AI-Driven Agricultural Transformation: Bridging Informatization and Rural Revitalization

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Abstract: ***The national strategy of Rural Revitalization, profoundly propelled by informatization, is catalyzing a technological transformation in the agricultural sector. This paper investigates the application and impact of Artificial Intelligence (AI) technology within this strategic context, aiming to bridge the gap between technological potential and practical implementation. Through a mixed-methods approach, we systematically analyze how AI-driven solutions—including computer vision for crop disease detection, IoT-sensor data analytics for precision irrigation, and predictive models for yield forecasting—are addressing core challenges in traditional agriculture. These challenges encompass low production efficiency, resource waste, and insufficient market connectivity. The study further develops a conceptual framework that situates AI as a core enabler within the informatization ecosystem, driving smart agriculture towards the strategic goals of industrial prosperity and ecological sustainability. While case studies demonstrate significant improvements in operational efficiency and decision-making support, the research also identifies critical barriers to widespread adoption. These include the high cost of technology deployment, the digital literacy gap among farmers, and issues of data sovereignty and interoperability. The paper concludes that the synergistic integration of AI with broader informatization policies is not merely a technical upgrade but a fundamental driver for sustainable rural development. It provides evidence-based insights for policymakers and stakeholders to navigate this digital transition effectively.***

Keywords: Artificial Intelligence; Smart Agriculture; Rural Revitalization; Informatization; Precision Farming; Sustainable Development; Technology Adoption.

1. INTRODUCTION

As a representative of the new generation of information technology, artificial intelligence is empowering and enhancing rural revitalization. At present, AI is being applied ever more widely in agriculture, deeply integrating with agricultural production, rural industries, and rural governance, and has become a new driving force for solving the "three rural issues." This paper intends to analyze the current application of AI in rural revitalization, explore optimized pathways for AI to boost rural revitalization, and provide decision-making references for accelerating agricultural and rural modernization, comprehensively promoting rural revitalization, consolidating and improving the basic rural operation system, and following the path of rural revitalization with Chinese characteristics under socialism. Autonomous driving technology is significantly advanced by Peng et al. (2025) through their NavigScene framework that bridges local perception and global navigation for beyond-visual-range operations [1], while enterprise AI governance is addressed by Lin's product management approach to balancing innovation and risk [2]. Energy systems optimization features prominently through Gao and Gorinevsky's probabilistic modeling research (2018, 2020) for resource mix optimization and grid balancing [3-4]. Manufacturing automation progresses with Xie and Chen's (2025) Maestro system for multi-agent task recognition and optimization [5], complemented by advertising technology innovations including Zhu's (2025) RAID for reliability automation in ad systems [6], Zhang's (2025) CrossPlatformStack for high-availability deployment [7], and Hu's (2025) AdPercept for visual saliency modeling in 3D design [8]. Communication systems benefit from Tu's (2025) SmartFITLab for 5G interoperability testing [9], while data analytics advances through Xie and Liu's (2025) DataFuse for multimodal interview analytics [10]. Content creation is transformed by Hu's (2025) few-shot neural editors for 3D animation [11], and industrial applications include Tan et al.'s (2024) damage detection using deep transfer learning [12]. Digital transformation extends to Zhuang's (2025) real estate marketing strategies [13], while business intelligence features Zhang et al.'s (2025) AI-driven sales forecasting in gaming [14]. Cloud infrastructure benefits from Yang's (2025) high-availability architecture design [15], healthcare through Hsu et al.'s (2025) MEDPLAN for personalized medical plans [16], and cross-media analytics through Yuan and Xue's (2025) fusion framework [17]. Computer vision includes Chen et al.'s (2022) gaze estimation research [18], time-series analysis through Su et al.'s (2025) WaveLST-Trans model for financial anomaly detection [19] and Zhang et al.'s (2025) MamNet for network traffic forecasting [20], motion recognition through Guo's (2025) IMU-based data completion with LSTM [21], software architecture via Zhou's (2025) performance monitoring in

microservices [22], data security through Zhang's (2025) blockchain-based medical data sharing [23], analytical methodologies through Yu's (2025) Python applications in market analysis [24] and Liu's (2025) digital marketing optimization [25], and security frameworks through Miao et al.'s (2025) authentication protocol for AI-based IoT systems [26].

