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Application of Artificial Intelligence in Agriculture, especially in Soil Science

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SUMMARY

In India, approximately 60 Percent of the rural population relies on agriculture, which is the oldest and fundamental sector of our country. Various factors such as the substantial population of 1.35 billion, infestations of crop diseases, inadequate storage facilities, pesticide pollution, weed management, and the risks posed by climate change have prompted the agricultural sector to seek advanced methods to enhance crop production. Given the limited availability of arable land and the significant growth in population, there is a pressing need for a second green revolution.

INTRODUCTION

Artificial intelligence (AI) refers to the emulation of human intelligence processes by machines, particularly computer systems. AI finds application in various areas, such as expert systems, natural language processing, speech recognition, and machine vision. Typically, AI systems function by processing substantial volumes of labelled training data, analysing the data to identify correlations and patterns, and utilizing these patterns to make predictions about future scenarios. For instance, a chatbot trained on textual conversations can acquire the ability to generate realistic exchanges with individuals, while an image recognition tool can learn to identify and describe objects in images through the examination of numerous examples.

AI programming focuses on three cognitive skills: learning, reasoning and self-correction.

Learning processes- This aspect of AI programming revolves around data acquisition and the development of rules to transform the data into actionable information. These rules, known as algorithms, furnish computing devices with step-by-step instructions on accomplishing particular tasks.

Reasoning processes- This aspect of AI programming involves the selection of an appropriate algorithm to achieve a desired outcome.

Self-correction processes- This aspect of AI programming is intended to constantly refine algorithms and ensure they deliver the utmost accurate results achievable.

Why is artificial intelligence important?

AI holds significance due to its ability to provide enterprises with insights into their operations that they may have been unaware of previously. Moreover, in certain instances, AI outperforms humans in task execution. This is particularly evident in repetitive and detail-oriented assignments, such as the analysis of extensive volumes of legal documents to ensure accurate completion of relevant fields. AI tools excel in swiftly accomplishing these tasks with minimal errors.

What are the advantages and disadvantages of artificial intelligence?

Advantages-

- Good at detail-oriented jobs
- Reduced time for data-heavy tasks
- Delivers consistent results
- AI-powered virtual agents are always available.

Disadvantages-

- Expensive
- Requires deep technical expertise
- Limited supply of qualified workers to build AI tools
- Only knows what it's been shown
- Lack of ability to generalize from one task to another.

AI in Agriculture-

The application of computers in agriculture was first documented in 1983. Agriculture plays a vital role in the economic sector of every country. With the world's population steadily increasing, there is a growing demand for food. The traditional methods employed by farmers are insufficient to meet the current requirements. Consequently, new automation methods have been introduced to address these needs and create numerous job opportunities within this sector. Artificial Intelligence has emerged as a pivotal technology across various industries, such as education, banking, robotics, and agriculture. In the agricultural domain, AI plays a critical role and is revolutionizing the industry.

Applications of Artificial Intelligence in Agriculture-

Autonomous Tractors-

- A driverless tractor refers to an autonomous farm vehicle designed to provide substantial tractive effort or torque at low speeds, primarily for tillage and other agricultural operations.
- These tractors are programmed to independently monitor their position, determine their speed, and navigate around obstacles such as humans, animals, or objects present in the field while carrying out their tasks. The driverless tractor technology can be categorized into two types: full autonomy and supervised autonomy.
- Utilizing GPS and other wireless technologies, these tractors can efficiently cultivate land without requiring a human driver. They can operate either under the supervision of a designated supervisor from a control station or in tandem with a manned tractor leading the way.

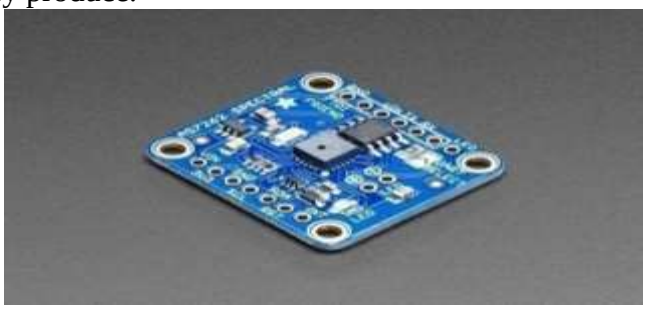
Drones/UAV-

- Agricultural drones are specialized aerial vehicles that can be remotely operated using a controller. They are commonly equipped with cameras or other load-carrying mechanisms, enabling them to provide valuable information to farmers or perform various tasks.
- These drones and UAVs find applications across different segments of agriculture, particularly in the field of precision agriculture, owing to their remarkable capabilities.
- To maximize crop yields, it is crucial to ensure consistent levels of fertilization throughout their growth cycles. However, this process is often costly, time-consuming, and demands a significant labor force.

