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Precision agriculture: technology, advantages and limitations.

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Abstract

Precision agriculture is all about generating maximum productivity and yield with minimal resource inputs by using various technologies such as sensors, image processing techniques, computing capabilities and computer vision. Precision agriculture attains greater significance due to dwindling land and water resources and drastic changes in the climatic conditions and weather and in the context of increasing demand for food and feed.

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Technologies used in precision agriculture

Precision agriculture takes into account the local features of agricultural land, dimensions and other topological characteristics of the crop field such as slope. New technological advancements enabled the practice of precision agriculture all across the world depending on the availability of the technology, knowledge, skill level and professional personnel [1]. A number of precision agriculture technologies are available for varied conditions and they have potential to show promising results. Some of the most promising technologies include the use of soil and plant sensors and water stress indicators for the nutrient and water management. Computer vision is also used for the assessment of the nutritional status of the crop plants. Several more technologies are being developed and are at experimental stage [2]. The latest technologies that are being used includes crop and soil sensors, global navigation satellite systems, global positioning systems, geographical information systems, variable rate application techniques and many more. Such improved management practices can improve the productivity and especially beneficial for small scale farmers.

The designing of soil and crop management practices in relation to the field environments and based on the soil type, soil moisture and nutrient content has been traditionally practiced. Optimal utilization of soil resources and water resources and the fertilizer levels and other external inputs are necessary for deriving maximum benefits [3]. But the introduction of inorganic fertilizers has caused their inappropriate usage leading to environmental damage. Therefore there is a need to the judicial usage of the inorganic fertilizers based on precision agriculture for deriving maximum benefits and this can be achieved by analyzing the temporal, spatial and individual data of the farm in combination with other systems. The management decision during the precision agriculture is based on the estimated variability for improvement in the resource use efficiency, productivity, quality of the produce, profitability and sustainability of agricultural productivity.

A large amount of data is required for the implementation of the precision agriculture and such data needs to be analyzed using advanced analytical system rather than the traditional data analysis systems that are time consuming [4]. The evolution of big data analysis and artificial intelligence has enabled the processing of large quantities of data and derivation of meaningful interpretations for effective implementation. Such big data analytics can process data from multiple disciplines of the agriculture domain including that of agro-geo climatic data.

The incorporation of the information and communication technology in the precision agriculture can increase the efficiency of the sensing and monitoring parameters. The focus and interest in precision agriculture has dramatically increased from the last two decades. A lot of research is taking place in Europe, Asia, North America, Africa and Australia on these aspects due to dwindling of the land resources for agriculture. Soil nutrition level remains the major focus of research in precision agriculture. For this a portable and energy efficient modern chemical sensor system that is affordable is very much required for their use in the rural area settings.

The mobiles and smartphone technology are also being integrated with the chemical sensor readings for information processing and transfer and also for the image processing that can process the raw information into accurate readings. Such information is then processed to provide feedback to the farmers. New technologies also includes monitoring of the yields and yield mapping based on automated guidance and section control systems unmanned aerial vehicles and satellite imagery and global navigation systems. However cost savings can be done using location and crop specific technologies and can save on the simultaneous usage of multiple technologies.

Advantages of precision agriculture

Precision agriculture takes into account crop and animal protection, growth monitoring, soil mapping, soil type, soil nutrient level, supply of irrigation and water levels and their cumulative environmental impact. Precision agriculture increases the number of the correct decisions per unit area in terms of the land productivity as in encompasses large amount of the data with lesser and more efficient usage of inputs [5]. Irrational usage of the fertilizers and the subsidies that are being provided by the government are burden to the Government and to the environment and there is also a chance of weed development due to the fertilizers. Precision agriculture enables use of precise amount of fertilizer and at precise location and at precise time for deriving maximum yield in the context of different soil types, crop requirements. Precision agriculture allows judicious usage of the fertilizers and the pesticides and therefore the environmental impact can be minimized. It can also be used as risk mitigation strategy and make counter measures. Precision agriculture technologies pertain to the efficiency

in the fertilizer usage, ability for the dry land agriculture. Monitoring of the resources inputs reduction of the usage of the chemical fertilizers also avoids environmental damage and increases demand for the qualitative and healthy food. Precision agriculture also addresses the issues of the soil fertility and variability of the soil type thus aids in the improvement of the yield and improving the quality of the food and at the same time increase the income of the farmers.

Limitations in the adoption of precision agriculture by the farmers

The United Nations has adopted sustainable developmental goals to ensure prosperity and end poverty for humanity. For attaining this long term strategies are being devised for large scale influence. However adoption of the technologies needs to be observable and perceivable and translatable addressing the local problems with proper solutions. For ensuring sustainable food production and feed availability for the livestock and meet the increasing demand of the future food production precision agriculture technology need to be adopted. This will lead to growth in agricultural food production all across the world under various diverse agro-climatic conditions [6]. The innovations are essential for ensuring dietary solutions. Several stakeholders need to be taken into account including government, agricultural research extensions, agricultural marketing units, media, and consumers themselves. A balance need to be struck to include the traditional farming practices and the new technologies and economic drivers for better sustainability. The International society for precision agriculture provides clear guidelines to achieve the agricultural production profitability, improvement in the resource utilization and environmental sustainability. The current rate of adoption of new technologies for precision agriculture is very low and the limitations that the farmers are facing are multifaceted. In addition technical issues such as lack of availability of the sophisticated instrumentation and equipment and their maintenance costs and accessibility to the services and software and lack of compatibility of the equipment to the traditional and current farm practices are also hindering the adoption of the precision agriculture technologies [7]. The agricultural data is also fragmented and from various sources of different agro-climatic conditions and the associated analytical and interpretation approaches fitting the local specification is also hampering the use of precision agriculture. Therefore more user friendly design need to be provided along with cost considerations. Therefore the desired attributes for precision agriculture are compatibility, simplicity, trialability and observability. To improve farmer participation, training programs and the hands-on workshops are very important.

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