# Era of Artificial Intelligence: Prospects for Indian Agriculture

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Artificial intelligence (AI) is silently but increasingly entering Indian agriculture and hence affecting our society at large. Even though machine learning (which is a subset of AI) has been used for classifications and prediction purposes for, to cite a few, food grading and crop yield forecasting, recently, the new set of deep learning algorithms have heralded the possibilities of taking the research and applications of AI to much higher levels and with much more accuracy. Similarly, other AI techniques are making inroads in all fields including agriculture. Amid high expectations about how AI will help the common man and also transform his mind set, thoughts and attitude towards the benefits that it may bring, there are certain concerns about the ill-effects of such sophisticated technologies as well. In the end, if AI systems can enhance farmers in terms of their social and economic wellbeing, we should be open to innovating new upcoming technologies with AI as their soul.

Technology, as we know, has improved drastically over the last half century. Explosion in digitised data and advances in Information and Communication Technology (ICT) can play a pivotal role in achieving digital agriculture with the use of modern digital devices and Artificial Intelligence (AI) to develop solutions for smart agriculture.

## What's artificial about intelligence in AI?

Let us start formally as to what an AI is? AI is an area of computer science that emphasizes the creation of tangible or intangible systems which not only behave intelligently but also display behaviour to the same level as human beings think and act (and in times to come, better than them), achieving human-like performance in all cognitive tasks using purely logical reasoning. Thus while the 'artificial' in AI can be understood as 'non-biological', the 'intelligence' can be taken as 'ability to accomplish complex goals or tasks'. AI is the cognitive process one can associate with human thinking like speech recognition, natural language understanding and translation, knowledge management, image analysis, decision making, learning etc. which will make systems powerful and useful.

There are three types of AI: ANI, AGI, and ASI. The first type, ANI (Artificial Narrow Intelligence) - is all over the place, like Google maps, it's awesome at finding efficient routes to places while riding a car, or can be likened to a chess playing program. Number two would be AGI (Artificial General Intelligence) - this would be like a computer that is as smart as a human in all aspects. So, anything we can do with our brain, it can do, including learning. AI is getting powerful day by day what with applications leading to machines and systems leading to more advanced AI i.e. ASI (Artificial Super Intelligence) – this would be when a computer or a system is better than a human being – wiser, more creative, more socially adept, and this ranges from being a little bit better to being smarter than the sum of all humanity combined.

**AI is the next big thing happening**

Now let us proceed foreseeing how AI can help the common man in the years to come. Technology has advanced at such an accelerating pace that what has been achieved during the past 15 years or so from the early 2000s is much more than what has been achieved during the 30 years past 1970s. In this era, we have computers in our pockets now connected to the Internet giving us a plethora of options like streaming video and music straight from our smartphone at any moment, with information in our finger tips, thanks to the omniscient Google Baba! Let us extrapolate this phenomenal leap jump in innovations to the development of AI. At this speed, development in AI should take a lot less time because with repeated instructions and experiences, AI can re-wire its own thinking to improve itself. After all, AI like everything else has two sides: while there are practical applications of AI, a chief and visible application that stands out being the robot, scientists are constantly finding out ways to programme safeguards to make sure AI, which on one hand enables technologies, on the other hand, does not destroy our daily lives by affecting the lives all around us. It seems not so far-fetched nowadays that people have started casually discussing about AI in their conversations, with many general articles appearing in newspapers. People did talk about climate change earlier, and that had a great role to what led towards useful steps being taken to prevent it. Now people are having conversations about AI and that will circumvent all the misgivings about the same. So if we want to do something, increasingly talking to people about AI seriously would be a good place to start.

Detecting deadly diseases, reducing accident risks, predicting consumer behaviour and helping farmers increase crop yields are some of the AI-based innovations that Microsoft is addressing. From Apple's intelligent personal assistant SIRI or Cortana of Microsoft to IBM's Watson to self-driving cars, AI is progressing rapidly. Another popular example includes Google Maps, Ridesharing in cabs, Face recognition in Facebook photo upload, Face unlock in Mobile, search and recommendation in online shopping sites etc. The internet giant Google is moving into an "AI first" world and is currently using AI technologies for numerous applications. In a recent Google AI event, it has been told that it is up to people's imagination to make things happen in the AI world. Google operates two of the top AI research labs in the world viz., DeepMind in London and GoogleBrain in California.