Most Common Sensors-

Thermal sensors- The potential application of thermal remote sensing in agriculture encompasses a range of areas, including estimation of fruit yield, evaluation of fruit maturity, nursery and greenhouse monitoring, irrigation scheduling, detection of plant diseases and detection of bruising in fruits and vegetables.

Visible light sensors (RGB) – A visible camera sensor is an imaging device that captures visible light in the range of 400 to 700 nanometers (nm) and converts it into an electrical signal. This information is then processed to generate images and video streams. Visible cameras operate within the same spectrum as human vision, utilizing light wavelengths of 400 to 700 nm. They are specifically engineered to replicate the visual perception of the human eye by capturing red, green, and blue wavelengths (RGB), thereby ensuring precise colour representation in the images they produce.

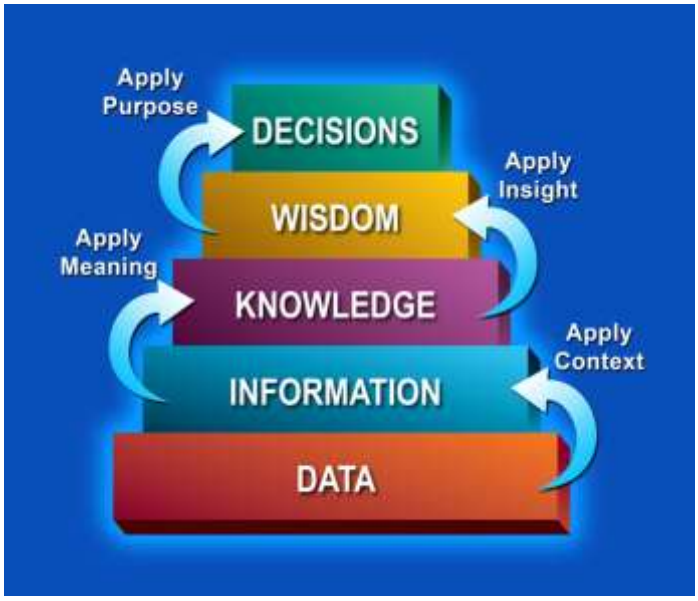


Multispectral sensors- Multispectral sensors are highly efficient sensors widely used in advanced sensing applications with drones. These sensors possess the capability to capture data at exceptional spatial resolution and accurately determine reflectance in the near-infrared spectrum. This versatility and effectiveness make them invaluable for a wide range of sensing purposes.

Hyperspectral sensors- Hyperspectral sensors capture imagery across hundreds of narrow and contiguous spectral bands, enabling precise differentiation between various features present on the Earth's surface. This type of sensor serves as a complementary data source to Synthetic Aperture Radar (SAR) and traditional multispectral data, enhancing the overall understanding and analysis of the Earth's surface.

Decision support system-

- The implementation of these technologies has the potential to enhance the efficiency of agricultural activities to a great extent.
- Researchers have concluded that the utilization of real-time artificial intelligence empowers computer programs to assist farmers in making informed decisions.



