REVIEW ARTICLE

Application Patterns and Challenges of Smart Agriculture Technologies Across the Mango Value Chain

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Abstract

As a pivotal tropical fruit crop in China, the mango (*Mangifera indica L.*) industry plays a strategic role in advancing agricultural modernization and augmenting rural incomes. However, the traditional mango value chain faces bottlenecks such as resource inefficiency, information asymmetry, and weak market resilience. Driven by the rapid evolution of next-generation information technologies—specifically the Internet of Things (IoT), big data, artificial intelligence (AI), and blockchain—smart agricultural technologies are profoundly reshaping the production, processing, and marketing paradigms of the industry. This paper systematically investigates the application patterns and challenges of smart agricultural technologies across the entire mango industry chain, covering pre-harvest cultivation, post-harvest handling, processing, and marketing. This study aims to provide theoretical insights and practical pathways for overcoming these hurdles, facilitating the high-quality, sustainable development of China's mango industry.

Keywords: smart agriculture, mango industry chain, Internet of Things, precision agriculture, intelligent processing, blockchain-based traceability.

1 Introduction

As a pivotal tropical cash crop in China, the mango (*Mangifera indica L.*) is predominantly cultivated in tropical, subtropical, or dry-hot valley regions, with Guangxi, Hainan, Yunnan, and Sichuan serving as the primary production hubs. According to 2024 statistics, China's total mango cultivation area reached approximately 397,200 hectares, yielding a total production of 5.125 million tons [1]. The robust development of the mango sector is therefore instrumental in augmenting rural incomes and propelling the strategy of rural revitalization in these producing regions. However, the traditional mango industry is currently constrained by a series of structural bottlenecks:

Cultivation Stage: The prevalence of empirical management over digital precision results in low standardization. Cultivation practices remain heavily reliant on farmers' personal experience rather than data-driven decision-making [2–6]. Critical agronomic operations—such as water and fertilizer regulation, pest and disease control, and harvest timing—lack the support of precise

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digital technologies. This dependence on empirical knowledge leads to heterogeneous management standards, ultimately resulting in inconsistent fruit quality across batches and a low proportion of premium-grade commodities.

Post-harvest Stage: Inadequate pre-cooling and sorting infrastructure exacerbates post-harvest losses [7–9]. Currently, the aggregate post-harvest loss rate for fruits and vegetables in China stands at 20%–30%, and mango, as a typical climacteric fruit characterized by rapid respiration rates and high susceptibility to softening and rotting during storage and transport, sits at the upper end of this range. Research data from the Guangxi Academy of Agricultural Sciences (2023) corroborate this, indicating that post-harvest losses due to softening and decay reach approximately 30% [10], representing a severe economic drain.

Processing Stage: Insufficient automation and the absence of real-time quality control hinder product consistency. Core processing procedures, such as peeling and slicing, remain labor-intensive, which not only limits production efficiency but also elevates the risk of exogenous contamination. Furthermore, the industry lacks an intelligent monitoring system based on sensors and data analytics to regulate critical process parameters [11]. Consequently, significant variations in color, flavor, and texture occur between batches, making it difficult to establish unified quality standards. This instability restricts brand equity construction and undermines market competitiveness.

Marketing Stage: The lag in traceability systems and brand authentication erodes consumer trust. The majority of small and medium-sized mango enterprises in China have yet to establish a full-chain trusted traceability network spanning from planting to end consumption. Consumers face information asymmetry regarding the origin of raw materials and the conditions of processing, storage, and logistics. Regional case studies on the mango industry in Baise (Guangxi) and Yuxi (Yunnan) consistently identify weak brand identity and the lack of differentiated, quality-certified branding as recurring constraints on the sector's competitiveness [12–15]. This opacity prevents the formation of stable brand loyalty and inhibits high-quality products from realizing a "quality premium" based on transparent safety and quality certification.

Fundamentally, the challenges facing the traditional mango industry stem from a deficiency in whole-chain data acquisition and a low level of refined management. Smart agricultural technology, underpinned by information and communication technology, integrates IoT sensing, big data analytics, and AI-driven decision-making. It offers a revolutionary paradigm for achieving precision, intelligence, and sustainability throughout the mango value chain, providing a clear pathway for the high-quality transformation of China's mango industry.

2 Development of a Smart Technology Framework for the Entire Mango Industry Chain

The intelligent transformation of the entire mango industry chain cannot be achieved through isolated technological upgrades. Rather, it constitutes a systematic endeavor that necessitates the elimination of data silos across the cultivation, processing, distribution, and sales segments. This integration is essential to establish a cohesive technical framework characterized by seamless connectivity and coordinated interaction across all operational levels. Guided by the principles of data flow and functional positioning, this framework is structured into four core layers: the perception layer, the transmission layer, the platform layer, and the application layer.

