



A Distributed Ledger Approach For Organic Product Authentication And Supply Chain Transparency

¹Thatiparthi Kalasri, ²Pagolu Sharmila Angel, ³Vatti Satish Kumar Reddy, ⁴Panditi Dinesh Babu, ⁵Dr. G. Lakshmi

^{1,2,3,4}B. Tech Student, ⁵Assistant Professor

^{1,2,3,4,5}Information Technology,

^{1,2,3,4,5}Prasad V. Potluri Siddhartha Institute of Technology, Vijayawada, India

ABSTRACT: The Organic Trace blockchain framework introduces a decentralized solution aimed at enhancing visibility, traceability, and reliability within agricultural supply networks. Developed using Solidity on the Ethereum platform along with a Python Flask backend, the system monitors farm products across every stage, from initial harvesting to final distribution, ensuring secure data handling and stakeholder confidence. Each product's lifecycle information is immutably recorded on the blockchain, enabling trustworthy status updates and a transparent transaction record. The platform supports real-time monitoring for farmers, distributors, retailers, and consumers through Web3-based role-specific access. Its dual-interface design allows administrators to efficiently oversee supply chain activities while enabling customers to verify product origin with ease. This solution demonstrates the potential of blockchain technology in resolving long-standing challenges in food supply systems by improving openness, maintaining quality standards, and increasing operational efficiency, ultimately strengthening trust between producers and consumers in agricultural environments.

Keywords: Blockchain, Agriculture, Supply Chain Management, Smart Contracts, Traceability, Transparency, Web3, Ethereum, Data Integrity, Flask.

I. INTRODUCTION

The agricultural supply network is essential for delivering farm produce to consumers in a secure, reliable, and transparent way. However, conventional supply chain models encounter several limitations, including poor visibility, counterfeit products, and ineffective data management practices. These challenges not only weaken consumer confidence but also contribute to economic setbacks for farmers and distributors. As the demand for food safety and sustainable practices continues to rise, there is an increasing need for systems that improve traceability, accountability, and operational efficiency throughout the agricultural supply process. Blockchain technology has gained attention as an effective approach to overcoming these limitations because of its distributed and tamper-resistant characteristics. Once information is recorded within the blockchain, it remains unchanged, ensuring data reliability and strengthening trust among participants. Additionally, smart contracts facilitate automated tracking and validation, reducing dependency on manual operations and lowering the risk of errors. In agricultural contexts, blockchain enables continuous monitoring of products from the point of harvest to final delivery, ensuring both authenticity and consistency. The adoption of blockchain-driven solutions has resulted in noticeable enhancements in supply chain performance and dependability. Tracking product history becomes more precise, while verification processes are significantly faster compared to traditional approaches. Consequently, stakeholders develop greater confidence due to the availability of secure and real-time data records. In summary, the Farm Trace Blockchain system illustrates how blockchain can modernize

agricultural supply chains by increasing transparency, maintaining product standards, and reinforcing trust among all involved parties.

