Plant Archives

A CLOUD-BASED DIGITAL PLATFORM FOR DISSEMINATION OF MANGO CULTIVATION AND MANAGEMENT PRACTICES

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ABSTRACT

Effective dissemination of scientific knowledge and technologies to stakeholders is essential for improving productivity and sustainability in horticulture. A cloud-based digital platform has been developed and hosted on the Google Cloud to provide information on mango cultivation and protection management. This paper presents the design and development of a digital platform providing comprehensive information on soil and climate requirements for mango cultivation, promising and ICAR-IIHR developed mango varieties, production technologies, propagation methods, irrigation and nutrient schedules, pest and disease management, and harvesting practices. The web interface delivers all functionalities in the English language, while the mobile app interface supports multilingual content in English, Hindi, Kannada, and Telugu improving accessibility to wider community including students and also ensuring that farmers can easily understand the content in their local languages. The digital interface incorporates interactive features such as dynamic sliders, developed using Java and jQuery languages to improve user interaction. The platform leverages cloud computing for scalability, high availability, and cross-device accessibility, enabling farmers, extension personnel, and agri-entrepreneurs faster technology adoption, improved productivity, and sustainable mango cultivation practices for enhanced profitability.

Keywords: Mango crop, digital platform, horticulture, regional languages, farmers, mango cultivation, management.

Introduction

Mango (*Mangifera indica L.*) is the most important fruit crop of the tropical and sub-tropical regions (Reddy *et al*., 2003) and contributes substantially to horticultural production. Mango has unique taste, flavor, and nutritional value and is a food source of vitamins A and C (Gautam *et al*., 2023) along with antioxidants and dietary fiber. However, its productivity is highly influenced by climatic variability (Halder *et al*., 2024), irregular flowering, fruiting behavior and extreme weather events (Reddy *et al*., 2017). ICAR-IIHR conducts extensive research on mango, with a focus on the development of high-yielding hybrids and cost-effective production and post-harvest technologies. ARKA is the trade mark of the varieties and technologies developed by the institute. Several high yielding hybrids/varieties in

Mango were developed and released of which, Arka Anmol is valued for its regular bearing habit, Arka Neelkiran known for its superior fruit quality, and consumer acceptability, Arka Puneet which exhibits uniform fruit size, Arka Aruna has attractive skin color, high pulp content, and excellent taste, suitable for value-added processing, Arka Suprabhath, characterized by excellent pulp quality and high total soluble solids (TSS), and Arka Udaya, which exhibits superior shelf life and has recorded higher yields under high-density planting systems. Machineries like tractor operated hydraulic platform for pruning, spraying and harvesting. The institute has also developed low-cost post-harvest technologies such as Arka Mango Wash for effective fruit cleaning that removes up to 99% of the blackening caused by sooty blotch. In addition, extensive research has been undertaken on micro

nutrient formulations, promising mango hybrids, fruit bagging techniques for the management of fruit fly and fruit borer, nutrient and water management, integrated pest and disease management, and mitigation of physiological disorders.

Although several improved cultivation and management practices have been developed, their adoption by farmers remains uneven due to gaps in effective information dissemination and accessibility, highlighting the need for digital advisory mechanisms. Application development is one of the commonly used ICT tools for agricultural information dissemination (Mulungu *et al*., 2025). Digital technology can deliver need based information (Abiri *et al*., 2023) which enhance crop production presenting significant potential for the future of farming. Furthermore, the design and development of farmer-friendly and simple digital interfaces significantly enhance the effectiveness of crop and technology information dissemination (Thomas *et al*., 2025). Hence, a web-based interface was designed and developed using web technologies to retrieve and display information on cultivation practices and crop management measures on mango crop. With the rapid penetration of smartphones and internet services available in India, digital platforms offer a cost-effective option for delivering crop-specific knowledge. This study explains the development of a cloud-based digital platform integrating web and mobile technologies to disseminate mango cultivation and management practices with seamless access across devices and data storage through standard web browsers, independent of language and platform. The developed applications are hosted on Google Cloud services (Sharma *et al*., 2024) ensuring high availability and secure storage of data.