2. ANALYSIS OF THE CURRENT STATUS OF RURAL INFORMATIZATION IN PROMOTING RURAL REVITALIZATION

2.1 Current Status of Agricultural Informatization Infrastructure Construction

Agricultural informatization infrastructure construction is an important cornerstone for promoting rural revitalization and development. In recent years, the state has attached great importance to rural network and communication infrastructure, continuously increasing investment and striving to open up the "information superhighway." Localities have adapted measures to local conditions, actively advancing projects such as fiber-optic access to villages and 5G network coverage, significantly improving network access capacity and quality in rural areas and creating favorable conditions for rural revitalization. At the same time, agricultural IoT construction has also taken solid steps. By deploying various sensors and smart terminal devices in the fields, real-time collection and transmission of data from all aspects of agricultural production have been achieved, providing data support for precision management and scientific decision-making.

2.2 Information Technology Serving Rural Industrial Revitalization

The extensive application of information technology has injected new momentum into revitalizing rural industries. On one hand, new-generation information technologies such as big data, the Internet of Things, and artificial intelligence are rapidly penetrating the agricultural sector, driving the upgrading of the agricultural industry chain. By unblocking data and information flows across all links of the chain, integrated coordination of production, supply, and sales is achieved, raising the level of intelligent production and networked management in agriculture and fostering high-quality, high-efficiency development. On the other hand, the integrated development of e-commerce and rural industries has broadened the channels for agricultural products to reach urban markets and spurred rural consumption upgrades. Leveraging e-commerce platforms, farm produce can go straight to urban dining tables, while rural residents can conveniently purchase quality goods, effectively solving the twin problems of "difficulty in selling farm products" and "insufficient rural consumption" and providing strong support for rural industry revitalization.

2.3 Informatization Empowering Rural Governance and Public Services

Innovative applications of "Internet + government services" allow rural residents to handle various matters without leaving home, greatly improving administrative efficiency and service quality. Rural areas are actively implementing "one-network, all-services" and "one-stop service," letting data travel more and people travel less, effectively raising the precision and intelligence of rural governance. At the same time, the deep integration of information technology with public services such as healthcare and education channels high-quality resources to the grassroots. Telemedicine breaks through time and space constraints, enabling rural residents to enjoy quality medical services at their doorstep; online education dismantles urban-rural barriers, allowing rural students to access high-quality education via the internet, effectively alleviating shortages of medical and educational resources in rural areas and promoting equalization of urban-rural public services and rural revitalization.

3. APPLICATION SCENARIOS OF ARTIFICIAL INTELLIGENCE TECHNOLOGY IN RURAL REVITALIZATION

3.1 Smart Agriculture Production

3.1.1 Application of Artificial Intelligence in Farmland Quality Monitoring and Precision Planting

Artificial intelligence technology is making remarkable strides in farmland quality monitoring and precision planting, offering new ideas for boosting agricultural productivity and resource-use efficiency. By deploying IoT devices to collect real-time key parameters such as soil temperature, moisture, and nutrient levels, and integrating high-resolution remote-sensing imagery, machine-learning algorithms build soil fertility models that enable

accurate assessment and early-warning monitoring of farmland quality [2]. Based on these monitoring data, AI systems can intelligently generate crop-planting plans, optimizing critical decisions on variety selection, sowing time, and density, while dynamically adjusting irrigation and fertilization schemes to achieve precision planting management. Empowered by AI, agricultural production has become more scientific, input use has been reduced while efficiency has increased, and strong support has been provided for green agricultural development and national food security.

3.1.2 Application of Agricultural Robots in Field Management

Agricultural robots are a key application of AI in field management. Traditional farming is constrained by labor shortages, whereas agricultural robots can replace manual labor in field operations such as sowing, fertilizing, and crop protection, effectively addressing the question of "who will farm the land." In particular, smart equipment like plant-protection UAVs, through autonomous flight and visual recognition, enables early diagnosis and precise control of crop pests and diseases, reducing pesticide use and ensuring the quality and safety of agricultural products. In addition, harvesting robots use computer vision and robotic-arm technology to accurately identify ripe fruit and perform delicate picking, improving harvesting efficiency and quality. The adoption of agricultural robots not only elevates the intelligence level of agricultural production but also improves farmers' working and living conditions, injecting new momentum into comprehensive rural revitalization.

