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Application of artificial intelligence in agriculture: Present scenario and impact

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Abstract

Artificial intelligence has been there for humanity for a while but we are seeing intense progress in the last 10 years. It has penetrated to all aspects of life-giving us comfort as well as concerns. On the other hand, there's agriculture sector, which in spite of various technological development, is not adopting it fast. Still, the combination of artificial intelligence and agriculture is raising its head in India. Economists and researchers have adopted artificial intelligence at a great rate. This narrative tries to put a scratched idea of the current day scenario of agriculture, economics and agricultural economics saga. More than 58 companies involved with artificial intelligence have come forward to invest in agriculture in India. Development of economics with AI in India is marching forward at it's own pace. So many future possibilities can be observed in this direction.

Keywords: artificial intelligence, agriculture, scenario

Introduction

Artificial Intelligence is a branch of computer science that deals with the simulation of intelligent behavior in computers.

Agriculture has too many uncertainties involved, whereas economics tries to take the uncertainties as constant to understand and formulate a better future prediction. Considering that agricultural economics find it harder to collect, analyze and formulate the database required. Hence artificial intelligence thinks in a way (but not so human-like) to work for a specific objective without considering others at all. Hence it has to have so many applications and advantages for Agriculture and Economics. Artificial Intelligence can be understood as training a machine within a predefined framework. And you can add an analogy like making a baby learn to differentiate between a cat and a dog by explaining the difference in their shape size and colour. It works with Machine Learning (ML), Deep Learning (DL) and Data Science (DS) and all of these work with synergy. Machine Learning enables us to explore and analyze data through statistical tools. It can be supervised, unsupervised or semi-supervised (reinforcement) Machine learning. When we are using previously labelled data, it comes under supervised machine learning. Clustering techniques (example: hierarchical mean clustering, K-mean clustering) come under unsupervised ML which groups the data based on the similarity in the dataset. In reinforcement learning some part of the data is labelled and some part is not. So that when the machine operates in the uncontrolled environment it labels the new data slowly. Deep learning creates multi neural network architecture to mimic human brain. DL has ANN (Artificial Neural network), CNN (Convolutional Neural Network), RNN (Recurrent Neural Network), Transfer Learning and so much more in it. DL is a subset of ML which is a subset of AI. Mathematical tools like statistics, Probability, Linear Algebra, Differential Calculus etc. are used by data scientists who also work with all of the above discussed techniques for creation of applications based on Artificial Intelligence.

Evolution of AI

In 1956 John McCarthy coined the term artificial intelligence and the era of man with machine synergy started. During the period of 1956 to 2002 at all robots and supercomputers rose their head. In 2002 to 2013 general problem solver, industrial robots were given emphasis. Knowledge based medical diagnosis, speech recognition, smart homes came into light in 2013 two 2017. The current day scientists are focusing more on machine learning and deep learning.

Opportunity of AI in Agriculture

According to an estimation the global AI in agricultural market is supposed to be 2.6 billion

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US dollars' worth in the year 2025, growing at a Compound Annual Growth Rate of 22.5% during the forecast. This amount was 519 million U.S. dollars in the year 2017.

Applications of AI in Agriculture

Analysis of Soil Health and Monitoring

To identify soil specific requirements, monitor soil health, nutrients needed for better productivity in general AI is being used. With the help of sensors, cameras and infrared rays That's Kansas oil for its nutritional properties, Moisture, temperature etc., We can monitor soil health even for targeted productivity ^[1]. Example: CropIn Bengaluru, the company conducted an experiment in the farms having a collective size of 5200 acres and now helps farmers with the help of remote sensing and weather advisory. They offer tips on scheduling and monitoring at various stages of farming, Farmer training on how to maintain and monitor crop health, alerts and impending pests and diseases ^[2].

Predictive Analysis

AI with predictive analysis tools can help farmers by suggesting farmers right time to sow, product decision, amount of product etc. with the help of climate, rainfall, moisture market situation data collected over a period of time without expensive investment for the farmer. Example: Microsoft has tested apps relied on data collected from 1986 to 2015 on climate and with the help of metric MAI (Moisture Adequacy Index). MAI estimates rainfall and moisture amount required for better productivity. The app sends voice and text messages to farmers suggesting the right time to sow the crop. The arguments over illiterate or poor farmers can come to an end, now that farmers can get spoon fed clinical recommendations with the help of agronomists, Artificial Intelligence and a basic phone without needing any expensive instruments or scanners.

