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Precision Agriculture: Transforming With Artificial Intelligence

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In the agricultural sector, the focus lies on the characteristics and dynamics of systems that vary across different spatial and temporal scales. Managing agricultural processes involves grappling with hundreds, if not thousands, of variables. Consequently, agriculture poses one of the greatest challenges for statistical quantification. Even within a single field, conditions are in constant flux from one area to another. Factors such as unpredictable weather patterns, fluctuating soil quality, and the persistent threat of pests and diseases further complicate matters. Traditionally, farmers have relied on their experience and expertise to navigate these variables. Despite their optimism about the potential harvest, certainty remains elusive until the actual day of harvest.

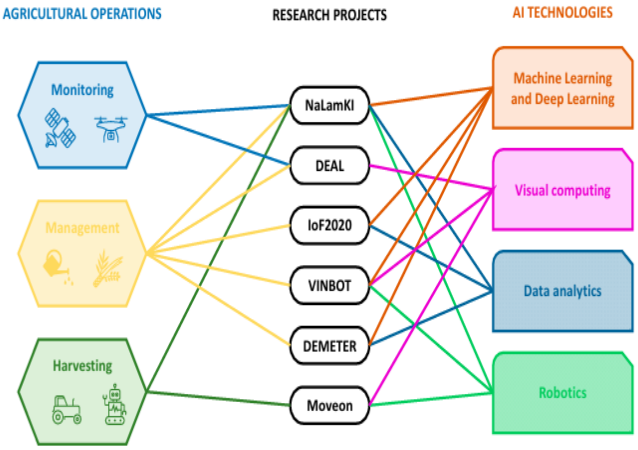
Precision agriculture

Precision agriculture refers to performing the right thing, in the right way, in the right place, and at the right time. Precision farming is meant to match agricultural practices as per agro-climatic conditions to increase the accuracy of application. In the last 40 years farming land has shrunk a little but the number of farmers has just doubled. As per the Agricultural Census of 2010–11, the total number of operational holdings (individual farmers) was estimated as 138.35 million and the total operated area was 159.59 million hectares. The average size of the holding had been estimated to be 1.15 hectares. It simply meant that one farmer had 1.15 hectares of land to grow the crops. Out of these statistics Rajasthan was estimated as having a 6888-million-hectare number of operational holdings and 21136 million hectares of total operated area. The average size of the holding was estimated to be 3.07 hectares. This means that there is a huge scope to create a balance between the available lands versus the land under cultivation. To make this viable, precision agriculture offers an opportunity to venture into this type of farming for its sustainability.

Artificial intelligence (AI)

Artificial intelligence (AI) is a collection of technologies that provide computers with the capacity to carry out a wide range of sophisticated tasks, such as analyzing data, recommendation making, speech and text comprehension, and vision. AI is the cornerstone of innovation in contemporary computing, providing benefits to both people and companies. optical character recognition (OCR) is an application of AI that transforms unstructured content into structured data that is ready for business use and provides insightful information by extracting text and data from photos and documents.

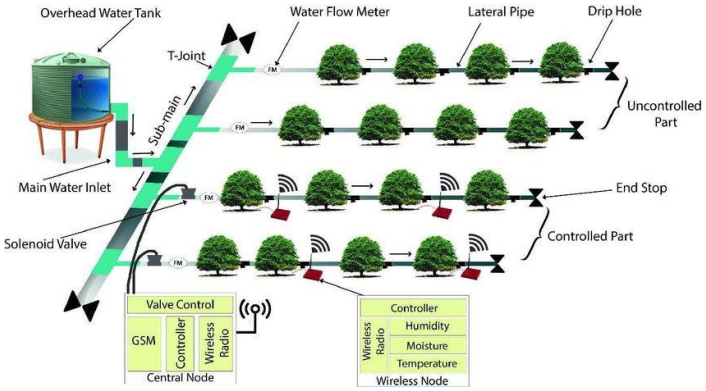
How is AI creating modern agriculture?



