

# AI APPLICATIONS IN AGRICULTURE: TRANSFORMING THE FUTURE OF FARMING

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# INTRODUCTION

Agriculture serves as the backbone of India's economy, providing the primary source of livelihood for over 58% of rural households. However, it grapples with formidable challenges throughout the agricultural cycle, from sowing to harvest. To address these challenges effectively, there is a pressing need for the modernization of agriculture. In the realm of agriculture, rapid strides are being made in the integration of Artificial Intelligence (AI) into various farming techniques. AI has emerged as a focal point in computer science research due to its swift technological advancement and wide-ranging applications. Its relevance in agriculture is escalating, given its robust applicability in addressing problems that are not easily solvable by humans. Agriculture, which engages approximately 80% of the population across 159.7 million hectares of agricultural land, requires efficient solutions. AI-powered farming solutions empower farmers to achieve more with fewer resources, elevating the overall quality of agricultural practices. Additionally, these solutions facilitate a swift Go-To-Market (GTM) strategy for crops. The incorporation of AI and machine intelligence in the farming sector represents

a paradigm shift from traditional practices. AI-powered agriculture plays a pivotal role in interpreting, acquiring and responding to diverse situations, thereby enhancing overall efficiency. The application of AI technology extends across various facets of agriculture, contributing to increased productivity and efficiency.

AI solutions are instrumental in overcoming traditional challenges across different fields within the agriculture sector. The intervention of AI in agriculture enables farmers to enhance efficiency while mitigating adverse environmental impacts. Notably, the agriculture industry has wholeheartedly embraced AI, resulting in a transformation of overall outcomes. The integration of AI in food production has led to a 20% reduction in emissions from the agricultural sector. The infusion of AI technology in agriculture serves as a valuable tool for controlling and managing unforeseen natural conditions, further fortifying the resilience of the industry. This seamless integration of AI into agriculture marks a significant leap forward, ensuring sustainable and technologically advanced practices in food production.

## WHAT'S ARTIFICIAL ABOUT INTELLIGENCE IN AI?

AI encompasses the exploration of computer systems that aim to emulate and apply the intelligence found in the human mind. It replicates intelligent human behaviors, striving to achieve and potentially surpass, human-like proficiency in all cognitive tasks through logical reasoning. The term 'artificial' in AI signifies its non-biological nature, while 'intelligence' denotes the capability to accomplish intricate goals or tasks. AI involves analytical processes a kin to human thinking, encompassing areas such as speech recognition, natural language understanding and translation, knowledge management, image analysis, decision-making and learning. These facets empower systems with considerable strength and utility. The rapid advancement of AI technology plays a crucial role in addressing problems by suggesting specific actions needed to overcome challenges, functioning as an adept and efficient problem-

solving tool. In the agricultural sector, AI serves as an intelligent monitoring system, contributing to enhanced results with minimal environmental impact and increased efficiency. AI holds the promise of instigating an agricultural revolution precisely when the world faces the imperative to produce more food while utilizing fewer resources. This article succinctly explores the pivotal applications of AI in agriculture across various stages of the cropping cycle, offering the potential for farmers to reap benefits in the form of increased efficiency and higher incomes.

## TYPES OF AI:

1. ANI (Artificial Narrow Intelligence): Specialized in one task
2. AGI (Artificial General Intelligence): Smart as human in all aspect
3. ASI (Artificial Super Intelligence): Smarter than human in all aspect

**NITI Aayog has decided to focus on five sectors that are envisioned to benefit the most from AI in solving societal needs:**

1. **Healthcare:** Increased access and affordability of quality healthcare.
2. **Agriculture:** Enhanced farmers' income, increased farm productivity and reduction of wastage.
3. **Education:** Improved access and quality of education.
4. **Smart Cities and Infrastructure:** Efficient and connectivity for the burgeoning urban population and
5. **Smart Mobility and Transportation:** Smarter and safer modes of transportation and better traffic and congestion problems.



## Top Artificial Intelligence (AI) Startups and Companies in Gujarat:

1. Legalwiz dot in Private Limited (Ahmadabad, India)
2. Torchit Private Limited (Ahmadabad, India)
3. XPERTNEST (Ahmadabad, India)
4. Innovura Technologies (Vadodara, India)
5. Plushvie (Ahmadabad, India)
6. Arocom IT Solutions Pvt Ltd (Gandhinagar, India)
7. Eveo (Surat, India)
8. F(x) Data Labs (Ahmadabad, India)
9. RoboSort(Jamnagar, India)
10. TopDoc AI (Ahmadabad, India)

## LIFECYCLE OF AGRICULTURE

### We can divide the Process of Agriculture into different parts:

- ✓ **Soil Preparation:** At the outset of the farming process, farmers engage in soil preparation to ready the land for seed sowing. This crucial step entails breaking down sizable soil clumps and clearing away debris such as sticks, rocks and roots. Additionally, farmers supplement the soil with fertilizers and organic matter tailored to the specific crop, fostering an optimal environment for successful crop growth.

