SUNSHINE AGRICULTURE
e-Newsletter

ISSN (E): 2583 – 0821

Sun. Agri.:e- Newsletter, (2026) *6*(11), 18-23

Article ID: 710

Monitoring and management of fruit crops by using drones

A S Kalatippi[1], S S Patil[2]
Kapil Patil[3]

[1]Assistant Professor
Department of Horticulture
College of Agriculture, Dharwad
Karnataka, India
[2]Associate Professor
Department of Horticulture
College of Agriculture, Raichur
Karnataka, India
[3]Assistant Professor
Department of Horticulture
College of Agriculture, Raichur
Karnataka, India

Open Access

*Corresponding Author
A S Kalatippi*

Available online at
www.sunshineagriculture.vitalbiotech.org

Article History
Received: 04.11.2026
Revised: 09.11.2026
Accepted: 14.11.2026

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INTRODUCTION

Drones (Dynamic Remotely Operated Navigation Equipment) also known as unmanned aerial vehicles which operate without a human pilot on board. Drones are also called as RPVs (Remotely piloted vehicles) which is operated remotely either by telemetry, where the operator maintains visual contact with the aircraft or autonomously along the pre-programmed paths using GPS and inertial guidance. UAVs are commonly used both in the military and police forces and now a day's using in the agriculture to obtain useful information about the properties of the land, crops, diseases in plants, wind, moisture levels, among many others properties.

Drone can be attached with infrared cameras and sensors that will allow the drones to collect data and then analyse it to understand the status of the crop enabling the farmer to take an optimum decision which would enable them to get better returns with optimum use of input resources. So that they can make better decisions that will save the time and money.

Fruits or nuts that are cultivated in orchards, which are specialized agricultural areas dedicated to the cultivation of perennial fruit-bearing trees or shrubs. Orchards are carefully managed to optimize growing conditions and maximize the yield of high-quality produce. The fruit crops such as mango, banana, sapota, custard apple, ber, citrus, avocado, apple, pear, peach, plum, almond, etc. are commonly grown orchard crops.

Successful orchard management involves considerations such as soil health, irrigation, pest control, pruning, and harvesting. Fruit crops are often grown in specific regions that provide suitable climate and soil conditions for optimal growth. Additionally, sustainable and environmentally friendly practices are increasingly being adopted in orchard management to ensure long-term productivity and minimize environmental impact.

ISSN (E): 2583 – 0821

Drones play a crucial role in the monitoring and management of fruit crops, offering a range of benefits such as increased efficiency, cost-effectiveness, and improved crop yields. Before implementing drone technology, farmers should consider factors such as the size of the orchard, the type of crops, regulatory constraints, and budget considerations. Integrating drones into orchard management practices requires training and expertise and ongoing support may be needed to ensure successful adoption. Here are some ways drones can be utilized for fruit crop monitoring and management.

Application of drone in fruit crops

1. Aerial Imaging

a) NDVI Mapping: Drones equipped with multispectral or hyperspectral cameras can capture images of orchards to generate NDVI (Normalized Difference Vegetation Index) maps. These maps provide valuable information about the health and vigour of crops, helping farmers identify areas that may require special attention.

b) High-Resolution Imagery: Drones can capture high-resolution images, allowing farmers to closely monitor individual trees for signs of diseases, pests, and nutrient deficiencies.

2. Pest and Disease Detection

a) Infrared Imaging: Infrared cameras on drones can detect temperature variations in orchards, helping identify areas affected by pests or diseases. Certain pests and diseases can cause changes in temperature, making them distinguishable through thermal imaging.

b) Machine Learning Algorithms: Drones can be equipped with machine learning algorithms that analyse images to detect early signs of diseases or pest infestations. This enables proactive intervention before issues become widespread.

3. Crop Health Assessment

a) Vegetative Indices: Beyond NDVI, drones can capture other vegetative indices like NDRE (Normalized Difference Red Edge) to provide a more comprehensive understanding of crop health.

b) Chlorophyll Fluorescence: Advanced sensors can measure chlorophyll fluorescence, providing insights into the photosynthetic efficiency of plants and indicating their overall health.

4. Fertilizer and Irrigation Management

a) Soil Moisture Monitoring: Drones equipped with sensors can assess soil moisture levels, helping farmers optimize irrigation practices and prevent overwatering or underwatering.

b) Nutrient Deficiency Identification: Drones can identify nutrient deficiencies by analyzing crop coloration and growth patterns, enabling precise application of fertilizers.

