

Agricultural Intelligent Knowledge Services Enabling Rural Revitalization: Internal Mechanisms and Dilemma Alleviation (Post-print)

Authors: Li Tian, Zhao Ruixue, Xian Guojian, Kou Yuantao

Date: 2024-04-03T00:00:00+00:00

Abstract

[Purpose/Significance] To address limitations such as the scarcity of micro-level research on enabling rural revitalization and the unclear understanding of how knowledge services impact rural revitalization, this study provides theoretical references and practical solutions for injecting digital intelligence momentum into the solid advancement of comprehensive rural revitalization. [Method/Process] Through literature review, research priorities are clarified; the foundation for enabling is organized around data, applications, and services; enabling mechanisms are analyzed from three dimensions—agricultural production, farmers' livelihoods, and rural governance—to construct the internal mechanism of how agricultural intelligent knowledge services enable rural revitalization; enabling dilemmas are examined through internal-external integration, and optimization paths for enabling are proposed. [Results/Conclusions] Agricultural knowledge services have entered an intelligent stage, possessing a solid enabling foundation in terms of data, applications, and services. They inject digital intelligence momentum into the comprehensive advancement of rural revitalization by enabling the development of new production models, facilitating the transformation of farmers' multiple identities, and empowering diverse stakeholders to participate equally in governance. However, internally, there exist problems of obvious user group bias and missing service content, while externally, they face challenges of unbalanced infrastructure and low literacy among primary users. These enabling dilemmas can be alleviated by clarifying enabling needs, integrating enabling scenarios, and enhancing enabling effects.

Full Text

Abstract

[Purpose/Significance] This study addresses the gaps in existing research, including the limited micro-level investigation of rural revitalization empowerment and the unclear impact of knowledge services on rural revitalization, aiming to provide theoretical reference and practical solutions for injecting digital intelligence momentum into the comprehensive advancement of rural revitalization. **[Method/Process]** Through literature review, this paper clarifies research priorities, systematically examines the enabling foundation from the perspectives of data, application, and service, analyzes the enabling mechanisms from three dimensions—agricultural production, farmers’ livelihoods, and rural governance—to construct the internal mechanism of agricultural intelligent knowledge services empowering rural revitalization. It further examines empowerment dilemmas by combining internal and external factors and proposes optimization paths for empowerment. **[Results/Conclusions]** Agricultural knowledge services have entered the intelligent stage, establishing a solid enabling foundation in data, application, and service. By empowering the development of new production models, facilitating the transformation of farmers’ multiple identities, and enabling equal participation of diverse stakeholders in governance, these services inject digital intelligence momentum into the comprehensive advancement of rural revitalization. However, internal challenges include obvious user group bias and missing service content, while external challenges involve unbalanced infrastructure and low user literacy. These dilemmas can be alleviated by clarifying empowerment needs, integrating empowerment scenarios, and enhancing empowerment effects.

Keywords: intelligent knowledge service; rural revitalization; artificial intelligence; internal mechanism; information literacy

1 Introduction

The integration of information technology in agriculture has given rise to smart agriculture, with information as a core element. This has demonstrated the tremendous potential of knowledge and intelligence in empowering agriculture and rural areas. As the focus of work has completed the strategic shift from poverty alleviation to comprehensive rural revitalization, using knowledge and intelligence to empower rural revitalization has become an opportune practical topic in the information service field. For several consecutive years, central government documents have emphasized the need to comprehensively promote rural revitalization. Currently, society has entered a period of rapid digital economy development, where the new kinetic energy role of data elements has been further strengthened. As a new business form and model in agricultural knowledge services, agricultural intelligent knowledge services offer broad possibilities for empowering rural revitalization. How to inject digital intelligence momentum for rural revitalization and solidly advance comprehensive rural revitalization

has become an urgent practical question that needs to be answered.