II. LITERATURE SURVEY

Blockchain technology and digital solutions have increasingly been applied in agricultural supply chain management to address challenges such as lack of transparency, inefficient tracking, and data manipulation. Several studies have explored different approaches to improve traceability, sustainability, and operational efficiency in this domain. Cardwell and Lawley [1] analyzed the political and structural risks in supply management systems and emphasized the importance of transparent and well-regulated frameworks in agricultural supply chains. Their work highlights the need for reliable systems that ensure accountability across stakeholders. Erfani and Goharian [2] proposed an optimized approach for integrated water supply management using policy tree models. Although their work focuses on resource allocation and sustainability, it indirectly supports agricultural productivity, which is a key factor in supply chain efficiency. Zanon et al. [3] studied environmental efficiency and food supply in dairy farming systems. Their research demonstrates the importance of monitoring environmental and operational parameters, which can be effectively integrated with digital traceability systems for better quality control. Tseng et al. [6] discussed sustainable supply chain management in the coffee industry, emphasizing digitalization and information integration. Their findings support the use of advanced technologies such as blockchain and smart contracts to improve transparency and operational performance. Imtiaz [7] introduced an ERP-based farm management system that enables structured monitoring of agricultural activities. While ERP systems provide efficient data management, they lack immutable data storage and decentralized verification, which are key advantages of blockchain technology. Zhang et al. [13] explored the application of artificial intelligence in food supply chains, highlighting improvements in traceability, demand forecasting, and quality management. However, these systems often rely on centralized architectures, limiting data security and trust. Kalirajan et al. [14] proposed an AI-based monitoring system for water supply and pest management in agriculture. Although it provides real-time environmental monitoring, it does not ensure tamper-proof data storage or end-to-end supply chain traceability. From the existing literature, it is evident that while several technologies such as ERP systems, IoT, and AI contribute to improving specific aspects of agricultural supply chains, they lack comprehensive solutions that ensure transparency, immutability, and decentralized verification. The proposed organic trace blockchain system addresses these limitations by integrating blockchain technology, smart contracts, and QR code-based tracking to provide a secure, transparent, and end-to-end traceability solution.

III. PROPOSED SYSTEM

The proposed system, Organic Trace Blockchain, introduces a blockchain-based solution to enhance transparency and traceability in the agricultural supply chain. It utilizes Ethereum smart contracts to securely record product details and lifecycle updates in an immutable manner, ensuring data integrity and trust among stakeholders. The system consists of a Python Flask backend for handling API interactions and a user-friendly frontend with separate dashboards for farmers and customers. Farmers can register products with detailed information such as category, quantity, quality, and environmental conditions and generate unique QR codes for each product. They can also update product stages throughout the supply chain. Customers, on the other hand, can track products using Product ID or QR code and view complete product history, including origin and movement details. Additionally, an “Available Crops” section displays all registered products in real time, improving usability and accessibility. The system follows a hybrid architecture by storing critical data on-chain while managing additional data off-chain, thereby ensuring scalability, security, and efficient performance. The system also improves usability by providing an “Available Crops” section, allowing customers to easily view and select registered products. This feature enhances accessibility and reduces dependency on manual product ID entry for tracking.

IV. METHODOLOGY

The methodology of the proposed Organic Trace Blockchain system describes the step-by-step process involved in designing and implementing a secure and transparent agricultural supply chain tracking system. The approach includes data handling, system design, blockchain integration, and user interaction mechanisms.

4.1 Dataset Description

The system does not rely on a traditional static dataset; instead, it dynamically generates and manages data through user interactions. The primary data is collected from farmers during product registration and updated throughout the supply chain lifecycle.

The key attributes captured in the system include:

- Product ID
- Product Category
- Product Name
- Variety/Type
- Quantity (kg)
- Quality Grade
- Farm Location
- Temperature
- Humidity
- Farmer Name
- Handler Name
- Stage Information (Harvested, Stored, Transported, Delivered)

Each product is assigned a unique identifier, which is used to track its movement and status across different stages. This structured data acts as a real-time dataset for monitoring and traceability.

4.2 Data Preprocessing

Before storing the data on the blockchain, preprocessing steps are performed to ensure data consistency and validity. The following operations are carried out:

- Validation of mandatory fields such as Product ID, Product Name, and Quantity
- Removal of duplicate or invalid entries
- Standardization of data formats (e.g., units for temperature and quantity)
- Verification of user roles and authorization before submission
- Formatting of environmental parameters (temperature and humidity)

These preprocessing steps help maintain data accuracy and prevent incorrect or incomplete data from being recorded on the blockchain.

4.3 Model Description

Unlike traditional systems that rely on machine learning models, the proposed system is based on a blockchain-driven architecture. The core logic is implemented using Ethereum smart contracts, which define the operations for product registration, stage updates, and data retrieval.

