



## Smart Agriculture- Importance and Some Challenges

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With the passage of time, agriculture has changed over the years with changing demands of ever-growing population. The world population has increased exponentially during the last four decades i.e. from 1960-2000 which indirectly led to increase in agricultural production to meet out at least the basic food needs of this increasing population and to provide food security. With the sincere efforts of agricultural scientists and government, the agriculture changed from traditional/subsistence to commercial agriculture. The country has witnessed various revolutions in the form of **Green revolution, Blue revolution, Grey revolution, White revolution, Yellow revolution**, etc. and ultimately **Rainbow revolution**. With the beginning of 21<sup>st</sup> century, we have entered into an era of digitization. Each sector has changed with the introduction of new technologies and agriculture is not an exception. Rather using heavy application of inputs, agriculture is now being focused more on sustainability and optimization of natural as well as all the available farm resources. Thus, a new term has come up i.e. **Smart Agriculture**. Smart agriculture means adoption of advanced technologies like artificial intelligence, automation, Internet of Things etc. and data-driven farm operations to optimize the resources and improve sustainability in agricultural production (IBM, 2023). Smart agriculture is gaining much popularity among the farming community because of following reasons:-

- Optimization of resources.
- More focus on sustainability to create harmony among humans, soil, animal and their environment.
- Ease of operating various tasks with minimum human errors.
- More accuracy in calculating the right inputs and their dose as compared to traditional farming and thus, helps to reduce soil degradation.
- Reduces cost of labour as many operations are handled by the machines.
- Reduces the death rate of farmers as they do not have to be necessarily present in the field for pesticide spray and other operations.
- Saves time and money during crop cultivation period.

Some of the various fields covered under smart agriculture are briefly discussed as under:-

- a) **Water management:** Water management is one of the crucial operations in agriculture. To reduce water wastage and timely irrigation to the crop for a good harvest, sensors are placed in the fields. These sensors detect the moisture level, monitor the water level and take pictures which can be seen in smart phones by the farmers. They then can give command for irrigation, mostly drip irrigation system is being automated to increase the water efficiency. The sensors like Soil Moisture Sensors determine amount of moisture present in the field which can be used to determine the number of irrigations required to achieve desirable yield.

- b) **Soil management:** Soil management provides insights to soil health and sustainable production through optimized fertilization, irrigation, tillage, organic matter incorporation, drainage etc. The sensors such as soil moisture sensor, temperature sensor (detects changes in soil temperature that may impact nutrients absorption by the plant/crop), humidity sensor, pH sensor (pH detection helps in deciding which crop to grow as many crops are pH sensitive; and to track the requirement of nutrient/fertilizers because the availability of nutrients is effected by change in pH), photodiode (determines soil properties like soil organic matter and moisture content with the help of light), tensiometer (detects water absorption by plant roots), etc. are employed in soil management practices which helps to reduce environmental pollution and input-use optimization.
- c) **Weather monitoring:** Agriculture is different from other sectors because it is predominantly dependent on the unpredictable weather which makes it very risky and uncertain. The agricultural losses occur every year due to unfavourable weather conditions at different stages of crop growth period. Therefore, weather monitoring and prediction is essential for good harvest; and not only that, the information regarding weather conditions also helps in crop planning i.e. which crop to grow, insect-pest and disease incidence rate etc. The weather parameters such as wind speed & direction, sunshine hours, precipitation, humidity, minimum and maximum temperature are frequently checked through different sensors and thermometers. Humidity sensor measures moisture and temperature content of the air to report humidity in the air.
- d) **Nutrient management:** Just as water and soil management are important, so is the nutrient management. The plant requires essential nutrients for its proper functioning as each nutrient has its individualistic function which cannot be replaced by another nutrient. Thus, there is a need to provide nutrients in right amount and at the right time to the crop which will not only help in crop growth but also to maintain soil fertility level and to reduce soil pollution and degradation. If the nutrients in the soil are analysed beforehand, it will help in crop selection and nutrient application. For this purpose, sensors such as photodiode and pH sensor are used.
- e) **Livestock monitoring:** Livestock is an integral part of agriculture/crop production. Most of the farmers have one or more livestock with them as both i.e. crop and livestock supplement each other. The waste of livestock is used as organic fertilizers for the crop and the crop remains are used for feeding livestock. The livestock is important not only in crop production aspect but also in dairy farming because of a big role of dairy industry in the country's Gross Domestic Product, employment sector and food security to supply the required minerals and vitamins. The monitoring of livestock is done with the help of Drones, Geographic Information System (GIS), Remote sensing, Motion detector sensor, Passive Infrared sensor (detects movement and direction of an livestock), etc.
- f) **Use of Global Positioning System (GPS):** GPS is a technology that helps in tracking and tracing the path of objects/living-beings. It also facilitates in tracking livestock, laser land levelling, tractor position, location of natural resources, etc.
- g) **Drone technology:** Drones are effectively and efficiently deployed in the agriculture field both manually and automated operated. They have a variety of features like crop monitoring, insect-pest & disease incidence monitoring, pesticides spray, livestock monitoring, crop planting/sowing, weed infestation, soil examining, crop health, etc. They are equipped with different sensors such as motion detector sensor, thermal sensors, light, camera and others whichever is required. The information obtained from drones can be stored in the cloud database for further information and decision-making process.
- h) **Remote sensing:** Each object reflects different amount of light depending upon its condition. Remote sensing helps in identification of objects through the satellites like