5. Survey and Mapping

a) 3D Mapping: Drones can create 3D models of orchards, aiding in terrain analysis and water flow management. This information is valuable for designing efficient irrigation systems and identifying potential drainage issues.

b) Field Boundaries and Crop Counting: Drones can assist in mapping field boundaries and counting the number of trees or plants in an orchard, facilitating accurate inventory management.

6. Weather Monitoring

a) Weather Sensors: Drones can be equipped with weather sensors to monitor temperature, humidity and wind speed. This data is crucial for assessing the impact of weather conditions on crop health and planning appropriate interventions.

7. Pollination Assistance

a) Precision Pollination: Some researchers are exploring the use of drones for pollination in orchards. Drones equipped with sensors can assess pollination levels, helping farmers make informed decisions to enhance fruit production while this technology is still in the early stages, it has the potential to address challenges related to declining bee populations.

8. Remote Sensing and GPS Technology

a) GPS-guided Navigation: Drones can be programmed to follow predefined flight paths, ensuring thorough coverage of the orchard and consistent data collection.

b) Remote Sensing: Drones enable farmers to monitor large orchards remotely, saving time and resources compared to traditional manual inspections.

9. Timely Action and Precision Farming

a) Real-time Data Transmission: Drones can transmit real-time data to farmers, allowing for immediate decision-making and timely intervention in case of issues.

b) Precision Application Systems: Drones equipped with precision spraying systems can target specific areas within an orchard, reducing the overall use of pesticides and minimizing environmental impact.

10. Efficient Spraying

Drone technology allows for the precise application of pesticides, fertilizers, and other inputs. This targeted approach minimizes environmental impact, reduces chemical usage, and can be more cost-effective compared to traditional spraying methods.

11. Post-Harvest Analysis

a) Yield Estimation: Drones can be used to assess crop yield by capturing images and data during different growth stages. This information helps in planning harvest logistics and estimating production.

12. Regulatory Compliance

a) Documentation and Compliance: Drones can assist in documenting farm activities, ensuring compliance with regulations related to pesticide application, land use, and environmental impact assessments.

13. Education and Training

a) Training Programs: Drones can be used as educational tools for farmers to learn about advanced agricultural practices and the effective use of technology in orchard management.

14. Cost Savings

a) Efficiency and Resource Optimization:

By providing precise and targeted information, drones help farmers optimize the use of resources such as water, fertilizers, and pesticides, leading to cost savings.

15. Data Analysis and Decision Support

The data collected by drones can be integrated into farm management software for in-depth analysis. This information can assist farmers in making data-driven decisions to optimize fruit productivity.

Using drones in fruit crops provides farmers with valuable insights, improves efficiency, and supports sustainable farming practices by minimizing resource use and environmental impact. However, it's essential to consider factors such as regulations, privacy concerns, and initial investment costs when adopting drone technology in agriculture.

Limitations of drone in fruit crops:

While drones have shown great potential in agriculture, including fruit crop management, there are several limitations associated with their use in this context. Some of the key limitations include

1. Limited Payload Capacity

Drones typically have a limited payload capacity. This restricts the types of sensors and

ISSN (E): 2583 – 0821

equipment that can be carried, limiting their ability to carry heavier or more advanced sensing technologies.

2. Limited Flight Time

Most drones have a relatively short flight time, typically ranging from 20 minutes to an hour. This limitation can restrict the area that can be covered in a single flight and may require frequent recharging or battery replacement.

3. Weather Sensitivity

Drones are sensitive to weather conditions such as strong winds, rain, and extreme temperatures. Adverse weather conditions can impact flight stability and safety, limiting their usability in certain environmental conditions.

4. Data Processing Challenges

While drones can capture large amounts of data through various sensors, processing and interpreting this data can be challenging. Efficient algorithms and computing resources are required to analyze the data and derive meaningful insights for crop management.

5. Regulatory Restrictions

Strict regulations govern the use of drones, and these regulations can vary by region. Obtaining the necessary permissions and adhering to local regulations can be a barrier to widespread drone adoption in agriculture.

6. Skill Requirements

Operating drones effectively for agriculture may require specialized skills.Farmers or operators need to be trained not only in drone piloting but also in data interpretation and analysis to make informed decisions based on the collected data.

7. Cost Considerations

Initial investment costs for purchasing drones and associated equipment can be significant. Additionally, maintenance costs, insurance, and the costs associated with skilled personnel further contribute to the overall expense.

8. Limited Ability for Physical Interventions

While drones can provide valuable information through imaging and sensing, they cannot physically intervene in the crop. Tasks such as pruning, thinning, or harvesting still require human or machinery intervention.