The system consists of three main components:

- Blockchain Layer: Handles immutable storage of critical data using smart contracts
- Backend Layer: Developed using Python Flask to manage API requests and blockchain interaction
- Frontend Layer: Provides user interfaces for farmers and customers

This architecture ensures secure data storage, transparency, and efficient system interaction without relying on predictive models. The system operates based on predefined smart contract logic rather than predictive models, ensuring deterministic and reliable execution of operations. This approach enhances data integrity and eliminates dependency on probabilistic decision-making.

4.4 Prediction Approach

The proposed system does not involve predictive analytics or forecasting. Instead, it focuses on real-time tracking and verification of agricultural products.

The approach is based on:

- Recording each product event as a blockchain transaction
- Maintaining chronological order of supply chain stages
- Allowing users to retrieve complete product history
- Using QR codes to quickly access product information

This ensures accurate traceability rather than prediction, making the system reliable and tamper-proof.

4.5 System Flow

Farmer Input → Data Validation → Blockchain Storage → QR Code Generation → Stage Updates → Customer Tracking → Product History Display

4.6 System Architecture

This architecture ensures smooth collaboration between the frontend, backend, and blockchain components. The farmer provides product details, which are validated and stored on the blockchain through the backend. The system then enables real-time tracking, where customers can access product information using a product ID or QR code, ensuring secure and transparent data flow across the supply chain.