AI has become crucial for transforming agriculture production and processing, moving over to traditional farming practices, data-driven and efficient methods are here to stay. By harnessing AI technologies, farmers can now make well-informed decisions with real-time and historical data, optimize resources, and boost productivity to meet the demands of a growing global population which will also help with addressing climate change challenges. At the forefront of modern agriculture, otherwise known as agrifood technology, are AI tools such as machine learning, satellite imagery, and predictive analytics. These technologies mark a significant departure from conventional farming practices, bringing innovation and efficiency. The applications of data annotation to agricultural production can take many forms. Satellite data on farmland can help farmers optimize growing patterns. Tracking farm output can save time when these products go to market. Having a robust set of training data is central to this process.

Artificial Intelligence technologies for precision farming

Agricultural digital twins for geospatial monitoring

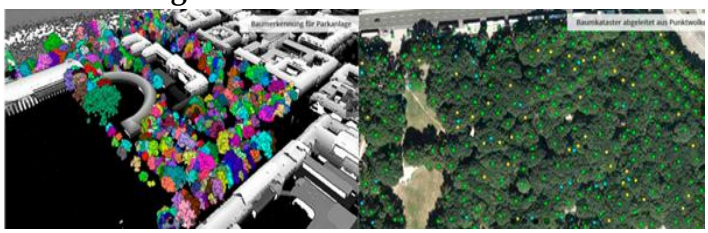


In the manufacturing domain, the digital twin (DT) concept allows for testing hypotheses through simulations, continuous monitoring, and implementing management and maintenance measures. While agriculture cannot be compared one-to-one with a factory production line, the DT concept can be extended to fulfill similar expectations in the industry 4.0 framework.

The initiative will address two key AI research challenges. First, AI methods, although precise, degrade with small training datasets, such as when detecting rare events or plant diseases. Integrating domain-specific knowledge and semantic models into AI methods can enhance precision. Second, AI algorithms often appear as black boxes to farmers, making results difficult to understand and reducing acceptance. Therefore, methods for explainability will be used to validate network decisions and improve training and generalization.

An agricultural DT acts as a virtual replica of the physical system, providing a reliable database for plantations and fields, increasing crop prediction accuracy, and significantly reducing costs and time expenditure. It can examine complex scenarios involving multiple, intertwined factors. Limited existing use cases include measurements of phenotype traits, precise weed control maps, and monitoring asset evolution over time.

AI-Based Irrigation



The Internet of Food and Farm 2020 (IoF2020) project, based in Europe, investigates how the Internet of Things (IoT) technology can revolutionize the European food and agricultural sector by enabling precision farming. Precision agriculture (PA) powered by IoT allows farmers to maximize crop yields, streamline operations, and reduce input costs for things like water, fertilizer, insecticides, and herbicides. The QUHOMA platform, a smart irrigation solution created as an end application supported by FIWARE, has been implemented as part of the project. Based on the present irrigation algorithms, which rely on daily accumulated sensor data, the irrigation plan is computed using a complex event processing (CEP) artificial intelligence method. Therefore, the computations would differ from the original if the data stream was stopped or imprecise because of sensor malfunction, failure, or loss of connectivity for prolonged periods.

Chatbots for farmers

Conversational virtual assistants, or chatbots, automate communications with end users. Chatbots are used in agriculture for communication between producers, markets, manufacturers, and government representatives. When chatbots were first introduced, most of their users were from the retail, travel, media, and insurance industries. Using this new technology, agriculture could potentially benefit from providing farmers with informational support and recommendations on certain farm issues. It approach will enable prompt and interactive remote crop monitoring.

Drones and unmanned aerial vehicles

Unmanned aerial vehicles (UAVs) and drones capture images and collect data about specific areas, offering low-cost operation and extensive environmental monitoring. These technologies provide innovative methods to boost crop yields through detailed analysis, long-distance crop spraying, and high efficiency, thus enhancing productivity. As drone technology rapidly gains trust

among farmers, practical applications continue to evolve. Consequently, drone-powered solutions will likely become increasingly prominent in the coming years.

Conclusion: This depicts that precision agriculture is modern agriculture that utilizes manpower also which causes overexploitation of water, herbicides, pesticides, etc. So, using AI in precision agriculture reduces overexploitation and limited utilization in site-specific management to avoid human errors. Using artificial intelligence platforms, one can gather large amounts of data from government and public websites or real-time monitoring of various data is also possible by using IoT (Internet of Things) and then can be analysed with accuracy which enables the farmers to address all the uncertain issues in the agriculture sector.

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