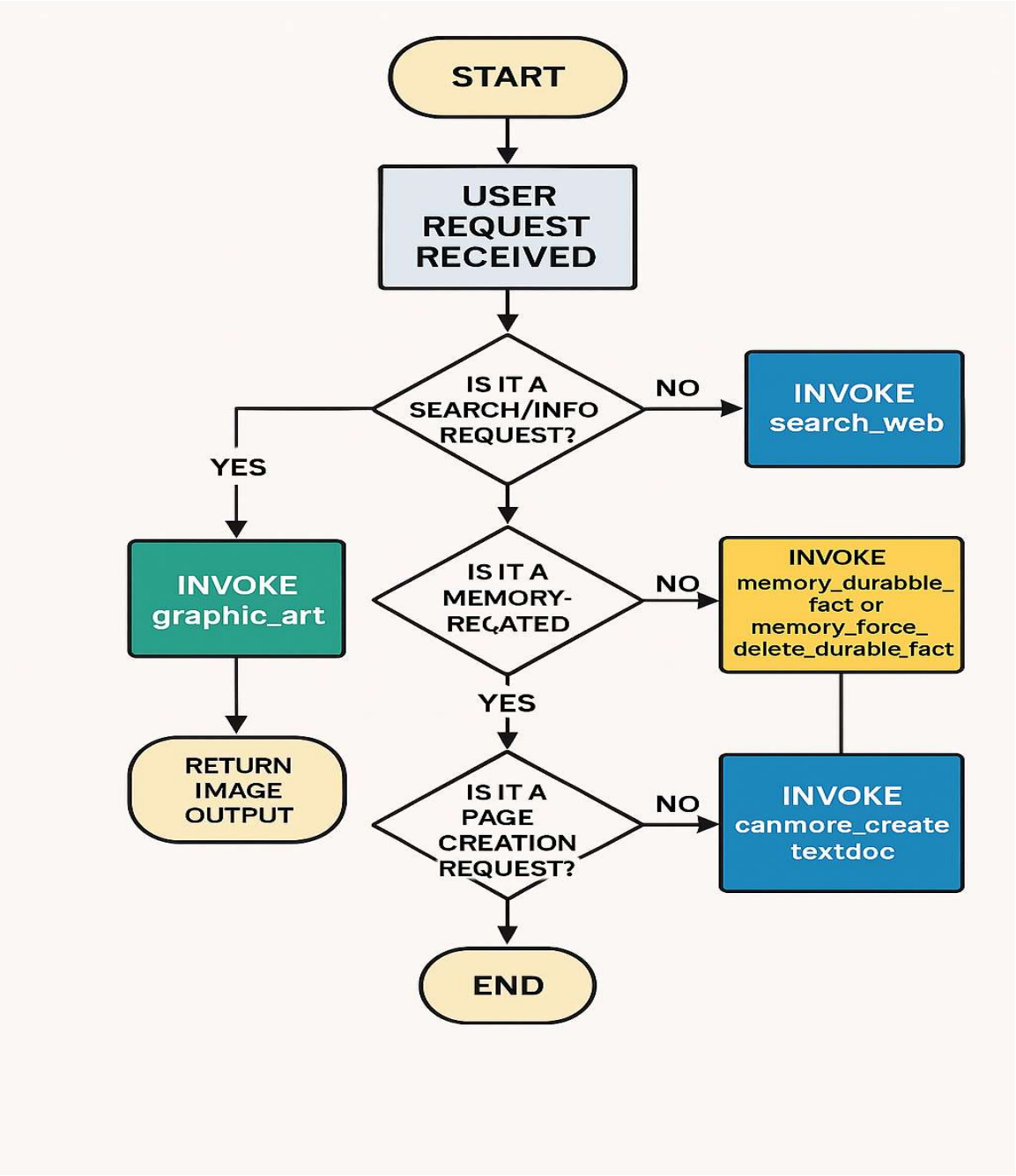
# Contents

## A. Project Abstract

Nanotechnology in agriculture uses materials in the size range of 1–100 nanometers to make farming more productive, precise, and environmentally sustainable. In this project, the applications of nano fertilizers, nano pesticides, nanosensors, nano-based food packaging, and nano-enabled water purification are studied to understand how they improve crop yield, input efficiency, and food safety.

