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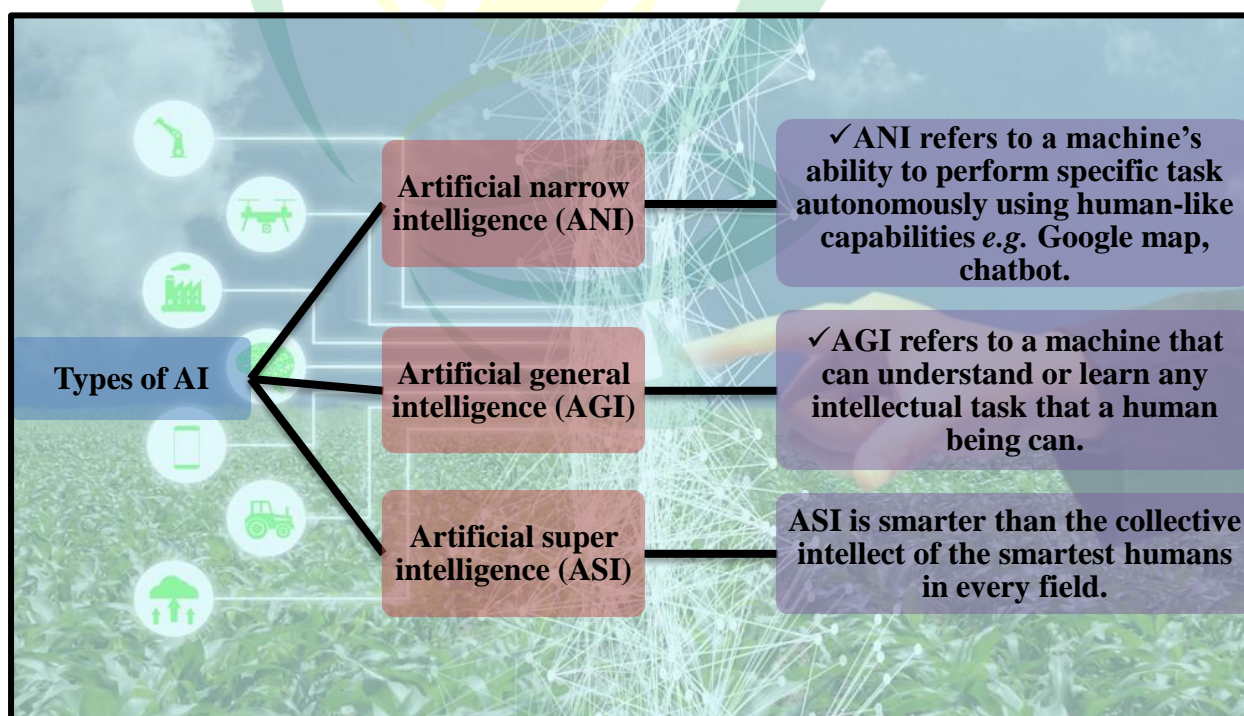# Artificial Intelligence: An Intelligent Path to Improve Indian Agriculture

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Introduction to Artificial Intelligence

Artificial intelligence (AI) is a branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. Back in 1956 at The Dartmouth Conference, an American computer scientist John McCarthy coined "Artificial intelligence (AI)" term. The term AI composed of word "artificial" which means made or produced by human being rather than occurring naturally and "intelligence" which is stands for the ability to acquire and apply knowledge and skills.AI makes it possible for machines to learn from past experience, adjust to new inputs and have the ability to execute tasks naturally associated with human intelligence, like speech recognition, decision-making, visual perception and translating languages. AI is not a "Man versus Machine saga" but it is a "Man with Machine synergy".

Types of AI

Artificial narrow intelligence (ANI) — ✓ANI refers to a machine's ability to perform specific task autonomously using human-like capabilities *e.g.* Google map, chatbot.

Artificial general intelligence (AGI) — ✓AGI refers to a machine that can understand or learn any intellectual task that a human being can.

Artificial super intelligence (ASI) — ASI is smarter than the collective intellect of the smartest humans in every field.

Why We Need AI in Agriculture Sector?

