

Exploration into the Impact of High Standard Farmland Construction on Smart Agriculture

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Abstract

The construction of high standard farmland provides material basis and technical support for the application of smart agriculture technology and equipment, promoting the deep integration of smart agriculture technology and modern agriculture. Based on data from agricultural departments in prefecture level cities, a model was used to analyze the impact of high standard farmland construction on smart agriculture and to clarify its mechanism of action. Research has found that both high standard farmland construction and smart agriculture exhibit agglomeration in space; High standard farmland construction, as an important factor in improving the level of smart agriculture, can not only directly promote the development of smart agriculture, but also promote the development of smart agriculture by promoting agricultural mechanization and optimizing the agricultural industry structure; At the same time, the impact of high standard farmland construction on the development of smart agriculture will also have an unbalanced effect, that is, the impact of high standard farmland construction on smart agriculture will be affected by the level of regional agricultural economic development; Compared with other regions, the construction of high standard farmland will significantly enhance the level of smart agriculture in affluent areas. Finally, under the background of fully improving the quality of arable land, suggestions for developing smart agriculture were proposed from three aspects: integrating high standard farmland construction with the development of smart agriculture, optimizing the agricultural industry structure, and promoting agricultural mechanization.

Keywords

High Standard Farmland Construction; Smart Agriculture; Non-equilibrium Effects; Agricultural Industrial Structure; Agricultural Mechanization.

1. Introduction

Smart agriculture is not only an advanced stage of agricultural informatization development, but also the foundation for building a strong agricultural country. The report of the 20th National Congress of the Communist Party of China proposed to "strengthen the support of agricultural science and technology and equipment". In 2024, the No. 1 central document of the Central Committee proposed specific measures to develop smart agriculture [1]. Smart agriculture relies on information technologies such as the Internet of Things, big data, and artificial intelligence to deeply integrate digital technology with agricultural production. By optimizing the input structure of agricultural factors, improving the agricultural ecological environment, and enhancing agricultural production efficiency, it achieves precision, intelligence, and efficiency in agricultural production, ultimately fundamentally changing the way agricultural production, operation, and management are carried out. From the development of smart agriculture, the market size of China's smart agriculture industry has increased from 65.3 billion yuan in 2020 to 71.3 billion yuan in 2023; Although China's smart agriculture continues to develop, there is still a certain gap compared to typical developed

countries in smart agriculture. For example, China's independently developed agricultural sensors account for less than 10% of the world's total. Compared with developed countries, China's smart agriculture has weak infrastructure, poor agricultural technology stability, and low sensitivity [2]. From the current development status of smart agriculture, smart agriculture utilizes information technology to real-time grasp the growth status of crops, reducing inputs of labor, fertilizers, and other factors, changing traditional agricultural production methods, and improving agricultural production efficiency and benefits [3]. In theory, smart agriculture applies intelligent agricultural machinery to the agricultural production process, optimizing the allocation structure of agricultural factors. On the one hand, smart agriculture improves the utilization rate of agricultural machinery while also having a substitution effect on traditional labor factors, thereby reducing the input of agricultural labor factors; On the other hand, the Internet of Things technology in smart agriculture provides real-time monitoring of agricultural production data. Based on the growth status of crops, it scientifically and accurately monitors soil temperature, humidity, nutrient content, etc. This not only reduces agricultural production risks but also lowers agricultural labor intensity. As a trend and way of future agricultural development, smart agriculture still needs to be further analyzed from the perspectives of new formats, new technologies, and new models to identify the sources of developing smart agriculture. [4]

2. The Direct Effect of High Standard Farmland Construction on the Development of Smart Agriculture

The biggest difference between the construction of high standard farmland and the comprehensive improvement of traditional farmland is that the construction of high standard farmland improves the quality of agricultural farmland elements by improving farmland quality, improving farmland supporting facilities, and optimizing farmland structure and layout, providing matching farmland for the application of smart agricultural technology and equipment. With the application of smart agricultural technology and equipment in the agricultural production process, its agricultural intelligence level will continue to improve. According to agricultural production theory, the construction of high standard farmland provides large-scale, intensive, and well-equipped farmland for the use of digital and intelligent agricultural machinery. With the improvement of arable land quality, in order to fully utilize its high standard farmland construction, intelligent, modern, and ecological agricultural equipment and technology are needed in the agricultural production process. Therefore, the construction of high standard farmland will directly promote the development of smart agriculture. From the perspective of the implementation effect of high standard farmland construction, with the advancement of high standard farmland construction, investment in agricultural irrigation, roads, and management will continue to increase, and agricultural intelligent production equipment, technology, and means will also be continuously applied to the agricultural production process, thereby promoting the development of smart agriculture in the region.

