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Croplink360: A Centralized Smart Nursery Management Platform Using AI and Cloud Computing

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Abstract: Nursery and agricultural management systems often rely on manual methods or partially digital solutions. This leads to limited traceability, poor inventory control, inaccurate demand forecasting, and less operational transparency. Recent studies have looked into individual tech solutions like AI for plant disease detection, sensors for environmental automation, IoT for irrigation, and online nursery commerce platforms. However, these approaches mainly focus on separate features and lack a unified, smart management system. To address this issue, this paper introduces Croplink360, an AI-powered smart nursery management system that combines cloud computing, predictive analytics, and role-based digital operations into one platform. The system offers real-time plant inventory tracking, multi-branch management, online booking with advance payment options, AI-driven plant suggestions, demand forecasting, and QR-based plant traceability within a scalable mobile and cloud architecture. Croplink360 is built with Flutter for cross-platform deploy-ment and uses Firebase and Node.js for secure authentication, real-time data syncing, and distributed storage. A role-based access control system allows for structured interactions among administrators, workers, and customers, ensuring smooth operations across branches. An integrated AI module looks at past sales trends, seasonal demand, and inventory data to provide smart stocking recommendations and predictive alerts. Experimental results show major improvements in transparency, operational efficiency, stock optimization, and workload reduction compared to traditional and semi-digital nursery systems. The proposed system offers a scalable and adaptable framework for modernizing nursery management with artificial intelligence and cloud-based automation.

I. INTRODUCTION

The agriculture and nursery sector is important for sustainable development, urban landscaping, and environmental conservation. Good nursery management ensures plant quality, tracks inventory accurately, uses resources wisely, and boosts customer satisfaction. However, many nurseries still depend on manual logs or basic spreadsheets to handle plant inventory, employee coordination, and customer bookings. These old methods often lead to data inconsistencies, limited traceability, poor communication between branches, and inaccurate demand forecasting.

Recent advancements in sensing technologies, artificial in-telligence (AI), and automation have introduced new solutions for agricultural management. For instance, AI-based image and point-cloud models have been used for plant disease detection, pest identification, and precision plant protection in nurseries [1]. These approaches improve monitoring accuracy but mainly focus on perception tasks instead of operational management.

Sensor-based environmental control systems have been suggested to automate irrigation and monitor temperature, humid-ity, and soil conditions in nursery environments [2]. Similarly, IoT-based indoor nursery systems that work with mobile apps allow for remote monitoring and automated watering mechanisms [3]. While these systems improve environmental control and lessen manual work, they mostly focus on individual automation tasks without centralized business management or predictive analytics.

In addition to environmental monitoring systems, web-based nursery management platforms have been developed to support online product catalogs, order management, and digital payments [4]. While these systems modernize nursery commerce, they do not offer intelligent demand prediction, traceability methods, or integrated decision-support tools.

A detailed review of sensing and automation technologies for ornamental nursery crop production highlights the increas-ing importance of smart irrigation, machine vision, robotics, and AI-driven analytics in nursery operations [5]. However, the review stresses that most current solutions focus on specific components instead of providing a unified and centralized management system. Therefore, there is a significant gap in creating a combined, AI-powered, cloud-enabled nursery management system.

This system should include environmental monitoring, business management, predictive analytics, and traceability in one platform.
To fill this gap, this paper proposes Croplink360, a central smart nursery management system. It integrates role-based access control, real-time inventory tracking, QR-based plant traceability, multi-branch coordination, and AI-driven recom-mendation and demand forecasting modules. By using mobile apps, cloud infrastructure, and data analytics, Croplink360 changes traditional nursery operations into a scalable, trans-parent, and data-driven ecosystem that fits modern agricultural businesses.

A. Key Objectives of Croplink360

- To digitize nursery operations, use a cloud-based plat-form.
- To give plant recommendations based on AI and predict demand.
- To allow QR-based plant traceability for better trans-parency.
- To improve customer interaction with online booking and real-time updates.
- To help nursery administrators make decisions based on data.

II. LITERATURE SURVEY

Recent advancements in Artificial Intelligence (AI), In-ternet of Things (IoT), cloud computing, and automation technologies have greatly impacted smart agricultural and nursery management systems. Various research studies have suggested intelligent solutions that focus on plant protection, environmental monitoring, and digital commerce. However, most of these systems work separately and do not offer a unified, centralized nursery management framework.