9. Interference with Wildlife

Drones may disturb wildlife in and around the farm, potentially causing stress to animals or disrupting ecosystems. This can have indirect impacts on crop health and overall biodiversity.

10. Scalability Challenges

Implementing drone technology on large-scale farms may present challenges in terms of scalability. Managing a fleet of drones efficiently and ensuring seamless integration with existing farm practices can be complex.

Despite these limitations, ongoing advancements in drone technology and ongoing research may address some of these challenges, making drones more effective and practical tools for fruit crop management in the future.

Challenges for use of drone in fruit crops

The use of drones in agriculture, including for monitoring and managing fruit crops, can offer several benefits. However, it also raises various security and privacy concerns. Here are some security issues associated with the use of drones for fruit crops in India.

1. Data Privacy Concerns

Drones equipped with cameras and sensors collect a significant amount of data. This data may include images of the crop fields, GPS coordinates, and other sensitive information.Unauthorized access to this data can pose a threat to farmers' privacy and may also lead to misuse.

2. Unauthorized Access to Drone Systems

Drones operate through complex systems, including software and hardware components. Unauthorized access to these systems could lead to hijacking or manipulation of the drone, causing potential harm to the crops or nearby infrastructure.

3. Communication Interception

Drones rely on communication systems for data transmission. Intercepting and manipulating these communications can compromise the security of the drone and the data it collects.

4. Physical Security Risks

Drones are physical assets that can be subject to theft or vandalism. This poses a risk not only to the expensive drone equipment but also to the data stored on board.

5. Regulatory Compliance

Adherence to regulations is crucial to ensure safe and legal drone operations. Non-compliance may result in legal consequences and may compromise the overall security of drone use in agriculture.

6. Airspace Intrusions

Unauthorized drones operating in the same airspace can pose safety risks, leading to collisions or interference with legitimate drone operations for crop monitoring.

7. Environmental Factors

Weather conditions, such as strong winds or heavy rainfall, can affect the stability and navigation of drones, potentially leading to accidents or damage to the equipment.

8. Dependency on Technology

Overreliance on drone technology for crop management can be a vulnerability. If the technology fails or is disrupted, farmers may face challenges in monitoring and managing their crops effectively.

To address these security concerns, it is important for drone operators, farmers, and relevant authorities to implement robust security measures, including encryption of data, secure communication protocols, adherence to regulatory frameworks, and the use of physical security measures for the protection of both the drones and the data they collect. Further, raising awareness among farmers about the potential risks and best practices for secure drone operations is crucial.

CONCLUSION

The use of drones in orchards and fruit crops has the potential to revolutionize horticultural practices, making them more sustainable, efficient, and environmentally friendly. As technology continues to advance and regulations evolve, the integration of drones into mainstream orchard management practices is likely to increase, providing tangible benefits to farmers and the agricultural industry as a whole.

Drones could help in tackling issues with general spraying of pesticides, spot applications in tall tree plantations and other areas where proper application of pesticides and other chemicals is difficult by conventional methods and to the areas that can't easily accessible by humans. It is to mainly adopted to overcome the ill-effects of pesticides on human beings' manual pesticide sprayers and other conventional sprayers and also to cover larger areas of fields while spraying pesticides in a short span of time.

The use of drone sprayers for application of chemicals makes the works of farming easier and more comfortable. Using remote control technology one can avoid the strain of driving, walking behind or along with the sprayer continuously for hours together by controlling its direction from a far-off point without even getting into the field. The adoption of the technology would help in increasing the area coverage, reducing the drudgery of farm labour and avoiding direct contact of labour with the chemicals thereby protecting human health. India's Ministry of Civil Aviation (MoCA) August 2021, has released a new set of drone laws and regulations for anyone operating an unmanned aircraft systemin India. Based on the feedback, the government has decided to repeal the UAS Rules, 2021 and replace them with the liberalised Drone Rules, 2021. Online registration for all drones is mandatory and can be done on the digital sky platform. The process for transfer and de-registration of drones is also expected to get easier.

ISSN (E): 2583 – 0821

REFERENCES

Unmanned Aerial Vehicle for Agricultural spraying.

Yalappa D., Kavita R., Surendra kumar A., Suthakar B. and Mohankumar A.P. Akinik Publications New Delhi- 2022.

Use of drones in Agriculture potentials , problems and policy needs

Pathak H., Kumar GAK., Mohapatra S.D., Gaikwad B.B. and Rane j. 2020. Publication No.300 ICAR, NIASM,PP-13+iv