Perception Layer: The perception layer, analogous to the sensory nerve endings of a biological organism, functions as the primary data gateway for the entire mango industry chain and serves as the fundamental prerequisite for intelligent decision-making. This layer utilizes diverse sensing devices deployed across orchards, processing facilities, and logistics networks—including environmental sensors, soil moisture meters, image acquisition devices, and equipment status monitors—to collect continuous, real-time dynamic data throughout the production process. This provides the foundational dataset required for subsequent analysis. Ranwa et al. [16] (2024) emphasized that the technological maturity and cost reduction of diverse sensor technologies constitute the core foundation for the current implementation and promotion of precision agriculture. Furthermore, a comprehensive perception network can systematically address the limitations of insufficient information acquisition and overreliance on manual, experience-based judgment that characterize traditional agricultural production.

Transmission Layer: The transmission layer acts as the information backbone of smart agriculture, bridging front-end sensing nodes with back-end cloud platforms. It necessitates the selection of

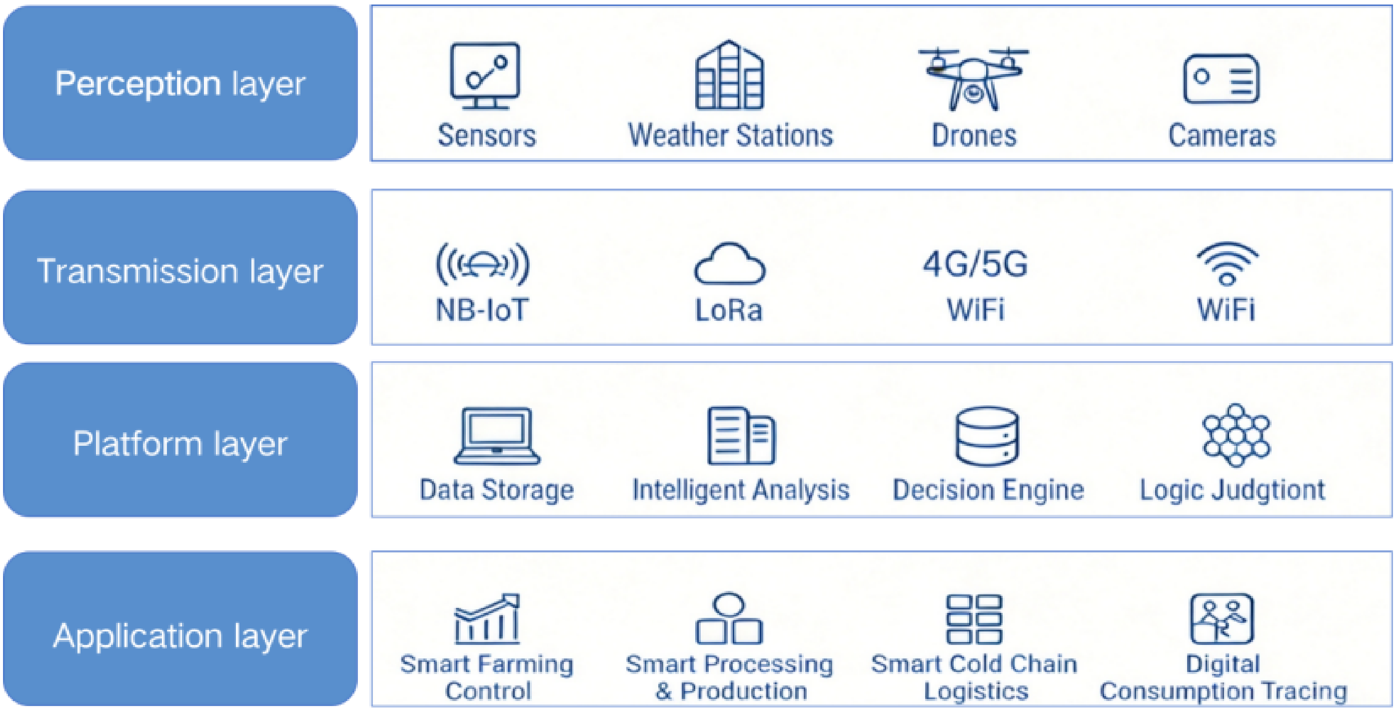

Figure 1. Framework of smart technologies for the entire mango industry chain.