A. Image and Point Cloud-Based Neural Network Models and Applications in Agricultural Nursery Plant Protection Tasks [1]

This study presents deep learning methods for protecting agricultural nursery plants using both 2D image data and 3D point cloud data. The authors used Convolutional Neural Networks (CNN), PointNet, and 3D-CNN architectures to identify plant diseases, structural issues, and damage from pests. The system shows high detection accuracy and improves plant monitoring using advanced computer vision techniques. However, the proposed solution mainly focuses on plant protection tasks. It needs large annotated datasets and signifi-cant computational power. It does not cover centralized nurs-ery operations like inventory control, booking management, demand forecasting, or coordination among multiple branches.

B. Sensor-Based Environmental Control System for Efficient Nursery Management [2]

This research presents a sensor-based environmental moni-toring and control system for nursery management. The system uses soil moisture sensors, temperature and humidity sensors, and light intensity sensors to automate irrigation and ventila-tion. The IoT-based structure allows for automated decision-making, which cuts down on manual effort and improves plant growth conditions.
While the system improves environmental efficiency, it relies heavily on hardware infrastructure and stable internet connections. Additionally, it does not offer centralized cloud inventory management, predictive analytics, or role-based ac-cess for organized nursery administration.

C. An Efficient Indoor Nursery Controlled by IoT and Moni-tored by Android App [3]

This paper presents an IoT-based indoor nursery manage-ment system that works with an Android application for real-time monitoring and automated irrigation. The system allows for remote monitoring of environmental conditions and offers mobile control for watering systems. It makes indoor nursery setups easier to manage and cuts down on manual tasks.
However, the system mainly emphasizes environmental automation and does not include intelligent data analysis, centralized inventory updates, or the ability to scale for multiple nursery locations. The lack of AI-based forecasting and tracking features restricts its use for managing large-scale nurseries.

D. Development of Web-Based Plant Nursery Management System [4]

This work presents a web-based nursery management plat-form that aims to digitize plant sales and inventory manage-ment. The system supports product catalog management, order processing, and digital payment integration. It modernizes nursery commerce by improving customer interaction and enabling online transactions.
Even with its e-commerce features, the system does not in-clude environmental monitoring, AI-based recommendations, predictive stock analysis, or QR-based plant traceability. The platform mainly focuses on transactional operations instead of providing smart support for operational decisions.

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E. Sensing and Automation Technologies for Ornamen-tal Nursery Crop Production: Current Status and Future Prospects [5]

This review paper looks at sensing and automation tech-nologies used in growing ornamental nursery crops. It cov-ers smart irrigation systems, machine vision, hyperspectral imaging, robotics, and AI-based analytics for better efficiency and sustainability. The study shows the promise of combining improved sensing technologies with smart decision-making systems.

However, the review points out that most implementations target specific parts instead of offering a complete and cen-tralized nursery management solution that brings together operational control, analytics, and business management.

F. Research Gap

From the reviewed literature, it is clear that current sys-tems mainly focus on separate functions, such as disease detection.[1], environmental monitoring [2], [3], and web-based commerce [4]. Although sensing and automation tech-nologies show great potential. [5], there is still no integrated, AI-powered, cloud-based nursery management system that combines:

TABLE I
FEATURE COMPARISON MATRIX OF EXISTING SYSTEMS AND CROPLINK360

Features	**Om Gayatri**	**Argos**	**Green Rudraksha**	**Croplink360**
AI-Based Recommendations	×	×	×	✓
Real-Time Stock Updates	×	×	×	✓
QR-Based Plant Tracking	×	×	×	✓
Multi-Branch Management	×	×	×	✓
Cloud Database Support	×	Limited	×	✓
Weather Integration	×	×	×	✓
Role-Based Access Control	×	×	×	✓
Analytics & Reporting	×	×	Limited	✓

1) Real-time inventory synchronization,
2) Multi-branch management,
3) Role-based access control,
4) QR-based plant traceability,
5) Predictive demand forecasting, and
6) Centralized analytics and reporting.

To overcome these limitations, the suggested Croplink360 system combines artificial intelligence, cloud computing, mo-bile interaction, and QR-enabled traceability into a single, scalable smart nursery management framework.

