

Agriculture Drone Technology for Plant Nutrition and Water Management

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ABSTRACT

Agriculture as the primary global food source, faces challenges like increased demand, food safety concerns and environmental sustainability. With the world population projected to reach 9.7 billion by 2050, the demand for food and water is expected to rise significantly. Challenges such as limited arable land, declining farmer numbers and environmental issues underscore the need for innovative and sustainable farming solutions. To address these challenges, incorporating novel technologies such as smart agriculture. Among many emerging technologies which can provide solutions unmanned aerial vehicles (UAVs) often known as drones is one of the most recent innovations. It is also a non-human centric, transparent, evidence-based technology. Drones save the excess use of water, pesticides and herbicides maintains the fertility of the soil also helps in the efficient use of man power and elevate the productivity and improve the quality. Drones equipped with cameras and other sensors can provide farmers with real-time data on crop health, soil moisture and other factors that affect crop growth and yield. One of the key benefits of drone technology in agriculture is its ability to collect large amounts of data quickly and easily allowing farmers to make more informed decisions about how to manage their crops. Drones equipped with sensors scan crops using visible and near-infrared light to track crop health over the time and monitor response to remedial measures. This can be programmed to detect details such as NDVI, water stress or lack of specific nutrients in crops.

INTRODUCTION

Farmers are now facing diverse problems in Agriculture. Climate change, decline in productivity, prevalence of weeds, insects, population growth, urbanization and deteriorated environment have all been identified as global concerns (Friha et al. 2021). Climate change is now having a major impact on food security and more than 815 million people are chronically hungry and among them 64 % are situated in Asia (Pathak et al. 2020). Adoption of modern technologies in agriculture, such as the use of drones or unmanned aerial vehicles (UAVs) can significantly enhance the ability to reduce risk and damage assessments and revolutionize the way we prepare for and respond to disasters that affects the livelihood of vulnerable farmers and the country’s food security (FAO, 2018). Drone is frequently utilized in farms to help the farmers to modernize farming in developed countries. Modern farmers have already started using high-tech solutions such as UAVs for monitoring and forecasting in agriculture. Drones collect data on crop yield, livestock health, soil quality, nutrient assessment and other aspects. This information is then utilized to produce a more accurate map of any existing problems, as well as their remedies, based on highly dependable data (Debangshi 2021). This technology offers cost-effectiveness, time efficiency and the ability to capture high-resolution images without causing damage.

Applications of drone sensors in agriculture

Applications	Sensors
Water stress monitoring	Multispectral or Hyperspectral sensors and NDVI, GNDVI, Thermal infrared sensor and RGB Sensor
Nutrient disorders	RGB, Multispectral and Hyperspectral sensors
Disease monitoring	RGB sensor, Multispectral images sensor, Hyperspectral and thermal sensor
Weed detection	Hyperspectral sensor, RGB sensors
Spraying	GPS sensor

Role of drone in plant nutrition and water management

Plants like us require a balanced diet for optimal health. Proper plant nutrition and water management are fundamental for successful growth. Nutrients provide the building blocks for strong structures, vibrant blooms, and abundant harvests. Water acts as a delivery system, carrying these nutrients to the roots and maintaining the plant's structure. Furthermore, water efficiency is enhanced by good nutrition allowing plants to thrive even in drier conditions. By ensuring both adequate nutrition and proper watering we create the ideal environment for plants to flourish.

Drones are becoming game-changers in managing plant nutrition and water management:

Identifying nutrient deficiencies

Through the use of multispectral imaging, drones can identify nutrient deficiencies in crops. The drones capture images at various wavelengths, highlighting the different nutrient levels in the vegetation.

Early detection of stress factors

Drones can detect crop stress factors such as water scarcity or temperature variations. By monitoring the thermal signature of the fields, farmers can identify areas that need irrigation or implement measures to protect crops from extreme weather conditions leading to better crop management and increased yield.

Advantages of Drone

- Farmers can increase production and productivity of farm produce by implementing comprehensive irrigation planning, adequate crop health monitoring

and surveillance and responding to environmental changes.

- Drone use enables farmers to get frequent agricultural data and contributes to the advancement of more productive farming methods.
- Using drones to spray pesticides in difficult to-reach terrains, contaminated areas and taller crops are safer and more convenient for farmers
- Surveys done through drones are 10 times faster and more accurate than conventional surveying and mapping techniques.
- Data from drone imagery can help farmers pinpoint areas that require more or less fertilizer leading to more efficient use of resources and potentially reducing overall costs.

Limitations:

- The cost of purchasing and maintaining drones can be a significant upfront investment for farmers.
- Drones' flying duration is limited by battery power.
- Operating drones in agriculture requires expertise and training which may not be readily available to all farmers.
- Drones are highly dependent on weather conditions, particularly wind speed and direction. High winds can make it difficult to fly drone safely and rain and fog can limit visibility.
- Drones have a limited payload capacity, which can limit the number and type of sensors and cameras that can be carried.

CONCLUSION

Drones provide real time and high-quality aerial imagery compared to satellite imagery over agricultural areas. Also, applications for identifying localized weeds and diseases, determining soil properties, detecting vegetation differences and the production of an accurate elevation models are currently possible with the help of drones. Drones enable to know more about the fields. These technologies can enhance their ability to regulate nutrient and water management decisions and develop the right management plan for each field. Drones serve as decision support tools for detection, large area coverage, optimization of spray volume, labor saving, quick response time and timely operation. Therefore, farmers will be assisted with producing more food while using fewer chemicals. Nearly all farmers who have made use of drones have achieved some form of benefit. They can make more efficient use of their land, eradicate pests before they destroy entire crops, adjust the soil quality to improve growth in problematic areas, improve irrigation to plants suffering from water stress and track fires before they get out of control. Therefore, drones may become part and parcel of agriculture in the future by helping farmers in managing their fields and resources in a better and sustainable way.

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