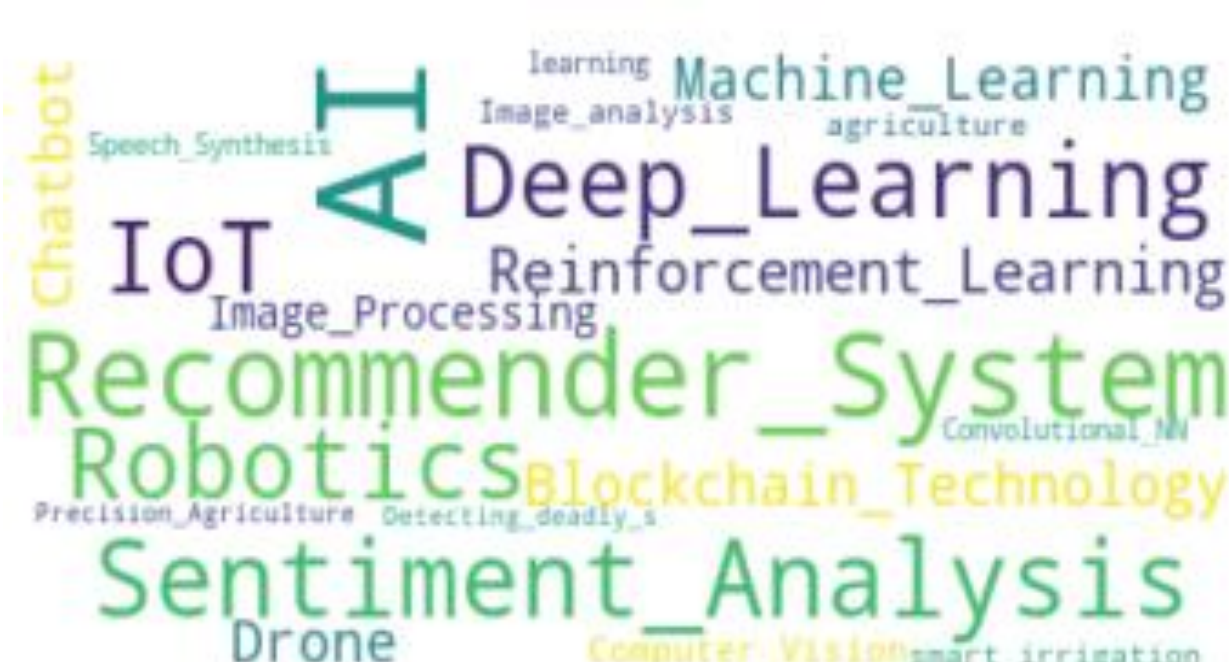
AI has become an essential part of the technology industry. Research associated with AI is highly technical and specialized. The core problems of AI include programming computers for certain traits such as Knowledge, Reasoning, Problem solving, Perception, Learning, Planning, Ability to manipulate and move objects etc. Mathematical analysis of Machine Learning (ML) algorithms and their performance is a well-defined branch of statistical cum soft computing. ML being a core part of AI has advanced from Artificial Neural networks (ANN), Fuzzy systems, Genetic Algorithms and/ or their hybrid approaches to what are called Deep Learning techniques like Convolutional NN, Generative NN etc. This involves, but not limited to, learning without any kind of supervision with an ability to identify patterns in streams of inputs (be it text, numbers, images, voices, video etc.), or learning with adequate supervision involving classification and numerical regressions. Here classification determines the category an object belongs to and regression deals with obtaining a set of numerical input or output examples, thereby discovering functions enabling the generation of suitable outputs from respective inputs. These concepts existed earlier in ML also in attempting to mimic the human brain, but the sophisticated deep learning of AI can boost accuracy to a much greater extent.

Robotics is also a major field related to AI. Robots require intelligence to handle tasks such as object manipulation and navigation, along with sub-problems of localization, motion planning and mapping. The Robot Sophia is an excellent example of potentials of AI. An added advantage of AI systems is that, once programmed to perform and evolve for doing specific tasks, they are shorn of bias common to humans and this lack of biasness can have a positive impact on the interaction between AI systems and the society at large.

**Can Indian agriculture benefit from AI?**

Natural Language Processing (NLP), Robotics, Machine Learning (ML), Automated Reasoning, Knowledge Representation, Expert Systems, Computer Vision, Speech Recognition, Automated Data Analytics, Virtual Reality, Augmented Reality, Internet of Things (IoT), Cloud Computing, Statistical Computing, Deep Learning etc. are some major sub-areas of AI having huge potential in solving complex problems of agriculture.

NITI Aayog has recently released a discussion paper wherein it envisions AI solutions for key sectors including agriculture. In agriculture, there is a great potential of AI machines to provide information to farmers on the quality of soil, when to sow, where to spray herbicide, and where to expect pest infestations. Thus if AI systems can advise farmers on best practices, India could see a farming revolution. However, such a futuristic scenario has a formidable challenge of scaling it up to cover the entire value chain with factors like capacity expansion and cost reduction in mind.




