AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 02, Issue: 12 (December, 2025)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Crop Pest Surveillance and Advisory (CROPSAP): A Digital Approach to Sustainable Pest Management in Agriculture

*Anand Nagsen Warghat, V.J. Tambe and B.N. Chaudhari
College of Agriculture, Nagpur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India
*Corresponding Author's email: anandwarghat07@gmail.com

Crop pests remain a major threat to agricultural productivity, causing significant yield losses and economic damage worldwide. Efficient pest management requires timely detection, continuous monitoring, and accurate advisory services for farmers. The CROP SAP (Crop Pest Surveillance and Advisory) project integrates digital technologies, data analytics, and advisory platforms to enhance pest management in agriculture. By combining real-time pest incidence data, environmental parameters, and predictive modeling, CROP SAP provides location-specific pest alerts and management recommendations. This system empowers farmers to take proactive actions, reduces dependency on excessive chemical inputs, and promotes sustainable agricultural practices. The study highlights the effectiveness of CROP SAP in optimizing pest control, improving yield security, and supporting data-driven agricultural decision-making.

Introduction

Crop pests and diseases are among the most critical threats to global agricultural productivity, causing billions of dollars in losses annually. Traditional pest management practices often rely on reactive measures, such as manual field scouting and delayed advisories, which are inefficient and sometimes too late to prevent significant damage. In addition, indiscriminate pesticide use contributes to environmental pollution, pest resistance, and health hazards. To address these challenges, digital agriculture platforms have emerged as a promising solution.

The Crop Pest Surveillance and Advisory Project (CROP SAP) is designed to leverage information technology, IoT, and data analytics to monitor pests effectively and provide real-time advisory services to farmers. By integrating field-level observations with predictive models, CROP SAP allows for early detection of pest outbreaks and informed decision-making for preventive and curative interventions. Furthermore, CROP SAP supports sustainable agriculture by promoting integrated pest management (IPM) practices. It emphasizes environmentally friendly pest control, reducing reliance on chemical pesticides while maintaining crop productivity. The system bridges the gap between scientific pest surveillance and practical advisory dissemination to farmers, contributing to higher efficiency, lower losses, and improved profitability.

Objectives

The primary goal of the CROP SAP project is to enhance pest management efficiency through a technology-driven surveillance and advisory system. One key objective is the early detection of pest incidence, which enables farmers to take timely preventive actions. Early detection is crucial, as delayed intervention often results in widespread crop damage and financial losses. By continuously monitoring pest populations and their growth dynamics, CROP SAP ensures that outbreaks are identified before they reach critical levels. Another objective is the provision of location-specific advisory services. Crop pests vary significantly by region, season, and crop type, so generic advice is often insufficient. The system uses real-

time data to generate precise recommendations tailored to the geographical location, crop type, and pest severity, allowing farmers to adopt the most effective management strategies. Finally, CROP SAP aims to promote sustainable and data-driven pest management practices. By providing accurate forecasts, recommended interventions, and automated alerts, the system reduces unnecessary pesticide use, supports integrated pest management, and enhances overall crop health. In addition, it empowers farmers with actionable information to improve yield security, reduce costs, and achieve environmental sustainability.

Methodology

Data Collection: The success of CROP SAP relies on comprehensive and accurate data collection. Field scouts, agricultural extension officers, and farmers contribute observations on pest incidence, crop stage, and severity. Mobile applications facilitate easy data entry, allowing farmers to report pest sightings directly from the field. In addition, IoT-enabled traps and sensors capture environmental and pest-related data, such as temperature, humidity, soil moisture, and pest population density. This real-time data is transmitted to central servers for analysis, ensuring continuous monitoring and minimizing manual reporting errors. Satellite imagery and drone-based remote sensing are also integrated into the system to assess crop health, vegetation indices, and large-scale pest infestations. This multi-source approach allows CROP SAP to generate comprehensive pest maps, identify hotspots, and provide a holistic overview of pest dynamics across regions.

Data Analysis and Prediction: Once collected, the data undergoes statistical and predictive analysis to determine pest risk levels. Machine learning models are applied to historical pest incidence, weather patterns, and crop growth stages to forecast potential outbreaks. These models help prioritize areas of high risk, allowing targeted interventions where they are needed most. GIS-based mapping is a core feature of CROP SAP, visualizing pest hotspots, severity levels, and spread trends over time. Decision-makers and farmers can easily interpret these maps to plan timely preventive measures. Trend analysis further identifies recurring pest patterns, which can inform seasonal crop planning and integrated pest management strategies. Predictive modeling is complemented with risk scoring systems, which classify pest threats as low, medium, or high. This structured approach enables farmers to adopt proportionate interventions, reducing the reliance on blanket pesticide applications and promoting resource efficiency.