This study analyzes the current research status of agricultural intelligent knowledge services empowering rural revitalization, explains its necessity, and further analyzes the development and enabling foundation of agricultural intelligent knowledge services to clarify its possibilities. Based on this analysis, the paper examines the problems and challenges in agricultural intelligent knowledge services empowering rural revitalization and proposes solutions, providing theoretical reference and practical solutions for better empowering rural revitalization through knowledge services and better developing agricultural intelligent knowledge services.

2 Literature Review

2.1 Limited Micro-Level Research on Empowering Rural Revitalization

The concept of “empowerment” was first proposed by psychologist Rappaport in 1984, referring to the process by which organizations or groups acquire capabilities and enhance competitive advantages. It mainly includes two meanings: first, from a process perspective, it refers to the process by which relevant actors acquire or enhance certain capabilities; second, from a result perspective, it refers to the objective outcome of capability enhancement brought about by the empowerment process. Existing research on empowering rural revitalization mainly covers two dimensions: the empowerment process and empowerment results. The empowerment process is primarily analyzed from the three dimensions of agricultural production, rural life, and rural governance included in rural revitalization, while empowerment results revolve around helping achieve the five major development goals of rural revitalization.

Current literature has conducted thorough analyses and discussions on the mechanisms and implementation paths through which the digital economy, characteristic industries, and digital culture industries empower rural revitalization, providing a rich theoretical reference framework. However, existing research on rural revitalization from an empowerment perspective is concentrated at the macro and meso levels, focusing primarily on economic models or industrial solutions, lacking direct empowerment tools and means at the micro level. Although some studies 切入 from micro perspectives such as digital technology or green food, they mainly focus on partial assistance to the rural revitalization strategy rather than macro-level solutions or strategies.

This study 切入 from the perspective of agricultural intelligent knowledge services empowering rural revitalization, extending the research on rural revitalization from an empowerment perspective to micro-level tools and means. This approach can not only clarify the impact and changes that agricultural intelligent knowledge services may produce on rural revitalization but also supplement the relevant research on empowering rural revitalization at the micro level.

2.2 Unclear Impact of Knowledge Services on Rural Revitalization

Research on rural revitalization from the perspective of knowledge services has analyzed knowledge service models for rural revitalization from the perspective of knowledge service providers such as libraries and scientific journals. For example, Zhu Meirong explored a scenario of public library smart services empowering new professional farmers' information literacy cultivation. Feng Changyang analyzed the basic logic and main requirements of library intelligent services under the background of the rural revitalization strategy and distilled the intelligent service models and risks. Chen Dazhao elaborated on the innovative development ideas of forestry knowledge services under the rural revitalization strategy from four aspects: platform and resources, internal and external environment, and construction.

However, the overall impact of knowledge services on rural revitalization remains unclear. Agricultural knowledge services, as specific applications of knowledge services in the agricultural field, possess dual characteristics of knowledge service 内核 and agricultural domain features. After experiencing an exploratory period intertwined with agricultural information services and a 爆发 development period characterized by platformization, agricultural knowledge services are now developing toward intelligence, entering the digital intelligence development stage. Although there is no clear definition of agricultural intelligent knowledge services yet, related research on intelligent knowledge services indicates that knowledge services have entered the intelligent knowledge service stage. For instance, intelligent search that enables access and retrieval across different modalities, intelligent Q&A for search services, and other new functions and applications have emerged. These new functions and applications have greatly enhanced the ability of agricultural intelligent knowledge services to empower rural revitalization.

3 Enabling Foundation: Advantages of Agricultural Intelligent Knowledge Services

The proposal of agricultural intelligent knowledge services empowering rural revitalization is not only necessary but also feasible. This study analyzes the advantages of agricultural intelligent knowledge services from the perspectives of development status and enabling foundation to demonstrate the feasibility of these services empowering rural revitalization.