communication technologies tailored to specific application scenarios to ensure the stable, low-latency transmission of the massive volumes of data collected by the perception layer. For mango cultivation environments predominantly situated in mountainous regions, cellular communication technologies such as 4G/5G, alongside low-power wide-area (LPWA) technologies such as LoRa and NB-IoT, are adopted to mitigate challenges related to inadequate network coverage and limited device battery life in remote areas. Conversely, for scenarios involving fixed high-density nodes, such as intensive orchards and processing workshops, Wi-Fi is utilized to meet high-speed, large-volume data transmission requirements, while ZigBee supports low-power, dense sensor-node networking. Wongrujira et al. [17] (2025) demonstrated in precision mango cultivation that a LoRa-based remote monitoring system can achieve stable, low-power, long-distance data transmission, making it highly suitable for the monitoring requirements of dispersed orchards. Additionally, Al-Fuqaha et al. [18] (2015) emphasized that the seamless integration of multiple communication protocols is fundamental to ensuring the stable operation of large-scale agricultural IoT systems.

Platform Layer: The platform layer functions as the cognitive core of smart agriculture, serving as the central hub for realizing data value transformation. It is responsible for processing multi-source heterogeneous data and generating decision-support outputs. By storing, cleansing, and integrating dispersed data collected across the entire industrial chain, this layer effectively eliminates data silos between different production segments. Leveraging artificial intelligence and big data analytics, it facilitates decision support for each segment of production management through the constructing of domain-specific analysis models. These include growth prediction models, pest and disease early warning models, processing parameter optimization models, and market demand forecasting models. Wolfert et al. [19] (2017) emphasized that platform-based big data integration and analysis are fundamental enablers for transitioning smart agriculture from data collection to data-driven decision-making, thereby systematically improving operational efficiency across the entire agricultural value chain.

Application Layer: The application layer serves as the service interface of smart agriculture, acting as the terminal connection between agricultural technology

Table 1. Effects of Smart Agriculture Applications in the Mango Industry Chain.

Application Stage	Application Effects
Planting Stage	Sensor-based precision irrigation and fertilization system enables the dynamic adjustment of water and nutrient supplies according to the specific growth requirements of mangoes. Field data indicates that this approach reduces water consumption by 32% and fertilizer use by 27%, while increasing the yield of first-grade fruit by 16% [22, 23].
	With the improved YOLOv8 model, verified by public datasets, the model' s detection accuracy reaches 92.3%, and it also meets the requirements for high-precision real-time detection [24]. When integrated with a UAV-mounted AI visual inspection system, detection efficiency improves by more than 8-fold compared to traditional manual inspection. This significantly reduces labor costs, facilitates earlier risk identification, and minimizes yield losses [25].
Post-Harvest Processing and Manufacturing Stage	Machine learning models integrating MobileNet-v2 deep features achieve up to 99.5% accuracy in classifying Indian mango varieties, providing a technical foundation for automated variety identification in grading systems [28].
	Non-destructive testing solutions integrating machine vision and hyperspectral technology (detecting fruit shape, surface defects, and sugar content) substantially reduce labor costs compared to manual grading and generate notable post-harvest value-added benefits, significantly enhancing economic efficiency [29].
	A comparable "AI-based multi-dimensional quality non-destructive inspection-ultra-low temperature freezing-high-value precision processing" technology pathway, validated in lychee processing where it reduces overall costs by approximately 30% and maintains a processing defect rate below 2%, offers a transferable model for balancing efficiency with product quality stability in mango deep-processing lines [30]
Marketing and Brand-Building Stage	In terminal sales and brand building, the tamper-proof nature of blockchain technology addresses trust deficits in agricultural branding. Using Peru's mango export supply chain as a case study, blockchain-based traceability records full-chain information from orchard to consumer. This effectively eliminates information asymmetry between suppliers and buyers, enhances trust among purchasers and end consumers, and ultimately enables mango brands to command a significant price premium [33].

and industrial demand. By addressing the specific needs of various value chain segments, it translates the decision-making capabilities of the platform layer into actionable intelligent services spanning the entire process from field to market. In the cultivation segment, precision farming applications are developed to provide intelligent irrigation and fertilization planning, automated pest identification and early warning, and accurate maturity prediction. For the processing segment, intelligent management systems are established to support automated sorting, real-time process optimization, and online quality monitoring. In the distribution segment, intelligent warehousing and logistics solutions are implemented to achieve end-to-end temperature and humidity tracking and product traceability. Finally, in the sales segment, digital marketing tools are provided to facilitate consumer traceability queries and precision marketing interactions. Kamilaris et al. [20] (2017) emphasized that the scenario-based implementation of diverse applications represents the ultimate manifestation of big data analytics creating tangible value for the agricultural sector, thereby providing actionable decision support and automated management capabilities for producers and stakeholders across the supply chain. The overall architecture integrating these four layers—perception, transmission, platform, and application—across the entire mango industry chain is illustrated in Figure 1. Moreover, the recent emergence of large language models and generative AI is beginning to extend platform-layer capabilities from structured predictive analytics toward natural-language-based agronomic advisory services, offering a new direction for lowering the technical barrier to smart agriculture adoption among smallholder farmers.