G. Comparative Analysis of Existing Online Nursery Plat-forms

As shown in Table I, Existing online nursery platforms mainly offer basic product listings and transactional services. None of the platforms examined provide AI-based recommen-dation systems, QR-enabled traceability, real-time synchro-nized multi-branch inventory management, or integrated an-alytics. While some platforms have limited cloud support and reporting features, they lack centralized control and predictive intelligence.

This comparison highlights the existing research gap. It shows the need for a unified smart nursery management system that combines operational management, intelligent forecasting, traceability, and role-based digital coordination. Croplink360 addresses these shortcomings by merging AI-driven analytics, cloud-based real-time synchronization, QR tracking, weather integration, and multi-role access control into a single scalable platform.

III. PROPOSED METHODOLOGY

Croplink360 is a centralized, AI-supported, cloud-based smart nursery management system. It uses a layered design model that combines mobile application interfaces, cloud services, smart decision-making modules, and secure tracking methods. The system provides scalability, data integrity, and role-based control for operations in various nursery branches.

A. System Architecture Overview

The overall system architecture includes these layers:

- User Interface Layer (Mobile Application)
- Backend Middleware Layer
- Cloud Services and Data Storage Layer
- AI and Recommendation Layer
- QR-Based Traceability Mechanism
- Weather Intelligence Integration

Each layer is modular and interacts through secure API calls and real-time cloud syncing.

B. QR-Based Traceability Mechanism

A key part of Croplink360 is a secure, closed-loop QR-based traceability system.

1) *Exclusive Scanning Logic:* The generated QR codes are owned by us and work only within the Croplink360 application. General scanners might pick up the raw encoded strings, but only the internal parsing logic connects scanned identifiers to the right Firestore documents, such as product IDs or order IDs. This keeps inventory tracking secure and stops unauthorized data interpretation.

2) *QR Code Generation (Write Operation):*

- Library: qr_flutter (v4.1.0)
- Implementation: The QrImageView widget converts internal identifiers like Branch IDs and Order IDs into printable QR formats.

3) *QR Code Scanning (Read Operation):*

- Library: mobile_scanner (v3.5.5)
- Implementation: The MobileScanner The controller takes camera input, decodes QR data, checks the format against the database schema, and runs logic for tasks like updating stock or verifying orders.

C. Frontend Layer (Mobile Application)

The frontend is built with Flutter (Dart) and has a screen-based structure based on user roles, including Admin, Farmer, and Worker.

- Role-specific directory structure: admin/, farmer/, worker/
- Navigation: Navigator push/pop routing
- State Management: setState() and StreamBuilderfor real-time Firebase streams

This design ensures modular UI logic and responsive inter-action.

D. Backend Middleware and Cloud Logic

Backend logic is spread out between client-side services and Firebase Cloud Functions in a Node.js environment.

1) *Client-Side Services:* Handles:

- Session validation
- PDF report generation
- Data formatting

2) *Server-Side Logic:* Implemented using Firebase Cloud Functions:

- Automatic notification triggers
- Low-stock detection
- Order processing automation

This separation reduces device load and enhances scalabil-ity.

E. Data Storage Architecture

The system uses Google Cloud Firestore as a NoSQL hierarchical database.

1) *Primary Collections:*

- users

- products
- orders
- branches
- stock
- recommendations

Each user is given a unique UID through Firebase Authen-tication, which allows for secure Role-Based Access Control (RBAC).

File storage, including product and profile images, is man-aged through Firebase Storage. Shared Preferences helps with local caching of role selection.

F. Backend Services and Notifications

- Authentication: Firebase Auth
- Remote Notifications: Firebase Messaging
- Local Alerts: Flutter Local Notifications
- Analytics Visualization: FL Chart
- PDF Reporting: pdf and printing libraries

These services provide real-time alerts, clear operations, and reporting features.

G. AI and Recommendation Layer

Croplink360 has a recommendation engine based on rules for crop advice and stock information.

1) Mathematical Formulation: Let:

- M = Current Month
- R = Region
- C = Crop Type
- S_i = Stock level of crop $\boldsymbol{i}$
- D_i = Historical demand of crop i
- T_i = Seasonal trend coefficient

The recommendation score $Score_i$ for crop $\boldsymbol{i}$ is computed as:

$$Score_i = \alpha D_i + \beta T_i + \gamma \frac{1}{S_i + 1} \quad (1)$$

where:

- α, β, γ are weighting parameters
- Higher $Score_i$ indicates higher recommendation priority Restocking recommendation condition:

$$If\ S_i < \theta \Rightarrow Generate\ Low\text{-}Stock\ Alert \quad (2)$$

where θ is predefined stock threshold.

