WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Role-Based Areca Management System with Predictive Analytics

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DOI : https://doi.org/10.55248/gengpi.07.1026.34070

A B S T R A C T :

Areca nut cultivation and farm management involve recurring decisions related to crop observations, input use, labour, expenses, harvest planning, and sales. When these records are maintained manually or across disconnected tools, it can be difficult to track activities consistently and use historical information for planning. This paper proposes a role-based Areca Management System with Predictive Analytics, a digital platform intended to organize farm operations and provide decision support to farmers and other authorized stakeholders. The system separates access by role, such as administrator, farmer or farm owner, field worker, and buyer or market user, with permissions tailored to each role. Core functions include farm and plot records, activity scheduling, input and expense tracking, harvest and stock records, sales history, notifications, and reports. A predictive analytics component is proposed to use available historical and contextual data to estimate selected outcomes, such as expected harvest quantity, likely expense patterns, or future demand, subject to data quality and local validation. The paper describes the proposed architecture, functional modules, data flow, analytics approach, and evaluation plan. As this is a proposed system, no measured performance or field-trial results are claimed. The design aims to improve record visibility, accountability, and evidence-informed planning while keeping predictions understandable and subject to human review.

Keywords: Areca nut; farm management; role-based access control; predictive analytics; agriculture information system; decision support

Introduction

Areca nut is an important plantation crop for many farming communities in India. Its management requires coordination across field activities, labour, inputs, expenses, harvest handling, storage, and marketing. Reliable records can help a grower understand how resources are used and compare outcomes across seasons. However, a small or medium farm may rely on notebooks, spreadsheets, messaging applications, or individual memory. These practices can make it difficult to maintain a single, consistent view of farm operations.

A digital management system can centralize records and make relevant information available to authorized users. Yet a single shared interface is not sufficient when different participants have different responsibilities. A farmer may need access to costs and production summaries, while a field worker may only need assigned tasks and the ability to report completion. An administrator may manage accounts and system configuration, whereas a buyer may only view approved stock or order information. Role-based access helps separate these responsibilities.

This paper proposes a Role-Based Areca Management System with Predictive Analytics. The initial project idea was suggested by the author's father; the subsequent system concepts and proposed features are the author's own work. The paper focuses on the proposed design rather than presenting an already validated deployed product.

1.1. Problem statement

Farm information can be fragmented, updates may be delayed, and planning may depend heavily on manual estimation. Without structured access control, sensitive financial or operational records may also be visible to users who do not need them. The proposed system addresses these issues through centralized records, role-specific workflows, and optional predictive summaries based on historical data.

1.2. Objectives

- Centralize farm, plot, activity, input, expense, harvest, inventory, and sales records.
- Provide role-specific access and permissions using the principle of least privilege.
- Offer dashboards, reminders, and reports that support day-to-day farm decisions.
- Explore predictive models for harvest quantity, expenses, and demand where adequate data exists.
- Evaluate usability, access-control correctness, data quality, and prediction error before real-world deployment.

Proposed System

1.3. User roles and permissions

The system uses role-based access control (RBAC). Each authenticated user is assigned a role, and each role is associated with permitted actions. Access should be checked on the server for every protected operation; hiding a button in the interface alone is not a security control.

Table 1. Proposed roles and example permissions.

Role	Primary responsibilities	Example access
Administrator	Manage users, role assignments, master data, and audit records.	User and configuration management; system-wide reports.
Farmer / Owner	Maintain farm records and make operational decisions.	Plots, activities, expenses, harvest, inventory, sales, analytics.
Field Worker	Receive assigned work and submit field updates.	Assigned tasks, completion status, limited observations.
Buyer / Market User	View permitted produce availability and record purchase requests.	Approved stock, order status, transaction-specific details.

1.4. Functional modules

Farm and plot management stores farm identifiers, plot area, crop details, planting information, and relevant seasonal notes. Activity management records scheduled tasks such as irrigation, nutrient application, weeding, and other locally relevant operations. Input and expense management records quantities, dates, suppliers, and costs. Harvest and inventory modules capture harvest dates, quantities, grades where applicable, storage movements, and available stock. Sales management records approved sales and order status. A notification module reminds users about scheduled activities and pending updates. Reporting provides summaries by plot, period, activity, or transaction.

1.5. System architecture

A practical implementation may use a web or mobile-friendly user interface, a backend API, a relational database, and a separate analytics component. The interface sends authenticated requests to the backend. The backend validates inputs, checks role permissions, and reads or writes records in the database. The analytics component receives approved, cleaned data and returns estimates with information about the time period, input variables, and model limitations. Predictions should not directly trigger high-impact farm actions without user review.

A possible student-project stack is React or Next.js for the interface, Python with FastAPI for backend services, PostgreSQL or SQLite for structured data, and pandas with scikit-learn for initial analytics experiments. These are implementation options, not a claim that the system has already been built with this stack.