Materials and Methods

System Design and Development

The cloud-based digital platform for mango cultivation and management was designed and developed using web technologies. The graphical user interface (GUI) of the digital application was developed using HTML5 and CSS3 for content structuring, layout design (Garett *et al.*, 2016), and styling of UI components such as sliders and navigation menus. JavaScript along with Java and jQuery was used to enable dynamic user interface design and interactive features like sliders and zoom-in or hover effects within the web pages. The Presentation Layer includes web browser interfaces and mobile application interfaces through which user access the system. The interfaces are designed to support multi-device access and ensure compatibility across desktop

and mobile platforms. The application Layer (Cevallos-Salas *et al*., 2024) manages server-side operations while the data Layer provides data storage and management of structured information and images related to mango cultivation, production technologies, pest and disease management, and post-harvest practices. The disease and pest management module of the applications were developed using a thumbnail-based navigation system to enable user-friendly identification of mango diseases. To optimize the load times and performance, images were compressed to reduce file size while maintaining visual quality. After validating and functional testing of the applications, the web and mobile applications were made public by deploying it to the cloud service with SSL (Secure Sockets Layer) enabled. The system is hosted on the Google Cloud Platform, utilizing managed cloud services (Kaloxylos *et al*., 2014) for application hosting, data storage, and system security. Users can access the platform through standard web browsers and mobile devices. The cloud-based design (Buyya *et al*., 2009) ensures uninterrupted access and supports future services such as decision-support features.

Results and Discussion

The mobile and web application interface developed through structured content layout and interactive components displays mango crop-specific information. The home page (Jonathan and Suprihadi, 2023) serves as the primary entry point and displays main content related to mango crop production, crop protection, varietal information, technologies and machineries developed. The home page (Fig. 1) incorporates image sliders to display key mango research information conducted at the institute. Crop production module delivers detailed information on mango crop production practices. Soil and climatic requirements, nutrient management methods, Irrigation, Crop regulation practices, etc. All production-related content is organized using structured pages with internal hyperlinks. These links are accessible both from the home page and the navigation menu, enabling seamless content traversal and improved usability. The varieties link provides information on promising mango varieties cultivated across the country and IIHR developed varieties supported with images and descriptions to guide region-specific varietal selection and cultivation.

Fig: 1. Homepage of the web interface for mango cultivation

The picture base of the system contains different images related to disease infection to identify the type of disease from the scrolling image list provided categorized into Bacterial, fungal and other disorders such as algal infections and malformation. Major diseases including anthracnose, dieback, powdery mildew, blossom blight, leaf blight, stem-end rot, and bacterial canker (Misra *et al.*, 2012) are represented, with images showing symptoms on different affected plant parts (Fig. 2). The user can compare field-observed infestations with reference images and identify appropriate management measures provided within the interface. If similar type of diseases is identified, then by clicking on the image, detailed information on symptoms, disease development, and recommended control practices are displayed to the users.

Fig: 2. Thumbnail images of diseases for identification of mango diseases

The disease images are displayed as small preview images (thumbnails), allowing users to easily browse through a wide range of disease images. Thumbnail images of diseases for identification of mango diseases serve as a visual diagnostic aid within the digital platform, enabling users to quickly recognize and differentiate various mango diseases. Upon selecting a specific disease thumbnail affecting the crop, the system opens a detailed description page which provides high-resolution images illustrating disease symptoms on various parts of the mango plant, such as leaves, panicles, fruits, stems, and branches across different stages of disease development. The inclusion of multiple images helps users accurately diagnose the problem by comparing field symptoms with the displayed visuals.