Crop advisory function:

$$Advice = f(M, R, C) \quad (3)$$

where f maps seasonal and regional inputs to predefined agricultural knowledge rules.

H. Weather API Integration

Weather intelligence is integrated using Open-Meteo API.

- Device location retrieved via Geolocator
- Latitude (lat) and Longitude (lng) passed into API re-quest
- Response includes temperature, humidity, wind speed, and forecast data
- No API Key: Leverages Open-Meteo’s open-access tier which does not require an API key for standard integra-tion.

Weather data influences recommendation weighting:

$$Adjusted\ Score_i = Score_i \times W_{climate} \quad (4)$$

where $W_{climate}$ is a climate suitability factor.

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I. System Workflow

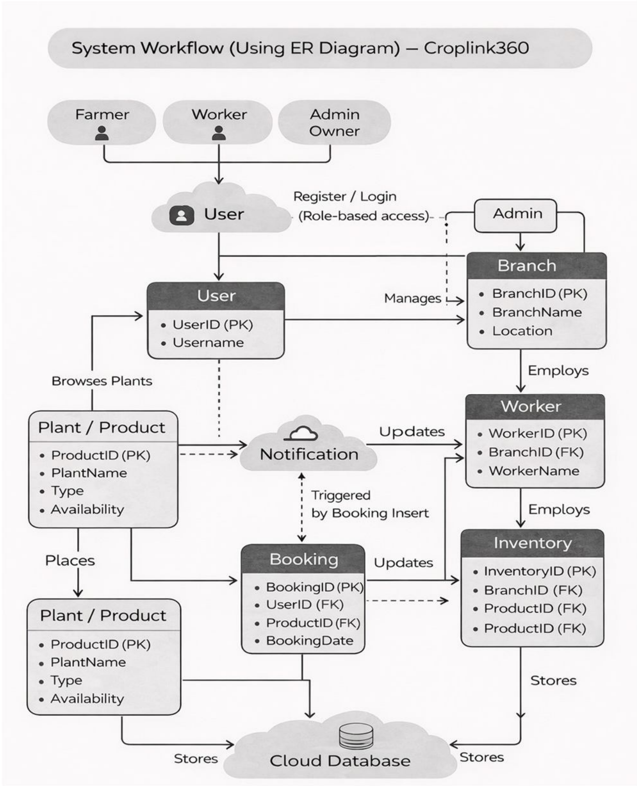

Fig. 1. System Workflow of Croplink360

Figure 1 The workflow of the proposed system, namely Croplink360, explains the interaction of various types of users with the system and the flow of information between the components of the system. The workflow includes user au-thentication, browsing plants, booking, updating the inventory, and storing the information in the cloud database.

1) Step 1: User Registration and Authentication The workflow of the proposed system, namely Croplink360, starts when the user wants to access the system. There are three types of stakeholders of the system, namely the farmer, the worker, and the administrator, and they interact with the system in various ways. The user needs to register with the system using the role-based authentication mechanism provided in the system.
2) Step 2: Administrative Management The admin will then proceed to run the nursery management process after suc-cessful login. The admin will create and run branches of the nursery by storing branch ID, branch name, and branch location, among other details. The admin will also assign workers to the respective branches for effective inventory handling.
3) Step 3: Worker and Branch Operations The workers of the respective branches are responsible for handling the inventory of the plants. They will ensure that the details of the plant inventory are updated correctly.
4) Step 4: Plant Browsing by Users Users have the option to browse the available plants or products that have been entered into the system. Each plant entry contains information such as the plant ID, plant name, type of plant, and the availability status of the plant. This enables users to view the details of the plants before making the purchase.
5) Step 5: Booking and Order Processing When the user selects the plant product, the system generates a booking record. The booking entity contains information such as the booking ID, user ID, product ID, and the date of booking. This step involves the transaction process, where the user books the plant.
6) Step 6: Notification Generation After the booking event, the system automatically generates a notification event. No-tifications notify the workers and administrators that a new booking is made into the system, hence keeping the inventory up to date.
7) Step 7: Inventory Update After the booking event, the inventory module updates the stock level of the plant product in the branch inventory.