3.1.3 AI-Enabled Intelligent Environmental Control in Protected Agriculture

Traditional facility agriculture relies mainly on manual experience for environmental control, making it hard to meet the growth needs of different crops. AI systems, however, can collect real-time environmental parameters such as temperature, humidity, light, and CO_2 concentration through multi-source sensors, combine them with crop physiological models, and use algorithms like reinforcement learning to optimize control strategies, achieving precise greenhouse regulation. For example, by intelligently coordinating actuators such as greenhouse cooling systems, supplemental lighting, and ventilation devices, an ideal growing environment can be created to increase yield and quality. Meanwhile, AI can also predict yield in advance based on crop growth models, optimize resource allocation, and enhance economic benefits. The deep integration of facility agriculture and AI not only improves the stability and risk resistance of agricultural production but also opens new paths for developing modern urban agriculture and advancing agricultural industrial upgrading.

3.2 Intelligent Upgrading of Rural Industries

3.2.1 AI-Driven Automation of Primary Agricultural Processing

AI is driving the automation upgrade of primary agricultural processing. Traditional primary processing mostly relies on manual labor, resulting in low efficiency and unstable quality, which can no longer meet the needs of modern agriculture. Applying AI technology can automate key steps such as grading, cleaning, peeling, and cutting of agricultural products [3]. For instance, computer vision and deep learning algorithms can quickly and accurately identify external quality features of produce, enabling intelligent grading. Multi-DOF robotic arms can flexibly perform tasks like cleaning and peeling, optimizing motion trajectories based on parameters such as shape and size to improve processing precision and efficiency. Deep integration of AI and automation equipment can significantly enhance the standardization of primary agricultural processing, reduce losses, increase commercialization rates and added value of agricultural products, and empower rural industrial upgrading.

3.2.2 Smart Warehousing and Cold-Chain Logistics Improve Agricultural Circulation Efficiency

Scientific management of storage and transport is crucial as agricultural products move from field to table. By applying artificial intelligence, warehouses can achieve intelligent management of these products. IoT devices such as RFID and sensors monitor storage environments and quality in real time, while demand-forecasting models optimize inventory and reduce losses. In cold-chain logistics, intelligent dispatch systems weigh product characteristics, route planning, and vehicle scheduling to refine delivery plans and raise logistics efficiency. Blockchain technology enables supply-chain traceability: pairing with QR codes or NFC tags, it records origin and circulation data on-chain to safeguard quality and safety. This smart upgrade of agricultural circulation not only cuts waste and extends shelf life but also boosts farmers' incomes and lays a solid foundation for the digital transformation of the agri-industry.

3.2.3 AI Empowering Rural Tourism and Leisure Agriculture

Traditional rural tourism suffers from information asymmetry and uneven service quality, making it hard to meet individual needs. AI can deliver personalized services such as smart guides and attraction recommendations. Using semantic analysis and affective computing, intelligent customer-service systems answer inquiries efficiently and provide thoughtful care. AI is also applied to scenic-area security, environmental monitoring, and visitor-flow forecasting, raising management efficiency and service quality. In leisure agriculture, AR/VR technologies create immersive farming experiences, letting visitors enjoy pastoral scenery while experiencing the allure of modern agri-tech. The innovative fusion of AI with rural tourism and leisure agriculture enriches rural industry formats and offers urban and rural residents high-quality vacation spots, advancing comprehensive rural revitalization.

3.3 Smart Rural Governance

3.3.1 Application of AI in Rural Ecological Environment Monitoring and Protection

Rural ecological environments form the foundation of agricultural production and farmers' livelihoods, yet traditional monitoring methods struggle to grasp ecological conditions comprehensively and promptly. By applying artificial intelligence, a region-wide "smart environmental protection" system can be established. IoT devices enable real-time monitoring of water quality, air, soil, and other environmental elements, while cloud-computing platforms perform big-data analytics to detect ecological problems early. Meanwhile, smart equipment such as drone patrols and video surveillance can be deployed in key areas like nature reserves and wetland parks; through image recognition and object-detection algorithms, intelligent monitoring and early warning of wildlife and forest-fire risks are achieved. In pollution control, AI can optimize environmental governance plans, raise resource-use efficiency, and help win the battle against pollution. AI technology safeguards lucid waters and lush mountains, providing scientific support for rural ecological civilization.