3 Application Models of Smart Agricultural Technologies Across Industrial Chain Segments

Building on the four-layer technical framework introduced above, this section examines how smart agricultural technologies are concretely applied across the planting, post-harvest processing, and marketing segments of the mango value chain. The corresponding application effects and quantitative outcomes reported in the literature are summarized in Table 1.

3.1 Planting Stage: Precision Management and Intelligent Decision-making

In mango cultivation, the integration of smart technologies aims to transform traditional experience-dependent production into a precise, intelligent, and data-driven paradigm.

Intelligent Environmental Monitoring and Control: The cornerstone of mango cultivation management is the precise perception and dynamic monitoring of orchard microclimates and crop physiological status. An IoT sensor network continuously tracks critical parameters, including soil temperature, moisture, pH, and electrical conductivity (EC), alongside ambient temperature, humidity, and light intensity. This real-time data is transmitted to a cloud platform for analysis. Based on the specific physiological requirements of different growth stages, the system autonomously actuates drip irrigation and variable-rate fertilization mechanisms, thereby significantly enhancing water and nutrient use efficiency [21–23].

Intelligent Early Warning and Control of Pests and Diseases: Utilizing remote sensing or fixed cameras to capture canopy imagery, AI-powered image recognition facilitates the early detection of pest and disease symptoms [24]. By integrating meteorological data, predictive models forecast pest and disease outbreaks, issuing timely alerts to growers. This enables targeted pesticide application via unmanned aerial vehicles (UAVs), thereby minimizing the indiscriminate use of agrochemicals [25].

Growth Stage and Optimal Harvest Prediction: Leveraging historical and real-time monitoring data, big data analytics models predict mango phenological stages, including flowering, fruit setting, and the optimal harvesting window. Furthermore, integrating near-infrared spectroscopy (NIR) for non-destructive testing allows for the rapid, on-site quantification of internal quality parameters such as soluble solids content, titratable acidity, and dry matter. This provides a rigorous scientific basis for harvest scheduling and post-harvest grading [26].

3.2 Post-harvest Processing and Manufacturing: Intelligence-Driven Value Enhancement

This stage serves as the critical nexus between primary agricultural products and high-value-added finished goods. The application of smart technologies here directly dictates final product quality and operational profitability.

Intelligent Sorting and Grading: Advanced grading systems integrate weight sorting, optical sorting, X-ray detection, and near-infrared spectroscopy to achieve automated, precise classification. These systems evaluate both external attributes (fruit shape, diameter, peel color, and surface defects) and internal qualities (sugar content, acidity, and internal defects). Fruit is automatically diverted to designated packaging lines, with sorting speed and classification accuracy significantly surpassing manual sorting methods [27–30].

Intelligent Processing Workshop Management: Smart technologies facilitate the precise regulation of processing workflows. By integrating sensors and Programmable Logic Controllers (PLCs) into processing equipment, critical parameters—including temperature, pressure, rotation speed, and processing time—are monitored in real time and automatically adjusted. This ensures consistent product quality across all batches for end products such as mango jam and puree.

Intelligent Storage and Cold Chain Logistics: During the storage phase, IoT technology continuously monitors temperature and humidity within cold storage facilities, ensuring optimal preservation conditions for fresh mangoes and processed goods. A smart warehouse management system enables dynamic inventory optimization and precise scheduling. Concurrently, GPS and IoT sensors provide real-time visualization of environmental and locational data throughout cold chain distribution. This establishes an intelligent quality traceability system from storage to distribution, effectively mitigating post-harvest losses and guaranteeing product integrity [31].

3.3 Sales and Brand-Building Phase: Digital Marketing and Traceability-Based Credit Enhancement

Blockchain-Enabled Product Traceability System: Comprehensive production records, encompassing cultivation inputs, processing parameters, quality inspection reports, and logistics data, are immutably recorded on a blockchain. This generates a unique traceability QR code for each product batch. Consumers can scan this code to access complete lifecycle information from "tree to table", thereby significantly enhancing brand transparency and consumer trust [32, 33].

