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Precision Agriculture

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ABSTRACT

Depriving natural resource base and emerging environmental pollution created the need to manage present agricultural practices to target hit accuracy. Precision agriculture focuses on precise utilization of Agri-inputs by site specific management that use technology to manage field variability while producing high profits and yield stability with less environmental impact. The unique spectral signature of available agricultural resources led to designing of database by which efficient decisions are now taken on farm with no time lapse. The wide applications of information technology, Global Positioning System, Remote sensing has made precision farming as excellent approach for sustainable intensification of crops. The more socially and economically effective way of assessing agro-ecological parameters, Crop monitoring, Soil mapping, Land suitability by precision farming techniques provide prior vigilance for future stresses. Researchers revealed the superiority of 'Nutrient Expert' based recommendations over existing practices in terms of yield profitability, while 86% of small holding Indian farmers are not having access to soil testing. The advancements in aerial photography, real time data analysis tools answer a farmer, how much to apply? Where and when to apply? The multidisciplinary approach of precision agriculture will aid in renovation of traditional farming to achieve sustainable development of India.

Key words: *Global Positioning System, Remote Sensing, Site specific management.*

Over the years technology played a great role in many sectors. It has literally transformed many lives and made them enable to run the years with advancements. Expanding the boundaries of technology into the backbone of Indian economy will surely bring its GDP to new heights. The main reason for inefficient farming in our country is due to less accuracy in application of input. This created a huge loss of many agri-inputs like fertilizers; Herbicides; Pesticides; Irrigation; Seed rate and even organic inputs are also facing a halt in maximizing production efficiency due to less efficient utilization of the input to its extended maximum. Certainly, the country needs a shift from basic farming to more efficient, sustainable and productive farming. Globally, the affordability and accessibility of trending technologies helped precision agriculture emerge as a research discipline in the 1980s. The aim of precision agriculture is to modify inputs spatially and temporally at the sub- field scale for cost efficiencies and productivity with less effect on environment. A strong focus has always been to improve nutrient use efficiency by matching inputs to site-specific field however it has further developed with access to an array of affordable soil and crop sensors, improved computer power, software, and equipment with precision application control, e.g. variable rate fertilizer and irrigation system. The advancement in automation technology made agricultural vehicles possible to provide the accuracy, reliability, and ability to display, combine, and manipulate spatial maps of field characteristics instantly to the vehicle operator. This has simplified many farming operations which are related to human drudgery. But the thing is there is a need for extension of these modern outcomes not only to the corporate level but even to the ground level of the agriculture sector. Precision agriculture is one of a concepts that integrates science with technology to bring a real sustainable and secured life in food and environmental aspects. This article reviews the advancements and applications of this interdisciplinary approach in farming and its need in India as it is a country where agriculture is the main occupation especially in rural areas. Section 2 will cover advancements of remote sensing and role of information technology and geometric precision in digital farming and highlights specifically agriculture drones. Section 3 covers results and discussion Section 4 covers conclusion and future scope.

MATERIAL AND METHODS

Remote sensing

Remote sensing is the use of reflected and emitted energy to measure the physical properties of distant objects and their surroundings. The first remote sensing technique was aerial photography, invented with panchromatic films in World War I and with color infrared films for camouflage detection in World War II. In the 1950s, multispectral systems, thermal infrared, radar, and sonar were invented and adapted for remote sensing. The first multispectral sensors for remote sensing by air and spacecraft were tested in 1964. Hyper- spectral imaging spectroscopy followed in the early 1980s. In plant sciences, remote sensing is a method used to obtain information from plants or crops without direct contact or invasive manipulation. To date, the leading application of PA still is the site Site-specific application of fertilizers. The original concept of SSNM to manage farm nutrient variability was first developed in Asia for rice [6]. The unmanned aerial vehicle (Drone) can fly with the help of an autopilot and GPS coordinates that brings pinpoint accuracy from even greater distances and can perform geological survey, Crop monitoring, Soil and field analysis and thus plays major role for attaining global food security. One of the most economically important sectors of UAVs is precision agriculture. Honeycomb AgDrone System is regarded as most sophisticated drone for Agriculture covering 600-800 acres of field every hour flying at 400 feet. Other agricultural drones that has found enormously efficient till date are DJI Matrice 100, DJI T600 Inspire 1, Agras MG-1- DJI, EBEE SQ- Sense Fly, Lancaster 5, Precision Hawk, SOLO AGCO Edition27. Nano and Micro Unmanned Aerial Vehicles (UAVs) has become a New Grand Challenge for Precision Agriculture in 2020. Four kinds of sensors cover almost all applications in UAV remote sensing in precision agriculture research. Commercial off-the-shelf RGB (red–green–blue) cameras are cheap and have a high spatial resolution, but a relatively poor spectral resolution. They can be used to calculate a range of vegetation indices (VIs), as well as to generate high-resolution digital elevation models (DEMs) and vegetation height maps. Modified RGB cameras are the same cameras in which the near-infrared filter has been removed and replaced with a red filter, making the former red band sensitive to the near-infrared spectrum (NIR) [19,3]. A second type of multispectral cameras with better spectral resolution consists of a set of sensors with different lenses, with each sensor sensitive in one spectral region. Hyperspectral cameras cover the full spectrum in (most commonly) the 400–1000-nm spectral region, in relatively narrow bands (usually <10 nm). Researchers from Wageningen University & Research used deep learning techniques based on hyperspectral image data and successfully detected Potato Virus Y infected plants in 2019. It is also proved that hyperspectral scanning can be used to distinguish different fungal infections. Snapshot and line scanning systems are available. Although their combination with UAVs is not always straightforward, the quality of the systems is expected to further increase in the coming years.Thermal cameras, finally, are typically low-resolution cameras (maximal resolution of 640 512 pixels, or 0.33 MP) with only one band measured with microbolometer sensors sensitive in the longwave infrared (7–12 mm) region. They can be used to extract canopy temperature. Indexes obtained by sensors focused on short wave infrared (SWIR) are able to detect, on a large scale, several soil properties as mineralogy, texture, organic carbon, and salinity. Spatial resolution is the main features that affect the sub-fields variability detection. The Nano satellites like Worldview 2-3-4, Geoeye-1, and Pleiades 1A/B provide images with a sub-meter resolution and have the highest value of minimum area price.

