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Adoption of Smart Agriculture, Precision Agriculture and Drones in Agriculture to Increase Farmers Income

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AGRICULTURE is the primary industry in the world & it plays an important role in social stability and economic development. Agriculture plays an important role in the making and development of a country. In India, agriculture is the primary source of living for more than about 60% of its population. The agriculture-related issues always hinder the development of a country. The enhancement of traditional agriculture methods and its modernization towards smart agriculture is the only solution for agriculture problems. The key features of smart agriculture are the deployment of smart sensors for the collection of data, cloud-based analysis, and decision based on monitoring for spraying and weeding etc. The development of agriculture is based on both the improvement in productivity and the restrictions of the era, and the progress of science and technology drives the revolution of agriculture. Different agriculture development eras are:

- ✓ **Agriculture 1.0:** The traditional agricultural era **(between 1784 & around 1870)** dominated by human & animal resources, the main issue of agriculture was the low efficiency of operation.
- ✓ **Agriculture 2.0:** The era of mechanized agriculture **(in the 20th century),** the main issue was the inefficient use of resources.
- ✓ **Agriculture 3.0:** The era of high-speed development of automatic agriculture **(between 1992 to 2017),** the main issue was the low level of intelligence.
- ✓ **Agriculture 4.0:** The era of smart agriculture **(which is characterized by unmanned operations, begin at 2017)** is mainly marked by the use of modern information technology to both serve agriculture and develop it intelligently.**(Yang *et. al.*, 2020).**

Smart agriculture is a new agricultural production mode that contributes to agricultural information perception, quantitative decision-making, intelligent control, precise investment, and personalized service through the deep integration of modern information technologies, e.g., the internet, Internet of Things (IoT), big data, cloud computing, and Artificial Intelligence (AI) with agriculture.

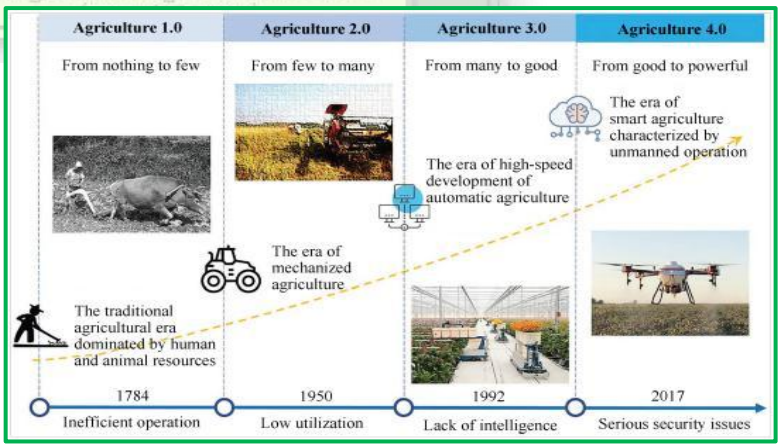


Fig. 1. Characteristics of agriculture development eras (from Agriculture 1.0 to Agriculture 4.0).

Adoption of Smart agriculture, precision agriculture and drones in agriculture to increase farmers income through reduction of costs of production

➢ **Smart Agriculture -** The term smart agriculture refers to the usage of technologies like. internet, artificial intelligence in agriculture, geographic information, remote sensing, image processing, and data analysis solution in agriculture. The ultimate goal is increasing the quality and quantity of the crops while optimizing the human labor used.

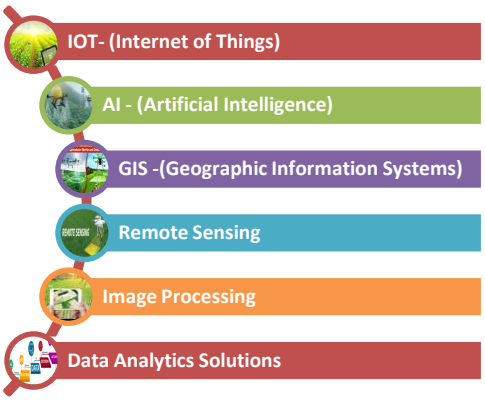
Example technologies used in smart agriculture are:

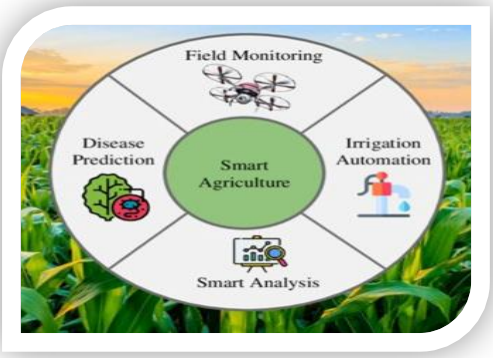
- Precision irrigation and precise plant nutrition
- Climate management and control in greenhouses
- **Sensors** – for the soil, water, light, moisture, for temperature management
- Software platforms
- **Location systems** – GPS, satellite, etc
- **Communication systems** – based on mobile connection, LoraWan, etc
- Robots
- Analytics and optimization platforms