3. The Mechanism of the Impact of High Standard Farmland Construction on the Development of Smart Agriculture

From the content of high standard farmland construction, it can be seen that high standard farmland construction fundamentally changes the traditional agriculture's dependence on manpower, low efficiency, and high resource consumption by protecting arable land resources, improving arable land quality, and utilization efficiency, and opens up a new path for agricultural mechanization. The construction of high standard farmland provides a favorable working environment for agricultural mechanization by filling in the gaps and weaknesses of

arable land, enabling agricultural machinery and equipment to effectively play their roles, reducing problems such as agricultural machinery failures and low operational efficiency caused by poor arable land conditions, and thus improving the level of agricultural mechanization. In the context of high standard farmland construction, agricultural mechanization is no longer just a simple application of agricultural machinery and equipment, but a combination of advanced technologies such as the Internet of Things, big data, cloud computing, and artificial intelligence to form an intelligent and precise agricultural production model. In the process of constructing high standard farmland, various sensors and monitoring equipment are installed to achieve real-time acquisition of farmland environmental parameters and crop growth status data, providing scientific basis for the application of smart agricultural production technologies such as precision irrigation, fertilization, and pest control. Intelligent agricultural machinery and equipment automatically adjust operating parameters based on agricultural production technology data, achieving precise operations and ultimately improving the level of intelligent agricultural production.

4. The Non-Equilibrium Effect of High Standard Farmland Construction on the Development of Smart Agriculture

The construction of high standard farmland and the development of smart agriculture will not only be affected by the natural environment, but also by the level of socio-economic development. The differences between the natural environment and socio-economic development will also affect the economic effects of high standard farmland construction and the level of smart agriculture development. According to relevant research, the differences between natural environment and socio-economic development are mainly reflected in the differences in the initial level of agricultural economic development. The higher (lower) the initial level of agricultural economic development, the faster (slower) the process of constructing high standard farmland in areas, and the higher (lower) the level of smart agriculture development. Therefore, when analyzing the impact of high standard farmland construction on the development of smart agriculture, it is also necessary to consider the initial level of agricultural economic development. Regions with relatively high levels of agricultural economic development (referred to as affluent areas for ease of analysis) have relatively abundant agricultural capital and land resources. High standard farmland construction provides high-quality farmland for the development of smart agriculture in affluent areas by filling in the gaps or weaknesses in high-quality agricultural development, thereby promoting the development of smart agriculture in these areas. Areas with relatively low levels of agricultural economic development (hereinafter referred to as poverty-stricken areas) are constrained by natural environment and socio-economic conditions, resulting in relatively backward agricultural economic development. Impoverished areas urgently need capital investment and comprehensive land improvement. Although the construction of high standard farmland has filled the gaps and weaknesses in high-quality agricultural development, the foundation of agricultural development in poverty-stricken areas is relatively weak. High standard farmland construction will promote high-quality agricultural development in poverty-stricken areas, but it is difficult to promote the development of smart agriculture in poverty-stricken areas.

5. The Challenges Faced by Smart Agriculture in the Construction of High Standard Farmland

5.1. Low Level of Technological Integration

In the current construction of high standard farmland, various smart agricultural technologies such as intelligent monitoring and automated operations are constantly being introduced, but there are often compatibility issues between these technologies. For example, intelligent irrigation systems may not be able to seamlessly integrate with soil moisture sensors, resulting in data that cannot be shared in real-time, thereby affecting the timeliness and accuracy of irrigation decisions. In addition, devices produced by different manufacturers often use different data formats and communication protocols, which enhances the complexity of system integration. The barriers between these technologies make it difficult for farmland management systems to achieve comprehensive collaborative operations, thereby reducing the overall efficiency and benefits of smart agriculture.

5.2. The Construction of Data Platforms Lags Behind

The effective implementation of smart agriculture requires a powerful data platform to provide support for the collection, transmission, storage, and analysis of large-scale data. However, the construction of data platforms for many high standard farmland is still lagging behind, with problems such as insufficient data processing capabilities and inconsistent data standards. In some regions, due to the lack of efficient data processing and analysis capabilities, the collected environmental data and crop growth data are difficult to convert into useful agricultural management recommendations in a timely manner. In addition, the inadequate measures for data security and privacy protection have also made farmers cautious about adopting smart agricultural technologies, further hindering the construction of data platforms.