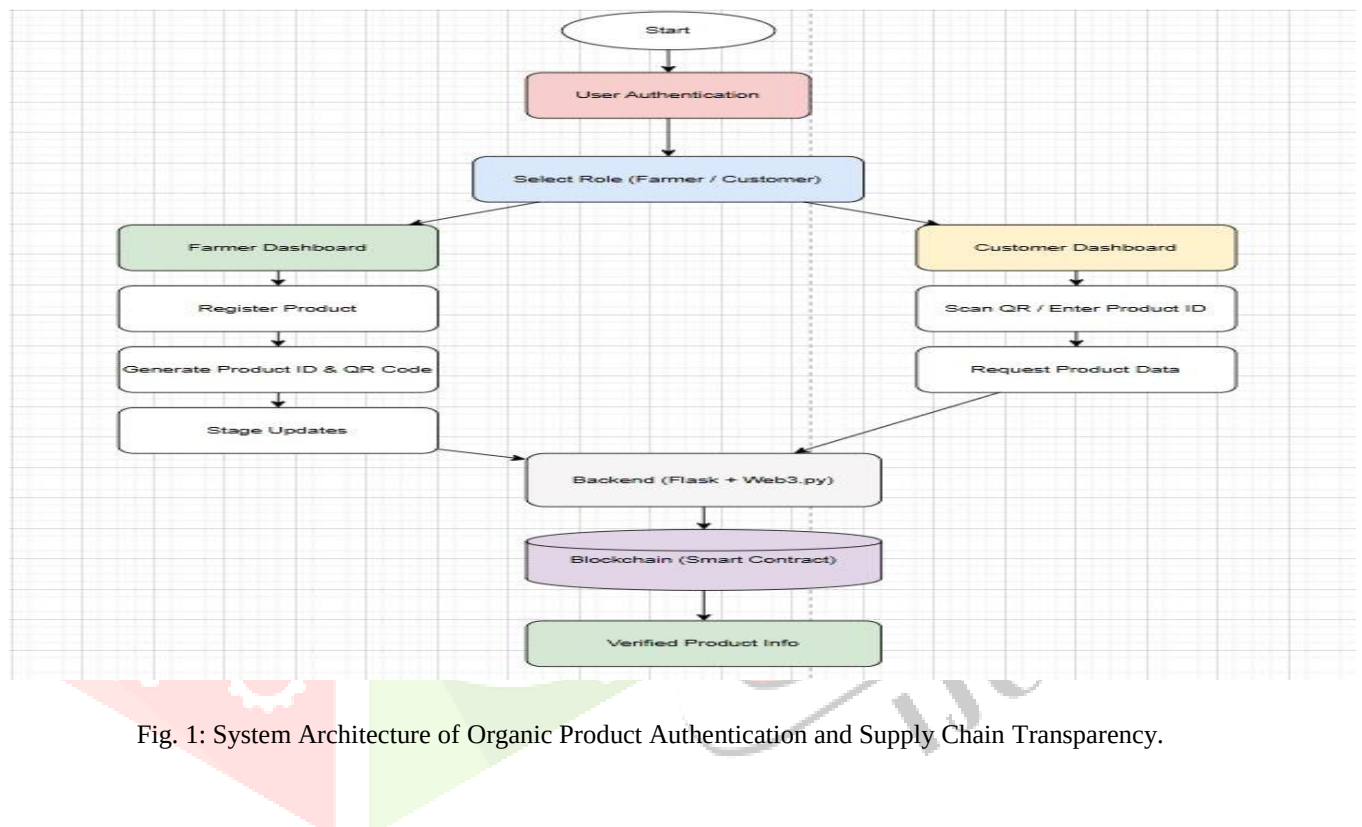
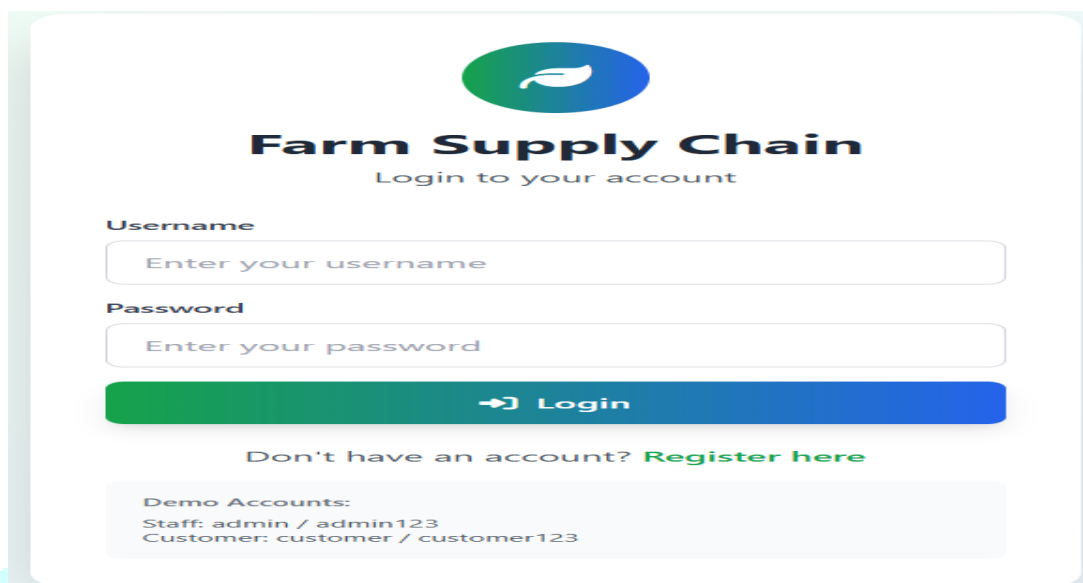


Fig. 1: System Architecture of Organic Product Authentication and Supply Chain Transparency.

