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Revolutionizing efficiency in modern agriculture

1. **S. Bala Murugan**
Department of Agricultural Entomology, Sri Venkateswaraa University, Ettayapuram, Thoothukudi
Email: sbala512945@gmail.com
2. **M. Kandeshwari**
Department of Agronomy, Sri Venkateswaraa University, Ettayapuram, Thoothukudi
Email: aasir.lotus@gmail.com

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Abstract

The world's agricultural sector faces immense challenges. A growing population demands more food, while climate change disrupts agricultural productivity. The UN FAO estimates a 70% increase in food production is needed over the next 40 years to meet this demand. India, with a population of 1.34 billion projected to reach 1.66 billion by 2050, exemplifies this challenge. Feeding this growing population with small-scale farming practices adds further strain. Sustainable agriculture offers a solution to environmental issues. This necessitates developing new automated technologies for efficient farm management and increased productivity. We need clean, green technologies for sustainable agricultural practices that reduce workload, provide real-time data collection, and simplify research for future sustainable agriculture.

Agricultural drones

Drones designed specifically to aid farmers in increasing crop yields and monitoring growth. Equipped with advanced sensors and high-resolution imaging capabilities, these drones allow farmers to collect detailed data about field. This data can be instrumental in optimizing yield loss and overall farm efficiency.

Reason for choosing drone in farming

The distinct feature of drones like low operational cost, low elevation operation with hovering ability, light weight, ground station full control, efficient communication and

operational ease may be harnessed for agricultural production, management and planning. The autonomous and stabilized flight of drones with navigation sensors and even low cost multi spectral or hyperspectral camera is able to geo decode aerial photographs of higher resolution of 1-2 cm, a relatively better image resolution than that of any satellite based images because they covers larger areas like globe and attaining up- to date information is expensive and having low resolution power (63 cm). Drones capture high-resolution imagery with a small ground sampling distance, enabling detailed analysis of crop health regardless of moderate cloud cover during critical growth stages. Additionally, they provide instant information communication to the user, facilitating real-time decision-making. Drone can be operated at lower height and knitting with modern cost effective sensors can gather more precise information with lesser complexity. This platform may be resourceful for generating reliable agricultural statistic of site and time specific. The data can generate firm base for precision agricultural technologies e.g. variable rate application of fertilizer, pesticide, irrigation and other agricultural inputs. In turn, it may be proven effective tool for enhancing input use efficiency, profitability as well as protecting ecosystem. Drones go beyond information gathering: they can also deliver targeted applications of pesticides, herbicides, and fertilizers, minimizing waste and improving operator safety.

Applications

Soil and field analysis: By carrying advanced sensors, drones can comprehensively analyze soil characteristics, including composition, moisture content, nutrient levels, and fertility variations across a field. This detailed spatial data empowers farmers with precision agriculture techniques like targeted crop selection and planting patterns, optimized irrigation schedules that consider localized needs, and variable-rate fertilizer application that precisely addresses specific areas.

Planting crops and trees: Drones offer a sustainable alternative to traditional tractor-based seeding. They eliminate fuel consumption and associated emissions, while also preventing soil compaction from repetitive passes. This makes them ideal for planting in remote areas or on sensitive terrain. Biodegradable seed pods or "seed bombs" can be dispersed by drones, facilitating the restoration of degraded lands, reforestation efforts, and afforestation initiatives.

Drones revolutionize crop monitoring: Throughout the growing season, drones provide farmers with a bird's-eye view of their crops, enabling **need-based and timely interventions**. This rapid data collection helps **prevent yield loss** by allowing for early detection of issues.

Weed identification: Drones can be used to identify the weeds present in the field. These weeds could be timely rooted out from the field so that they do not compete for resources with the main crop.

Crop spraying: Drones enable precision agriculture by allowing targeted spraying of chemicals like fertilizers and pesticides. They can adjust the application based on real-time data about crop health and pest severity within specific zones of a field. This reduces waste and minimizes environmental impact by lowering chemical runoff and soil pollution. Furthermore, drones can efficiently spray tall crops, unlike traditional machinery prone to tipping, thus preventing accidents. Drones offer a solution for managing crop residue as well. They can precisely target residue removal, eliminating the need for burning which harms the environment and degrades soil health.

Irrigation scheduling of crops: Equipped with optical, multispectral, and thermal sensors, drones can pinpoint specific areas experiencing heat and water stress within a crop field. This detailed information allows for targeted irrigation, delivering water precisely where it's

needed most. This data-driven approach minimizes water waste and ensures efficient irrigation practices.

Early disease detection with multispectral power: Drones equipped with multispectral sensors, capturing visible, near-infrared (NIR), and thermal infrared wavelengths, unlock a powerful tool for crop health assessment. By analyzing the crop's reflectance patterns at different wavelengths, these sensors enable the calculation of various multispectral indices. These indices, like the Normalized Difference Vegetation Index (NDVI), provide insights into overall plant health, while others can detect specific stresses like water deficiency even before visible symptoms appear. This early detection capability makes drones a valuable tool for disease and pest management, allowing farmers to take timely actions based on the severity of the stress.

Crop insurance: Drones hold significant potential for revolutionizing crop insurance by enabling precise estimation and monitoring of crop damage. This benefits both farmers and insurance companies. Farmers can receive faster and more accurate claim assessments based on the severity of damage captured by drone data. For insurance companies, drones can provide unbiased evidence to streamline claim processing for schemes like India's Pradhan Mantri Fasal Bima Yojana.

Conclusion

Drones have the potential to revolutionize the agricultural sector, making it more appealing to younger generations. This cutting-edge technology ushers in an era of data-driven precision agriculture, where drones play a central role in information gathering and analysis. By leveraging data insights, farmers can optimize crop yields while minimizing environmental impact**.** This translates to improved livelihoods for farmers and fosters sustainable agricultural practices**.**

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