3.1 Agricultural Knowledge Services Have Entered the Intelligent Stage

Currently, academia has not yet provided a clear definition of agricultural intelligent knowledge services. Only Zhao Ruixue et al. have proposed that agricultural intelligent knowledge services are technical systems constructed by researchers based on agricultural operators' information needs and experiences, using full-chain data of agricultural planting and production as the founda-

tion to provide personalized, data-knowledge-solution value chain intelligent knowledge services. Characterized by real-time perception of agricultural conditions, intelligent prediction of agricultural production, precise recommendation of agricultural knowledge, and smart decision-making in agricultural management, agricultural intelligent knowledge services represent the latest business form and model in agricultural knowledge services.

Although there is no consensus definition, research on intelligent knowledge services shows that knowledge services have entered the intelligent stage. For example, numerous big data intelligent knowledge service platforms have emerged domestically and internationally. Based on traditional knowledge service content and methods such as search and consultation, new functions have appeared, including intelligent search enabling access and retrieval across different modalities and intelligent Q&A providing question-and-answer style search services. These new functions and applications, with engineering applications of knowledge organization systems and intelligent applications of big data governance technology systems as typical features, have significantly improved the ability of agricultural intelligent knowledge services to empower rural revitalization.

3.2 Enabling Foundation: Changes in Data, Application, and Service

The enabling foundation behind agricultural intelligent knowledge services mainly stems from changes in three dimensions: data, application, and service.

3.2.1 Data: Expanded Acquisition Scope and Enriched Application Methods Agricultural knowledge services differ from other knowledge services in that agricultural data occupies a significant proportion. Agricultural data includes both narrowly defined biophysical information about agricultural crops themselves and their environment, and broadly defined social information about people engaged in agricultural production and market dynamics. Whether biophysical or social information, both are in constant dynamic change.

Agricultural intelligent knowledge services have utilized remote sensing technology, IoT technology, and other means to achieve real-time dynamic data acquisition, breaking temporal and spatial limitations in data collection. The proportion of fresh data in datasets has continuously increased, with overall data shifting from relatively static to real-time dynamic. Data application methods have become more diverse, with both posterior and prior data being utilized. Posterior data refers to mining and analyzing previously collected data to discover and summarize new knowledge. Prior data can predict outcomes before a decision is fully implemented. When data acquisition is insufficiently dynamic and real-time, knowledge services mainly rely on posterior data, focusing on thematic services and consultation. After breaking through temporal and spatial limitations in data acquisition through remote sensing and ICT technologies, agricultural intelligent knowledge services can provide rich prior data applications, such as intelligent production guidance and production-marketing coordination, through algorithm and model exercises based on artificial intelligence.

The expansion of data acquisition scope and enrichment of application methods provide possibilities for full-chain data acquisition and full life-cycle service guidance in agricultural production (pre-production, mid-production, post-production). This greatly enhances the ability of agricultural intelligent knowledge services to empower farmers' production and operation and policy departments' management decision-making.

3.2.2 Application: Panoramic Coverage Breaking Spatial-Temporal Limitations In terms of application, agricultural intelligent knowledge services can achieve panoramic coverage of functions and applications through online platforms, computer terminals, and mobile terminals, extending the breakthrough of spatial-temporal limitations from the data level to the application level and breaking the limitations between production and life. Under rich application scenarios, agricultural intelligent knowledge services can link agricultural production with market sales and deliver data, knowledge, and solutions to target users anytime and anywhere, whether in fields or at conference sites.

This panoramic application coverage is mainly achieved through three approaches. First, the “base + platform” model forms offline application bases for agricultural intelligent knowledge services through agricultural science and technology parks and agricultural technology extension stations, while building online platforms with various agricultural intelligent service platforms, achieving interconnectivity between offline bases and online platforms. Second, the “online + offline” model uses various mobile applications to achieve linkage between PC and mobile terminals. With the popularization of smartphones, the era of mobile Internet has quietly arrived. According to the 50th Statistical Report on China's Internet Development, as of June 2022, China's netizen population reached 1.051 billion, with 99.6% using mobile phones to access the Internet. Providing mobile applications has become an important development trend for agricultural intelligent knowledge services, with WeChat public accounts and mini-programs becoming important mobile platforms.

