

Research on the practical difficulties and solutions for the promotion and application of smart agriculture technology from the perspective of comprehensive rural revitalization: based on the perspective of "cognition attitude behavior motivation"

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Abstract

Agricultural development cannot be separated from technology. In the context of the comprehensive rural revitalization strategy, developing smart agriculture to assist in the comprehensive rural revitalization is not only a powerful lever to accelerate the construction of digital China, but also a realistic path to promote the modernization of agriculture and rural areas. Based on this, this article focuses on the promotion and application of smart agriculture technology in the context of comprehensive rural revitalization. From the perspective of "cognition attitude behavior motivation", through literature research, field research, and empirical analysis, it deeply analyzes the difficulties it faces and proposes solutions. Research has found that the promotion of smart agriculture technology is constrained by multiple factors such as technology, talent, funding, and policies. Therefore, targeted strategies should be proposed at the government, enterprise, and individual levels through the establishment of incentive mechanisms to promote the widespread application of smart agriculture technology and assist in the modernization and comprehensive revitalization of agriculture and rural areas.

Keywords

Comprehensive Rural Revitalization; Smart Agricultural Technology; Realistic Dilemma; Cracking Strategies

1. Introduction

The report of the 20th National Congress of the Communist Party of China clearly proposes to deepen rural reform and solidly promote comprehensive rural revitalization. Smart agriculture is an important focus for the development of modern agriculture and a strategic high ground for building a strong agricultural country. To

implement the decisions and deployments of the Party Central Committee and the State Council, we must vigorously develop smart agriculture, help promote comprehensive rural revitalization, and accelerate the construction of an agricultural powerhouse. For many years, we have continuously focused on the development of "precision agriculture" and "smart agriculture", outlining a clear blueprint for China's agricultural modernization transformation. Since the strategic significance of rural agricultural informatization was first emphasized in 2012, this process has been accelerating. In 2015, agricultural modernization was listed as the top priority, and China officially entered a new stage of exploration and practice of smart agriculture. During the 14th Five Year Plan period, the "Proposal of the Central Committee of the Communist Party of China on Formulating the 14th Five Year Plan for National Economic and Social Development and the Long Range Objectives for 2035" pointed out that the construction of smart agriculture should be regarded as an important part of the 14th Five Year Plan period and aimed at improving agricultural quality, efficiency, and competitiveness by 2035, and its core position in future development plans should be clarified. In 2022, the central "No. 1 Document" will further refine measures, emphasize the urgency of digital rural construction, and specifically deploy the path of smart agriculture development, that is, through the deep integration of information technology and agricultural machinery and agronomy, broaden the application boundary of agricultural and rural big data, and provide a strong driving force for intelligent and accurate agricultural production. In 2023, the proposal to accelerate the application of big data in agriculture and rural areas and promote the development of smart agriculture demonstrates the firm determination and sustained investment of the country in the development of smart agriculture. On February 23, 2025, the "Opinions of the Central Committee of the Communist Party of China and the State Council on Further Deepening Rural Reform and Solidly Promoting Comprehensive Rural Revitalization" put forward for the first time the concept of "developing new agricultural productivity according to local conditions", emphasizing the use of technological innovation to promote the construction of smart agriculture and inject new momentum into agricultural modernization.

In fact, the development of smart agriculture is not only a process of upgrading and iterating agricultural technology, but also a key link in the controllable elements, technologies, products, and other aspects of China's resource-based and ecological industries, becoming the future trend of agricultural development. Therefore, it is of great significance to promote the application of digital technologies such as the Internet, big data and artificial intelligence in the field of agriculture and rural areas, and to realize the comprehensive revitalization strategy of smart agriculture empowering rural areas. However, due to multiple challenges such as high prices of intelligent agricultural technology, equipment, and software systems, low levels of digital literacy among farmers, and poor ability to accept new things, its market

promotion and application have fallen into difficulties. How to further promote the promotion and application of smart agriculture technology, achieve effective integration of agricultural development and digital technology, requires scientific analysis and accurate assessment of its overall development status.