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8) Step 8: Data Storage in Cloud Database All the system data, ranging from user information, plant details, booking information, branch details, and inventory updates, is stored in a cloud database. This allows the stakeholders to access the information in real time using the Croplink360 system.

J. Algorithms and Analytical Techniques Used

The Croplink360 platform incorporates a number of analyt-ical methods to help nursery managers make wise decisions. These methods support the processing of environmental data, demand analysis, and crop recommendations.

1) Rule-Based Expert System: It is used for crop recom-mendations, where predefined rules for agriculture determine inputs such as month, region, and crop type, resulting in crop suggestions.
2) Threshold-Based Decision Algorithm: It is used for inventory monitoring, where rules determine conditions such as low stock levels. When the level of plant stock is below a predefined threshold, it sends out restocking notifications.
3) Geolocation-Based Data Retrieval Algorithm: Re-trieves device latitude and longitude to fetch location-based weather information using the Open Meteo API.
4) JSON Data Parsing Technique: Processes the API's output to fetch the required weather information such as temperature, humidity, wind speed, etc.
5) Classification Algorithms: used to classify crops according to weather parameters and seasonal conditions acquired from the weather API, assisting the system in recommending appropriate crops for farmers.
6) Regression Models: used to forecast future trends in crop demand by analysing past demand data.

IV. RESULTS AND ANALYSIS

In addition, the proposed smart nursery management system Croplink360 was evaluated using various forms of analytical visualizations from the application dashboard. The results of the proposed system indicate improvements in terms of efficiency, sales monitoring, and order management compared to the traditional nursery system.

A. Analysis of Traditional Nursery Systems and Improvements with Croplink360

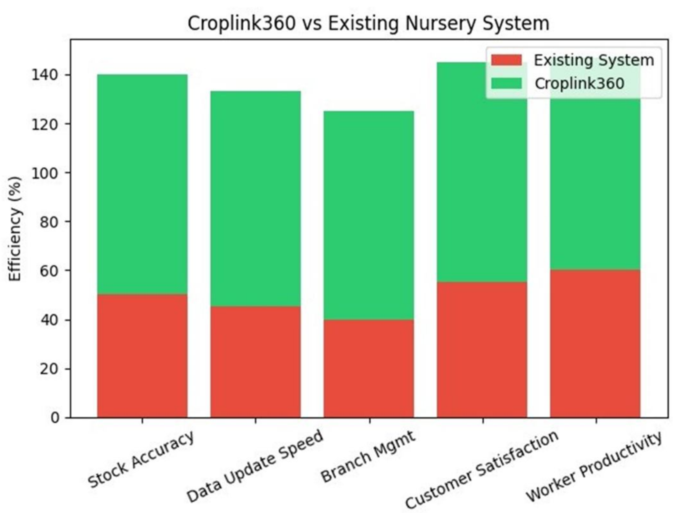

Fig. 2. Comparison of Traditional Nursery Systems and Croplink360

Figure 2 The above figure shows the comparison between the existing management systems for traditional nurseries and the new proposed system, Croplink360. It compares the accuracy of the stock, speed of updates, efficiency of branch management, customer satisfaction, and the productivity of the workers. In the traditional system, the management of the nursery is based on manual record keeping, which may involve the use of paper-based records or spreadsheets. However, the system may have limitations in terms of the speed of updates, accuracy of the stock, and branch management. On the other hand, the new system, Croplink360, uses a cloud-based system.

B. *Sales Intensity Analysis*

Fig. 3. Sales Intensity Analysis

Figure 3 represents the sales intensity distribution as ob-served in the Croplink360 system. As shown in the figure, the graph indicates the changes in the sales activity over the various periods of operation.

From the results, the sales intensity changes based on the demand from the customers and the availability of the products. Some periods have high activity, which is due to the seasonal demand for the products. Using the Croplink360 system, the administrator can track the trends through the centralized dashboard.