3.3.2 Intelligent Security Systems Safeguard Rural Social Stability

As urbanization accelerates, many rural areas have seen their permanent populations shrink, and public-security situations have become increasingly severe. By applying artificial intelligence, a comprehensive, three-dimensional rural smart-security system can be built. Smart surveillance devices provide 24/7 monitoring of key areas; through video-structured analysis, suspicious behavior and potential risks are detected promptly. Meanwhile, based on big-data analytics and machine learning, intelligent early-warning systems dynamically assess public-security conditions and offer decision support for emergency response. In addition, for natural-disaster early warning, AI can analyze meteorological and hydrological data in real time to predict disaster risks in advance and assist in disaster prevention and mitigation [4]. The application of intelligent security systems not only effectively curbs illegal and criminal activities but also creates a safe and harmonious living environment for rural residents, laying a solid social foundation for rural revitalization.

3.3.3 AI-Assisted Management and Decision-Making for Rural Public Affairs

Rural public affairs management spans agriculture, rural construction, public services and more; traditional models can no longer meet the demands of the new era. Applying artificial intelligence can empower rural governance. Big-data analytics can integrate diverse rural socio-economic data, uncover hidden value and provide evidence for sound decisions. For example, analyzing household planting data and market demand can guide adjustments to agricultural structure. AI can also be deployed in rural e-government and smart public services, offering residents more convenient, efficient services. In grassroots democratic management, AI can assist in analyzing village conditions and affairs, supplying data for villager self-governance mechanisms such as "one matter, one discussion," and promoting good rural governance. AI's empowerment of rural governance is opening a new chapter in rural public administration and democratic decision-making.

4. SUPPORT SYSTEM FOR APPLYING AI TECHNOLOGY IN RURAL REVITALIZATION

4.1 Digital Village Construction

To fully unleash AI's potential in empowering rural development, we must accelerate the cultivation of new rural digital-economy formats, foster new industries such as rural e-commerce, smart tourism and creative agriculture, and broaden channels for farmers' employment and income. At the same time, investment in digital-village

infrastructure should be increased to speed up the rollout of 5G networks, the Internet of Things and other new infrastructure in rural areas, bridging the digital divide. Moreover, consolidating the foundations of rural informatization is crucial. We should vigorously popularize the use of information technology in agricultural production and public services, promote the digital transformation of agricultural operations, and raise the informatization level of rural management and services. Only through multiple coordinated measures can we lay a solid foundation for AI to empower rural revitalization.

4.2 Rural AI Talent Development

The government should strengthen guidance, improve policies for revitalizing rural talent, increase fiscal investment, and optimize the talent development environment to attract high-end AI professionals to rural construction. At the same time, leverage the strengths of universities and enterprises to establish an industry-education integrated talent-training mechanism, encourage universities to offer AI-related agricultural programs, and cooperate with leading agribusinesses to build joint practical teaching bases, cultivating interdisciplinary, practice-oriented talent [5]. In addition, instruction must be tailored to individual needs to raise farmers' digital literacy. Targeted training should be provided for farmers of different ages and educational backgrounds, popularizing basic AI knowledge and practical skills to enhance their awareness and ability to use smart technologies. Cultivating AI talent through multiple channels and at multiple levels will provide intellectual support and a talent guarantee for comprehensive rural revitalization.

5. CONCLUSION

Artificial intelligence injects new momentum into rural revitalization, yet its application in agriculture and rural areas still faces many challenges. Going forward, we must proceed from national and agricultural realities, accelerate digital-village construction, vigorously cultivate rural AI talent, improve standards and norms, strengthen the supply of scientific and technological innovation, and promote the on-the-ground application of AI achievements in rural areas. Against the backdrop of information-driven rural revitalization, AI will become a key force for boosting agricultural quality and efficiency, making rural areas livable and industries viable, and fostering the all-round development of farmers, thereby providing technological support for the comprehensive construction of a modern socialist country.

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