- ✓ **Seed Planting:** In this stage, meticulous attention is given to the spacing and depth of seeds planted. Climatic conditions, including temperature, humidity and rainfall, play a pivotal role in ensuring optimal conditions for seed germination.
- ✓ **Fertilization:** Maintaining soil fertility is paramount for cultivating nutritious and robust crops. Farmers utilize fertilizers, rich in essential plant nutrients like nitrogen, phosphorus and potassium to supplement the soil's natural elements. This stage significantly influences crop quality.
- ✓ **Irrigation:** Irrigation is vital to keep the soil adequately moist and humidity levels optimal. Precise watering is crucial, as under or overwatering can adversely affect crop growth and lead to potential damage.
- ✓ **Weed Control:** Managing unwanted plant growth near crops or on farm perimeters is crucial. Effective weed protection is essential to prevent yield reduction, control production costs, avoid interference with harvest and maintain overall crop quality.
- ✓ **Crop Harvesting:** The harvesting phase involves gathering ripe crops from the fields, a labor-intensive process that requires a significant workforce. Post-harvest activities, including cleaning, sorting, packing and cooling are integral to this stage.
- ✓ **Storage and Transportation:** Post-harvest products are carefully stored to ensure food security beyond the agricultural season. This phase encompasses packing and transportation activities to preserve crop quality and facilitate distribution.



# CHALLENGES IN THE ADOPTION OF AI IN AGRICULTURE:

- ✓ Despite the vast potential that AI offers in agricultural applications, a prevalent challenge is the limited awareness and understanding of advanced machine learning solutions within global farming communities. Agriculture remains susceptible to external factors such as weather conditions, soil variations and pest threats, introducing uncertainties into crop cultivation. A well-planned crop strategy at the season's onset may undergo modifications during harvesting due to the influence of these external parameters.
- ✓ AI systems demand substantial datasets for effective machine training, enabling accurate forecasting and predictions. While collecting spatial data over extensive agricultural landscapes is manageable, acquiring temporal data poses a significant challenge. The periodic nature of crop-specific data, obtainable only during the growing season complicates the timely development of a mature and robust AI machine learning model.
- ✓ Annual data collection for specific crops results in a prolonged database maturation process, contributing to the time-intensive nature of constructing resilient AI models. This time constraint prompts a preference for AI utilization in agronomic products like seeds, fertilizers and pesticides, rather than focusing on on-field precision solutions.