Third, the “large screen + small screen” model combines digital large screens with mobile small screens. Digital large screens use large displays to visually present data as charts, videos, and other intuitive content through visual language, effectively compensating for mobile screens' deficiencies in content richness and interactivity. In recent years, digital large screens have been increasingly applied in B-end enterprises and government projects, providing panoramic application coverage that enhances users' ability to utilize agricultural intelligent knowledge services anytime and anywhere, breaking rural spatial and geographical limitations.

3.2.3 Service: User-Participatory Services Achieving Personalized Customization Personalization is an important characteristic of agricultural intelligent knowledge services. Through user profiling based on IP addresses, historical behavior, and other personalized data, agricultural intelligent knowl-

edge services provide personalized page displays and function recommendations. For example, farmers from major soybean-producing regions are prioritized to see the soybean thematic database. This personalized service not only enhances user engagement but also improves the targeting of agricultural knowledge services and increases service conversion efficiency.

The enhancement of data acquisition and application development capabilities has strengthened agricultural intelligent knowledge services' ability to provide customized data and applications for specific groups. The difficulty in advancing rural revitalization lies in China's vast territory with huge differences in geographical conditions and development levels, making it challenging for one-size-fits-all data or solutions to achieve ideal results. The enhanced personalized customization and service capabilities of agricultural intelligent knowledge services are precisely conducive to solving this problem.

4 Enabling Mechanism: Internal Mechanism of Agricultural Intelligent Knowledge Services Empowering Rural Revitalization

As a typical model integrating digital technology, data, and other emerging elements, agricultural intelligent knowledge services empower rural revitalization by enabling new production relations and productive forces. Drawing on common analytical frameworks in rural revitalization empowerment research, this study constructs an analytical framework for agricultural intelligent knowledge services empowering rural revitalization, analyzing the internal mechanism from three dimensions: agricultural production, farmers' livelihoods, and rural governance.

[Figure 1: see original paper] Agricultural Intelligent Knowledge Service Empowering Rural Revitalization Analytical Framework

4.1 Agricultural Production: Enabling Development of New Production Models

Agricultural production has entered a transformation and development stage, with new production models such as digital agriculture and precision agriculture continuously emerging, driving the modernization and digital transformation of agricultural production. These new-generation agricultural production models share a common driving element: the ability to achieve information perception and acquisition and intelligent decision-making and implementation through new-generation information technology. Agricultural intelligent knowledge services, with intelligent perception and scientific implementation as main content, have unique advantages in promoting agricultural production information perception, acquisition, and intelligent decision-making and implementation.

By providing a data-knowledge-solution core, agricultural intelligent knowledge services promote the deep integration of data and knowledge as production fac-

tors with agricultural production, boosting the emergence and development of new production models. For example, intelligent pest and disease diagnosis applications facilitate the realization of visual and precise perception in smart agriculture. For precision agriculture, rapid detection and analysis technologies for soil environment information, crop growth information, climate information, and agricultural product quality information are important foundations. Agricultural intelligent knowledge services have developed intelligent applications for holographic perception of agricultural conditions and precise identification of animal and plant life states based on remote sensing, geographic information technology, and global positioning technology, providing real-time agricultural condition services and enabling one-stop real-time viewing of crop growth and livestock information in different regions to guide crop production and field management strategies.

4.2 Farmers' Livelihoods: Enabling Transformation of Farmers' Multiple Identities

Farmers are one of the main user groups of agricultural intelligent knowledge services. The empowerment of rural revitalization by agricultural intelligent knowledge services is also reflected in the impact on farmers' lives and the transformation of their roles. First, agricultural intelligent knowledge services equip farmers with knowledge by providing training materials and knowledge, achieving low-cost, unlimited-time knowledge acquisition and utilization through intelligent retrieval, which is conducive to cultivating new-type farmers who are educated, technically skilled, and good at management. Second, agricultural intelligent knowledge services equip farmers with capabilities. For example, using sensors to collect breeding environment parameters 24 hours a day and identify livestock life indicators and behaviors, intelligent pest and disease diagnosis through photo recognition of major crops and livestock diseases—these intelligent applications enhance farmers' sensory capabilities of hands, eyes, and ears, enabling them to detach from production lines to a certain extent and transform from relying on traditional factors such as land to relying on technical factors such as networking and information.