Supply Chain Management

AI can create a data driven online market place for the farmers, can help in automated grading and sorting. By better sorting improved transactions can take place. Farmers would get better price so will the buyers, in domestic as well as international platforms. Example: Gobasco is a Lucknow based company that brings AI optimized automated pipelines for the agricultural product supply chain focusing especially on India's market scenarios ^[3].

Gramophone, Indore worked 2 years in ground level to create a platform that leverages Machine Learning for predictions which helps with all aspects of agriculture starting from irrigation, fertilizer application to pricing. The company claims to be offering "personalized farm management solutions". AI based chatbots help with figuring perfect crop cycles out ^[4].

Crop Cycle Expertise

Using past meteorological, agronomic, entomology data sets AI helps to create an optimized crop cycle. Example: Clover Ventures, Bengaluru is an AgriTech startup that claims to offer "full-stack agronomy solutions to farmers, especially greenhouse farmers based in semi-urban and rural areas. Urban Kissan, Future Farms, BitMantis Innovations are some other examples of the same venture.

Farm Produce Aggregation

Technology is helping with bridging the demand supply gap,

better market for farmers and better products to buyers, provide product authentication by tracing the food back to the farm. Example: Jivabhumi, Bangalore explores the scope of AI in agriculture in India by using block chain ensuring the buyer of the safety of food by tracing back to the farm ^[5].

Farm Advisory

Agronomy and data science working with a synergy can provide farmers crop and time specific suggestions such as fertilizers, machinery and pesticides application. Example: Agrostar, Pune operates in Gujrat, Maharashtra and Rajasthan offering farmers help with identifying the problems associated with their crop, suggests the crop needs and also delivers whatever is required to the doorstep ^[6].

Disease Detection and Crop Harvesting

The strategy of disease and growth stage determination with the help of AI starts from capturing images at the field. Pre-processing them to segment them into background diseased and non-diseased part will help AI to send them to remote labs for further diagnosis. Usage of white and UV-A light on the image can determine maturity of crop. Nutrient deficiency, Abnormalities due to environmental effects, Pest infestations, Physiological and pathological diseases can be identified by this process. Example: Government of Odisha has given internship opportunities to Agriculture undergraduates to work in the ground level, one of the task being capturing images and sending it to the specialists through authenticated apps, tagging it with the GPS location and farmer's details. Involvement of Village Agriculture Workers, Assistant Agriculture Officers helps with data accuracy and better advisory for the farmers.

More examples of plant disease detection mobile applications are FarmerZone app by developers from IIT Mandi, Plantix app developed by Progressive Environmental and Agricultural Technologies (PEAT), Germany with partners ICRISAT and Acharya N G Ranga Agricultural University.

Precision Farming

Precision farming is attractive because it replaces the repetitive and labor-intensive activities of agriculture with more accuracy and controlled techniques. Geo-mapping, Sensors, Automated steering systems are used here. It efficiently provides water management, crop rotation, nutrients and pest management, optimum planting related guidance and even implicating them. Multiple sensor data and high resolution images impaired with machine learning models plants helps to obtain identification of stress level in a plant. The key stages are named as identification, classification, quantification and prediction. They accomplish the while approach and help to make better decisions.

Examples are various, of those who have implemented it. In India companies like Tata Kisan Kendra (TKK), Trimble, Fasal and many other are working on it. ISRO and various other labs are consistently experimenting and improving this technology for Indian scenarios.

Artificial Intelligence in Agricultural Economics

Algorithmic Collusion

The folk theorem says Virtually any outcome can be achieved as in equilibrium in a repeated game. It can be seen from decades there are many equilibria in repeated games. Fundenburg has worked on it extensively. Strategies are used to facilitate collusion, on which attention is focused on

interaction of oligopolists can be viewed as a repeated game. The strategies are named as rapid response equilibrium, repeated prisoner's dilemma, NASDAQ price quotes. Recently, the context of algorithmic conclusion is put on round tables as a part of economists work on competition in the digital economy.

