Journal of Engineering and Technology

EVALUATION OF CHINA'S RURAL AGRICULTURAL DEVELOPMENT RESPONSE TO FOREIGN INTELLIGENT AGRICULTURE EXPERIENCE

Y. K. An[1], M. F. Rashid[*1] and K. H. Kamarudin[1]

[1] Faculty of Building Environment and Surveying, Universiti Teknologi Malaysia, Johor Bahru 81310, Johor, Malaysia.
*corresponding: m.fadhli@utm.my

Abstract— China has always prioritized the advancement of agriculture and encouraged agricultural modernization to play a significant role. Intelligent agriculture is a new framework for advancing agricultural modernization. Hence, this paper examines China's rural agricultural development response to the foreign intelligent agriculture experience regarding agricultural competitiveness and sustainable agricultural development. This paper concludes a comparative literature analysis after reviewing many publications on intelligent agriculture (including Chinese and English literature) and government policies

and developments in various countries. The findings highlighted that China's intelligent agriculture growth is starting to show results. However, there are still several issues across the board. For instance, there is a lack of talent, insufficient scale and intensification, lack of specialized agricultural production information, and imperfections in the infrastructure service facilities of intelligent agriculture and the management system of agricultural science and technology innovation. In response to these issues, suggestions were made to cultivate awareness of intelligent agriculture's development and strengthen planning leadership and resource integration. Therefore, this paper examined and drew inspiration from the intelligent agriculture development systems in advanced nations like Europe and the United Kingdom, identified the state-of-the-art and emerging trends in Chinese agriculture, and offered a development framework for advancing intelligent agriculture in China.

I. Introduction

Intelligent agriculture emerged in the United States in the early 1980s [1]. By the 21st century, its development took shape, enhancing agricultural production capacity, improving agricultural production efficiency, and making agriculture a sustainable industry efficient [2].

In the context of China's comprehensive push for supply-side reform, the traditional mode

of agricultural development has not been adapted to the needs of modern agricultural development. It is in urgent need of transformation and upgrading [3]. Intelligent agriculture is a new mode of agricultural development and a new way to realize the upgrading of traditional agriculture [4]. This paper draws on the current situation of China's intelligent agriculture development through a literature review and, at the same time, puts forward some suggestions for China's intelligent agriculture development based on summarizing the experience of intelligent agriculture development in developed countries.

II. Literature Review
A. China's Intelligent Agriculture Development Model

Combined with the characteristics of agriculture itself and the agricultural industry chain, agricultural big data can be divided into three categories: agricultural environment and resource big data [5], agricultural production big data [6], agricultural market and management big data [7], which include the whole process of agricultural products from production to marketing as shown in Figure 1.
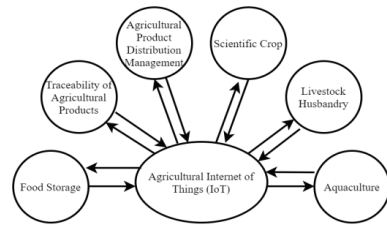

Figure 1: The Internet of Things as An Important Source of Big Data

China's intelligent agriculture development is in the primary stage. Therefore, there are three main models of intelligent agriculture development in the era of big data. First is the establishment of a nationwide big data platform for agriculture. It utilizes the latest computer data mining technology, the Internet, multimedia, and cloud computing service models. With the agricultural intelligent comprehensive information service platform "cloud platform + intelligent terminal" as the main carrier, all parties are organically combined to

establish integrated information channels [8, 9].

Second is the provision of services and information support. In pre-production, big data can be predicted according to the historical needs of agriculture, guiding the scientific production of agriculture; in mid-production, big data applications dynamically monitor the agricultural production of goods and enhance the production efficiency and product quality through intelligent breeding: in the post-production, big data can provide price quotation information and market trend prediction, product traceability, etc., to help realize the networked distribution of rural commodities and the informatization of farmers' services [10, 11].

Third is the establishment of mechanisms for collecting, sharing, analyzing, and using agricultural data. It integrates agricultural data resources and unifies agricultural big data standards; takes the lead in developing the agricultural sector's data; guides the coordination of agricultural-related departments in opening their data; actively introduces the participation of all aspects of society in the construction of the agricultural big data platform; and develops agricultural big data products to serve agricultural production [12].

Overall, intelligent agriculture in China is still in its infancy, with problems such as a lack of talent, insufficient scale and intensification, a lack of specialized agricultural production information, and an incomplete intelligent agriculture infrastructure and agricultural science and technology innovation management system.

B. Foreign Intelligent Agriculture Development Model

The first foreign intelligent agriculture development model is the United Kingdom's precision farming, which starts with extensive data integration. Precision agriculture has been practiced and developed in the United Kingdom, and a technological system that combines high technology and

agricultural production has been formed [13, 14].