Digital Marketing and Market Analysis: Social media and content-driven e-commerce platforms provide cost-effective, high-efficiency marketing channels for regional mango brands. By leveraging e-commerce transaction data and social media analytics, operators can extract insights into consumer preferences and evolving market trends. This data-driven approach informs product development and targeted marketing strategies, ultimately amplifying the brand's market influence [34].

4 Challenges Faced

Although intelligent technologies have unlocked significant potential for quality improvement and efficiency enhancement in the mango industry, their large-scale implementation and diffusion face multiple bottlenecks, including economic barriers, talent shortages, technological hurdles, and public awareness gaps.

Economic Cost Barriers: A comprehensive smart agricultural system encompassing the entire industrial chain requires substantial upfront investment. Hardware expenditures include orchard environmental sensors, intelligent pruning and harvesting machinery, and plant protection and inspection UAVs. Concurrently, software necessitates fixed capital outlays for cloud platform deployment, data storage, and algorithm licensing, alongside continuous operational and maintenance costs [35]. In China, primary mango-producing regions such as Sichuan, Hainan, and Guangxi are predominantly characterized by mountainous and hilly topography, with production dominated by small-scale farmers and cooperatives. This structural reality imposes prohibitive economic pressure on these operators, constituting the most direct barrier to technology adoption.

Technical and Talent Barriers: Unlike staple grain crops, mango is a specialty economic crop with highly sophisticated agronomic requirements. Consequently, smart agriculture technologies must be extensively customized to accommodate specific production scenarios, including the biological characteristics of distinct mango varieties, harvest period management, and post-harvest quality control. This necessitates that practitioners possess not only comprehensive expertise in the entire mango production process but also technical proficiency to operate and maintain digital equipment and systems. Currently, China's agricultural sector exhibits a general deficit of interdisciplinary professionals in both agronomy and information technology. Furthermore, grassroots agricultural technology extension institutions frequently lack technicians equipped with practical skills in smart agriculture [36].

Data Standards and Interoperability Issues: The smart agriculture sector currently lacks unified equipment interfaces and standardized data protocols. Most sensing devices and management platforms developed by various manufacturers rely on closed, proprietary data architectures. Because equipment across the mango industry chain is sourced from multiple suppliers, seamless data sharing across production stages remains unattainable. Moreover, the heterogeneous coverage and access conditions of communication networks across mango-producing regions exacerbate this fragmentation: as Tang et al. [37] (2021) note, the uneven rollout of 5G infrastructure in agricultural settings creates uneven connectivity that further constrains real-time data exchange between field-level devices and platform-level systems. This data silos phenomenon is particularly acute within the mango industry: environment and growth data from the cultivation stage cannot be synchronized with quality grading parameters at the processing stage, nor can traceability and sales data from the distribution stage provide reverse feedback for variety optimization at the planting stage. This fragmentation severely restricts the efficacy of whole-industrial-chain intelligent decision-making.

Cognitive and Behavioral Barriers: Mango production and marketing in China remain predominantly managed by small-scale farmers, most of whom rely on long-accumulated traditional experience and exhibit low acceptance of novel technologies. The phenomena of technological reluctance ("daring not to use") and operational incompetence ("being not good at using") are widespread [38]. Overcoming this predicament requires not only clear demonstrations of economic benefits but also sustained, practical offline training and guidance. A 2021 FAO report on rural e-commerce and digital agriculture in China identified insufficient digital literacy and inadequate training as core bottlenecks hindering the digital transformation of the nation's agricultural sector [39].

5 Conclusion

Smart agricultural technologies serve as a fundamental catalyst for the high-quality and efficient development of the mango industry. Through the systematic deployment of IoT, big data, AI, and blockchain across the entire industrial chain, these technologies facilitate the optimization of resource allocation and the precise control of production processes. Furthermore, they substantially enhance product value-added potential and strengthen consumer trust in market brands, thereby providing robust digital support for the industrial upgrading of the mango sector.

Currently, the intelligent transformation of the mango industry is impeded by several challenges, including high initial cost thresholds, a shortage of specialized professionals, the absence of data standards, and insufficient technological adoption among market entities. Addressing these barriers necessitates coordinated efforts in policy guidance, technological innovation, and business model restructuring. With the ongoing enhancement of digital rural infrastructure and the decreasing costs of smart agricultural technologies, these systems are poised for deep integration throughout the entire mango industry chain. Ultimately, this integration will pave the way for significant advancements in product quality, operational efficiency, and the sustainable development of the industry.