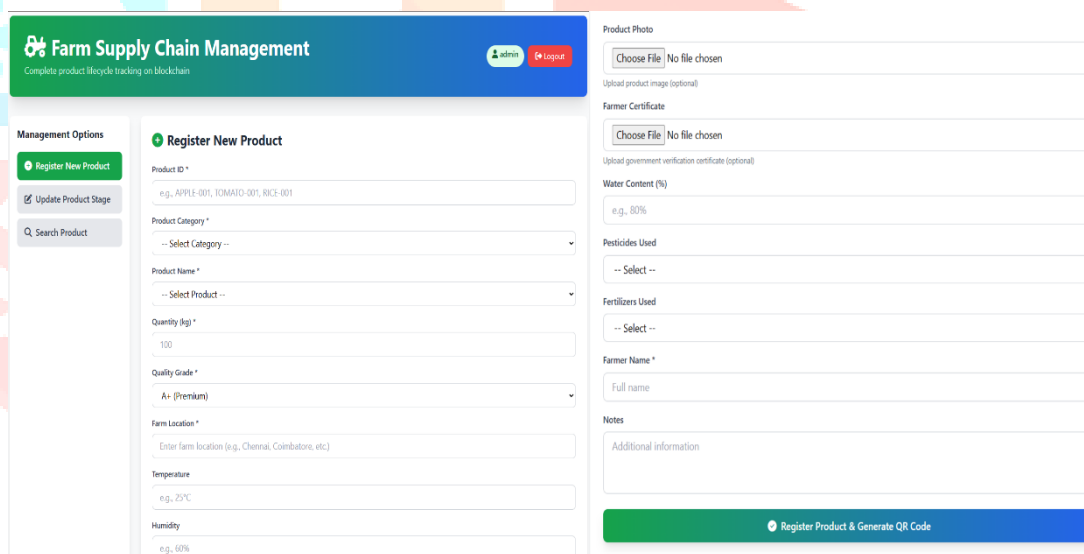
V. RESULTS

The Organic Trace Blockchain system showed great advancements in the traceability and transparency of agricultural products. The product journey from harvest to retail was effectively documented on the Ethereum blockchain, thereby forming unchangeable records of ownership, status updates, and crucial handling events.



The image shows a login/register dashboard for the Farm Supply Chain system. At the top is a logo consisting of a green and blue circle with a white leaf-like shape inside. Below the logo, the text "Farm Supply Chain" is displayed in a large, bold, black font, followed by "Login to your account" in a smaller, regular black font. The dashboard contains two input fields: "Username" with the placeholder text "Enter your username" and "Password" with the placeholder text "Enter your password". Below these fields is a large green button with a white right-pointing arrow and the text "Login". Underneath the button, there is a link that says "Don't have an account? Register here". At the bottom, there is a section titled "Demo Accounts:" which lists "Staff: admin / admin123" and "Customer: customer / customer123".

Fig. 2: Login/Register Dashboard



The image shows the "New Product Registration" form within the "Farm Supply Chain Management" system. The header bar is blue and contains the system name, a subtitle "Complete product lifecycle tracking on blockchain", and user roles "admin" and "Logout". On the left, there is a sidebar with "Management Options" including "Register New Product" (highlighted), "Update Product Stage", and "Search Product". The main form area is titled "Register New Product" and contains several input fields: "Product ID *" (with example "e.g., APPLE-001, TOMATO-001, RICE-001"), "Product Category *" (a dropdown menu), "Product Name *" (a dropdown menu), "Quantity (kg) *" (with value "100"), "Quality Grade *" (a dropdown menu with "A+ (Premium)" selected), "Farm Location *" (with placeholder "Enter farm location (e.g., Chennai, Coimbatore, etc)"), "Temperature" (with example "e.g., 25°C"), and "Humidity" (with example "e.g., 60%"). To the right of these fields are sections for "Product Photo", "Farmer Certificate", "Water Content (%)", "Pesticides Used", "Fertilizers Used", "Farmer Name *" (with placeholder "Full name"), and "Notes" (with placeholder "Additional information"). Each of these sections has a "Choose File" button and a "No file chosen" status. At the bottom right, there is a large green button labeled "Register Product & Generate QR Code".

Fig. 3: New Product Registration

Register Product & Generate QR Code

Product Registered Successfully!

Product ID: PAPAYA_001

Organic: Yes (85% confidence)

Score: 4/5

Reasons: Temperature 29.0°C outside organic range (18-28°C)

Transaction Hash

d293d7f6c6311fd05dea23e52de37357a72327a999dc43246f16e328c8ab9d28

Block: 1

QR Code Generated! See below.