To cope with the challenges posed by climate change and the increase in the intensity of global competition in agricultural production, the relevant departments of the United Kingdom believe that, on the one hand, the United Kingdom's agriculture needs to move towards "precision agriculture," combined with digital technology, sensing technology and spatial geographic technology, more accurate planting and breeding; on the other hand, it is necessary to improve the capacity of agricultural production and the interface between market demand [15, 16]. Overall, precision agriculture in the UK is characterized by precision sowing, fertilizer application, precision irrigation, and precision harvesting as shown in Figure 2.
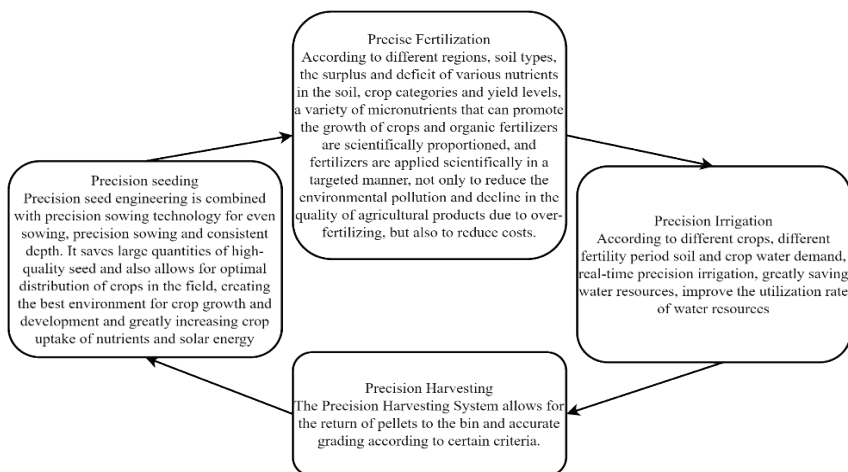

Figure 2: Characteristics of Precision Agriculture in The UK

The next foreign intelligent agriculture development model is France's system improvement in informatization as shown in Figure 3. France's agriculture is very developed. It is the world's second-largest exporter of agricultural products after the United States. Agricultural production and output values are among the highest in Europe [17]. France has a unique

agricultural information database that is divided into two main sections.

The first section is the government-led agricultural information database. The French agricultural information database is complete, and its domestic agricultural information is mainly collected, summarized, and published by agricultural departments at all levels. In terms of categories, the database covers various agricultural fields, including cultivation, fisheries, animal husbandry, and processing of agricultural products [18]. France's "Big Agricultural" data system includes high-tech research and development, business market consulting, legal and policy protection, and Internet applications [19, 20].

The second section is the private pay sites for agricultural information. In France, several agricultural associations have been set up on their initiative, and their websites provide more detailed and specialized information on agriculture for a fee. With access to detailed agricultural information, French farmers can make targeted and timely adjustments to the types and yields of farm products to maximize efficiency.
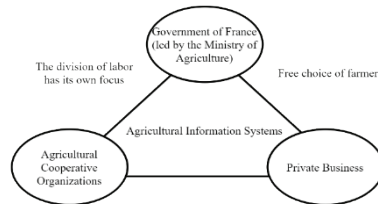

Figure 3: French agricultural informatization system

III. Methodology and Results
A. Comparative Literature Analysis

Comparative literature analysis is a research method that compares two or more objects, phenomena, theories, or data to find similarities and differences and then conducts in-depth analysis. This method helps to gain a deeper understanding of the inherent laws and connections in the development of intelligent agriculture and provides a more comprehensive perspective.

B. China's Intelligent Agriculture Development Framework

Based on the above-mentioned foreign intelligent agricultural

development models in the UK and France, intelligent agriculture is an inevitable trend in the development of modern agriculture.

Hence, by reviewing the current development practice of intelligent agriculture in China, this paper proposes an intelligent agriculture development framework from five levels based on the analysis of the above foreign intelligent agriculture development models and development results as shown in Figure 4.
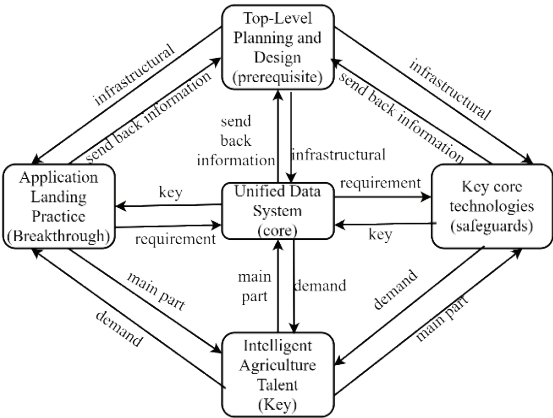

Figure 4: China's Intelligent Agriculture Development Framework

Top-Level Planning and Design: To realize the healthy development of intelligent agriculture, top-level planning and design must be carried out strategically. The development orientation must be clarified, and goals and plans must be formulated to ensure intelligent agriculture's scientific and sustainable development.

Agricultural Big Data and Integration of Unified Data Systems: Agricultural big data is significant for improving agricultural production efficiency, optimizing agricultural resource allocation, and realizing precision agriculture [5]. Establishing a data-sharing mechanism is required through data sharing to reduce duplicate collection, improve data utilization, and provide more comprehensive and accurate information

support for intelligent agriculture.

