

Digital Intelligence Empowers Rural Revitalization: Design, Practice and Promotion Research of Gaoxian's Five-Dimensional Integration Cloud Platform

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Abstract: Against the background of rural revitalization and digital rural construction, the digital integration of county-level agricultural, cultural, tourism and ecological resources has become a key breakthrough in the modernization of agriculture and rural areas. Taking Gaoxian County in Yibin as a research sample, this paper focuses on its pain points such as traditional agricultural production, weak industrial linkage, and poor market information transmission, and constructs a "agriculture + ecology + culture + e-commerce + cultural tourism" five-dimensional integration cloud platform. With "agricultural large model + digital twin" as the core and adopting a "cloud-edge-end" architecture, the platform integrates technologies such as AI planting, blockchain traceability, and VR intangible cultural heritage activation, and builds four major functional modules to form a lightweight service system adapted to rural areas. Through resource integration and model innovation, the research realizes the coordinated development of agriculture, culture, tourism and ecology, lowers the threshold for entrepreneurship, and enhances industrial added value and brand strength. Its "modularization + whole-regionization + localization" model can provide replicable experiences for similar counties, enriching the theory and practice of multi-industry integration in digital rural areas and rural revitalization.

Keywords: Rural Revitalization; Digital Empowerment; Five-Dimensional Integration Cloud Platform; AI Agriculture; Integration of Agriculture, Culture and Tourism; Digital Intelligent Countryside

0. Introduction

Currently, the national government is vigorously promoting the strategies of rural revitalization and digital rural construction, injecting strong momentum into the modernization of agriculture and rural areas. The Report to the 20th National Congress of the Communist Party of China clearly points out that "the most arduous and onerous task in building a modern socialist country in all respects still lies in the countryside. We must accelerate the development of the digital economy and promote the in-depth integration of the digital economy with the real economy"^[1]. The Outline of the Digital Rural Development Strategy also explicitly proposes to vigorously develop digital agriculture, promote the in-depth integration of digital technology with agriculture and rural areas, and accelerate the process of industrial digitalization, cultural digitalization and intelligent ecological protection^[2]. In this context, how to empower county economies through digital technology to promote agricultural quality and efficiency improvement, rural environmental improvement, and farmers' income growth has become a key issue to be addressed.

As a typical agricultural county in southern Sichuan, Gaoxian County of Yibin City has significant ecological advantages and rich characteristic resources. Its specialty agricultural product "Shahe Watermelon" is renowned in Sichuan and Chongqing, and it has also nurtured intangible cultural heritages such as "Spring Wine Invitation" as well as traditional crafts like Shu embroidery and bamboo weaving. However, its development still faces many challenges: the agricultural production method is relatively traditional, the technological empowerment of characteristic industries is insufficient, and there is a lack of intelligent monitoring and precise management, leading to slow improvement in industrial efficiency and product added value; the integration of cultural resources with agriculture and tourism industries is low, the transformation of cultural

value is inadequate, and the regional brand influence is limited; the coordination mechanism between ecological protection and industrial development is weak, and the path of green and sustainable development has not yet been fully formed. These problems have seriously restricted the industrial upgrading and farmers' income increase in Gaoxian County. Therefore, constructing a digital platform that can integrate agricultural, cultural, tourism and ecological resources is of great practical significance and practical value.

To address the above development dilemmas, the "Zhigi Gaoxian • Whole-Region Agriculture-Culture-Tourism Cloud Platform" project has emerged as the times require. Based on the theories of digital countryside and rural revitalization, this project takes Gaoxian County as a practical case and is committed to building a comprehensive five-in-one cloud platform of "agriculture + ecology + culture + e-commerce + cultural tourism". The platform will realize real-time monitoring and precise regulation of the growth environment of characteristic crops such as Shahe Watermelon through technologies such as IoT sensors and intelligent water-fertilizer integration systems, promoting the transformation of agricultural production towards digitalization and intelligence. At the same time, it will deeply explore local cultural elements such as "Spring Wine Invitation" and Shu embroidery, and combine 3D printing and virtual reality (VR) technologies to develop cultural and creative products and immersive experience projects, enhancing the cultural connotation and brand value of the industry. In addition, through the innovative model of "Fruit Rhyme Cloud Cultivation + Ecological Rural Residence", the platform will provide online cloud-based planting management and customized experience services, and build an offline pastoral complex integrating sightseeing, picking and cultural experience, realizing the coordinated development and mutual promotion of online and offline.

This research not only helps to enrich the theoretical and practical achievements of digital countryside and rural revitalization, but also provides a reference solution for similar regions. Through the implementation of the platform, it is expected to achieve precise agricultural production, dynamic cultural inheritance, and systematic ecological protection, injecting new momentum into the rural revitalization of Gaoxian County and even broader areas.