2. Literature review

Based on the focus on comprehensive rural revitalization and smart agriculture technology, scholars mainly conduct research from the following three aspects. Firstly, regarding the theoretical connotation of smart agriculture technology. Different scholars have given different definitions, but they mainly focus on smart agriculture, which utilizes cutting-edge information technologies such as big data, cloud technology, blockchain, and artificial intelligence to achieve digitalization and networking of all factors, the entire production process, and the complete life cycle of agriculture. It constructs a modern agricultural industry model characterized by agricultural information monitoring, precise decision-making, automated management, precise input, and customized services (Jiang Luwen, Mei Yan, 2018; Yin Haodong et al., 2021; Cao Xuexue et al., 2021; Mou Shaoyan et al., 2022). In addition, Ma Hongkun et al. (2019) pointed out that smart agriculture effectively improves agricultural production efficiency and enhances the overall competitiveness of agriculture through intelligent management and efficient production methods. Smart agriculture is also regarded as an important carrier for the integration of traditional agriculture and advanced Industry 4.0 technology, which can help enhance the future development potential of China's agriculture (Zhang Zaiyi, Mao Xuefeng, 2020; Goel et al., 2021). Smart agriculture is not only the advanced stage of agricultural production, but also the smart economy in agriculture. It utilizes modern information technologies such as cloud computing to not only improve the level of agricultural production management, but also bring new effective solutions for the transformation and upgrading of Chinese agriculture (Wen Tao, Chen Yiming, 2020). Secondly, regarding the practical application of smart agriculture in the context of comprehensive rural revitalization, it mainly focuses on two aspects: technological application and industrial scale. At the technical application level, the widespread use of Beidou navigation technology, intelligent monitoring and precise fertilization and spraying, fine management of agricultural product supply chains, the application of big data and digital twin technology, and the promotion of smart greenhouse technology jointly promote the improvement of agricultural production efficiency and the innovation of production methods (Voutos et al., 2019); Liu Changquan, 2023; Osrof et al., 2023); In terms of industrial scale, Zhang Shigui et al. (2023) pointed out that the rapid expansion of the smart agricultural machinery market, the deepening of the application of agricultural Internet of Things, the improvement of agricultural big data platforms, and the rapid development of system integration enterprises mark the rapid growth and continuous expansion of smart agriculture

related industries. Thirdly, regarding the future development of smart agriculture technology, Cui Ningbo (2024) believes that the development of smart agriculture currently faces multiple challenges, including incomplete policy guidance and low levels of data collection and integration; Zhao Chunjiang (2024) elaborated on the problems of weak agricultural and rural infrastructure in China, insufficient effective supply of smart agriculture technology, and the urgent need for joint efforts in technology research and application demonstration for the future development of smart agriculture.

Overall, existing literature has emerged in recent years, providing useful explanations on the comprehensive rural revitalization strategy and how smart agriculture technology can drive rural revitalization and promote agricultural and rural modernization. This lays the foundation for the theory and methods of smart agriculture empowering rural revitalization. However, overall, most research on the promotion and application of smart agriculture technology is still insufficient, and a systematic and comprehensive theoretical research framework has not yet been formed. Based on this, this study first clarifies the concepts of smart agriculture and rural revitalization strategies, and based on relevant research data, analyzes the promotion and application of smart agriculture technology from the dimensions of "cognition attitude behavior motivation". Based on the research results and relevant theories, it analyzes the practical difficulties of smart agriculture technology promotion, and finally proposes solutions to promote the realization of comprehensive rural revitalization.

3. Theoretical analysis and content design

The theory of industrial development provides an important perspective for understanding the formation, development, and evolution of the smart agriculture industry. This theory emphasizes the key role of industrial structure optimization, industrial agglomeration effect, and technological innovation in industrial development, which helps to deeply analyze how the smart agriculture industry can achieve effective resource allocation, complete industrial chain, and enhance industrial competitiveness under policy guidance.

Behavioral choice theory focuses on the decision-making behavior of agricultural production entities, government departments, and related enterprises in the promotion and application of smart agricultural technology. According to this theory, when faced with technology choices, each subject will make decisions based on their own objective function, information cognition, and cost-benefit considerations. This has important guiding significance for exploring the acceptance and promotion enthusiasm of different subjects towards smart agriculture technology.