Agricultural intelligent knowledge services empower the transformation of farmers' roles, enabling them to shift from a single farmer role to multidimensional roles such as new professional farmers and digital farmers. On one hand, agricultural intelligent knowledge services provide knowledge for farmers' production and operation to reduce production costs and improve production efficiency. On the other hand, platforms can provide decision-making guidance for farmers' production and sales to increase production income. With the emergence of new professional farmers and digital farmers, farmers' income levels improve, and their consumption levels in both material and spiritual culture continuously increase, enhancing their prosperity.

4.3 Rural Governance: Enabling Equal Participation of Multiple Stakeholders in Governance

Since the Qin Dynasty, China's rural governance has roughly formed four rural governance scenario models and is currently in the stage of digital technology enabling the integration of multiple stakeholders in governance. Co-governance by multiple stakeholders is a key element of rural governance. Agricultural intelligent knowledge services, with their improved intelligence and precision levels, have advantages in reducing the cost of knowledge search and utilization, including time, money, and usage thresholds.

Research investigating 14 typical national rural governance cases selected by the Ministry of Agriculture and Rural Affairs found that information openness and sharing in village communities can reshape governance fields, facilitate the transformation of governance structures from closed to open, and enhance governance subjects' information collection capabilities to achieve transparent and scientific decision-making processes. These scenarios all revolve around agricultural production. If data correlations behind phenomena can be quickly collected and viewed, governance can be carried out proactively and efficiently. Agricultural intelligent knowledge services, based on data and knowledge to provide solutions, are conducive to improving the governance capabilities of multiple rural governance stakeholders, including village-level grassroots autonomous organizations, and enabling equal participation of multiple stakeholders in governance.

5 Enabling Dilemmas: Challenges of Agricultural Intelligent Knowledge Services Empowering Rural Revitalization

Despite optimistic prospects in terms of enabling foundation and mechanisms, agricultural intelligent knowledge services face challenges in empowering rural revitalization that affect their effectiveness. From the perspective of agricultural intelligent knowledge services themselves, there are problems of limited influence scope and incomplete influence effects. From external perspectives, challenges include insufficient infrastructure support and low user literacy.

5.1 Internal Problems of Agricultural Intelligent Knowledge Services Empowering Rural Revitalization

From the perspective of rural revitalization tasks and goals, especially from the perspective of assisting rural revitalization, the internal problems of agricultural intelligent knowledge services in empowering rural revitalization mainly concentrate on obvious user group selection bias and missing main service content. User scope and service content fundamentally impact the resource construction and service development of agricultural intelligent knowledge services, and the aforementioned practical problems constrain the better empowerment of rural revitalization by agricultural intelligent knowledge services.

5.1.1 Obvious User Group Bias Limits Empowerment Scope Currently, agricultural intelligent knowledge service practices mainly target agricultural production and operation entities. For example, serving and supporting new agricultural production models such as precision agriculture and smart agriculture are typical scenarios of agricultural intelligent knowledge services, all focusing on agricultural production. Other user groups such as government managers and decision-makers in the management field and researchers and R&D personnel in the science and technology field have been neglected to varying degrees in service strategies. This neglect is reflected in the relatively insufficient quantity and depth of specialized applications and functions compared to those focused on agricultural production and operation.

Government managers and scientific and technological workers, who play key roles in rural revitalization, have an inverse relationship between their demand for and development of agricultural intelligent knowledge services. While the services' advantages in reducing knowledge and information utilization thresholds and costs are concentrated in specific agricultural production and operation affairs, their empowerment for production management and decision-making is insufficient, limiting the scope of empowerment influence.