1. Prominent Problems and Restrictive Conditions Facing Rural Industrial Development in Gaoxian County

1.1 Traditional Production Technology, Realistic Obstacles to Smart Agriculture Transformation

Agricultural production in Gaoxian County still generally adopts the experience-based management model. For cash crops such as Shahe Watermelon and yellow peaches, there is a lack of real-time data support in key links such as irrigation, fertilization, and pest control, which easily leads to the waste of water and fertilizer resources and large fluctuations in product quality and yield^[3]. The cutting-edge technologies relied on by modern smart agriculture, such as sensors, intelligent control platforms, and drones, not only have high purchase costs for ordinary farmers or small cooperatives, but also require relatively high technical proficiency. Restricted by factors such as capital investment, knowledge reserve, and maintenance capacity, farmers generally face the problem of "wanting to use but daring not to, and being able to use but not being good at it", making it difficult to popularize advanced production methods on a large scale and hindering the process of industrial upgrading^[4].

1.2 Weak Industrial Linkage Effect

Need for Improvement in the Integration of Agriculture, Culture and Tourism The three industries of agriculture, culture and tourism show a state of "isolated development" and fail to form an effective synergistic development effect. Agricultural products are mainly sold in primary form, and the deep processing link and the development of cultural and creative derivatives are relatively lagging behind. For example, apart from being eaten fresh, there are few products of watermelons and yellow peaches in extended fields such as beverages, food processing, and

cultural and creative gifts. Local intangible cultural heritage crafts such as Shu embroidery and bamboo weaving have not been effectively combined with agricultural product packaging and tourist souvenirs, and the added value of products has not been fully released. The integration of tourism resources is insufficient. Red memorial venues, intangible cultural heritage workshops, orchard scenic spots lack organic connection. Tourist experiences are mainly single activities such as picking and venue visits. Comprehensive cultural and tourism projects are scarce, and the overall attractiveness and consumption-driven effect are limited.

1.3 Poor Market Information Transmission, Weak Innovation and Entrepreneurship Ecosystem

Farmers' production decisions mainly rely on historical market conditions and surrounding planting situations. There is a serious information asymmetry between producers and consumers, leading to frequent occurrences of regional supply and demand imbalances^[5]. For example, due to supply and demand imbalances in recent years, the purchase price of yellow peaches in Gaoxian County has fluctuated significantly. The sales channels of agricultural products are still dominated by traditional commercial purchases and offline physical stores. The utilization of new sales channels such as e-commerce and live streaming is insufficient. In addition, there is a lack of product traceability systems and the ability to tell cultural stories. Consumers have a shallow understanding of the ecological connotation and cultural heritage of products, and the phenomenon of "good products not being able to be sold at good prices" is common^[6]. Rural areas lack comprehensive innovation and entrepreneurship service platforms. Returning young people and entrepreneurs have to independently cope with multiple challenges such as project planning, operation and management, and technological application, resulting in high trial-and-error costs and great difficulty in starting a business, leading to insufficient innovation vitality and talent aggregation effect. At present, Gaoxian County has not yet formed a one-stop service ecosystem that can centrally provide technical tools, resource connection, skill training, and market drainage, which to a certain extent inhibits the vitality of rural innovation and entrepreneurship and the aggregation of talents.

2. Construction Methods of the Five-Dimensional Integration Cloud Platform

Combining the characteristics of digital technology to design the overall platform architecture, core functional modules, and operation mechanism is a key link in building an "Internet +" rural innovation and entrepreneurship support platform that is adapted to rural innovation and entrepreneurship scenarios and has both technological innovation and practical value. It can empower the platform from the technical bottom layer, make digital technology truly an important starting point for rural innovation and entrepreneurship, promote the platform to accurately meet the actual needs of rural innovators and entrepreneurs, reduce the technical threshold and operation costs of innovation and entrepreneurship, and improve the efficiency, flexibility, and adaptability of platform services.