Intelligent Agriculture Talent: Cooperating with local colleges and research institutions to cultivate composite talents with multidisciplinary backgrounds in agriculture, information technology, management, and other disciplines is necessary to improve the talent cultivation system [1].

Practice of Intelligent Agriculture Application on the Ground: Combining industry, academia, research, and utilization is an important way to promote the application of intelligent agriculture on the ground [3]. China should actively build a platform for cooperation between industry, academia, and research and encourage in-depth cooperation among universities, research institutions, enterprises, and farmers.

Key Core Technology of Intelligent Agriculture: The "new infrastructure" field is developing rapidly and has become the core infrastructure and technical means to support the development of intelligent

agriculture [7]. It provides stable financial support for technological research and development. It also optimizes the innovation environment, stimulates the enthusiasm and creativity of innovation subjects, and promotes the breakthrough application of key core technologies.

IV. Conclusion

The development of intelligent agriculture in foreign countries is a top-down organizational approach, and its experience has a certain reference value for China. This paper proposes a development framework for five aspects: top-level planning and design, application and implementation practice, unified data system, key core technology, and intelligent agriculture talents. This framework not only enriches the connotation of China's intelligent agriculture development but is also significant in promoting the modernization of China's agriculture and rural areas and accelerating the construction of intelligent agricultural power.

V. References

[1] I. Charania and X. Li, "Smart farming: Agriculture's shift from a labor intensive to technology native industry," Internet of Things, vol. 9, p. 100142, 2020.

[2] N. Khan, "Current progress and future prospects of agriculture technology: Gateway to sustainable agriculture," Sustainability, vol. 13, no. 9, pp. 4883, 2021.

[3] V. Saiz-Rubio and F. Rovira-Más, "From smart farming towards agriculture 5.0: A review on crop data management," Agronomy, vol. 10, no. 2, p. 207, 2020.

[4] A. Gandomi and M. Haider, "Beyond the hype: Big data concepts, methods, and analytics," International journal of information management, vol. 35, no. 2, pp. 137-144, 2015.

[5] S. Rajeswari, "A smart agricultural model by integrating IoT, mobile and cloud-based big data analytics," in 2017 international conference on intelligent computing and control (I2C2), 2017: IEEE, pp. 1-5.

[6] K. Coble, "Advancing US agricultural competitiveness with big data and agricultural economic market information, analysis, and research," 2016.

[7] H. A. Issad, "A comprehensive review of Data Mining techniques in smart agriculture," Engineering in Agriculture, Environment and Food, vol. 12, no. 4, pp. 511-525, 2019.

[8] C. Li and B. Niu, "Design of smart agriculture based on big data and Internet of things," International Journal of Distributed Sensor Networks, vol. 16, no. 5, p. 1550147720917065, 2020.

[9] J. Xiao, "Coupling of agricultural product marketing and agricultural economic development based on big data analysis and "internet+"," Mobile Information Systems, vol. 2021, no. 1, p. 3702064, 2021.

[10] R. Alfred, "Towards paddy rice smart farming: a review on big data, machine learning, and rice production tasks," Ieee Access, vol. 9, pp. 50358-50380, 2021.

[11] Y. Su and X. Wang, "Innovation of agricultural economic management in the process of constructing smart agriculture by big data," Sustainable Computing: Informatics and Systems, vol. 31, p. 100579, 2021.

[12] A. Balafoutis, "Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics," Sustainability, vol. 9, no. 8, p. 1339, 2017.

[13] H. Kendall, "Precision agriculture technology adoption: A qualitative study of small-scale commercial "family farms" located in the North China Plain," Precision Agriculture, pp. 1-33, 2022.

[14] Y. Huang and M. Brown, "Advancing to the next generation of precision agriculture," Agriculture & food systems to, vol. 2050, p. 285â, 2019.

[15] E. L. White, "Report from the conference, 'identifying obstacles to applying big data in agriculture'," Precision Agriculture, vol. 22, pp. 306-315, 2021.

[16] A. Monteiro, "Precision agriculture for crop and livestock farming—Brief review," Animals, vol. 11, no. 8, p. 2345, 2021.

[17] H. Friedmann, "Changes in the international division of labor: agri-food complexes and export agriculture," in Towards a new political economy of agriculture: Routledge, 2021, pp. 65-93.

[18] J. Garnier, "Long-term changes in greenhouse gas emissions from French agriculture and livestock (1852–2014): From traditional agriculture to conventional intensive systems," Science of the Total Environment, vol. 660, pp. 1486-1501, 2019.

[19] C. Rega, "A classification of European agricultural land using an energy-based intensity indicator and detailed crop description," Landscape and urban planning, vol. 198, p. 103793, 2020.

[20] R. D. Andrimont, "Harmonised LUCAS in-situ land cover and use database for field surveys from 2006 to 2018 in the European Union," Scientific data, vol. 7, no. 1, p. 352, 2020.