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Conflicts of Interest

Chunxiang Yang is affiliated with the GourmetMore (Beijing) Technology Co., Ltd., Beijing 100081, China. The author declares that this affiliation had no influence on the study design, data collection, analysis, interpretation, or the decision to publish, and that no other competing interests exist.

AI Use Statement

The author declares that no generative AI was used in the preparation of this manuscript.

Ethical Approval and Consent to Participate

Not applicable.

References

[1] National Banana (Mango) Industry Technology System. (2026, March 20). China mango market and industry economic analysis [Industry information]. Cars31. Retrieved from http://www.cars31.cn/contents/9/3915.html

[2] Klerkx, L., Jakku, E., & Labarthe, P. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS: wageningen journal of life sciences*, *90*(1), 1-16. [CrossRef]

[3] Gao, A., Chen, Y., Luo, R., Huang, J., Zhao, Z., Wang, W., ... & Dang, Z. (2019). Development status of Chinese mango industry in 2018. *Adv. Agric. Hortic. Entomol*, *1*, 21-60. https://kosmospublishers.com/wp-content/uploads/2019/12/Development-Status-of-Chinese-Mango-Industry-in-2018.pdf

[4] DING, L., & ZHANG, Y. (2021). China's mango industry development situation and countermeasures. *Journal of Yunnan Agricultural University (Social Science)*, *15*(5), 65-69. [CrossRef]

[5] Lei, Y., Zhou, X., & Cheng, H. (2025). Assessment of emergy, environmental and economic sustainability of the mango orchard production system in Hainan, China. *Sustainability*, *17*(15), 7030. [CrossRef]

[6] Feng, Z. C., Li, Y. Y., Song, C., & Xie, C. D. (2022). Discussion on the sustainable development of modern mango industry in Yanbian County. *China Tropical Agriculture*, (5), 5-8. https://kns.cnki.net/kcms2/article/abstract?v=nTS8fe6ew4pwCjw0j0tm1b32L0RH4RJqk3KPiUBv0ww6kirlohkUUcZLCeX1rt61o5qRjNvBsZUGZwE85x8mp6rehV6dnslufR7o6aGtB1YudUgA-59pPjNbcTnPaACRM8EkGdrl3qtJRsj5NsYeQorYfwtHudWCUAnsj8XZPvM=&uniplatform=NZKPT

[7] Liu, B., Xin, Q., Zhang, M., Chen, J., Lu, Q., Zhou, X., ... & Sun, J. (2022). Research progress on mango post-harvest ripening physiology and the regulatory technologies. *Foods*, *12*(1), 173. [CrossRef]

[8] Yang, Y. N., Li, X. N., Zhou, J. J., & Zhang, S. Q. (2024). Research progress on mango preservation technology. *Agricultural Products Processing*, (9), 111-113. https://kns.cnki.net/kcms2/article/abstract?v=nTS8fe6ew4p8dyiebfSnwn0CxRGcwZ8eKdQvJrgE5tVDPlouOsy1glbtXpXWm_TfnO_jnNE7lWKUKmBe-Zvlp0R1RnXtOgGEL2ttqMAbrx5XLYdW5OcJlVdJJl5d4djQnDkJwUT7I7f1j8uYUIRGewFpW3GmZPdO4G2NJuJxgH8=&uniplatform=NZKPT

[9] Wei, S. C. (2022). Research on loss-reduction technology of mango during post-harvest low-temperature storage and transportation. [Master's thesis, Shanghai Ocean University]. https://kns.cnki.net/kcms2/article/abstract?v=yAka2kXFwSRwoSDaKfG9-zps-Bi3K6KvM4sUlldDzrCZFaLCzQN_ajAZrhXP9uWuTbwFZy6coMM7sEGB-DadgPsTghdYzsGYBSjXKi4KjXX0aEjoy-2ZsxnnzdscRA9eOLOQ3qx1VaEiJJJl2tOqjLgaopyj0MiCBYb1Zq6sCkYitUjsrweTEeOU2lTKQ5nu&uniplatform=NZKPT&language=CHS

[10] Guangxi Academy of Agricultural Sciences. (2023). Overcoming the difficulties in mango preservation and processing to boost the quality and upgrade of the featured industry. http://www.gxaas.net/front/detail/146/9140/95701

[11] Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., & Martynenko, A. (2020). IoT, big data, and artificial intelligence in agriculture and food industry. *IEEE Internet of things Journal*, *9*(9), 6305-6324. [CrossRef]

[12] Huang, Q., Yang, Z. R., Cen, Z. G., & Liang, Y. (2025). Analysis of current situation and development countermeasures of Baise mango industry. *Agricultural Research and Application*, 38(5), 515-522. [CrossRef]

