

*Ministry of External Affairs*  
*NEST Division*

*Artificial Intelligence in Agriculture*

India's growth story is and will always be intrinsically linked to Agriculture. Despite making significant progress in the fields through several government, civil society and private sector interventions, the agricultural sector still suffers from low productivity, information asymmetry, poor supply chain linkages and resource utilization, land degradation, unsustainable agricultural practices, low income for farmers, and lack of access to agricultural credit and insurance systems. Current global trends such as increasing population, rapid urbanization, rise in consumerism, outbreak of pandemics, loss of essential biodiversity such as honeybees and climate change impacts such as frequent floods and droughts is significantly disrupting the agricultural supply chain. In light of these global trends and unsustainable agricultural practices, these unpredictable variables remain difficult to understand, analyze, and predict. These variables manifest as risks to our agricultural systems making the supply chain opaque. Poor understanding of these variables lead to vast information gaps and poor decision making and thus result in low productivity. The use of AI along with related emerging technologies is of critical importance to build a robust, efficient and secure agricultural supply chain.

*Use of AI and Related Emerging Technologies in the Agricultural Supply Chain*

1. *AI based Pest Detection and Management Systems:* Management of agricultural pests have been going on thousands of years. Pests like weeds, fungi, bacteria, viruses, rodents, insects, mites etc. are known to destroy, in some cases, over one third of the agricultural yield. Traditional practices, cultivating pest resistant plants and chemical pesticides are some of solutions employed to manage pests. In recent times, AI based systems offer solutions to detect and manage pest infestations. For instance, combining, consolidating and analyzing data obtained from drones, satellites and on ground sensors, AI systems can predict pest infestations before they happen. Based on the type of infestation, these AI systems can identify specific blend of pest control mechanism and limit its usage in only

affected areas. Such a solution can not only improve the quantity and quality of the agricultural yield but also reduce the cost incurred due to manual intervention. Some examples of such solutions include, 1) PwC's drone consulting project with the UN on monitoring of health of date palms by identifying potentially pest infected areas using AI.<sup>1</sup> 2) An Indian based startup, Fasal, that uses Internet of Things (IoTs) and Machine Learning Algorithms to provide precision data to farmers vis-à-vis pest and disease management. Provision of such precise data is seen to reduce farmer's cost of pest and disease management by 50 percent.<sup>2</sup> 3) Garuda Aerospace, a drone solution start up allows farmers for precision spraying of pesticides.<sup>3</sup> 4) A Bengaluru based startup Aerologiks, uses an AI enabled drone loaded with pesticides to spray precise level of pesticide in infected areas and thus cutting down time and cost of pesticide application and saving labourers the risk of exposure to harmful chemicals.<sup>4</sup>

2. *Environment and Biodiversity Prediction Models:* Machine Learning algorithms are able to draw excellent insights into weather, seasonality conditions, and migratory patterns of biodiversity that are essential for agriculture. Currently, large amount of agricultural data is currently being generated but not utilized. Providing accurate information on weather conditions such as on rainfall can allow farmers to make smart decisions. BigTech companies are partnering with governmental agencies to provide such services. For instance, 1) IBM's Watson Decision Platform provides village level or in some cases farm level (hyper local) information on weather forecast and soil moisture. As a pilot project, IBM has partnered with the Ministry of Agriculture and Farmers Welfare to deploy weather forecasting solutions in three districts of Bhopal, Nanded and Rajkot and now has extended the projects to 10 more districts.<sup>5</sup> 2) Microsoft has collaborated with International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) to develop an AI Sowing App powered by Cortana Intelligence Suite including Machine Learning and Power BI to provide farming advisories including

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<sup>1</sup> <http://www.fao.org/3/i8494en/i8494en.pdf>

<sup>2</sup> <https://indiaai.gov.in/article/how-ai-powered-drones-are-changing-the-agritech-landscape-in-india>

<sup>3</sup> <https://indiaai.gov.in/article/how-ai-powered-drones-are-changing-the-agritech-landscape-in-india>

<sup>4</sup> <https://indiaai.gov.in/article/when-data-surpasses-intuition-the-future-of-precision-agriculture>

<sup>5</sup> <https://indiaai.gov.in/article/ai-weather-forecasting-is-helping-farmers-to-improve-decision-making-and-crop-production>

information related to weather. Farmers following these advisories have shown better yield production capabilities.<sup>6</sup>

3. *AI based Precision Agriculture Systems:* Through integration of IoTs, AI, BigData and Cloud Computing, such an information based system identifies, analyzes and manages farm inputs with an aim to maximize yield production, profitability, efficient use of inputs, and environmental sustainability. AI based Precision Agriculture Systems allows farmers to better manage crops, water intake, land use, irrigation, soil profiling, livestock, allows for controlled use of pesticides and minimizes wastage. Some examples include, 1) Microsoft's AzureFarmBeats that aggregates agricultural datasets ( through drones, satellites) across providers and generates actionable insights using AI/ML models on farm health allowing farmers to make precise smart decisions on farm management.<sup>7</sup> 2) Aibono, an agritech startup that uses AI based demand prediction solutions to help increase farmers' income and crop yield for small perishable crops like carrots, lettuce etc.<sup>8</sup>