The global population is expected to reach 10 billion people by 2050, which means double agricultural production in order to meet a food demand which is about 70% increase in food production. Primarily India is an agricultural country so economics of farm produce plays an important role in country's economy. Seventy percent of rural household depends directly on agriculture for their livelihood in India (Champaneri *et al.,* 2020). Indian agriculture sector accounts for 18 % of India's gross domestic product (GDP) and ensure food security to roughly 1.3 billion people. India still depends on resource intensive agriculture practices. Major problems such as degradation of land, increased dependence on inorganic fertilizers, reduction in soil fertility, reduction in ground water table and pest resistance *etc.* are clear indication for India's unsustainable agricultural practices. As climate change becomes more sensible and unpredictable, dependence on unsustainable agriculture practices will only increase the risk of food scarcity. Use of water in agriculture continues to be high and sub-optimal. In spite of having just one-third of the gross cropped area under irrigation, agriculture use 89% of extracted groundwater. Absence of functional end-to-end agriculture value chains has caused the price realization. Artificial Intelligence technologies are helpful to yield healthier crops, provides information of prevailing weather conditions such as temperature, rain, wind speed, wind direction and solar radiation, control pests, monitor soil and growing conditions, organize data for farmers, help with workload and improve food supply chain (Manaware, 2020).

Application of AI in Agriculture

1. Image Based Insight Generation:

Drone-based images can help in in-depth field analysis, crop monitoring, scanning of fields and so on. Computer vision technology, IOT and drone data can be combined to ensure rapid actions by farmers. Feeds from drone image data can generate alerts in real time to accelerate precision farming.

Disease detection: Pre-processing of image ensure the leaf images are segmented into areas like background, non-diseased part and diseased part. The diseased part is then cropped and sends to remote labs for further diagnosis. It also helps in pest identification, nutrient deficiency recognition and more.
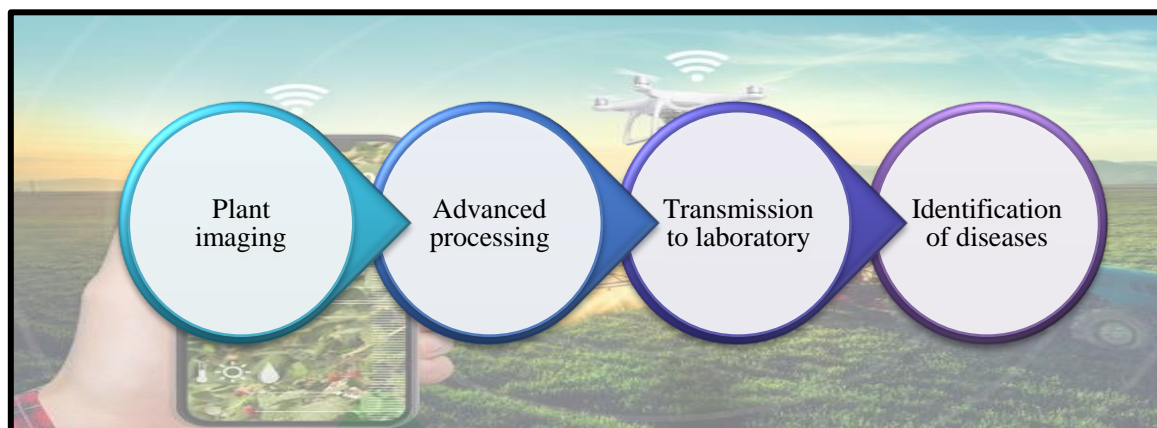
Crop readiness identification: Images of different crops under white/UV-A light are captured to determine how ripe the green fruits are. Farmers can create different levels of readiness based on the crop/fruit category and add them into separate stacks before sending them to the market.

Field management: Using high-definition images from airborne systems (drone or copters), real-time estimates can be made during cultivation period by creating a field map and identifying areas where crops require water, fertilizer or pesticides. This helps in resource optimization to a huge extent.

2. Health Monitoring of crops:

Remote sensing techniques along with hyper spectral imaging and 3D laser scanning are essential to build crop metrics across thousands of acres. It has the potential to bring in a revolutionary change in terms of how farmlands are monitored by farmers both from time and effort perspective. This technology will also be used to monitor crops along their entire lifecycle including report generation.

Decrease Pesticide Usage: Weed management can be effectively done by implementing computer vision, robotics, and machine learning. With the help of the AI, data are collected to check the weed infestation area which helps the farmers to spray chemicals only where the weeds are. By this there is a reduction in over pesticide losses as well as herbicide losses which also lead to reduce the contamination of the soil and groundwater as well as chances of pesticides residues in human food system. This also helps farmers to overcome the labour challenge.

3. Automation Techniques in Irrigation:

The smart Irrigation system is an Internet of things (IoT) based device which is can automate

the irrigation process by analyzing the moisture of soil and the climate condition. Irrigation is one of the most labour intensive processes in farming which can be avoided by artificial intelligence because it is aware of historical weather pattern, soil quality and kind of crops to be grown. Automated irrigation systems are designed to utilize real time machine which can constantly maintain desired soil conditions in order to increase water use efficiency and average yields. With close to 70% of the world's fresh water being used in irrigation, automation can help farmers better manage their water problems.