Therefore, it is crucial to conduct a preliminary assessment of the attitudes and perceptions of agricultural production entities, government departments, and related enterprises in the promotion and application of smart agriculture technology.

As direct users of technology, the level of awareness, willingness to accept, and application ability of smart agricultural technology by agricultural production entities directly affect the scope and effectiveness of technology promotion. The government plays a leading role in policy formulation, resource allocation, and public service supply. Its emphasis and support for smart agricultural technology determine the policy environment and resource guarantee for technology promotion. As an important force in technology research and promotion, the innovation ability, market development ability, and service quality of related enterprises affect the supply level and promotion efficiency of smart agriculture technology. By comprehensively evaluating the attitudes and cognition of these three types of subjects, it is helpful to accurately grasp the key issues and potential obstacles in the process of promoting and applying smart agricultural technology, and provide scientific basis for formulating targeted policy measures and promotion strategies in the future.

4. Realistic difficulties faced by the promotion of smart agriculture technology

4.1. Cognitive level

Some government departments have a biased understanding of the strategic significance of smart agriculture technology in promoting agricultural modernization and achieving comprehensive rural revitalization. In the policy-making process, they have not fully considered the systematic needs of smart agriculture technology promotion, and resource allocation has not been tilted towards this, resulting in a lack of scientific, reasonable, and comprehensive planning for the promotion of smart agriculture technology. When evaluating the application prospects of smart agriculture technology, enterprises may not accurately predict the input-output ratio of technology due to market uncertainty, technological maturity, and other factors. Based on the cost-benefit principle, they are concerned that technology investment may not be able to achieve significant returns within expectations, which may affect their initiative and enthusiasm for participating in the promotion of smart agriculture technology. Due to limited long-term education and lagging digital literacy cultivation, the rural population lacks in-depth understanding of the complex principles, refined operational processes, and significant advantages of smart agriculture technology compared to traditional agriculture. The limited cognitive level constitutes a substantial obstacle to their acceptance and application of new technologies, making it difficult for them to actively integrate into the wave of smart agriculture development.

4.2. Attitude level

Due to the inertia of traditional administrative management thinking, government departments lack innovative awareness and driving force for change when facing the innovative work of promoting smart agricultural technology. Some officials,

based on a risk aversion mentality, have a fear of difficulties and challenges that may be encountered in promotion work, lacking the determination and action to break conventions and actively promote reforms. Enterprises tend to pursue short-term economic benefits based on their profit driven nature. The research and development of smart agriculture technology requires a long period of time, and there are many uncertainties from laboratory results to practical applications. The promotion process also requires a large amount of resources, and it is difficult to achieve profitability in the short term. This makes enterprises cautious about long-term investment in smart agriculture technology after weighing the pros and cons, lacking a firm strategic development belief. Under the long-term traditional agricultural production mode, farmers have formed relatively fixed thinking patterns and naturally have a cautious mentality towards new things. In addition, agricultural production is influenced by multiple factors such as natural factors and market fluctuations, and the economic foundation of farmers is relatively weak. They have a low ability to bear the economic losses that may result from the failure of smart agricultural technology applications, which in turn limits their willingness to apply smart agricultural technology.

4.3. Behavioral level

The government has not yet established an effective inter departmental coordination and linkage mechanism when leading the promotion of smart agricultural technology. There are ambiguous areas in the division of promotion responsibilities among different functional departments, lacking clear and defined responsibilities. Information communication and cooperation between departments are poor, which seriously restricts the overall efficiency of promotion work and prevents the formation of an efficient collaborative work force. In the field of smart agriculture technology, enterprises have insufficient R&D funding and a lack of talent reserves for technological innovation, which limits their ability to innovate and makes it difficult to launch cutting-edge technological achievements that meet market demand. At the same time, there are shortcomings in the construction of technology service systems for enterprises, such as single service content and untimely service response, which cannot fully meet the diverse and personalized needs of farmers in the application of smart agricultural technology. Due to limited financial accumulation, farmers find it difficult to bear the high costs of equipment procurement, technical training, and other expenses required for the application of smart agriculture technology. Due to insufficient knowledge reserves and technical capabilities, there are many difficulties in operating smart agricultural equipment and applying related technologies in practice, which greatly hinders the promotion and application of smart agricultural technology in the front line of agricultural production.