2.1 Based on the Characteristics of Digital Technology, Design a Multi-Level Overall Platform Architecture

Relying on the core characteristics of digital technologies such as cloud computing, containerization, and distributed storage, a multi-level overall platform architecture of "infrastructure layer – technical support layer – service application layer – user interaction layer" is constructed as shown in Figure 1, realizing functional coordination, data intercommunication, and resource sharing among all levels. The infrastructure layer integrates hardware resources such as edge computing nodes, cloud servers, and rural network base stations to provide stable computing power and network support for the platform, adapting to the scenario characteristics of uneven distribution of rural network resources; the technical support layer builds a PaaS-level technical base based on Docker Engine containerization technology and microservice architecture, encapsulating basic software such as operating systems, databases, and development

frameworks to realize elastic scheduling of technical resources^[7]; the service application layer focuses on the actual needs of rural innovation and entrepreneurship and develops scenario-based service modules such as rural e-commerce, rural tourism, and digital agriculture; the user interaction layer creates lightweight interaction entrances such as WeChat mini-programs, rural exclusive webpages, and mobile APPs, adapting to the operating habits of rural innovators and entrepreneurs, and realizing one-click access and use of platform services^[8]. The overall architecture follows the principles of "lightweight, modularization, and scalability", which not only reduces the difficulty of underlying technical management, but also dynamically adjusts architecture modules according to changes in rural innovation and entrepreneurship needs. ![img] (WeChat Mini-Program Rural Exclusive Webpage Mobile APP Actual Needs Rural E-commerce Rural Tourism Digital Farm Service Application Layer Technical Support Layer Rural Network Base Stations Edge Computing Nodes Cloud Servers Infrastructure Layer)

2.2 Focus on Rural Entrepreneurship Scenarios, Build Core Functional Modules of the Platform

Guided by the scenario-based needs of rural entrepreneurship and empowered by digital technology, this platform builds four core functional modules that are interconnected and can be independently combined to achieve in-depth adaptation of services to entrepreneurship scenarios^[9]. The scenario-based technical service module provides deployment-free technical templates covering core entrepreneurship scenarios; the data management and analysis module integrates various types of data to solve the problem of information asymmetry; the resource connection and incubation module opens up online channels to achieve precise matching of various resources; the platform operation and management module intelligently controls platform operation to ensure service quality. Overall, services and resources can be selected and configured on demand^[10].

2.3 Construct a Technology-Driven Full-Process Operation Mechanism of the Platform

Based on the automated, intelligent, and distributed characteristics of digital technology, the platform builds a full-process operation mechanism of "resource encapsulation – demand matching – elastic scheduling – dynamic update – feedback optimization" to ensure efficient, flexible, and sustainable operation of the platform^[11]. The resource encapsulation mechanism standardizes and encapsulates various resources according to rural entrepreneurship needs, generates quickly deployable container images, and manages them in a standardized manner; the demand matching mechanism realizes intelligent matching between entrepreneurship needs and platform resources through user portrait construction and demand keyword extraction, supporting precise service push and one-click deployment; the elastic scheduling mechanism dynamically allocates resources relying on cloud computing and containerization technologies, adapting to the fluctuating characteristics of rural entrepreneurship resource needs and avoiding waste; the dynamic update mechanism iterates template images and service modules on demand to ensure advanced technology and adaptive services; the feedback optimization mechanism collects information through multiple channels and conducts data analysis to form an optimization closed loop, continuously improving the quality of platform services and scenario adaptability^[12].

3. Technical Implementation of the "Five-Dimensional Integration" Rural Innovation and Entrepreneurship Support Platform Under the Background of Rural Revitalization

3.1 Platform Technical Route

The platform takes "agricultural large model + digital twin" as the core technical base, combined with a technical architecture adapted to rural scenarios, to realize centralized management and elastic scheduling of underlying technical resources. This allows rural innovators and entrepreneurs to directly obtain full-process services through lightweight entrances without having to pay attention to complex operations such as server deployment and operating system configuration. The technical selection focuses on rural actual needs: in agricultural production

scenarios, technologies such as AI multi-modal perception, computer vision-based pest and disease identification, and satellite remote sensing-based yield prediction are adopted to realize intelligent management and control of the entire planting process; in ecological governance scenarios, waste identification algorithms and carbon sink accounting models are integrated to quantify ecological value; in cultural inheritance scenarios, technologies such as VR immersive experience, virtual digital human performances, and digital collection generation are used to activate intangible cultural heritage resources; in e-commerce and cultural tourism scenarios, intelligent recommendation engines, blockchain traceability systems, and online cloud tour modules are built to open up the "cloud seeding – offline consumption" link^[13]. The overall technical route follows the logic of "technology adapting to scenarios and functions serving needs", ensuring seamless connection between cutting-edge technology and rural practical applications.