Management of crop and Soil quality-

- Utilizing AI is an efficient method for conducting soil analysis and monitoring, as it can identify potential defects and nutrient deficiencies. Through image recognition, AI can detect possible defects by analyzing images captured by cameras.
- Moreover, AI-powered deep learning applications have been developed to analyze flora patterns in agriculture. These applications play a supportive role in understanding soil defects, plant pests, and diseases.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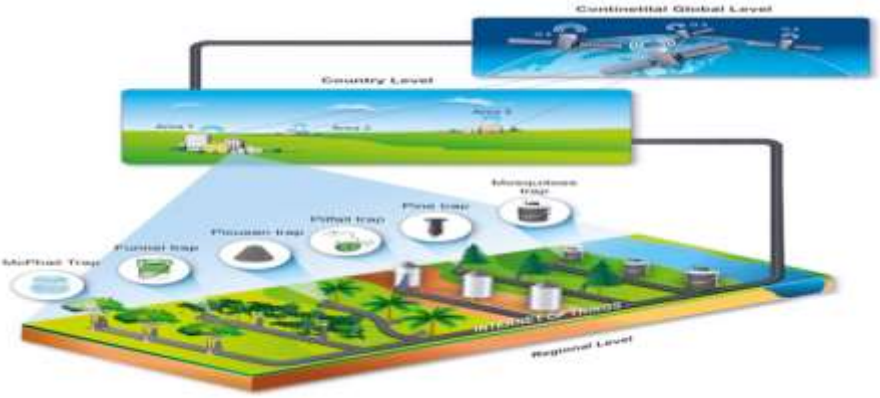
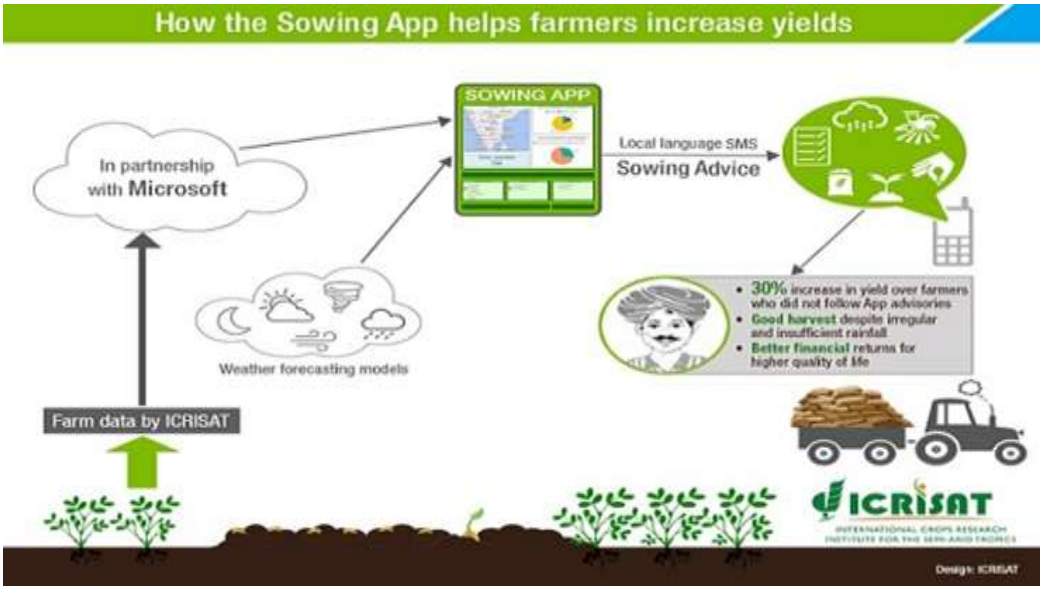
Identification of pest outbreak and disease management-

- The pre-processing of images ensures that the leaf images are segmented into different areas such as the background, non-diseased parts and diseased parts.
- Subsequently, the diseased parts are cropped and sent to remote laboratories for additional diagnosis. This process also aids in pest identification, recognition of nutrient deficiencies, and more.



Microsoft sowing app-

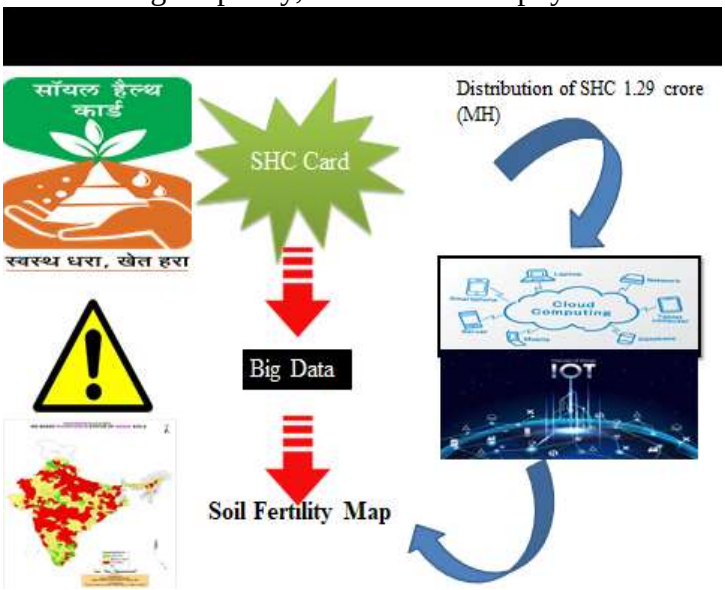
- Microsoft and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a local non-profit agricultural research organization, worked together to develop an AI-powered sowing app.
- This app utilizes the Microsoft Cortana Intelligence Suite and Power Business Intelligence. In June 2016, a test pilot of the AI-sowing app was launched, involving 175 farmers in Andhra Pradesh.