4.4. Incentive Level

The incentive policy system formulated by the government for the promotion of smart agriculture technology has deficiencies, and the subsidy standards have not fully considered the actual costs and benefits of technology application. The subsidy intensity is not sufficient to effectively compensate for the economic gap between enterprises and farmers in the process of technology investment. At the same time, the incentive methods are limited to a single fiscal subsidy, lacking diversified and flexible incentive measures, making it difficult to fully mobilize the inherent enthusiasm of enterprises and farmers to participate in the promotion of smart agricultural technology. In the internal management mechanism of the enterprise, a comprehensive performance evaluation and incentive system has not been established for employees to participate in the research and promotion of smart agriculture technology. As a result, employees' efforts and rewards in their work are not proportional, leading to a decline in their work enthusiasm. In addition, the market mechanism in the field of smart agriculture is not yet perfect, and there are problems such as information asymmetry, high transaction costs, and inadequate property rights protection in the process of technology transfer, which make it difficult for technology achievements to achieve market value smoothly, seriously affecting the enthusiasm of all parties to participate in the innovation and promotion of smart agriculture technology.

5. Cracking Strategies for the Promotion and Application of Smart Agriculture Technology

5.1. Government level

5.1.1. Strengthen the policy support system

The government should increase policy support for the promotion of smart agriculture technology and formulate special support policies. By increasing fiscal budget investment and establishing a special fund for the development of smart agriculture, the fund will be dedicated to supporting technology research and development projects in the field of smart agriculture, providing financial support for technological innovation; Provide subsidies to agricultural production entities for purchasing smart agriculture related equipment, reduce their equipment procurement costs, and increase equipment penetration rates; At the same time, part of the funds will be used to carry out talent training programs, cultivating compound professional talents who understand both agriculture and information technology, and providing talent support for the development of smart agriculture.

5.1.2. Improve infrastructure construction

Efforts will be made to strengthen the construction of network communication infrastructure in rural areas, improve network coverage and signal quality, and ensure stable and efficient data transmission of smart agricultural equipment. Simultaneously promoting the optimization and upgrading of power supply infrastructure,

ensuring stable power supply for the operation of smart agriculture equipment, and providing solid support for the widespread application of smart agriculture technology from a hardware perspective.

5.1.3. Strengthen publicity, education and training work

Adopting diversified publicity and education methods, such as regularly holding smart agriculture technology training courses, inviting industry experts to give systematic lectures, imparting the principles, operating methods, and application cases of smart agriculture technology; Conduct demonstration lectures to showcase the significant advantages of smart agriculture technology in improving production efficiency, increasing agricultural product quality and yield through practical cases; Organize on-site demonstration activities to allow farmers to personally experience the operation process of smart agricultural equipment and enhance their intuitive understanding. Through these measures, we aim to comprehensively enhance farmers' awareness and application capabilities of smart agricultural technology.

5.2. Enterprise level

5.2.1. Increase investment in technological innovation and industry university research cooperation

Enterprises need to significantly increase their R&D investment in the field of smart agriculture technology and actively establish deep cooperative relationships with universities and research institutions. Integrate resources from all parties, jointly carry out technological breakthroughs, and strive to break through the key technological bottlenecks faced by current smart agriculture technology, such as improving the accuracy and stability of sensors, optimizing agricultural big data analysis algorithms, etc., in order to enhance the practicality and stability of smart agriculture technology and make it more in line with the actual needs of agricultural production.

5.2.2. Building a comprehensive technical service system

Establish a professional technical service team, whose members should include technical experts, engineers, after-sales maintenance personnel, etc. Provide comprehensive technical services to farmers, including technical consulting services, and promptly answer any questions they may encounter during the application of smart agriculture technology; Equipment maintenance services, regularly testing, repairing, and maintaining smart agricultural equipment to ensure its normal operation; Operation training services provide personalized operation training courses for farmers at different levels, enabling them to proficiently master equipment operation skills.