4. *Data analytics for yield prediction and mapping:* Internet of Thing (IoT) devices like smart sensors, drones, satellites are providing new streams of data that were not previously available. Clustering of datasets vis-à-vis sensor data on moisture, fertilizer use, soil nutrient levels etc. can be used by Machine Learning algorithms to provide intelligent insights to farmers regarding crop health and yield prediction. Using AI it is also possible to know the potential yield rate of a specific field before the vegetation cycles begin. Machine Vision (capabilities of machines to perceive the environment and perform complex automated operative tasks. Typically it's a combination of smart sensors and Machine Learning Algorithms) can be used to produce maps of estimated yields pre-harvesting, thus allowing farmers to make tactical and strategic decisions and allow for corrective actions in crop production. Such maps can be used to schedule harvesting, arrange labour and machinery, and guide crop marketing decisions.<sup>9</sup> For instance, 1) Niti Aayog partnered with IBM to develop a crop yield prediction model to help farmers increase crop productivity, increase soil yield and improve farmers' income by

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<sup>6</sup> <https://www.icrisat.org/microsoft-and-icrisats-intelligent-cloud-pilot-for-agriculture-in-andhra-pradesh-increase-crop-yield-for-farmers/>

<sup>7</sup> [https://azuremarketplace.microsoft.com/en-us/marketplace/apps/microsoftfarmbeats.microsoft\\_farmbeats?tab=overview](https://azuremarketplace.microsoft.com/en-us/marketplace/apps/microsoftfarmbeats.microsoft_farmbeats?tab=overview)

<sup>8</sup> <https://indiaai.gov.in/article/when-data-surpasses-intuition-the-future-of-precision-agriculture>

<sup>9</sup> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7947278/>

efficiently utilizing farm inputs.<sup>10</sup> 2) Pradhan Mantri Fasal Bima Yojana (PMFBY) where AI based solution is used to optimize crop cutting experiments in various states for yield estimation.<sup>11</sup> 3) Airpix, a Mumbai based startup deployed drone based surveying & mapping solutions with AI based image and video analytics in Maharashtra and Madhya Pradesh for intelligent crop counting and yield estimation solutions.

5. *Digital Assistants:* Digital Assistants help farmers and other stakeholders in the agricultural supply chains to make informed decisions by providing recommendations on information related to seeds, soil content, weather patterns, crop insurance and pricing information. For instance, 1) A startup called DeHaat provides 24/7 digital advisory services to farmers in UP, Odisha, Bihar and West Bengal.<sup>12</sup> 2) BharatAgri, an advisory services platform provides decision making and activity planning solutions on farming operations.<sup>13</sup>

6. *AI based surveillance systems to detect breaches and issue alert:* Several States in India have reported thousands of cases of destruction of cultivated land due to crop raiding animals such as wild boars, elephants, peacocks, deer, monkeys to name a few. Farmers have suffered huge losses due to crop raids. Crores of rupees have been spent as compensation benefits to affected farmers. To combat the problem of crop raids, AI based video surveillance system can be used to protect crops from animal breaches and allow farmers to secure the perimeter. These AI systems can also be programmed to recognize employees and help secure remote facilities and deter trespassers. For instance, NGO RESOLVE and CVEDIA, developed a low cost AI solution called WildEyes<sup>TM</sup> AI to detect elephants and transmit alerts to community members. Such a solution was deployed in response to avoid human-elephant conflict, protect the endangered elephants and prevent crop damage.<sup>14</sup>

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<sup>10</sup> <https://economictimes.indiatimes.com/news/science/niti-aayog-ropes-in-ibm-to-use-ai-in-agriculture/articleshow/64033626.cms?from=mdr>

<sup>11</sup> <https://indiaai.gov.in/news/government-to-use-ai-for-studies-under-pradhan-mantri-fasal-bima-yojana>

<sup>12</sup> <https://indiaai.gov.in/article/ai-is-sowing-seeds-of-productivity-and-sustainability-in-india>

<sup>13</sup> <https://bharatagri.com/>

<sup>14</sup> <https://www.resolve.ngo/blog/WildEyes-AI-Helping-to-Save-Wild-Elephants-and-Prevent-Human-Elephant-Conflict.htm>

7. *Agriculture Robots*: To meet the ever increasing demands of the population, with the need for real time solutions and coupled with new developments in AI and emerging technologies are pushing the stakeholders in the agricultural supply chain towards robotics. Robots are used to pick fruits, prune, weed, spray and monitor crops. Robots are used to distribute fertilizer with a precision point mechanism that helps in cutting down cost and improve agricultural produce. In livestock application, robots can be used for automatic shearing, milking, washing and castrating. Autonomous driverless tractors equipped with cameras and GPS systems can be used to plough, plant and harvest in optimal patterns. For instance, a Bengaluru based startup called Green Robot Machinery Pvt Ltd. (GRoboMac) developed India's first agritech robot to pick cotton as a response to labour shortage.<sup>15</sup>