4. Drone Based Technology:

One of the most promising areas is agriculture, where drones have the potential to address major challenges. Drone technology is giving agriculture a high-tech makeover. Here are six ways drones will be used throughout the crop cycle:

- **Soil and field analysis:** By producing precise 3-D maps for early soil analysis, drones can play a role in planning seed planting and gathering data for managing irrigation and nitrogen levels.

- **Crop spraying:** Drones can scan the ground, spraying in real time for even coverage. The result of aerial spraying is five times faster with drones than traditional machinery.

- **Crop monitoring:** Inefficient crop monitoring is a huge obstacle. With drones, time-series animations can show the development of a crop and reveal production

inefficiencies, enabling better management.

- **Irrigation:** Sensor drones can identify which parts of a field are dry or need improvement.

- **Health assessment:** By scanning a crop using both visible and near-infrared light, drone-carried devices can help track changes in plants and indicate their health and alert farmers to disease. UAVs may one day consist of autonomous swarms of drones, collecting data and performing tasks. The biggest obstacle to that becoming a reality is sensors capable of collecting high-quality data and number crunching software that can make that high-tech dream a reality.

5. Models for Farmers' Services:

The beneficiary of this service can be offered with following service models:

a. **Chatbot:** Agriculture can use chatbot (virtual assistant) technology by assisting farmers with answers and recommendations on specific problems. This service lets the farmer to get their queries answered via interactive voice chat in their native languages. The chatbot engine is driven with both supervised and reinforced machine learning techniques for a continuous and context sensitive learning. Thereby the chatbot answers to most of the generic queries before it lets to human operator intervention for any queries that are unique in nature.

b. **Agri-E calculator for suitable crop selection along with resource estimation:** The farmer can use the smart calculator and just choose the desired crop to be cultivated over his preferred coverage area of farm. Then all other required inputs based on various dependency factors are automatically identified and taken by the e-calculator and provides the estimation results. This output result provides useful data on estimation of fertilizers cost/quantity, water, seeds, cultivation equipment cost and Labour Day efforts/cost with Labour Day effort distribution on calendar chart of crop life cycle, crop yield along with extrapolated market price at the harvest time and its profitability.

c. **Crop care service:** The crop care service guidance spans right from the sowing of seeds as start point till the time of harvesting as endpoint. The complex structured data sampled from IoT sensors from the fields are analyzed along with the data collected from sources of information sites along with domain expert inputs wherever

needed through Artificial Intelligence techniques. After the analysis of complete data, the overall corrective action item is derived out of PID (Proportional Integral & Differential) controller mechanism. Accordingly, the corrective measures are alerted to the farmer on their smart phone to prioritize the action based on severity and urgency to act upon.

d.   **Price prediction and market guidance:** Based on the statistical data collected from various sources a predictive price and demand information is shared with the famers during the complete crop lifecycle. And hence the farmers can plan better for releasing their commodities to market.

e. **Crop loan and insurance service:** This service helps the farmers in facilitating feasibility of the getting, crop loan, processing support, eligibility criteria and loan limit as per the smart estimation made for the proposed crop. Also, it helps to get the crop insured as a mitigation plan for crop failures due to any uncertainties or calamities.

6. Robot Drone Tractor:

Driverless tractors are independent tractors that perform all the farm practices autonomously and precisely. They are fixed with sensors that are able to perform the required practices, monitoring obstacles and determining where to apply the farm inputs. Driverless vehicle technology becomes prevalent across a wide array of technological firms.

Agriculture is now combining off- shelf technologies such as GPS systems, radars and sensors which promote new avenues of enterprising farming. Robot will decide where to

plant, when to harvest and how to choose the best route for crisscrossing the farmland. These robots are to reduce the usage of pesticides, herbicides, fertilizers and water.

Challenges With Artificial Intelligence In Agriculture

Though Artificial Intelligence offers vast opportunities for application in agriculture, there still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world. Exposure of farming to external factors like weather conditions, soil conditions and presence of pests is quite a lot. So, what might look like a good solution while planning during the start of harvesting may not be an optimal one because of changes in external parameters. AI systems also need a lot of data to train machines and to make precise predictions. In case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model. This is one reason why AI sees a lot of use in agronomic products such as seeds, fertilizer, pesticides and so on rather than in-field precision solutions.

Conclusion

The AI can help the farmers to increase the capacity of production and reduce the cost of production. Application of AI in all application domains will also bring an ideal shift in the way we do research and development in agriculture now. AI moves towards more automation with more accuracy to perform on real time management, which is helping in standard shifting of traditional agriculture to precision agriculture with low cost. The AI solution must be viable and accessible to the farming community. For faster adoption and greater insight among the farmers AI solutions should offer an open source platform by making its solutions more affordable.

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