QR Code Generated



Scan this QR code to track the product

Download QR Code

Fig. 4: Registered Product Details

Management Options

Register New Product

Update Product Stage

Search Product

Search Product

papaya_001

Search

Papaya

Product ID

PAPAYA_001

Variety

Quantity

200 kg

Quality Grade

A+

Farm Location

Vijayawada

Current Stage

Harvested

QR Code



Download QR Code

Product History

1. Harvested

Handlen: sharmila

Location: Vijayawada

Time: 2026-04-06 10:08:56

Notes: Organic: Yes | Confidence: 85% | Score: 4/5 | Water: 80% | Pesticides: organic | Fertilizers: biofertilizer | Reasons: Temperature 29.0°C outside organic range (18-28°C)

Transaction Hash

d293d7f6c6311fd05dea23e52de37357a72327a999dc43246f16e328c8ab9d28

Fig. 4: Search Product

Track Product

Browse All Products

All Registered Products

Browse all products available on the blockchain

Load All Products

Farm Supply Chain Tracker

Verify your product's journey from farm to table

Enter Product ID or Scan QR Code

Enter Product ID (e.g., BANANA-001)

Track Product

Reset

Scan QR Code

Upload QR

Fig. 5: Product ID Dashboard

IJCRT2604292 | International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org | c446

The screenshot displays the 'Organic Trace Blockchain' web application. At the top, there's a search bar with 'papaya_001' entered, and buttons for 'Track Product', 'Scan QR Code', 'Upload QR', and 'Reset'. Below this, the 'Product Information' section for 'Papaya' shows details like Product ID (PAPAYA_001), Quantity (200 kg), Quality Grade (A+), Farm Location (Vijayawada), Harvest Date (2026-04-06 10:08:56), Current Status (Harvested), and Verification Status (Not Verified by Government Bodies). A green badge indicates 'ORGANIC 85% confidence'. The 'Supply Chain Journey' section shows the product was 'Harvested' at 'Vijayawada' on '2026-04-06 10:08:56'. It lists details like Handler (sharmila), Temperature (29), Location (Vijayawada), Humidity (60), and a detailed note about organic status and temperature. A blockchain transaction hash is also visible at the bottom.

Fig. 6: Supply Chain Journey

VI. WEB APPLICATION

A web-based application is developed to make the system accessible and easy to use. It allows users to register, update, and track agricultural products in real time using blockchain technology.

Features of the Web Application:

- User-friendly interface for farmer and customer dashboards
- Product registration with detailed information and QR code generation
- Real-time product stage updates (harvested, stored, transported, etc.)
- Product tracking using Product ID or QR code scanning
- “Available Crops” section to view all registered products
- Simple and interactive interface

This system helps users easily monitor product details, track supply chain stages, and verify product authenticity, improving transparency and trust in the agricultural supply chain.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to DR. G. LAKSHMI, Ph.D., Assistant Professor, for his valuable guidance, constant support, and encouragement throughout the development of this project. His insightful suggestions and continuous motivation played a significant role in the successful completion of this work.

The authors also extend their heartfelt thanks to the Department of Information Technology, Prasad V Potluri Siddhartha Institute of Technology, for providing the necessary infrastructure, resources, and technical support required for carrying out this project. The supportive academic environment and encouragement from the faculty members greatly contributed to enhancing the quality of this work.

Finally, the authors express their sincere appreciation to the management of Prasad V Potluri Siddhartha Institute of Technology for their continuous support and encouragement in successfully completing this project and its presentation.

CONCLUSION

The Organic Trace Blockchain system is an excellent example of the transformative power of blockchain in the agricultural supply chain through the introduction of real transparency, traceability, and trust. The system integrates Ethereum smart contracts, a Flask-based backend, and user-friendly interfaces, allowing the producer to track the farm produce totally from harvesting to the final sale. In order to record all the transaction details securely and efficiently, the framework uses the blockchain for logging the critical

information while storing large metadata away from the chain. This mixed method provides ultra-potent data integrity while at the same time not affecting performance or scalability.