[13] Pang, H. T., & Shi, R. (2026). Research on the development of mango industry competitiveness in Baise, Guangxi under the background of rural revitalization. *Cross-Strait Science & Technology and Industry*, 39(2), 66-71. https://kns.cnki.net/kcms2/article/abstract?v=nTS8fe6ew4olxTNBHoKHg5N57RsYb9uhhK0OKygXcS8elccgFeY5_CL-RUfe49rmoAk8oJZHpp-DrdmnGuCahxMP6o7hYVWsn_gtwodwenG4vNi5RNP1b9plWq-u04CLGWFrdl-F2nbyJ55vhOn0AQUGPOBo-LQ2&uniplatform=NZKPT

[14] Zou, W. P., & Wei, S. M. (n.d.). Exploration on brand building of Baise mango in Guangxi under the background of rural revitalization. *Journal of Smart Agriculture*, 4(21), 100-103. https://kns.cnki.net/kcms2/a

rticle/abstract?v=yAka2kXFwSStv5D_LNJxbi9hyKv_CfVrYf6kGQSWCTQu90Mb5cxWzE7NclZvL1N4TyGtUoKoF4xMt6oUx3UwLW1wy7bsMpLF18QovHuizwX62zcUCqA_gRLdhG7Nfp8wNZhuZed436GHN5YZeCgVQ_btXnABn9vn9ZltiFW_S7PJJyoUSbnn-A==&uniplatform=NZKPT&language=CHS

[15] Yang, Y. G., Li, H. Y., Xiao, M., Zhan, X. D., Pu, J. A., Hou, G. Q., Shi, Y. F., Zhao, Z., & Bai, Y. D. (2021). Current situation and countermeasures of mango industry development in Yuxi City. *Bulletin of Agricultural Science and Technology*, (5), 4-6. https://kns.cnki.net/kcms2/article/abstract?v=yAka2kXFwSR2AwExZ6jlbTeKI33mL8I0LAqiRuzOrDMNcWXrsdbkAvv5XeR3iuGfttXmrGUSGtnR2RaSlkHUYTtYgWUFvtqmnZ453AjCEz0gsKaCNTy6kKe5Hs-l7wKNHJ5W7rsdVhRc_7MzPn5h1G90MStQzb2bI063tfJpkwAuRBInRtknxA==&uniplatform=NZKPT&language=CHS

[16] Ranwa, M., Sri, K. R., Khare, A., Kumar, V., Kumar, K., Rajeshwar, J. R., & Niharika, M. (2024). A summative review of advances in sensor technology for precision agriculture. *Archives of Current Research International*, *24*(10), 257-275. [CrossRef]

[17] Wongrujira, K., Pun, U. K., & Rakmae, S. (2025). Implementation of LoRa-Based Remote Monitoring System for Precision Mango Farming. In *E3S Web of Conferences* (Vol. 661, p. 03003). EDP Sciences. [CrossRef]

[18] Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of things: A survey on enabling technologies, protocols, and applications. *IEEE communications surveys & tutorials*, *17*(4), 2347-2376. [CrossRef]

[19] Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). Big data in smart farming–a review. *Agricultural systems*, *153*, 69-80. [CrossRef]

[20] Kamilaris, A., Kartakoullis, A., & Prenafeta-Boldú, F. X. (2017). A review on the practice of big data analysis in agriculture. *Computers and electronics in agriculture*, *143*, 23-37. [CrossRef]

[21] Karunathilake, E. M. B. M., Le, A. T., Heo, S., Chung, Y. S., & Mansoor, S. (2023). The path to smart farming: Innovations and opportunities in precision agriculture. *Agriculture*, *13*(8), 1593. [CrossRef]

[22] Mohamed, Z. E., Afify, M. K., Badr, M. M., & Omar, O. A. (2026). IoT-driven smart irrigation system to improve water use efficiency. *Scientific Reports*, *16*, 2609. [CrossRef]

[23] Ahmad, U., Alvino, A., & Marino, S. (2022). Solar fertigation: A sustainable and smart IoT-based irrigation and fertilization system for efficient water and nutrient management. *Agronomy*, *12*(5), 1012. [CrossRef]