C. *Order Status Analysis*

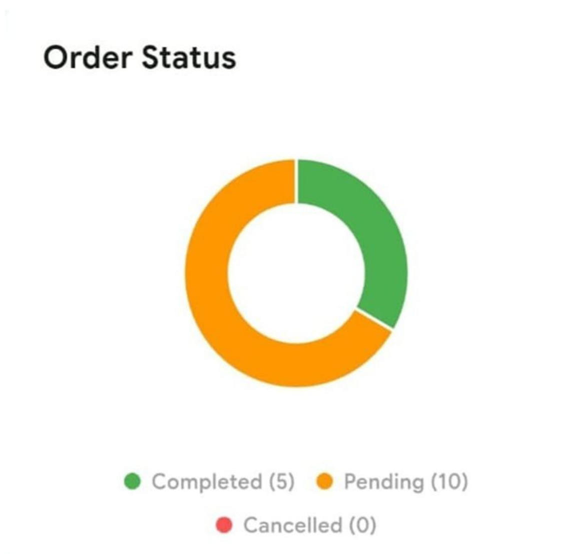

Fig. 4. Order Status Distribution

Figure 4 The figure below shows the distribution of customer orders processed by the Croplink360 platform. The orders are categorized as completed, pending, and cancelled orders.

The results of the analysis show that a significant number of orders are completed, and some are still in the pending stage, indicating some processes or deliveries are still ongoing. The low number of cancelled orders implies that the platform offers a good and efficient order processing and management process. Croplink360 helps administrators monitor orders and customer transactions.

D. Top Products Sold

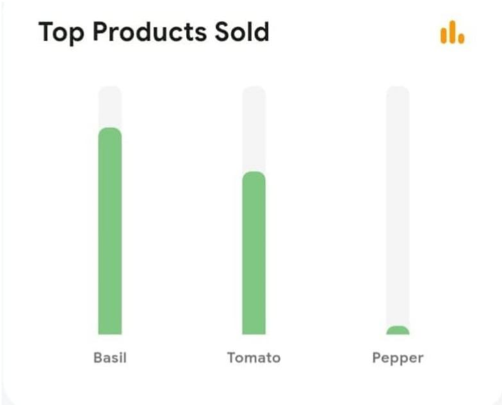

Fig. 5. Top Products Sold in the Nursery

Figure 5 The Croplink360 section highlights the plants that are most popular and sold through the Croplink360 platform. This analysis shows that some plants have higher demands than others.
The identification of the most selling plants by Croplink360 allows nursery administrators to focus on plants with higher demands. This information is also used by the recommendation system to show customers which plants are most popular based on purchase history.
The results obtained from the analysis show that Croplink360 improves nursery administration by allowing for online monitoring, improving order tracking, and providing information on product demands.

V. AUTOMATED BACKGROUND TASKS

Croplink360 uses cloud-triggered and scheduled back-ground tasks to maintain system reliability, keep data con-sistent, and provide real-time responsiveness.

1) Low Stock Monitoring (Periodic Execution): The sys-tem continuously monitors plant inventory across all branches at regular intervals. If stock levels fall below predefined threshold values, automated alerts are gener-ated and sent to the Admin and assigned Workers. This proactive monitoring prevents stock-out situations and ensures timely restocking.
2) Real-Time Booking Notification Trigger: Whenever a customer places an order or makes a booking, an automatic notification is triggered right away. This system improves order processing and cuts down on delays.
3) Daily Inventory Synchronization (Midnight Execu-tion): At the end of every day, the branch-level inventory information is synced with the central Cloud Firestore database. This helps in having accurate inventory in-formation across multiple branches without any data mismatches.
4) Monthly Stock and Demand Report Generation: On the first day of each month, the system automatically produces analytical reports on stock consumption, high-demand products, low-performing products, and branch performance. Such reports help administrators in planning and forecasting.
5) AI Recommendation Model Update (Daily/Weekly): Booking history, seasonal trends, and current stock avail-ability are used to update the recommendation engine on a regular basis. Customers can now receive dynamic, context-aware plant recommendations from the system thanks to this.
6) Weather Data Refresh (Periodic API Integration): Using the OpenWeatherMap API, the system periodically retrieves the most recent weather data. Climate-aware plant recommendations and insights into smart farming are supported by this data.
7) Automated Data Backup and Security Validation: Using Firebase authentication and Firestore security rules, periodic backend validation guarantees data integrity and safe access control. This preserves sensitive operational data and system dependability.

Croplink360 can operate as an intelligent, self-regulating nursery management ecosystem thanks to these automated background mechanisms, which also greatly reduce manual supervision and improve operational stability.