identifying soil fertility, pH level, problematic soils, biological activity in soil, livestock monitoring, livestock health status, crop health status, water, environment, weather prediction, infestation of weeds, insect-pest & disease etc. Through remote sensing, soil maps, agricultural/crop maps, ecological and natural resources maps are created which help in keeping the track of all the objects and thus, farmers can accordingly plan their year-based cropping system.

- i) **Crop management:** It involves assessment and documentation of the crop. It revolves from crop selection to marketing stage of the crop. Crop health, weed infestation, crop damage due to unfavourable weather conditions, insect-pest & disease incidence, soil monitoring, harvesting and market information about prices besides demand and arrivals of the produce. It includes use of UV sensor (which monitors the intensity of UV radiation for optimal crop production), Weed Seeker, Remote sensing, Drones, GPS and other sensors.

The above tools and technologies can be operated in every agricultural sector. A combination of above sensors/apps/tools can be used by the farmers according to their needs and availability. Now the question arises in which fields the types of agriculture, the concept of smart agriculture is in operation. Here are given certain areas where the smart agriculture can be used:-

- a) **Precision farming:** One of the fields where smart agriculture is linked is precision farming. It means application of technology/inputs at the **right time, at the right place, in the right amount and in right proportion**. It employs soil moisture testing, automated drip irrigation system, pH sensors, Variable Rate Irrigation (VRI) optimization, cloud-based central system etc. The user/farmer can check all the progress and can monitor the crop through his/her phone and can also give command for operations from it.
- b) **Greenhouse technologies:** Greenhouse is another field where smart agriculture is being employed in large scale. The greenhouses are known for efficient use of vertical spaces which provides more yield from a small piece of land compared to the same piece of land in open fields. It also protects crop from unfavourable weather conditions and insect-pest attack. In greenhouse, all the above-mentioned sensors are installed for cloud-based decision making for water, nutrient, crop and soil management by keeping track of soil moisture content, temperature in air & soil, humidity, light etc.
- c) **Hydroculture:** Refers to aeroponics, aquaponics and hydroponics (Kour *et al.* 2022).
- **Aeroponics-** Refers to cultivation of seeds using soilless media by hanging the roots in the air and providing it nutrient through nozzles after fixed interval of time.
  - **Aquaponics-** It is combination of raising fish culture and plants in which the nutrient rich water helps in raising of fish and the fish, in turn, acts as natural fertilizers for plants. The plants also help in purifying water for fish.
  - **Hydroponics-** It refers to using of water as medium for planting. Nutrients are provided in the water at fixed intervals.

**However, there are following certain challenges and issues in smart agriculture which need to be addressed:-**

- Since our farmers are generally ignorant about the use of smart agriculture, therefore, there is urgent need of technology literacy/capacity building of our farmers so that they can use the improved technologies efficiently besides making them aware about the use/operation of these practices.
- The initial cost of installation has been observed too high especially for marginal and small farmers who may not be able to afford it. Therefore, the technologies used under smart agriculture should be provided to them at affordable/subsidized rates.

- A large majority of farmers in India are small and marginal who find it difficult or reluctant to use smart agriculture. Therefore, they should be motivated/encouraged to use smart agriculture by organising training programmes on smart agriculture.
- Since most of the operations which were formally done by the labours are now being overtaken by the machines so care should be taken by the policy makers that it may not lead to increase unemployment rate in the country.

## References

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