Globally, AI-driven technologies are emerging to help in improving the efficiency with respect to crop and soil monitoring, weather forecasting, predictive agricultural analytics, markets and supply chain efficiency. The cloud computing infrastructures with the use of, data ecosystems, Internet of Things (IoT) and AI enables the development of digital agriculture and strengthen the farmers in practicing smart farming, smart irrigation, smart fertilizer application, and disease/ pest diagnosis/ detection, smart spraying, and harvesting. Machine learning and soft computing methods with pattern recognition through image and video (drone cameras, satellite imagery) data processing are being widely used world-wide in

monitoring and managing various farm operations and predicting the incidence of disease/ pests, weather forecasts, time of application and optimum dose of chemical sprays, time of harvest, life of produce etc. Deep Learning is concerned with algorithms inspired by the structure and function of the brain called Artificial Neural Networks (ANNs). Deep learning can solve more complex problems particularly those consisting of large number of features, because here more complex models are used, which allow massive parallelization. Deep learning techniques is being used effectively on image data for segmentation which results in disease/ variety identification and crop yield estimation and prediction with far more accuracy.

Agriculture will for sure immensely benefit from AI applications. AI can be used to create intelligent systems which are embedded in machines that can work with higher accuracy and speed than humans and at the same time be responsive like humans. AI together with Internet of Things (IoT) and Sensor Technology can be the great enabler of precision agriculture. AI can also play a critical role along with remote sensing technology in wide scale implementation of Climate Smart Agriculture. Some of the AI Techniques like Mobile based Recommender Systems and Expert Systems can drastically increase the adoption rate of agriculture technologies like high yielding or disease resistant varieties, innovative farm implements thereby helping in increasing farmer's income. These AI techniques can also be the enabler of the paradigm shift of location based advisory services to the personalized and context specific advisory for the millions of farmers of our country. Automation, Sensors, Drones, IoT, Solar Power aided with AI provide new opportunities for business and entrepreneurs to deliver innovative solutions as service at affordable prices to the farmers. Precision farming one another area where we can benefit from AI and it can also help farmers to maximise the space they have, to be more precise about the types of crops, weather pattern and when and where we should go for raising crops. The best thing that AI can do in agriculture is to avoid drudgery and tedium from many agricultural operations so that we can put our time and efforts in much better ways of finding an array of creative AI innovations to surpass human capabilities.

At the national level, AI based automatic grading and sorting are already being done for vegetables and fruits with a view of creating an international agri-commodity standard aiding reliable trading across country boundaries. Deep learning and advanced image processing techniques are used for viewing images and pictures thus digitizing food quality. But scaling up the utility to expand to several products and also across geographical locations need millions of more such images. This can be quite farfetched unless such images are collected, digitised and annotated. It is a fact that the biggest agricultural data lies with the government and hence the onus is entirely up to them to annotate it and make it usable. Hence both quality and quantity has a direct bearing on efficacy of deep learning. In addition, for certain other situations like solar or electricity power planning, deep learning needs data over many years to predict power generation.

AI based adaptive e-learning and decision support systems can also help students towards learning new concepts and able to identify areas where students are deficient providing more focus on that content. These systems can generate new problems from source material. These online systems can actually generate better material and more comprehensive testing than typical classroom curriculum.

## AI: Data is the new oil

ICAR being a research organization with a primary role of discovery or generation of new knowledge requires to build its organizational knowledgebase which is not only human understandable but also machine understandable. Ontologies being the latest AI based knowledge representation technique can play crucial role in not only creating scientific repositories of generated knowledge but can also enable various applications to use these knowledge for generating intelligent decisions. India being a multi-lingual society with majority of farmers being non-literate, AI techniques like auto-translation among various languages, text to speech and speech to text in Indian languages can help the poor farmers in accessing the required knowledge generated by the National Agricultural Research and Education System (NARES).

For any AI application to be successful, underlying databases and the processes employed to populate these databases must be reliable, secure and updated at any given point of time. It is essential for the AI based system to provide intelligent decisions based on the underlying database. AI systems are data-guzzling machines learning from large reams of historical data as input for identifying relationships among data elements and make decisions. Hence we should take concerted efforts to collect and digitize data better under focussed projects if we desire to see AI solutions powering agriculture. We should also ponder as to what we do about this data, where to store them and also as to what are we going to do around getting intelligence out of that data. Ultimately, the AI-enabled solutions cannot sustain without a steady supply of fresh data to improve and evolve itself which can only come from non-AI (human) sources. Thus, knowledge engineering should become a core part of AI research.

Machines can often act and react like humans only if they have abundant information/ data relating to the world. AI must have access to objects, categories, properties and relations between all of them to implement knowledge engineering. Without a sound database, initiating common sense, reasoning and problem-solving power in machines is a difficult and tedious task.

## 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.

## Summary

AI has both non-biological and human aspects embedded in it. Needless to say, diffusion of AI in all application arenas will also bring a paradigm shift in the way we do research and development in agriculture now. AI systems require continuous feeding of new information and increasing the amount of information in the backend databases used for performing tasks with almost accuracy, including mapping the history of and guiding the predictions from such systems. In this way, the AI systems will get evolved over time akin to human perfection in addition to adaptability.