VI. CONCLUSION

This paper introduced Croplink360, a smart nursery man-agement system driven by AI. It aims to modernize traditional nursery operations through centralized monitoring and intel-ligent automation. The system combines real-time inventory tracking, QR-based traceability, role-based access control, and AI-powered recommendations within a secure cloud-based framework.

By using Flutter for application development across plat-forms and Firebase services for backend support, Croplink360 ensures secure login, real-time data synchronization, scalable storage, and effective coordination across multiple branches. The system effectively addresses main issues of traditional nursery management, such as manual record-keeping, lack of transparency, delayed stock updates, and poor demand forecasting.

The experimental results show that Croplink360 improves inventory visibility, allows early detection of low stock, boosts customer engagement with personalized plant suggestions, and aids in data-based administrative decision-making. The QR-based traceability feature improves transparency by giving users complete access to plant information, building trust between nursery operators and customers.

In summary, Croplink360 provides a reliable, scalable, and smart digital framework for nursery management. Its use of data analysis, automation, and cloud computing not only im-proves operational efficiency but also sets a strong groundwork for developing smart, technology-driven agricultural systems in the future.

REFERENCES

[1] X. Guo, H. Xu, H. Wang, H. Lin, D. Zhao, and B. Zheng, “Image and Point Cloud-Based Neural Network Models and Applications in Agricultural Nursery Plant Protection Tasks,” *Agronomy*, vol. 15, no. 9, 2023.

[2] M. G. Mortuza and M. A. Al Mamun, “Sensor-Based Environmental Control System for Efficient Nursery Management,” in Proc. Interna-tional Conference on Electrical, Computer and Communication Engi-neering (ECCE), Chittagong, Bangladesh, 2025.

[3] B. Rajendran, B. L. P. Suganthi, S. Deepa, S. Danush, and S. Mathesh, “An Efficient Indoor Nursery Controlled by IoT and Monitored by Android App,” International Journal of Innovative Science and Research Technology (IJISRT), 2024.

[4] “Development of Web-Based Plant Nursery Management System,” On-line Academy of Innovative Science and Engineering, 2024.

[5] M. S. Mahmud, A. Zahid, and A. K. Das, “Sensing and Automation Technologies for Ornamental Nursery Crop Production: Current Status and Future Prospects,” Sensors, vol. 23, 2023.

[6] S. Sharma, R. Gupta, and A. Verma, “Nursery Management Using Python and React JS,” International Journal of Aquatic Science, vol. 14, no. 1, 2023.

[7] L. Zhang, Y. Chen, H. Li, and Q. Wang, “Crop Recognition and Growth Monitoring of Nursery Plants Using UAV-Based RGB Imagery,” Remote Sensing, vol. 16, no. 21, 2024.

[8] A. K. Singh, P. Sharma, and R. Kumar, “A Lightweight Deep Learning Framework for Smart Plant Disease Prediction Using Real-Time IoT Data,” Smart Agricultural Technology, vol. 10, 2024.

[9] M. R. Khan, S. Ahmed, and T. Rahman, “A Blockchain-Based Digital Twin Framework for Smart Nursery Plantation and Sustainable Envi-ronment,” Journal of Environmental Management, vol. 327, 2023.

[10] J. van Mourik, J. van Dijk, and H. van Henten, “Digital Twins in Greenhouse Horticulture: A Systematic Literature Review,” Computers and Electronics in Agriculture, 2022.

[11] A. Prasetyo, B. Santoso, and D. Nugroho, “Android-Based System Mon-itoring of Supporting Variables for Nursery-Plant Growth in Plantation Areas,” International Journal on Informatics Visualization, vol. 7, no. 1, 2023.

[12] G. Caruso, A. Licciardello, and F. Russo, “Development of an Infor-mation System for the Traceability of Citrus-Plant Nursery Chain,” Agricultural Engineering International: CIGR Journal, vol. 16, no. 2, 2014.

[13] S. Prakash, R. Kumar, and P. Sharma, “Real-Time Greenhouse Mon-itoring and Controlling System Using Wireless Sensor Networks and Android Application,” in Proc. 2023 IEEE 8th International Conference for Convergence in Technology (I2CT), Lonavla, India, Apr. 2023.

[14] R. Kumar, A. Singh, and P. Verma, “IoT-Based Smart Irrigation and Environmental Monitoring System for Agricultural Applications,” Inter-national Journal of Advanced Computer Science and Applications, vol. 13, no. 4, 2022.