3.2 Deployment of Core Technical Architecture

The platform adopts a three-level deployment architecture of "cloud-edge-end" to realize the rational allocation and efficient coordination of computing resources. The cloud end deploys agricultural large models, digital twin systems, and data middle platforms, integrating multi-dimensional data such as agricultural production, ecological environment, cultural resources, and market demand in Gaoxian County to provide model training, data storage, and intelligent analysis services; the edge end deploys IoT gateways and edge computing nodes to collect real-time data such as farmland temperature and humidity, soil moisture, and crop growth status nearby, reducing network transmission delay and ensuring real-time data interaction in remote villages; the terminal takes the WeChat mini-program "Shiyun Huzhu" as the core entrance, with supporting mobile-adapted versions, supporting lightweight access for different user groups such as farmers, entrepreneurs, and tourists, and realizing one-click operation of functions such as planting management, product sales, cultural and tourism reservations, and cultural experiences^[14]. Based on technology, core functional modules are encapsulated to form quickly deployable container images, including five templates: "intelligent agricultural planting service", "ecological cycle governance service", "digital inheritance service of intangible cultural heritage", "intelligent e-commerce operation service", and "integration service of agriculture, culture and tourism". Resources are dynamically allocated according to user needs, and functional modules are flexibly combined. Through the unified management of container clusters, resource scheduling, load balancing, and fault self-healing are automatically completed, ensuring the stability of the platform during high-concurrency access and simultaneous operation of multiple scenarios^[15].

3.3 Key Technical Implementation Details

Based on the growth data, historical climate data, and planting experience data of local crops in Gaoxian County (such as Shahe Watermelon and yellow peaches), a dedicated intelligent planting model is trained. AI algorithms are used to dynamically optimize irrigation, fertilization, and pest control schemes. Combined with satellite remote sensing and field IoT data, real-time modeling and precise prediction of crop growth are realized. Blockchain traceability and rights confirmation: a "grain code traceability" system is built to assign unique blockchain identifiers to agricultural products, cultural and tourism products, and intangible cultural heritage cultural and creative products, recording the entire process information from production, processing, circulation to consumption to ensure product credibility; at the same time, ecological protection behaviors (such as waste resource utilization) and cultural inheritance contributions (such as the dissemination of intangible cultural heritage crafts) are converted into confirmable "ecological value points" and "cultural contribution values", and the ownership and redemption rights of values are guaranteed through blockchain technology. Build an "intangible cultural heritage digital workshop", use multi-modal large models to deeply explore the technical details and cultural connotations of intangible cultural heritage resources such as bamboo weaving and Gaoxian local hot pot,

develop VR immersive experience courses, virtual digital human craft performance videos, and AI-generated digital cultural and creative products, supporting users' online learning, interactive experience, and purchase consumption, and expanding the coverage of cultural communication. Develop a "rural digital passport" system, integrate resources such as ecological homestays, agricultural experiences, intangible cultural heritage workshops, and red venues, and push personalized travel routes according to user portraits through intelligent recommendation engines; build an online cloud tour module, use 3D modeling technology to restore rural styles and cultural scenes, realize the linkage between "cloud check-in" and offline experience, and form a complete economic chain.

3.4 Technical Support System

A three-fold guarantee mechanism of "data security + operation adaptation + continuous iteration" is established. In terms of data security, a multi-level protection system is constructed to encrypt and store sensitive data such as agricultural production data, user information, and cultural resources, and control access rights to prevent data leakage and abuse; in terms of operation adaptation, the interface design of the mini-program is optimized, the operation process is simplified, and offline technical training and online customer service guidance are provided to reduce the digital use threshold for groups such as farmers and elderly entrepreneurs; in terms of continuous iteration, a closed loop of "rural demand feedback – technical optimization and iteration" is built. User opinions are collected through online questionnaires and offline visits, and combined with the actual development needs of rural areas, algorithm models are dynamically updated, functional modules are optimized, and service scenarios are expanded to ensure that platform technology always meets the needs of rural innovation and entrepreneurship^[16].

4. Conclusion

In summary, the five-dimensional integration cloud platform constructs an overall integrated ecosystem of "agriculture + ecology + culture + e-commerce + cultural tourism" in Gaoxian County, expands the market through intelligent e-commerce, and extends the industrial chain through the integration model of agriculture, culture and tourism. The platform adheres to the ecological bottom line, promotes ecological planting technologies, controls the carrying capacity of scenic spots, and builds a waste recycling system. It awakens local cultural resources through digitalization, explores characteristic cultures, develops diverse carriers, and enhances cultural influence. It builds a link for the two-way flow of urban and rural factors, narrows the gap in public services, and promotes talent exchange^[17]. Adhering to the construction experiences such as overall resource integration and four-party linkage, the platform optimizes and upgrades from multiple aspects such as technology and operation. Its "modularization + whole-regionization + localization" model can be replicated and promoted, providing core inspirations of overall planning, practical technology, and equal emphasis on culture and ecology for the construction of digital rural areas across the country^[18].

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