[24] Liu, H., Chen, X., & Chen, J. (2023). Research on the identification of common diseases of mango leaves based on improved YOLOv8. *Smart Agriculture*, 5(4), 124-136. https://kns.cnki.net/kcms2/article/abstract?v=yAka2kXFwSRicz1KQxmILzfiqQ7OPCkauX7BjVgghIA68fHOUnrW8owbF2zEi8FI2XYcjeGVg6B5gqoh9Yd9gKlOQuMKGpyJSEI6aMe3-IHmUJUIoV1j2jdw3yYX4Uv9aGYpx5y1Cqw7qdzi64SoeMw5YuKl3UNfMI_5h6Ae9Vc_oCZun9uO6QL83NcsYCsG&uniplatform=NZKPT&language=CHS

[25] Sreenithi, R. (2025). Smart agriculture: Enhancing plant disease detection with drone technology. *International Journal of Engineering Research and Sustainable Technologies* (*IJERST*), *3*(3), 1-8. [CrossRef]

[26] Gabriëls, S. H., Mishra, P., Mensink, M. G., Spoelstra, P., & Woltering, E. J. (2020). Non-destructive measurement of internal browning in mangoes using visible and near-infrared spectroscopy supported by artificial neural network analysis. *Postharvest Biology and Technology*, *166*, 111206. [CrossRef]

[27] Nithya, R., Santhi, B., Manikandan, R., Rahimi, M., & Gandomi, A. H. (2022). Computer vision system for mango fruit defect detection using deep convolutional neural network. *Foods*, *11*(21), 3483. [CrossRef]

[28] Ratha, A. K., Barpanda, N. K., Sethy, P. K., & Behera, S. K. (2024). Automated classification of Indian mango varieties using machine learning and mobilenet-v2 deep features. *Traitement du Signal*, 41(2), 669-678. [CrossRef]

[29] Department of Market and Informatization, Ministry of Agriculture and Rural Affairs. (2025). Intelligent sorting and full-chain digital technology for fruits and vegetables. https://chinacrops.org/44/202602/6390.html

[30] Department of Market and Informatization, Ministry of Agriculture and Rural Affairs. (2025). Intelligent quick-freezing and freshness-locking technology and high-value processing technology for lychees. https://chinacrops.org/44/202602/6390.html

[31] Han, J., Sun, C., Ji, Z., & Yang, X. (2025). Smart cold chain logistics for fresh agricultural products: Key technologies, challenges, and future trends. *Trends in Food Science & Technology*, 105421. [CrossRef]

[32] Zhai, Q., Sher, A., Li, Q., & Chen, C. (2022). Consumers' food control risk attitude for blockchain traceable information seeking: Evidence from fresh fruit buyers in China. *Frontiers in Sustainable Food Systems*, *6*, 984493. [CrossRef]

[33] Pérez, D., Risco, R., & Casaverde, L. (2020, September). Analysis of the implementation of Blockchain as a mechanism for digital and transparent food traceability in Peruvian social programs. In *2020 IEEE XXVII international conference on electronics, electrical engineering and computing* (*INTERCON*) (pp. 1-4). IEEE. [CrossRef]

[34] Fan, M., & Zhang, C. (2025). Social platform content marketing strategies for sustainable sales growth of local specialty green agricultural products. *Frontiers in Sustainable Food Systems*, *9*, 1609196. [CrossRef]

[35] Klerkx, L., & Rose, D. (2020). Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways?. *Global Food Security*, *24*, 100347. [CrossRef]

[36] Xiao, A. N., & Chen, W. Y. (2025). Research on countermeasures for high-quality development of Baise mango industry under the digital economy. *Special Wild Economic Animal and Plant Research*, 47(1), 240-245. https://kns.cnki.net/kcms2/article/abstract?v=qQAO62XqY5JJpgP1cAxFx-mDR-kOXhnS4Ovt5ZcKcL5lgbwoaV1OmUsjmvl_BawUv0Jw5zbos7AN8lhqKP8qZhDpF07YHLgP9EPOGvsR-qVe-GbPwJPNUj9acEF016WR25u2hPSkx5O2Nqi4GoNS5f_lLpl63aou1F-dRvEvqBdR6UXEBQbLLw==&uniplatform=NZKPT&language=CHS

[37] Tang, Y., Dananjayan, S., Hou, C., Guo, Q., Luo, S., & He, Y. (2021). A survey on the 5G network and its impact on agriculture: Challenges and opportunities. *Computers and electronics in agriculture, 180*, 105895. [CrossRef]

[38] Cao, B., Zhao, C., Li, J., & Fan, B. (2025). Current status, challenges and prospects of the development of intelligent agricultural technology in China. *Transactions of the Chinese Society of Agricultural Engineering*, 41(21), 1-10. [CrossRef]

[39] FAO. (2021). *Digital agriculture report: Rural e-commerce development experience from China*. Rome. https://openknowledge.fao.org/handle/20.500.14283/cb4960en

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