Fig.3: Zoom-in feature in the web application

An interactive feature is incorporated wherein, on moving the mouse cursor over a thumbnail, a full-sized image is displayed for closer examination. This zoom-in or hover-based preview functionality enhances visual clarity and allows users to observe finer symptom details, such as lesion shape, color progression, and texture changes. Alongside the enlarged images (Fig. 3), concise textual descriptions are provided, detailing the characteristic symptoms, disease development stages and control measures. By integrating images with explanatory content and management strategies, the thumbnail navigator–based disease management module improves disease identification accuracy and strengthens on-farm plant protection practices. This module enhances the effectiveness of digital dissemination by combining visual and text content making disease management information accessible and farmer-friendly. The pest management module gives information on the commonly affected pest of the mango crop as thumbnail images. The common pests of mango crop are mango hoppers, fruit fly, stone weevil, mealy bug, shoot borer, stem borer etc. Users can click the thumbnail image for more details.
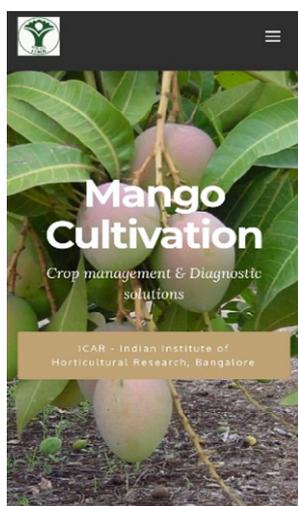

Fig. 4: Mango mobile app in English

The mobile application is designed in a way easy to navigate with menus simple to understand and easy to tap buttons which makes the data flow easy. After completing the functional, usable and performance testing, the app was deployed for public access. The mobile app is available (Fig.4) in English (https://mangocultivation.web.app/) and three regional languages to cater to a diverse user base. By offering content in Hindi and regional languages, the platform reduces language barriers. The mobile interface is

available in Hindi language at URL https://mango hindi.web.app/ for large farmer populations in northern and central India.

Telugu and Kannada are the primary languages spoken in Andhra Pradesh, Telangana, and Karnataka, which together maintains a large mango cultivation area next to Uttar Pradesh and are among the major mango producing regions in India. Providing research-backed mango cultivation guidance in Telugu (https://mangotelugu.web.app/) and Kannada (https://mangokannada.web.app/) language will reach farmers directly. Farmers are more likely to understand and adopt cultivation practices when information is presented in their mother tongue. Technical concepts related to disease and pest management, nutrient scheduling, cultivation practices become easier to comprehend when explained in familiar languages. Users can also post cultivation-related queries in regional languages.
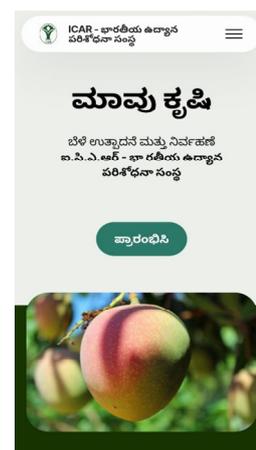

Fig. 5: Mobile app in Hindi

Fig. 6: Mobile app in Kannada

The developed digital platform on mango crop cultivation provides, device-independent usability through web and mobile interfaces. The platform complements traditional extension approaches by enabling, wider reach to farmers and stakeholders, faster dissemination of improved technologies and enhanced knowledge sharing between researchers and end users. Such digital platforms can significantly contribute to bridging the information gap in horticultural crop management.

Conclusion

The rapid adoption of smartphones and internet access in rural areas has opened new avenues for mobile and web-based advisories. Tools developed by agricultural research institutions can help improve farming outcomes by enhancing knowledge transfer

and adoption of best practices. The cloud-based digital platform developed at ICAR-IIHR demonstrates the potential of web and mobile technologies in disseminating mango cultivation and management practices effectively. By leveraging cloud computing, the system ensures scalability, accessibility, and reliability, making it a valuable tool for digital agricultural extension. The platform can be further enhanced by integrating decision support tools, and real-time advisory systems to improve farmer engagement.

Acknowledgements

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