5.1.2 Missing Service Content Leads to Incomplete Empowerment Effects Agricultural intelligent knowledge services have missing content in terms of the strategic content and tasks of rural revitalization. Rural revitalization includes five aspects: industrial revitalization, talent revitalization, cultural revitalization, ecological revitalization, and organizational revitalization. Agricultural intelligent knowledge services directly empower industrial revitalization by acting on agricultural production and operation scenarios and subjects, but services and applications in cultural, ecological, and organizational aspects are relatively weak, and the promotion of talent revitalization is mainly indirect. The missing service content regarding the strategic content and tasks of rural revitalization greatly reduces the role of agricultural intelligent knowledge services in empowering rural revitalization.

5.2 External Challenges of Agricultural Intelligent Knowledge Services Empowering Rural Revitalization

From an external perspective, the challenges faced by agricultural intelligent knowledge services in empowering rural revitalization mainly concentrate on infrastructure imbalance and low user literacy.

5.2.1 Infrastructure Imbalance Limits Application Effects The application and services of agricultural intelligent knowledge services, while improving precision and intelligence, also impose higher requirements on infrastructure, especially digital infrastructure. The effective support of infrastructure is the foundation for data collection, processing, and application in agricultural intelligent knowledge services. However, the current state of infrastructure is not

optimistic. According to the 50th Statistical Report on China's Internet Development, as of June 2022, China's internet penetration rate was 74.4%, with 82.9% in urban areas but only 58.8% in rural areas, showing extreme imbalance between regions. This status of internet penetration is just a typical microcosm of the overall level and distribution imbalance of infrastructure.

5.2.2 Low Technical Literacy of Main Users Affects Application and Promotion Literacy is a comprehensive combination of knowledge, skills, and attitudes applicable to specific contexts. With the evolution of the technical environment, corresponding literacy concepts have changed accordingly, forming a literacy concept group including information literacy, computer literacy, digital literacy, data literacy, and AI literacy corresponding to the information age, digital age, big data age, and artificial intelligence age. In the digital intelligence context, data has become an emerging element, and the importance of digital information is increasing day by day. The rapid development of ChatGPT has further confirmed the unlimited potential of future algorithms and AI technologies.

Technical literacy affects individuals' adaptability to new technologies and services and significantly impacts the realization of technology empowerment. The main users of agricultural intelligent knowledge services are concentrated in production and operation frontlines—farmers and enterprises. These users are primarily traditional farmers or transformed from traditional farmers, and their digital capabilities and digital thinking urgently need improvement. Their acceptance and adaptability to new technologies and services need enhancement. According to the 50th Statistical Report on China's Internet Development, although mobile internet usage has reached 99.6% among netizens, there remains a gap between access to smartphones and the ability to use applications and digital participation behaviors. The low technical literacy of main users has become a shortcoming that cannot meet the needs of agricultural and rural modernization, bringing challenges to the promotion and use of agricultural intelligent knowledge services.

Concept Cluster of Technology Literacy

6 Dilemma Alleviation: Optimization Paths for Agricultural Intelligent Knowledge Services Empowering Rural Revitalization

This study reflects on agricultural intelligent knowledge services empowering rural revitalization from the perspectives of dilemma causes and solutions, aiming to propose optimization paths for empowering comprehensive rural revitalization from the perspective of agricultural intelligent knowledge services.

6.1 Conduct In-Depth Investigation of Rural Revitalization to Clarify Empowerment Needs

To effectively alleviate the dilemmas of agricultural intelligent knowledge services empowering rural revitalization, it is essential to correctly and fully understand the tasks and content of the rural revitalization strategy. The missing service content in existing agricultural intelligent knowledge services is partly due to planning service content only from the perspective of agricultural information services rather than confirming service needs from the rural revitalization perspective. By conducting in-depth investigations of rural revitalization stakeholders and strategic content, and systematically analyzing the empowerment needs for agricultural intelligent knowledge services in terms of content and function, the service content and development direction of agricultural intelligent knowledge services can be optimized and improved. This involves expanding the service users and scenarios of agricultural intelligent knowledge services to include government managers, scientific researchers, and enterprise producers.