Predictive Analytics Method

1.6. Candidate prediction tasks

The analytics module should begin with a small number of clearly defined targets. Harvest estimation could use past harvest quantity, plot area, season, crop age if reliably recorded, weather summaries if available, and documented management activities. Expense forecasting could use past input and labour costs, planned activities, and seasonal patterns. Demand or price-related estimates would require dependable market data and careful treatment of market volatility. These tasks should be developed separately because their data requirements and error costs differ.

1.7. Data preparation and model selection

Data should be checked for missing values, inconsistent units, duplicate entries, impossible dates, and outliers caused by recording errors. Training and test sets should be separated by time or season where possible, so future observations do not leak into training data. A simple baseline, such as the previous season's value or a seasonal average, should be evaluated before introducing more complex models. Linear regression, decision-tree-based regressors, or random-forest regression may be considered for numeric outcomes, depending on dataset size and quality.

Model selection should be driven by validation rather than complexity. For a numeric prediction, mean absolute error (MAE) can communicate the average absolute difference between predicted and observed values; root mean squared error (RMSE) gives greater weight to larger errors. Results should be reported alongside the baseline and the number and coverage of observations. If sufficient local data is not available, the system should show that a prediction is unavailable instead of presenting a fabricated estimate.

1.8. Explainability and user feedback

Each prediction should show its target, forecast period, generation date, and a short explanation of important input factors where the model supports it. Users should be able to flag incorrect records and correct source data. A prediction must be presented as an estimate, not a guarantee. Model quality should be rechecked as farming practices, climate conditions, and market patterns change.

Data Management and Security

The database should use unique identifiers for users, farms, plots, activities, harvest batches, inventory movements, and sales. Records should include creation and update timestamps. Validation rules should prevent negative quantities where inappropriate and help keep units consistent. Audit logs should record important changes to roles, permissions, and financial or inventory records.

Authentication should use secure password handling or a trusted identity provider. Authorization must be enforced in the backend, with tests for both permitted and prohibited actions. Data should be transmitted over HTTPS in deployment, backups should be protected, and personal or commercial information should be collected only when necessary. Buyers and field workers should not receive access to private farm finances unless explicitly authorized for a legitimate workflow.

Evaluation Plan

The proposed system should be evaluated in stages. Functional testing will check that each module supports its intended workflow. Role-based tests will verify that users cannot access records or actions outside their permissions. Data-integrity tests will check validation, duplicate handling, and consistency between harvest, stock, and sales records. Usability testing with representative users can assess whether task assignment, record entry, and reports are understandable.

Predictive performance should be evaluated only after an adequate, consented dataset has been collected. The dataset should document its source, time span, geographic relevance, missingness, and target definition. Models should be compared with simple baselines using a held-out test period. A field pilot should collect user feedback and compare predicted values with actual outcomes before any claims of operational benefit are made.

Expected Benefits and Limitations

Potential benefits include more consistent records, clearer responsibility for tasks, quicker access to farm summaries, improved traceability of harvest and stock, and a structured basis for planning. The actual benefit will depend on adoption, data-entry discipline, device and network availability, and whether the workflows match local farming practices.

The main limitation is data availability. Predictive analytics cannot provide reliable farm-specific estimates without representative historical records. Crop outcomes are influenced by multiple factors that may not be captured in the database, and market estimates can change rapidly. The proposed role structure may also need adjustment after consultation with farmers, workers, and buyers. Accordingly, the system should be treated as decision support and not as a substitute for local expertise.

Conclusion

This paper presented the design of a Role-Based Areca Management System with Predictive Analytics. The proposed platform combines farm-operation records, role-specific access, reporting, notifications, and a carefully evaluated analytics component. The recommended development path is to implement secure recordkeeping and permissions first, validate the quality of collected data next, and add prediction tasks only when sufficient relevant data is available. Future work includes building a working prototype, gathering feedback from intended users, testing access-control boundaries, and measuring model performance against simple baselines.

Acknowledgements

- The author acknowledges his father for suggesting the initial project idea. The subsequent system design concepts and proposed feature set were developed by the author. We sincerely acknowledge Farmer **Chandrashekhar C** for suggesting the initial idea for the Areca Smart project, ***"A Role-Based Areca Management System with Predictive Analytics."***

- His practical perspective on areca farming inspired us to explore the challenges associated with market-price awareness, farm and business record management, worker attendance, salary calculation, and agricultural decision-making.

- Building upon this initial idea, our team independently developed the project concept, identified the functional requirements, planned the system architecture, and designed the proposed features to address the practical needs of farmers, managers, workers, and business owners.

- We also explored relevant research and technical documentation on arecanut price forecasting, Long Short-Term Memory (LSTM) networks, predictive analytics, database management, and web application development to support our technical understanding and implementation approach.

- This project reflects our effort to bridge practical agricultural needs with digital technologies and data-driven decision support. We are grateful for the initial inspiration that guided us toward developing a unified platform for areca management and predictive analytics.

REFERENCES

The initial idea for the Areca Smart project was suggested by farmer Chandrashekhar C. The project concept, feature planning, system design, and development approach were subsequently developed by our team. The project is based on our understanding of the practical challenges faced in areca farming and business management. No external references were used during the initial ideation of the project.