Advisory Generation: The advisory module of CROP SAP is designed to deliver actionable recommendations directly to farmers. Based on the analyzed data, the system generates both preventive and curative advisories. Preventive advisories may include crop rotation, field sanitation, and deployment of biological control agents, whereas curative advisories recommend specific chemical or organic treatments tailored to pest type and severity. Advisories are disseminated through multiple channels, including SMS, mobile apps, and web dashboards, ensuring accessibility for all farmers, including those in remote areas. Notifications are delivered in local languages for better comprehension and adoption. Regular feedback loops allow farmers to report the effectiveness of interventions, which helps refine the predictive models and advisory accuracy. Over time, this iterative process enhances the reliability of the system and strengthens decision-making for sustainable pest management.

System Architecture

The CROP SAP system integrates multiple functional modules to ensure efficient pest surveillance and advisory delivery:

Module	Functionality
Data Collection	Field reports, IoT traps, sensors, drone and satellite imagery
Analytics & Prediction	Machine learning-based outbreak forecasting and trend analysis
Advisory Module	Preventive and curative recommendations for farmers
Dashboard & Reporting	Real-time pest maps, severity levels, and alerts
Integration with Crop Planning	Aligns pest management with crop schedules and resource allocation

This modular architecture ensures scalability, adaptability, and ease of use, making CROP SAP suitable for smallholder farms, cooperative societies, and large-scale agricultural enterprises.

Benefits

CROP SAP offers numerous advantages for both farmers and agricultural stakeholders.

1. Early Warning and Prevention: Timely identification of pest outbreaks reduces crop losses and minimizes economic damage. By alerting farmers before infestations become severe, preventive measures can be implemented effectively.
2. Optimized Use of Resources: Advisory recommendations guide judicious use of pesticides, fertilizers, and labor. This reduces input costs, prevents overuse of chemicals, and supports environmental sustainability.
3. Data-Driven Decision-Making: Farmers and extension officers gain access to real-time pest incidence data, trend analysis, and predictive maps, allowing informed decisions regarding crop protection strategies.
4. Traceability and Documentation: The system maintains detailed records of pest incidence, intervention methods, and outcomes, which can be leveraged for research, policy planning, and improving future interventions.
5. Sustainability: By promoting integrated pest management and reducing excessive chemical use, CROP SAP contributes to environmentally friendly and sustainable agricultural practices.

Challenges and Solutions

Farmer Adoption

Some farmers may be reluctant to adopt digital tools due to lack of awareness or technical skills. CROP SAP addresses this challenge through training programs, demonstration workshops, and user-friendly mobile apps, making the system accessible and easy to use.

Connectivity Issues

Remote rural areas often suffer from poor internet connectivity, which can affect real-time data transmission. Offline-enabled mobile applications and periodic data synchronization ensure that data collection and advisory dissemination continue uninterrupted.

Accurate Pest Identification

Misidentification of pests can lead to incorrect recommendations. CROP SAP incorporates AI-based image recognition and expert validation to improve pest detection accuracy. Farmers can simply upload photos of affected crops for instant analysis and advice.

Data Management

Large volumes of data from multiple sources may overwhelm the system. Automated analytics, prioritization, and visualization techniques are applied to ensure that only actionable insights are highlighted for farmers and decision-makers.

Conclusion

The Crop Pest Surveillance and Advisory Project (CROP SAP) demonstrates how digital technologies can transform pest management in agriculture. By integrating real-time field monitoring, predictive analytics, and advisory services, CROP SAP enables early intervention, optimized pesticide use, and sustainable crop protection. The project supports data-driven decision-making, environmental sustainability, and economic efficiency, empowering farmers to reduce crop losses and improve productivity. With further expansion, integration with AI, IoT, and remote sensing, CROP SAP can become a national-scale platform for proactive pest management.

Future Scope

- Integration of AI-based pest and disease recognition for rapid diagnosis.
- Expansion to cover nutrient deficiency advisory and crop health monitoring.
- Multi-language mobile apps for wider farmer adoption.
- Integration with regional and national agricultural databases for large-scale monitoring.

- Development of predictive pest outbreak alerts based on climate change models to anticipate future challenges.

References

1. FAO. (2021). Integrated Pest Management for Sustainable Agriculture. Rome: FAO Publications.
2. Singh, R., & Sharma, P. (2020). Digital pest surveillance systems for crop protection. Journal of Agricultural Informatics, 11(3), 45–58.
3. Gupta, A. et al. (2019). Application of IoT and mobile-based advisory for pest management. Computers and Electronics in Agriculture, 162, 1010–1020.