6.2 Build Integrated Service Platforms to Integrate Empowerment Scenarios

An agricultural intelligent knowledge service integrated platform refers to a unified service platform that provides different functions needed by different users in different scenarios. Whether the needs of agricultural operators, managers, or researchers can be met on the same platform is crucial. Considering the characteristics of personalized user needs and multi-source heterogeneous data in the digital intelligence context, the integrated platform should achieve integrated governance and utilization of multi-source heterogeneous data, precise matching of algorithms and models, and other functions.

Building an integrated service platform can integrate different empowerment scenarios, which is conducive to solving the aforementioned problems of user bias and missing content. By providing service functions for different empowerment scenarios on the integrated platform, the data governance chain can be opened up to build a data foundation. The intelligence of agricultural intelligent knowledge services is data intelligence. By developing diverse intelligent applications and driving data intelligence, the most effective diversified applications can be developed to meet the diverse and personalized empowerment needs of rural revitalization.

6.3 Construct and Optimize Promotion Models to Enhance Empowerment Effects

The challenges of infrastructure imbalance and low user literacy faced by agricultural intelligent knowledge services empowering rural revitalization require systematic solutions. The promotion and application of agricultural intelligent knowledge services can effectively help users and society better understand and participate in these services. By providing supporting training services and

cultivating user technical literacy, users' abilities to use agricultural intelligent knowledge service functions can be improved, promoting the promotion and expansion of these services and thereby enhancing their empowerment effects.

Typical users with demonstration effects can be selected to play a leading and exemplary role. For example, large-scale planting households, farmers' professional cooperatives, and family farms as new types of business entities have relatively better economic benefits and stronger leading roles. They also have certain advantages in terms of acceptance, usage willingness, and capability for new technologies and functions. Through the demonstration application of these typical users, agricultural intelligent knowledge services can be promoted and applied among main user groups, enhancing the empowerment effects on rural revitalization.

References

- [1] ZHANG Y P, LUAN J. Digital economy enables rural revitalization: Theoretical mechanism, restrictive factors and implementation path[J]. Reform, 2022(5): 79-89.
- [2] ZHAO C J. Current situations and prospects of smart agriculture[J]. Journal of South China Agricultural University, 2021, 42(6): 1-7.
- [3] ZHAO K R, WANG Y F. Empowerment analysis on information fusion[J]. Information Studies: Theory & Application, 2021, 44(11): 8-14.
- [4] XIAO W D. Internal logic and action path of rural vitalization energized by characteristic industries[J]. Theory Journal, 2023(1): 117-126.
- [5] ZHONG Y, GAN L Z, WANG Q, et al. Digital economy empowering rural revitalization: Characteristics, difficulties and path for implementation[J]. Journal of Xinjiang Normal University (Philosophy and Social Sciences), 2023, 44(3): 105-115.
- [6] WU L L, LUO T T. Typical case analysis and feature research of big data intelligent knowledge service platform[J]. Technology Intelligence Engineering, 2022, 8(4): 41-49.
- [7] ZHOU J. Mechanism and path of digital culture industry empowering rural revitalization strategy[J]. Rural Economy, 2021(11): 10-16.
- [8] ZHU M R. Research on public library intelligent service enabling new professional farmers information literacy cultivation[J]. New Century Library, 2023(3): 12-17, 96.
- [9] ZHAO R X, LI J, ZHANG J, et al. Construction of multi-scenario agricultural knowledge service system[J]. Journal of Library and Information Science in Agriculture, 2020, 32(1): 4-11.
- [10] FENG C Y. Library intelligent services in the context of rural revitalization

strategy: Logic, modes and challenges[J]. Library & Information, 2022(1): 101-108.