Geographic Information System (GIS)

Big Data applications in the agricultural sector have also revealed several collection and analytics tools that may have implications for the power relationships between farmers and large corporations. However, statistics show that the rural population and arable land per person is declining. This is an ominous development for a country with a population of more than one billion, with over sixty-six percent living in rural areas. Nevertheless, there is a need to adopt latest advancements to all streams of farming population because routine agriculture operations are cumbersome and labour intensive. For example, Manual methods for crop quality assessment are challenging even for people who are able to perform these tasks. One of the negative aspects is the time required to carry out such assessments, which impedes rapid decision-making and large-scale evaluation. In this sense, computer vision presents as a valuable asset. They can be used in grading systems for orange, papaya, almond, potato, lemon, wheat, corn, rice, and soybean. It was identified that there are gaps to be filled with the development of intelligent devices that use computer vision and artificial intelligence for automation of tasks in the field, as well as their integration with agricultural machines and drones. Prescription maps for SSWM based on machine learning technology have proven to significantly reduce herbicide use without affecting yield. The modelling of two variables used for lime requirement calculations (target pH, buffering capacity) proved to be as good as or better than, using soil samples obtained at farm level and mapped through interpolation, indicating the potential of regional digital maps for precision agriculture. It was found that the Farm Interactive methodology worked at least as well for construction of variable-rate application files for need based application.

The Nutrient Expert TM is a new, computer-based decision support tool developed to assist local experts to quickly formulate fertilizer guidelines based on the principles of Site-Specific Nutrient Management (SSNM). Results from validation trials, comparing NEbased recommendations with farmer practice and the state recommendation in 82 farmer fields of southern India, demonstrated the utility of the decision support system tool in improving the yield and profitability of maize farmers in the region.

Geographic Positioning System (GPS)

The Navigation Satellite Timing and Range Global Positioning System, or NAVSTAR GPS, is a satellite-based radio-navigation system that is capable of providing extremely accurate worldwide, 24 hour, 3-dimensional location data owned by US but the services are for worldwide who are having GPS receiver. However, there are other navigation systems by Russia, Europe, Japan and China but their global coverage is limited. IRNSS is an (Independent Regional Navigation Satellite System) being developed by India with an operational name of NavIC (Navigation with Indian Constellation). It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area. Some applications of IRNSS to agriculture are: Terrestrial, Aerial and Marine Navigation, Disaster Management, Vehicle tracking and fleet management, Integration with mobile phones, Precise Timing, Mapping and Geodetic data capture. GPS allows farmers to accurately navigate to specific locations in the field, year after year, to collect soil samples or monitor crop conditions for example yield monitors will be connected to GPS receivers to map yield. The resultant yield maps will help to identify areas of the field requiring different treatments.

RESULTS AND DISCUSSION

Where there is an advance notice, it will allow decision makers to implement plans to minimize the impact of adverse events and find opportunities within favourable events. The digital advancement has integrated the art of gathering weather information with other environmental information such as crop variety, soil type, soil maps, soil fertility, soil moisture and long-term drought conditions. This will maximize the value of prediction information for decision-making process and help farmers and agribusinesses to utilize the information more effectively in decision-making [21]. Future research should focus on exploiting the complementarity of hyperspectral or multispectral data with thermal data, on integrating observations into growth models and on combining UAV products with other spatially explicit information. Due to the number of sensors available for precision agriculture, a comparative analysis is needed, to assist the selection of the best satellites sensors for farmers.

The integration of satellite services with digital agriculture technologies could be profitable for both small- and large-scale farms. The radiometric resolution does not affect vegetation indices measurement considerably for agricultural needs, but it may be considered to detect variability with a value of NDVI (Normalized difference vegetation index) close to the saturation. Spatial resolution is the main features that affect the sub-fields variability detection. However, identification and quantification of plant diseases is based on monitoring of crops by both spectral and spatial resolution. Continuous improvement in remote sensing technologies leads to a better data available for precision agriculture[16].There is a need to improve NavIC(IRNSS) services in near future, as it addresses many critical aspects like cropping system studies, experimental crop insurance, production estimation *etc*. The applications offered by modern agriculture technologies should be utilised by even non experts in the field. For attaining this ultimate goal should be a fully automated agriculture that needs no specific expertise to operate.

CONCLUSION

UAVs, GIS and GPS artificial intelligence has real potential to improve resource use efficiency of agriculture. A possible factor holding back this development is the stringent UAV regulations established in the country, which were often not issued with precision agriculture applications in mind. If it is realized and utilised efficiently, precision farming can be considered as another revolution, following after the green revolution. Finally, our intention is that this article would present diverse utility aspects and advancements of precision farming technology in order to motivate more researchers to apply them for solving agricultural problems currently open. The study of the presented works of different scientists would solve together with the new advances in computer vision and artificial intelligence and can lead to new solutions for agriculture bringing gains of production, quality, food security and sustainability. Application of artificial neural networks, genetic algorithms, fuzzy logic, wavelet techniques, decision tree, smart microprocessors, Nano satellites, biosensors along with other future development areas will make PA not only suitable for developed countries but also for developing countries. If applied properly, it can work as a tool to minimise the distance between developed world and the rest.

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