8. *AI for price forecasting*: The fluctuations in prices, especially in the light of unstable climatic conditions, of agricultural produce have a severe impact on farmers and the economic health of the country. Prediction of prices based on yield rates, quality, environmental conditions and so on are crucial in removing information asymmetry regarding market conditions, and thus help defining pricing strategies for relevant stakeholders in the supply chain. Such a solution can help stakeholders minimize and manage risks of price fluctuations and save the agricultural business from losing significant revenue. For instance, 1) Microsoft in partnership with the Karnataka Agricultural Price Commission (KPAC) developed an AI based commodity price forecasting model using historical sowing area, production, yield, and weather datasets for the Tur crop.<sup>16</sup> 2) IBM in partnership with KPAC developed a price forecasting model to predict the prices and production patterns of tomatoes. In addition to predicting prices, the IBM platform can also detect pest and disease infestations and predict yield output.<sup>17</sup>

9. *AI for insurance payouts*: As illustrated earlier, AI can help in estimating yield. Predictive yield estimates are crucial for insurance companies to estimate premiums and facilitate payouts. It can also help financial institutions with the necessary inputs to offer loans. For instance, 1) Under the Pradhan Mantri Fasal

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<sup>15</sup> <https://www.thehindubusinessline.com/economy/agri-business/start-up-grobomac-to-pilot-robot-cotton-picking-in-tn-this-summer/article34246968.ece>

<sup>16</sup> <https://news.microsoft.com/en-in/government-karnataka-inks-mou-microsoft-use-ai-digital-agriculture/>

<sup>17</sup> <https://indiaai.gov.in/article/ai-weather-forecasting-is-helping-farmers-to-improve-decision-making-and-crop-production>

Bima Yojana (PMFBY), a nationwide crop insurance cover, the Central Government worked with a Bengaluru based startup to develop an AI based solution to optimize crop cutting experiments in various states for yield estimation. Such a solution helped in robust assessment of crop loss and expeditious disbursement of insurance payouts.<sup>18</sup>

#### 10. *AI in Animal Husbandry:*

AI enabled wearable technology allows farmers to monitor livestock's vital signs and behavioral patterns. Coupled with information around boarding conditions and food intake, crucial insights can be obtained vis-à-vis resource optimization, quality control, long term sustainability of rearing livestock and profitability. For instance, TCS's AI enabled platform matches existing cattle breed with suitable mates for cross-breeding. This has a direct impact on quality and quantity of milk production as it is directly related to effective cross-breeding techniques.<sup>19</sup>

11. *Tracking and Traceability of Agricultural Supply Chain:* Producing high quality agricultural yield depends on the location of the produce, quality of soil, weather conditions, and agricultural practices to name a few. The agricultural transactions in the supply chain are risk prone due to limited transparency vis-à-vis origin of food source, the process of production and transportation, and the quality of the produce. Limited transparency leads to information gaps in the agricultural supply chain system that arise due to insufficient traceability provisions, and opaque quality verification systems. As a result, consumers remain ignorant of the environmental footprint of food generation, quality of produce, nutrition, and origin of produce. In addition, at least 25 to 30 percent of food cannot be traced or is wasted according to a 2019 IPCC report. The cost of wastage is over 1 trillion dollars each year and produces 8 to 10 percent of all man made GHG emissions globally. A well connected supply chain helps to increase the efficiency of crop production, increase food safety, and reduce both waste and the ecological footprint. New innovative digital information streams in real time could operationalize predictive science and technological inventions and help devise solutions to address inefficient and opaque agricultural supply chain challenges. A digital ecosystem of Blockchain, Internet of Things, Big Data, and AI algorithms

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<sup>18</sup> <https://indiaai.gov.in/article/how-ai-is-used-to-streamline-pradhan-mantri-fasal-bima-yojana>

<sup>19</sup> <https://indiaai.gov.in/article/holy-cow-she-s-different>

can help develop a robust accounting, auditing, transacting, and quality verification tool for a digital agricultural supply chain system. For instance, 1) Punjab Agri Export Corporation (Pagrexco) partnered with a startup CropIn to enable the traceability of potato seeds in the value chain to ensure authenticity of the seeds sold vis-à-vis its origin and quality and penalize counterfeit ones.<sup>20</sup> 2) AgNext, an agritech startup that uses AI driven hardware, software and analytics to carry out spectral and image analysis for instant quality assessment with an aim to address quality challenges, traceability and cost optimization.<sup>21</sup>

June 2021

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<sup>20</sup> <https://indiaai.gov.in/article/for-agriculture-and-more-four-ways-punjab-is-capitalising-on-ai>

<sup>21</sup> <https://indiaai.gov.in/article/providing-ai-driven-solutions-for-agriculture-and-food-commodity-value-chains>