Chapter 1
Introduction to Precision Agriculture:
Overview, Concepts, World Interest, Policy, and Economics

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Abstract

The global population is increasing at a tremendous speed; thus, the demand for safe and secure food to meet this population is in demand. Therefore, traditional farming methods are insufficient to meet this demand; thus, the next revolution in agriculture is required, which is Precision Agriculture (PA), the Fourth Agriculture Revolution. PA is a technology where the concept of farm management is based on observation, measuring, and responding to inter- and intra-field variability in crops. The technologies used for performing precision agriculture are mapping, global positioning system (GPS), yield monitoring and mapping, grid soil sampling application, variable-rate fertilizer application, remote sensing, geographic information systems (GIS), quantifying on farm variability, soil variation, variability of soil water content, time and space scales, robots, drones, satellite imagery, the internet of things, smartphone, and machine learning. Hence, the current chapter will be emphasizing the overview, concepts, history, world interest, benefits, disadvantages, and precision farming needs.

CHAPTER OVERVIEW AND CONCEPT

With the growing population and lifestyle changes the demand for food is on the increase. People are now more inclined in eating healthy organic food, all for the reason for green life. However, arable acreage cannot keep pace with this ever-growing demand as the area for growing crop is decreasing due to climatic and human activity. Hence, the impending food security threat could easily devolve into regional or even global instability. Similarly, there is a growing need to balance the ratio of the cultivable land and consumption rate.

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The traditional farming methods relies on managing a large field, while planting, harvesting, irrigation and applying pesticides and fertilizers majorly based on the regional conditions and historical data. Therefore, just depending on traditional farming method is not faceable to meet the escalating need. As a result, there is a need to manage the agriculture activity to increase the crop yield by maximizing land use, since the area for arable land is limited and traditional farming method has left certain previously fertile land now barren. Therefore, precision agriculture can be used to overcome the drawbacks faced by traditional agriculture, namely by, maximize land usage, management of time, reduction in the usage of water and chemicals which will benefit in the healthier and higher crop yield. Such farming method will not only benefit the farmers but also the environment by preserving resources.

Precision agriculture in general is an approach to manage farm using information technology (IT) for ensuring optimal health and productivity of the crop. Precision Agriculture also known as PA in acronym, had a major breakthrough in farming due to the investment by AL Myers on the on-the-go crop yield monitor.

PA is also known as satellite farming or site-specific crop management (SSCM), wherein the concept of farm management is based on observation, measuring and responding to inter and intra-field variability in crops. Phytogeomorphology, is an approach in precision agriculture which attributes to topological terrain features to tie multi-year crop growth stability and/or characteristics. An interest in such an approach arises from the fact that the geomorphological component typically dictates hydrology in the farm sector.

Agriculture sector has witnessed transformation from the time human started planting, wherein an increase in mechanized agriculture was observed from 1900 to1930 which considered as the first revolution in agriculture, leading to feeding about 26 people. Followed by Green revolution in the 1960s which led to feeding approximately 155 people using gene modification techniques in plants. Finally, precision agriculture came in as the next revolution in the farming industry, wherein the farmer is expected to feed about 265 people on the same acreage. The first initiation of precision agriculture was using satellite and aerial imagery, weather prediction, variable rate fertilizer application, and indicator of plant health. Next advancement in PA saw the use of machine (data mining) to even more accurately predict precise planting of crops, topographical mapping, and soil data.

In contrast to traditional farming methods, precision farming incorporates sensors, robots, GPS, mapping instruments and data analysis software to adapt based on the plant's requirement without an increase in labour. Information regarding a plant stem size, shape of leaf and soil humidity around a plant is send to a computer via a stationary or robot-mounted sensors and camera-equipped drones in the form of images and data on individual plants for seeking signs of health and stress. These information on individual plants is accessible to farmers in real time as a feedback, so that they can decide on the distribution of water, pesticide or fertilizer in a calibrated dosage on the required region. Thus, also help in estimating the time of planting and harvesting.

The use of unmanned aerial vehicles in precision agriculture such as the DJI Phantom, which are comparatively economical and can be operated by novice pilots. These drones are equipped with hyperspectral or RGB cameras that capture numerous field images which are managed by using ortho-photos and NDVI maps using photogrammetric techniques.

The GPS system in precision agriculture enables farmers in planning and mapping the field, soil sampling, crop scouting and mapping of yields. Conditions such as fog, dust, rain and darkness which are visibly low and does not hinder the farming process. Satellite imaging is also applied in precision-