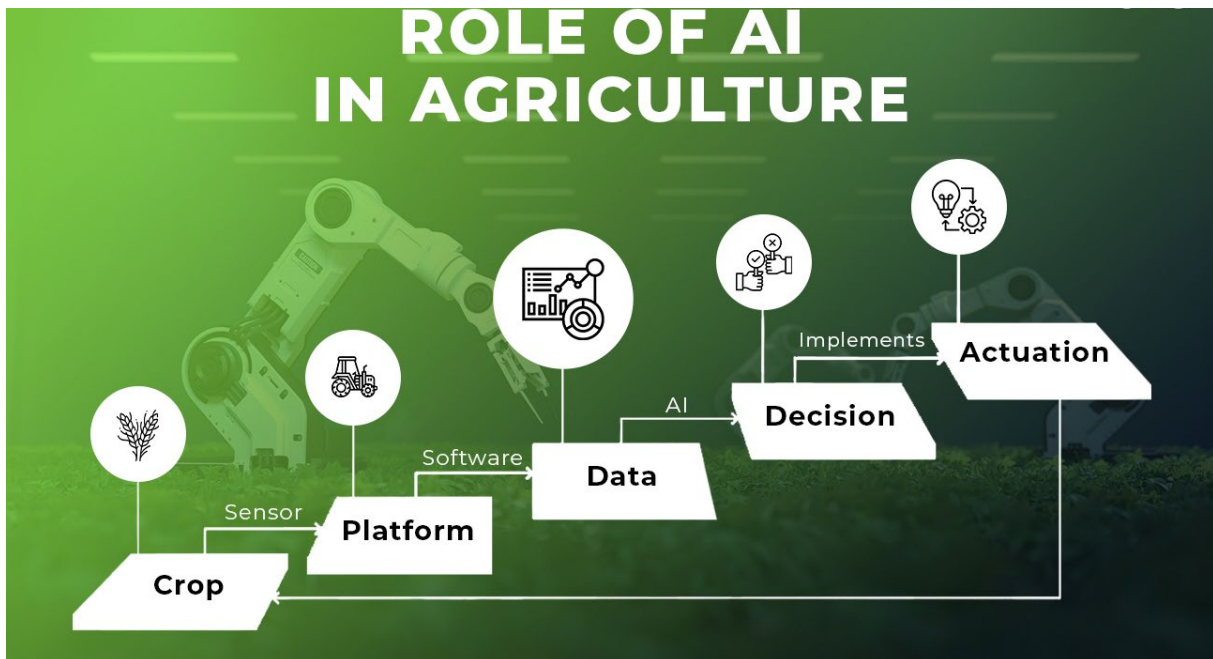


# CHALLENGES IN USE OF AI FOR AGRICULTURE

- ✓ **Complexity of the Indian Agricultural System:** Navigating the intricate structure of the Indian agricultural system poses a substantial challenge for the seamless integration of AI technologies. The diverse and multifaceted nature of farming practices adds layers of complexity that must be addressed for effective AI adoption.
- ✓ **Inadequate Datasets for AI Model Training:** The scarcity of essential datasets required to train AI models is a significant hindrance. Insufficient and fragmented data can impede the development of robust and accurate AI solutions tailored to the specific needs of the agriculture sector.
- ✓ **Cost Constraints Associated with AI Hardware/Software:** The expense associated with acquiring and maintaining the various hardware and software components of AI systems poses a financial challenge. Cost considerations may limit the accessibility of AI technologies to a broader spectrum of farmers and stakeholders in the agricultural domain.
- ✓ **Effective Management of Massive Data in a Secure Manner:** The sheer volume of agricultural data generated demands an effective mechanism for safe and secure handling. Ensuring the privacy and integrity of this massive dataset is crucial, requiring sophisticated infrastructure and protocols to prevent data breaches or unauthorized access.

# APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

- ✓ **Embracing Artificial Intelligence (AI) technologies** has become pivotal in enhancing crop quality, pest control, soil and growing condition monitoring, data organization for farmers, workload management and overall optimization of tasks throughout the entire food supply chain.
- ✓ **Weather Forecasting Integration:** Farmers leverage AI-driven weather forecasting to analyze weather conditions, aiding in crop selection and optimal seed sowing timing. AI technologies empower farmers to make informed decisions based on real-time weather data.
- ✓ **Soil and Crop Health Monitoring Innovations:**
  - A. PEAT's Plantix Application: The German startup PEAT developed Plantix, an AI-based app employing image recognition to detect soil nutrient deficiencies, plant pests and diseases. It offers farmers tailored advice on fertilizer application, promoting higher harvest quality through smart image capture technology.
  - B. Trace Genomics Soil Analysis: Startups like Trace Genomics utilize machine learning for soil analyses. Farmers benefit from real-time tracking of soil and crop quality, resulting in more robust and productive harvests.



✓ **Precision Farming and Predictive Analytics:**

- A. **AI-Enabled Farming Apps:** Agriculture AI applications provide farmers with precise guidance on water management, crop rotation, optimal harvesting times, suitable crop cultivation, insect assaults and nutrition management. Predictive analytics powered by AI assess weather conditions, crop sustainability and potential threats, ensuring informed decision-making for farmers.
- B. **Blue River Technology:** Integration of AI, computer vision and robotics by Blue River Technology helps reduce costs and minimize pesticide usage. By distinguishing individual plants and employing machine learning, robots intelligently control farming machinery, optimizing tasks such as picking and packing while ensuring efficient use of resources.

✓ **AI-Driven Robotic Farming:**

- **Multi-Tasking Robots:** AI-powered robots designed for farming tasks demonstrate enhanced efficiency in

weed control, crop harvesting, quality assessment and weed detection. These robots perform tasks at a faster pace and higher volumes compared to human labour, addressing challenges faced by the agricultural workforce.

✓ **Pest Detection Using AI:**

- **Satellite-Based Pest Detection:** AI systems utilize satellite images and historical data, employing algorithms to detect pest landings, including locusts and grasshoppers. Farmers receive real-time alerts on their smartphones, enabling prompt actions and pest control measures.

✓ **Jivabhumi's Smart Agricultural Marketplace:**

- **Blockchain-Enabled Agricultural Marketplace:** Jivabhumi pioneers a "Smart" Agricultural Marketplace, leveraging technologies like blockchain to optimize supply and demand for agricultural products. This innovative solution integrates agricultural products, e-marketplace services and blockchain to collect information at various stages of the supply chain, enhancing transparency and efficiency.

# CONCLUSION

Artificial Intelligence (AI) stands as a transformative force, empowering farmers to amplify production capacity while minimizing production costs and labour-intensive tasks. The widespread integration of AI across diverse application domains is poised to revolutionize the landscape of agricultural research and development. As AI progresses, it gravitates towards increased automation with heightened accuracy, facilitating real-time management and steering traditional agriculture towards precision farming at a reduced cost. The efficacy of AI solutions hinges on their viability and accessibility to the farming community. To expedite adoption and cultivate broader understanding among farmers, AI solutions should adopt an open-source platform, ensuring affordability and inclusivity.



# THE ROAD AHEAD FOR AI

Opportunities abound in AI and the onus lies on us to ideate, innovate and create AI based systems for the benefit of agriculture towards our well-being. Having said that, there will always a bit or lot of ‘artificiality’ in AI leaving space for humaneness in the humans to intervene, if not interfere, in the way AI systems will affect our lives. It is up to our imaginations and passion to make AI solutions to enhance the way we do agriculture in the days to come.