5.2.3. Optimize the internal incentive mechanism of the enterprise

Establish a sound innovation reward system and clarify the incentive standards for employees to participate in the research and promotion of smart agricultural tech-

nology. For employees who have made outstanding contributions in technology research and development, material and spiritual rewards will be given, such as bonuses, honor certificates, promotion opportunities, etc; For employees who perform well in technology promotion work, corresponding rewards will be given based on the promotion effect, fully stimulating their work enthusiasm and creativity, and promoting the innovative development of enterprises in the field of smart agriculture.

5.3. Personal level

5.3.1. Enhancing Farmers' Digital Literacy

Carry out targeted rural digital skills training programs, covering computer basic operations, network application knowledge, smart agricultural equipment operation skills, etc. By combining theoretical teaching with practical operation, gradually enhance farmers' information technology application and learning abilities, ensure that farmers can proficiently operate various smart agricultural equipment, and lay the foundation for the widespread application of smart agricultural technology in rural areas.

5.3.2. Expand Farmers' Financing Channels

The government and financial institutions should strengthen cooperation and jointly launch a series of financial products targeting the application of smart agriculture technology. For example, developing small loan products, simplifying the loan application process, and providing convenient financing channels for farmers who are short of funds; Establish interest subsidy loan projects to provide loan interest subsidies to eligible farmers, reduce their financing costs, and solve the funding bottleneck problem for farmers in the application of smart agricultural technology.

5.3.3. Establish a mechanism for mutual assistance and cooperation among farmers

Actively guide farmers to establish mutual aid and cooperation organizations, and encourage farmers to participate in cooperation organizations by investing in resources such as land, funds, and labor. The cooperative organization will unify the planning of the application of smart agricultural technology, jointly purchase equipment, share technical services, reduce production costs and technology application risks through large-scale operation, achieve economies of scale, and improve the benefits and enthusiasm of farmers in applying smart agricultural technology.

6. Research Conclusion

This study is based on the systematic perspective of "cognition attitude behavior motivation", and conducts in-depth and comprehensive exploration on the promotion and application of smart agriculture technology in the context of comprehensive rural revitalization. Through research and analysis, it has been found that there

are significant challenges in the promotion of smart agriculture technology in terms of cognition, attitude, behavior, and motivation. These challenges seriously hinder the widespread application and deep popularization of smart agriculture technology. At the cognitive level, some agricultural production entities, government officials, and business practitioners have insufficient understanding of the concept, principles, application scenarios, and potential value of smart agriculture technology, resulting in insufficient emphasis on technology promotion. In terms of attitude, some entities hold a wait-and-see or conservative attitude towards the application prospects of smart agriculture technology, lacking the willingness to actively accept new technologies, which to some extent affects the enthusiasm and initiative of technology promotion. From a behavioral perspective, agricultural production entities face practical challenges such as complex technical operations and high equipment costs in the process of technology adoption, which limit their actual application behavior; The efforts of government departments in policy implementation, resource allocation, and other aspects need to be strengthened; The lack of synergy among enterprises in technology research and development, market promotion, and other aspects. At the incentive level, existing incentive policies and measures have not fully mobilized the enthusiasm of all parties to participate in the promotion of smart agricultural technology, and the incentive effect is not significant.

In response to the above difficulties, this study proposes targeted solutions from the perspectives of government, enterprises, and individuals. The government should strengthen policy guidance and support, increase capital investment, improve infrastructure construction, enhance publicity, education, and training, and improve the cognitive level and application ability of all parties towards smart agricultural technology; Enterprises need to increase their efforts in technological research and development innovation, reduce technology costs, optimize products and services, establish effective market promotion mechanisms, and enhance the market competitiveness of smart agriculture technology; At the individual level, especially for agricultural production entities, they should actively learn new technologies, change their production and management concepts, improve their own quality and skills, in order to better adapt to the development needs of smart agriculture. Based on this, we will promote the deep integration of smart agriculture technology and agricultural and rural development, providing solid and powerful technical support and guarantee for achieving comprehensive rural revitalization and modernization of agriculture and rural areas.

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