Applications of Artificial Intelligence in Soil Sciences-

Soil testing and monitoring-

- The farmland analysis includes an assessment of multiple parameters such as chemical content, toxicity, pH level, salinity, and earth-dwelling biota.
- These tests also yield valuable information regarding chemical contamination, humic or organic content, electrical conductivity, cation exchange capacity, as well as other physical and chemical properties.

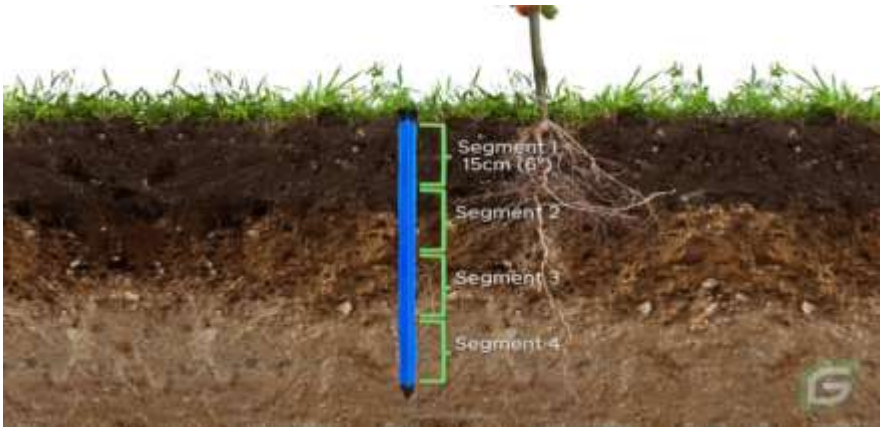


Mini Soil Testing System-

- IBM (2018) has developed a compact soil testing system specifically designed for soil analysis. This system effectively tests five indicators using colorimetric tests.
- The micro-fluidic chip integrated into the device performs chemical analysis, while, an AI-driven machine vision algorithm accurately estimates the values obtained from the colorimetric tests, surpassing the capabilities of the human eye.
- The Internet of Things (IoT) can significantly contribute to soil testing by connecting sensors to the cloud. This allows remote access to data stored on IoT cloud servers, offering convenient and remote monitoring capabilities (Sindhu *et al*., 2018).

Monitoring of soil/ land cover-

Utilizing AI Analyze the moisture content, temperature, Humidity in soil at real time and it will also suggest the crops based on determined pH.



Mumbai Startup AutoNxt Pioneers Autonomous Vehicles In India, Starting With An Electric Tractor

- AutoNxt's autonomous tractor is ideal for farm operations such as tilling, pest control, ploughing and sowing.
- Founded in 2016, AutoNxt is currently working with bigger farmers working with grapes.
- It envisions a tractor-sharing platform to reach more farmers and make its tractor more affordable.

AUTONEXT

Soil fertilization Assessment of soil quality-

- By taking into account factors such as soil moisture level, soil type, soil quality, and water quality in relation to climate change, farmers can make informed decisions regarding the appropriate crops to cultivate in specific soil conditions, ultimately aiming to maximize profits.
- Moreover, this information allows farmers to determine the optimal amount of fertilizers needed for a particular field, effectively addressing soil deficiencies based on the levels of Nitrogen, Phosphorus, and Potassium.

Identification of nutrient dificiency-

- The data collection process involves measuring various factors such as chlorophyll content and photosynthetic activities to monitor nutrient deficiencies. This data is then stored on cloud servers for analysis.

- The Plantix application utilizes image recognition technology to identify nutrient deficiencies in the soil, as well as plant pests and diseases.

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CONCLUSIONS

The integration of AI technology in crop sowing has the capacity to enhance crop yield while simultaneously reducing input costs for farmers. The analysis and monitoring of soil health contribute to the overall sustainability of arable land, effectively conserving labour and time resources for farmers.Furthermore, AI aids farmers in monitoring and enhancing crop productivity.

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