Processes taking place on a farm using smart agriculture

- **Data collection:** The sensors installed at all critical places in the farm gather and transmit data about the soil, air, etc
- **Diagnostics:** The data collected is analyzed by the system and conclusions are made regarding the status of the object or process monitored. Potential problems get identified.
- **Decision making:** Based on the problems identified in the previous steps, the software platform and/or a human managing the platform decides on actions that need to be taken.
- **Actions:** The actions identified in the previous step are performed. A new measurement on the soil, air, moisture, etc is performed by the sensors and the whole cycle starts again.

The result from this automated smart farming process is – high precision and 24/7 control, eventually leading to considerable savings in all key resources used – water, energy, fertilizers, time spent by strategic people, time spent by lower-qualification human resources.





➢ **Precision agriculture-** Precision agriculture involves the use of new technologies like use of sensors to measure a variety of field parameters, using remote sensing to detect problems in the field and monitor field performance, use of robotics in precision application of inputs, such as fertilizers, pesticides and seeds, use of drones in agriculture. Precision agriculture increase the efficiency of agrochemical applications, automate and

simplify the collection and analysis of information, help in decision making for quick implementation of technologies and finally reduction in the production costs.

- **Drones in agriculture-** Drones is one such technology in agriculture through which crop input application efficiency could be increased and simultaneously lowering the overall production costs to the farmers. Drone may be used in agriculture for soil and field planning, crop monitoring, alleviate labour pressure on agricultural operations, data collection, drones are capable of spraying precise amounts of insect, weed and disease control and improve the overall effectiveness of the products. Many countries such as China, Japan, the ASEAN, the US and Brazil are making rapid strides in adopting drones for use in agriculture and have prioritized both regulatory and structural developments to accelerate the adoption of drones powered by Artificial Intelligence (AI).

Drones Applications in Agriculture

(i) Soil and field planning: Drones can be used for soil and field analysis for irrigation, fertilization and planting activities including checking nutrient levels, moisture concentrations, and soil erosion**.**

(ii) Crop monitoring: Drones can perform continuous and consistent crop surveillance that can trigger actions to mitigate the effect of various biotic and abiotic stresses on crops and use of inputs to promote sustainable farming.

(iii) Productivity: Drones can significantly alleviate labour pressure on agricultural operations like applying pesticides or fertilizers, while enhancing the crop coverage area per day. This will provide significant ease of farming for farmers, who can use the time saved to carry out other activities, while responding quickly to biotic challenges.

(iv) New service models: Adoption of drones for data collection is likely to trigger new agricultural services models for other stakeholders to offer crop protection/nutrition as a service for a fee to farmers.

(v) Crop protection from weeds, pests and diseases: Drones are capable of spraying precise amounts of insect, weed and disease control products in a way that can ensure correct dosage, minimize accidental exposure to applicators and improve the overall effectiveness of the products.

Benefits of drones

- **Wastage reduction:** Due to a high degree of atomization while spraying, 30% of pesticide is saved.

- **Water saving:** Drone utilizes ultra-low volume spraying technology, thus saving 90% of water in comparison to traditional spraying methods.
- **High field capacity and efficiency:** Drones have very less turnaround time and other field operational delays. The drone can spray 30-35 acres per day depending upon the capacity of drone which is 10 times more than the traditional knapsack sprayer.
- **Greater safety of farmers:** It is safer and more convenient for farmers to use drones to spray pesticides in terrains challenging to reach, infected areas, taller crops, and power lines. It also helps farmers prevent spraying the crops, which leads to less pollution and chemicals in the soil.
- **Easy to use and maintain:** The agricultural drone are made rugged. It has low maintenance cost, a long productive lifespan, and its parts replacement is simple, as and when required for the company offering drone services

Conclusion

The use of precision agriculture in insect and plant disease management is profitable and smart. Decisions that are based on reliable and accurate information increases the yield of the farmers by protecting in insect-pest and diseases. Having an open mind to new ideas and technologies can help conquer the challenges of the future.

Future Prospects

Precision agriculture includes improvement in the availability and performance of existing technologies like internet connectivity, sensor technology, more accurate mobile applications, machinery equipment's, etc. The drone applications most promising prospect in the future of Precision Agriculture.