[11] ZHAO C J. Agricultural knowledge intelligent service technology: A review[J]. Smart Agriculture, 2023, 5(2): 126-148.

[12] KANG M Z. Empowering smart agriculture with intelligent technology[J]. China Surveying and Mapping, 2020(1): 25-26.

[13] CHEN D Z. Study on the knowledge service of forestry sci-tech periodicals under the rural revitalization strategy[J]. Journal of News Research, 2020, 11(24): 187-189.

[14] China Internet Network Information Center. The 50th Statistical Report on China's Internet Development[EB/OL]. [2022-08-31]. <https://www.cnnic.net.cn/n4/2022/0914/c88-10226.html>.

[15] WANG X C, LU D Y. Implementing the strategy of strengthening agriculture with knowledge and empowering the construction of a strong agricultural country[J]. Journal of Hubei Engineering University, 2023, 43(4): 121-128.

[16] YAO Y N. Research and analysis on large screen UI design for data visualization[J]. Process Automation Instrumentation, 2021, 42(5): 107-110.

[17] REN J Y. Research on information monitoring and analysis technology under fine agriculture[J]. Agricultural Machinery Using & Maintenance, 2023(3): 90-93, 98.

[18] SUN T, HUANG Y W, XIAN G J, et al. Considerations for the development of agricultural informatization driven by a new generation information technologies[J]. Journal of Library and Information Science in Agriculture, 2021, 33(3): 4-15.

[19] ZHANG Y, SONG H Y. Smart agriculture empowers rural revitalization: Transmission mechanisms, key issues and path optimization[J]. Journal of Huazhong Agricultural University, 2023, 42(3): 1-9.

[20] ZHAO R X, YANG C X, ZHENG J H, et al. Agricultural intelligent knowledge service: Overview and future perspectives[J]. Smart Agriculture, 2022, 4(4): 105-125.

[21] HE Y, ZHANG H L. Agricultural Internet of things technology and its scenario application[J]. China Fruits, 2023(5): ID 161.

[22] FAN Z J, LIU Z Y, YANG X Y. Characteristics of information poverty in rural areas in the era of digitalization & intellectualization: Explorations based on field cases[J]. Journal of Library and Information Science in Agriculture, 2022, 34(1): 38-48.

[23] YIN Y, LIU J Y. How digital technology is changing rural China: A survey from 10 villages in 5 provinces[J]. Journal of China Agricultural University (Social Sciences), 2023, 40(2): 101-117.

- [24] GORDON J, HALÁSZ G, KRAWCZYK M, et al. Key competences in Europe: Opening doors for lifelong learners across the school curriculum and teacher education[J]. SSRN Electronic Journal, 2009(87): 14-15, 157-159.
- [25] SUN Z, WANG Y K. From “gentry governance” and “integrative governance” to “digital governance” : A review of rural governance scenarios evolution[J]. Journal of Hebei Agricultural University (Social Sciences), 2023, 25(2): 65-72.
- [26] WU D. Algorithmic literacy: The new trend of the library on the smart service outlet[J]. Library Development, 2022(4): 4-5.
- [27] YANG X Y, HE X Y. Practical review on digital technology empowering rural governance[J]. Journal of South China Agricultural University (Social Science Edition), 2023, 22(2): 110-120.
- [28] LI C Q, ZHANG M, ZHANG Q, et al. The composition and connotation of farmers digital literacy framework under the background of digital rural construction[J]. Documentation, Information & Knowledge, 2023, 40(3): 62-71.
- [29] HUANG B. Digital empowerment: A three-dimensional review of the modernization of rural governance empowered by big data[J]. Journal of Hohai University (Philosophy and Social Sciences), 2021, 23(6): 28-36, 43, 110.
- [30] WANG W, WANG X T, DAI J. High-quality agricultural development: Towards digital transformation—Research based on digital agriculture in Yangxi County[J]. Southwest Finance, 2023(5): 59-69.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv –Machine translation. Verify with original.