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Precision agriculture: An introduction

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Abstract
Precision agriculture (or precision farming) is about providing more accurate farming techniques for planting and growing crops. It is the use of information and communication technology (ICT) along with best agricultural practices. It may boost agricultural production while reducing harmful impact on the environment. It can make a big difference to food production facing the challenge of a rising world population. This paper provides a brief introduction on precision agriculture.

Keywords: precision agriculture, precision farming, satellite farming

Introduction

A third of the global population still depends on agriculture for their livelihood.

Agriculture has undergone through some evolutions. Recently, mechanization revolutionized farming with machinery and replaced horses with tractors. Today, technology has been adopted in an increasing rate to the extent that technology has become an indispensable necessity for every farmer, especially in developed nations.

The idea of precision agriculture (PA) (also known as precision farming) first emerged in the United States in the early 1990s with the introduction of GPS guidance for tractors.

Precision agriculture (PA) is one of modern farming practices that make production more efficient. It is a marriage between new information technologies and a mature agriculture industry. It promises to boost the quantity and quality of agricultural output while utilizing less input – water, energy, fertilizers, herbicides, pesticides, etc. More effective use of input leads to great crop yield without polluting the environment.

Principles OF PA

Precision agriculture (PA) is the application of precise amount of inputs like water, fertilizer, pesticides etc. at the correct time to the crop for increasing its productivity while boosting yields. It achieves this objective by using high-tech systems. It allows farmers and soils work better, not harder.

By monitoring soil, crop, and climate in a field, it is possible to deliver treatments, such as irrigation, fertilizer and pesticide application, for specific areas of the field in real time.

A decision support system regulates farm needs precisely in order to gain maximum benefits.

The basic principles underlying PA are [1]: correct information, correct observation, correct analysis, correct doses, correct place, correct time, correct conditions, and correct equipment. PA follows the site-specific management principle, which has the idea of doing the right thing, at the right time, at the right place. For example, this allows farmers to apply nutrients at the right time, at the right place, at the right rate, and at the right source.

Enabling Technologies

The practice of precision agriculture is enabled by several technologies such as drones CPS, IoT, WSN, GNSS**,** GPS guidance, control systems, sensors, robotics, autonomous vehicles, automated hardware, telematics, and software [2].

- *CPS:* Precision agriculture is an application area of cyber-physical system (CPS). including three layers: the physical layer, the network layer, and the decision layer [3]. CPSs are smart systems that depend on the synergy of cyber and physical components. CPSs can collect fundamental information about the climate, the ground, and other data, in order to realize more accurate systems of agricultural management. Precision agriculture and food security can be achieved through the integration of CPS technologies with agricultural and food systems [4].
- *GNSS:* The use of global navigation satellite systems is rapidly increasing in PA. Satellite imagery is commonly used to study the variation is soil conditions. GPS is the most widely used component of GNSS.
- *GPS*: This is the heart of PA. Large agricultural machinery is equipped with global position systems (GPS). GPS receivers use satellite signals to precisely determine a position on the globe. This allows the farmer locate their precise position in a field. Data can be collected by sensor arrays mounted on GPS-equipped harvesters [5]. The marriage of remote sensing data with GIS and GPS software tools makes it unnecessary for the farmers to treat a field of crops as one homogeneous unit. Precision farming allows growers to target areas within their fields and apply just the right amounts of chemicals there.
- *Drones***:** Precision agriculture uses drones or unmanned aerial vehicles, which can be easily operated. Drones take high quality images, while satellites capture the bigger picture.
- *WSN*: Wireless sensor networks have become an important component of PA. They consist of sensors, computation,

and wireless communication unit. A node consists of six units [6]: (i) sensor unit, (ii) amplifier unit)m (iii) analog to digital converter, (iv) processor, (v) transceiver, (vi) power unit. Nearly all the sensor nodes use 2.4 GHz radio waves. Using sensors allows farmers to exploit available resources appropriately [7]. The sensor nodes sense the environment parameters (temperature, humidity, soil moisture content, etc.) continuously and see if the sensed value exceeds a threshold.

- *Robots*: Robots in agriculture sector is an newly emerging technology. Agribot is a robot designed to perform sowing for crops. Robots enable automaton of farming processes, which saves the time and energy required for performing repetitive tasks [8].

Benefits and Challenges

A major benefit of PA results from the targeted placement of crop inputs such as nutrients, pesticides, and water. AP saves farmers on water, pesticide, and fertilizer costs. Other benefits include variable rate irrigation, decrease in environmental pollution, increase in the quality and yield of crop, and provision of a precise records through GIS database [9]. PA techniques can improve environmental sustainability of crop production. It can contribute to food security and food safety.

The AP technology is expensive and limited to certain nations. Agricultural production can affect the environment, especially water quality. Sensor nodes used in PA are powered by low energy batteries, which are limited in cost and weight. Therefore, energy management is a major concern in using WSN in PA [10]. The safety risks in introducing unmanned aircraft systems (UAS) in PA should be properly understood and managed. PA will require that farmers acquire new skills (technological, managerial, and environmental), which may not be easy.

Conclusion

Precision farming is managing variations in the field accurately to grow more food using fewer resources**.** It is becoming more cost-effective and easier for farmers to use. It contributes to the broader goal of sustainability and agricultural production. It can address both economic and environmental issues currently facing production agriculture.

The adoption of mobile devices, easy access to the Internet, and low cost and reliable satellites are some of the key technologies characterizing the trend for precision agriculture today. Precision agriculture is a new dawn. More information on AP is available in *Precision Agriculture*, the journal that is exclusively devoted to it.

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