5.3. Shortage of Professional Talents

The rapid development of smart agriculture requires a team of professional talents with multidisciplinary backgrounds, who not only need to master agricultural scientific knowledge but also be proficient in information technology. However, such versatile talents are extremely scarce in the current market environment. Many agricultural practitioners lack the ability to accept and apply new technologies, making it difficult to effectively utilize smart agricultural equipment and technology. In addition, the income level and working environment in the agricultural sector are relatively poor, making it difficult to attract professionals in the information technology field to engage in the research and practical work of smart agriculture technology, thereby affecting the promotion and application of smart agriculture technology.

5.4. Insufficient Capital Investment

The research and development, equipment procurement, system integration, and maintenance of smart agriculture technology require a significant amount of capital investment. However, due to the long return cycle and unstable returns of agricultural projects, investors often hold a cautious attitude towards this field, resulting in relatively limited investment in the agricultural sector, especially in smart agriculture projects. In some regions, although government departments provide financial support, these funds are often just a drop in the bucket compared to the high costs of technology introduction and maintenance. The severe shortage of funds has severely constrained the research and large-scale application of smart agriculture technology, affecting the quality and efficiency of high standard farmland construction.

6. Suggestions on Strengthening the Application of Smart Agriculture in High Standard Farmland Construction

6.1. Strengthen Technology Integration and Innovation

Government departments should play a leading role and take the lead in building a multi-party cooperation platform, closely linking scientific research institutions, universities, and enterprises to jointly contribute to the development of smart agriculture technology standards and the construction of compatibility frameworks. This framework should not only focus on the uniformity of technical details such as data formats, communication protocols, and hardware interfaces, but also fully consider the diversity and specificity of agricultural production in China, ensuring that the standards developed are both forward-looking and in line with practical application needs.

6.2. Improve Data Platforms and Services

To strengthen the construction of agricultural data centers, advanced big data processing and analysis technologies such as distributed storage systems and real-time data processing frameworks should be introduced to improve the speed and efficiency of data processing and provide timely and accurate information support for agricultural production. It is crucial to develop customized data services and applications for agricultural production needs of different scales and types. We need to provide simple and easy-to-use mobile applications for small farmers, so that they can easily and quickly access key information such as weather forecasts, market trends, and pest and disease warnings; Develop a comprehensive management system for large farms and agricultural enterprises, including multiple functional modules such as intelligent irrigation, automated fertilization, and pest monitoring, in order to improve their management efficiency.

6.3. Build a Professional Team

Universities and enterprises need to deepen cooperation and work together to develop specialized courses and training programs for smart agriculture, in order to cultivate professional talents that can adapt to the development of modern agriculture. The curriculum design should integrate knowledge from multiple fields such as agricultural science foundation, information technology application, and intelligent device management, such as "agricultural Internet of Things technology", "agricultural big data analysis", "intelligent agricultural machinery operation and management", etc., and adopt a teaching mode that emphasizes both theory and practice to comprehensively enhance students' comprehensive abilities. Enterprises should provide internship opportunities for students to help them accumulate experience in real work environments.

6.4. Increase Capital Investment and Policy Support

The government should establish a special fund for smart agriculture to provide financial support for technology research and development, application, and promotion, covering scientific research projects, technology demonstrations, talent cultivation, and other aspects. For example, providing research and development subsidies to teams developing intelligent agricultural machinery and precision irrigation systems; Provide construction funding subsidies for high standard farmland projects that adopt smart technology to stimulate market innovation vitality. At the same time, tax reduction and subsidy policies will be implemented, such as providing subsidies to farmers and enterprises who purchase smart devices and software, and offering income tax incentives to smart agricultural technology research and development enterprises.

7. Conclusion

In summary, smart agriculture has shown great potential in the construction of high standard farmland, and has profound significance for improving production efficiency, optimizing resource allocation, and ensuring food safety. However, in order to fully unleash the efficiency of smart agriculture, it is necessary to continue to increase investment in technology integration, information platform construction, talent cultivation, and funding. In future work, with the continuous innovation of technology and the continued tilt of policies, smart agriculture will play a more important role in the construction of high standard farmland in Xilin County, injecting fresh blood and strong momentum into agricultural modernization.

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