REFERENCES

- [1] Cardwell, R. and Lawley, C., "Political Risk and the Persistence of Canada's Supply Management Regime," SSRN, 2025. [Online]. Available: <https://ssrn.com/abstract=5208444>
- [2] Erfani, M. and Goharian, E., "Optimizing integrated water supply management for multi-purpose reservoirs: a policy tree approach," *Hydrological Sciences Journal*, vol. 70, no. 3, pp. 483-494, 2025.
- [3] Zanon, T., Hörtenhuber, S., Fichter, G., Peratoner, G., Zollitsch, W., Gatterer, M., and Gauly, M., "Effect of management system and dietary seasonal variability on environmental efficiency and human net food supply of mountain dairy farming systems," *Journal of Dairy Science*, vol. 108, no. 1, pp. 597-610, 2025.
- [4] Elliot, T., Goldstein, B., and Charlebois, S., "Over 6 billion liters of Canadian milk wasted since 2012," *Ecological Economics*, vol. 227, p. 108413, 2025.
- [5] Wang, M., Islam, S., and Yang, W., "Supply chain risks in the dairy industry," *Benchmarking: An International Journal*, 2025.
- [6] Tseng, M.L., Bui, T.D., Lewi, S., Rizaldy, H., Lim, M.K., and Wu, K.J., "Causality of sustainable supply chain management practices in the Indonesian coffee industry using qualitative information: digitalization integration leads performance improvement," *International Journal of Logistics Research and Applications*, vol. 28, no. 2, pp. 210-240, 2025.
- [7] Imtiaz, G.A., "Designing and developing CattleSync: a comprehensive ERP solution for cattle farm management," Doctoral dissertation, Brac University, 2025.
- [8] Ho, H., "A maturity model approach to evaluating sustainable supply chains of organic agricultural cooperatives amid the transition to Industry 5.0 in rural Vietnam," *Org. Farming*, vol. 11, no. 2, pp. 90-101, 2025.
- [9] Murala, D.K., "Product Supply Chain," in *Innovations in Information and Decision Sciences: Proceedings of the 12th International Conference on Frontiers in Intelligent Computing: Theory and Applications (FICTA 2024)*, vol. 422, p. 277, Springer Nature, 2025, Mar.
- [10] de Arruda Pollice, F.F. and Scarcelli, M., "Purchasing and supply management journey into Unilever's circular economy strategy," in *A Systemic Transition to Circular Economy: Business and Technology Perspectives*, Cham: Springer International Publishing, 2024, pp. 161-173.
- [11] Ataei, P., Takhravan, A., Gheibi, M., Chahkandi, B., Faramarz, M.G., Waclawek, S., Fathollahi-Fard, A.M., and Behzadian, K., "An intelligent decision support system for groundwater supply management and electromechanical infrastructure controls," *Heliyon*, vol. 10, no. 3, 2024.
- [12] Pato, I.D., Osewe, M., and Han, J., "Effects of perceived effectiveness in contract farming on adoption of best crop management practices among sugarcane farmers in Tanzania," *Frontiers in Sustainable Food Systems*, vol. 8, p. 1442301, 2024.
- [13] Zhang, L., Zhang, M., Mujumdar, A.S., and Chen, Y., "From farm to market: Research progress and application prospects of artificial intelligence in the frozen fruits and vegetables supply chain," *Trends in Food Science & Technology*, vol. 153, p. 104730, 2024.
- [14] Kalirajan, M., Mageshen, V.R., Aswitha, K., and Saranya, M., "AI-Based Regulation of Water Supply and Pest Management in Farming," in *Artificial Intelligence Techniques in Smart Agriculture*, Singapore: Springer Nature Singapore, 2024, pp. 195-215.

[15] Akpabio, E., Narad, S., Ulhe, P., Akpabio, I., and Akpabio, I., "Digital Innovations in Agriculture: Leveraging IT for Sustainable Farm Management," in International Conference on Information and Communication Technology for Competitive Strategies, Singapore: Springer Nature Singapore, 2024, Dec., pp. 27-37.