Returns to Scale

Three types of returns to scale can be seen that can be relevant to machine learning. First is classical supply side returns to scale which is associated with decreasing average cost. Another one is demand side returns to scale related to network effects. Third one is learning by doing related to improvements in quality or decrease in cost due to experience. Learning by doing and demand side or supply side network effects are thought to be automatic. But the truth is that companies never analyze the resources or data they have because of lack of skill. They may or may not hire a lot of internal expertise to hire good data scientists which is why we can expect to see percolates in productivity as this new skill particular through the labor markets. Hal Varian, 2018 has raised this issue in his papers.

Pricing

Customer characteristics based price adjustment opportunities are offered by machine learning with assistance of the availability of cloud computing. But it goes both the way, customers can also avail applications to get product that satisfies their demand with the limited resources they have. Various theoretical models can be found over the Internet on how consumers would respond do attempts to base prices on consumer history.

Financial Sector

In financial securities (stocks, bonds), the decision-making job can be given to Artificial Intelligence. AI is already well established in the financial sector. It can cut slacks by taking over a lots of repetitive, lengthy manual work so that financial professional can indulge in higher-value tasks like making better customer relation. Human error and a lots of time can be saved by relying on Machines for data entries, review and verification necessary to approve an application. It helps to reduce fraud risks and costs, all while enhancing customer satisfaction, customer services and customer lifetime value [7].

Socio-Economic Applications

Use of Big Data, Data Science and AI can be used to predict numerous macroeconomic and developmental economic problems like inflation, unemployment. Calculations of data like laborer migration from one region to the other will be easily done for urban economies. Public finances by government can use AI to calculate interest losses and funds returned. In Indian economy, behavior of agents involved and unaccounted transactions in Informal Sector can be monitored. Many farmers disconnect from the e-NAM app at a point of time due to various reasons and it causes crop loss to certain extent which can be calculated for references.

Economic Research

Revolution in information, communication and Technology Sector has automated the process of collection of data on economic behaviour evolve. Theorizing economic behavior has become easier since. Researchers, Scientists and students are now keen on using big data from online portals, compiling

and analyzing them, using apps like "GRAMMARLY", "FRED Economic Data" for better writing experiences. AI has eased up the usage of statistical and econometric models.

Preventing Loan Defaulters

By using AI for moral hazard detection that associates with certain lending borrowing decisions can provide an earlier signal to detect a loan defaulter [8]. CIBIL defaulter list has caught woke lenders' eyes and they are trying to maintain a good credit score of 750 points by timely payments, having credit as per the requirement as suggested by paisabazar.com.

Econometrics and Machine Learning

According to Hal Varian, Econometrics has to adopt train-test-validate to avoid over fitting, cross validation, Non linear estimation, Bootstrap, bagging, boosting, variable selection, model averaging, computational Bayesian methods, tools for manipulating big data, textual analysis; from Machine Learning [9].

Economic Predictions

148 out of 150 recessions were not well predicted by economists according to Prakash Louganis's analysis. Ajay Agrawal in his book Prediction Machines has emphasized how AI will ease economic predictions. Starting from media influencing sentiments, mitigating business cycle effects, prediction of supply and demand, sudden trend change in consumer behaviour; various economic conditions can be predicted within lesser time correctly unlike traditional methods. Example: JP Morgan claims to be using an algorithm that tells President Trump's tweets' affect on financial markets.

Challenges in Implications

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 the best one because of changes in external parameters. There are concerns and fears in people regarding privacy, security when it comes to accessing sensitive areas like ATMs and banking, insurances and many more.

Conclusion

This narrative only focuses on an overview of how AI & ML are working for agriculture, economics and agricultural economics. These sectors having so many risks and uncertainties involved, recurrent and other advanced neural networks can solve many problems involved and ease in operations can be obtained. There's vigorous research going on and it is a constantly evolving sector. People are also accepting it at a dynamic rate. Yet professionals have fear AI can hamper Employment rates which can be converted to a myth by employing people in AI based jobs rather than labor intensive ones by increasing AI literacy. When people would let artificial intelligence do the labor intensive repetitive part of the work they can use their minds on human relations and areas where human intervention requires the most, ensuring a better work life balance for so many professionals, people in different positions, jobs and interests.

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