The project explains how nano fertilizers such as nano urea deliver nutrients in controlled doses, how nano-encapsulated pesticides reduce chemical load, and how nanosensors enable precision farming through real-time monitoring of soil and crop health. It also highlights the role of nanomaterials in extending food shelf life and purifying irrigation water by removing pathogens and toxic contaminants. Overall, the project shows that nanotechnology can help farmers “produce more with less” by saving water, fertilizers, and pesticides while reducing pollution and post-harvest losses.

## B. Flow Chart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USER REQUEST RECEIVED
IS IT A SEARCH/INFO REQUEST?
NO
INVOKE search_web
YES
INVOKE graphic_art
IS IT A MEMORY-RELATED
NO
INVOKE memory_durable_fact or memory_force_delete_durable_fact
YES
RETURN IMAGE OUTPUT
IS IT A PAGE CREATION REQUEST?
NO
INVOKE canmore_create textdoc
END

**Flow of Nanotechnology Applications in Agriculture**

1. Problem in Conventional Agriculture

   → Low fertilizer use efficiency, high pesticide use, soil and water pollution, post-harvest losses.

2. Introduction of Nanotechnology (1–100 nm materials)

   → Nano-formulation and controlled delivery of inputs.

3. Major Nano Applications

   - Nano Fertilizers (e.g., nano urea)
     → Controlled nutrient release → Better nutrient uptake → Higher yield, less wastage.
   - Nano Pesticides (e.g., nano-encapsulated neem oil)
     → Slow, targeted release → Effective pest control with reduced chemical quantity.

- Nanosensors / Nano-biosensors
  → Real-time data on soil moisture, nutrients, and diseases → Precision farming and smart irrigation.
- Nano-based Food Packaging
  → Improved barrier and antimicrobial properties → Longer shelf life, safer food.
- Nano-enabled Water Purification
  → Removal of microbes, pesticides, and heavy metals
  → Cleaner irrigation water.

4. Outcomes

→ Increased crop yield and quality
→ Reduced input use and pollution
→ Better food safety and sustainability.

## C. Module Description

### Module 1: Introduction to Nanotechnology in Agriculture

- Explain the meaning of nanotechnology and the size range of nanoparticles (1–100 nm).
- Describe current challenges in agriculture: low productivity, input wastage, soil and water degradation, and food safety issues.
- State the main aim of the project: to study how nanotechnology improves productivity, efficiency, and sustainability in agriculture.

## Module 2: Nano Fertilizers

- Define nano fertilizers and how they differ from conventional fertilizers (higher surface area, controlled release, better absorption).
- Explain mechanisms like slow and targeted nutrient release that match crop demand, reducing leaching and volatilization losses.
- Include examples such as IFFCO nano urea and discuss benefits: higher yield, less fertilizer use, and reduced environmental pollution.

## Module 3: Nano Pesticides and Plant Protection

- Define nano pesticides and nano-encapsulation of active ingredients such as neem oil.
- Explain how nano formulations allow slow, controlled, and site-specific release, increasing efficacy at lower doses.
- Mention advantages: lower chemical residues, reduced impact on non-target organisms, and longer protection against pests and diseases.

## Module 4: Nanosensors, Disease Detection and Smart Farming

- Describe nanosensors and nano-biosensors used to measure soil moisture, nutrient status, and plant health in real time.
- Explain how networks of nanosensors support precision agriculture by guiding irrigation, fertilizer application, and pest management.
- Add early disease detection: nano-biosensors can detect pathogens at low concentrations, enabling quick action before visible damage.

## Module 5: Nano-based Packaging, Water Purification and Overall Impact

- Explain nano-enabled food packaging: better barrier properties, antimicrobial activity, and longer shelf life for stored food.
- Describe nano-based water purification: nano-filters and membranes that remove microbes, pesticide residues, and heavy metals from water.
- Conclude with overall advantages and concerns: higher yield, resource saving, lower pollution, food security benefits, and the need to study safety and regulation of nanomaterials.