A Review of Research on the Concept of Digital Agriculture Competitiveness in Domestic and International Contexts

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Abstract: Digital agricultural competitiveness reflects the development status of agriculture in a region. Studying the concept of digital agricultural competitiveness can provide a theoretical foundation for the modernization of agriculture. This paper explores the concepts of both digital agriculture and agricultural competitiveness to define the notion of digital agricultural competitiveness.

Keywords: Digital agriculture; Agricultural competitiveness; Conceptual research

1. Research background

The documents of the 20th CPC National Congress have further clarified the implementation pathway of the national digitalization strategy. As a core component of this strategic framework, the intelligent transformation of the agricultural sector has become a critical direction for industrial upgrading.

Digital agriculture, as the product of deep integration between modern information technologies and digital tools in agricultural applications, is centered on data collection, transmission, storage, analysis, and utilization. Leveraging technologies such as the Internet of Things, big data, and artificial intelligence, it drives comprehensive digital transformation across agricultural production, management, and services, thereby realizing intelligent, precise, and efficient agricultural development.

The strength of digital agricultural competitiveness determines a region's capacity to develop its agricultural industry and increase farmers' income. It serves as a crucial supporting force in the process of agricultural modernization and represents a novel approach to promoting rural economic development and lifting farmers out of poverty. Therefore, conducting a literature review on the concept of digital agricultural competitiveness both domestically and internationally can lay a solid foundation for the transformation and upgrading of agricultural

modernization and rural economy, thereby advancing the development of digital agricultural competitiveness.

Regarding the concept of digital agricultural competitiveness, there has yet to be a universally accepted and unified definition within the industry. As people's understanding of modern agriculture continues to evolve and improve, the perception of digital agriculture has also undergone a process of continuous change and updating.

In light of this, this paper will separately examine domestic and international literature on the concepts of digital agriculture and agricultural competitiveness. Through summarization, analysis, and synthesis, it aims to develop a new and comprehensive understanding of the concept of digital agricultural competitiveness, while accurately grasping its relevant characteristics.

2. Literature review of domestic and international research

2.1. Digital agriculture

In the 1990s, with the rapid global proliferation of internet technology, the concept of digital agriculture emerged. Expert teams from the U.S. National Academy of Sciences and the Chinese Academy of Sciences first systematically articulated this concept [1]. According to the 1997 definition by the U.S. National Academies of Sciences and Engineering, digital agriculture refers to "a precision agricultural management model supported by geospatial information technologies." Al Gore further elaborated it as "a novel agricultural management paradigm integrating digital earth theory with intelligent agricultural machinery and equipment" [2]. Kamble and Gunasekaran subsequently expanded the concept to "an innovative agricultural production system that incorporates modern technological approaches, including computer science and spatial information technologies" [3].

In November 1999, China hosted the International Symposium on "Digital Earth" in Beijing. This conference focused on exploring the application prospects of digital agriculture technologies in the agricultural sector, identifying it as one of the key directions for implementing the Digital Earth strategy. Chinese academia has been actively engaged in exploration and research in this field.

Ge Jiakun and Liu Shuxia defined digital agriculture as the deep integration of traditional agriculture with information technologies and intelligent systems, enabling dynamic monitoring and intelligent regulation of agricultural production processes [4]. Wang Limin et al. proposed that through the comprehensive application of modern technologies such as the Internet of Things and big data analytics, digital agriculture can effectively mitigate agricultural production risks and significantly enhance production efficiency [5]. Zhou Qingbo et al. argued that digital agriculture essentially represents the digital transformation of the entire agricultural production process, with its core lying in the application of digital technologies to achieve visual representation and intelligent management of agricultural elements. Their study also systematically differentiated digital agriculture from related concepts such as smart agriculture [6]. Tian Na et al. further expanded the scope of this concept, noting that digital agriculture encompasses not only traditional crop cultivation and animal husbandry but also involves multiple dimensions such as agricultural IoT system development, big data analytics applications, and e-commerce platform construction [7]. Wu Xinke characterized digital agriculture as an advanced stage of agricultural modernization, with its essential feature being the deep integration of digital information technologies with the agricultural industry. Digital agriculture is not only an imperative requirement for building a "Digital China" but also an effective measure to promote rural revitalization and enhance rural governance efficiency through the agricultural big data system [8].

2.2. Agricultural competitiveness

The international academic community has not yet reached a consensus on the definition of agricultural competitiveness, and the conceptualization remains relatively limited. Fischer and Schornberg, from an industrial perspective, argue that agricultural competitiveness is primarily reflected in the profitability, production efficiency, and output growth potential of agricultural products [9]. Anna and Agnieszka suggest that agricultural competitiveness is shaped by multiple factors collectively influencing agricultural development [10]. Matyja posits that, under fair and open market conditions, agricultural competitiveness manifests as higher production efficiency compared to competitors and the ability to sustainably generate profits using available resources [11]. These studies explore the connotation of agricultural competitiveness from different perspectives but have yet to establish a unified definitional framework.

Chinese scholars hold diverse perspectives on the conceptualization and constituent elements of agricultural competitiveness. The Competitiveness and Evaluation Research Center of Renmin University of China posits that the core essence of agricultural competitiveness lies in the comprehensive manifestation of agricultural production capacity in a specific country or region. From a research perspective, this concept can be categorized into narrow and broad dimensions. The narrow dimension primarily refers to improvements in agricultural production efficiency and the enhancement of agricultural product supply capacity. The broad dimension further encompasses key elements underpinning sustainable agricultural development, including the level of infrastructure improvement, agricultural technological innovation, the professional competence of practitioners, as well as institutional policies and financial services as supporting mechanisms.

Su Hang proposed that agricultural competitiveness should encompass multiple dimensions, including market adaptability, value creation capacity, risk resilience, and sustainable development capability. The integration of these capacities constitutes the overall strength of agriculture [12]. Liu Feixiang et al. emphasized the dynamic characteristics of agricultural competitiveness, suggesting that evaluation systems should incorporate dual indicators reflecting both current performance and future potential [13]. Liu Shumei, from an industrial perspective, argued that agricultural competitiveness manifests as the ability of agriculture, forestry, animal husbandry, and fishery sectors to allocate resources more efficiently and realize product value, specifically including national security safeguarding capacity, international market share, and potential for stable industrial development [14]. Luo Dan proposed a five-dimensional analytical framework that decomposes agricultural competitiveness into five aspects: industrial efficiency, market responsiveness, risk management, sustainable development, and scale expansion capabilities [15]. Cui Hongfang constructed a more comprehensive system of agricultural competitiveness elements, highlighting key factors such as technological innovation, factor allocation, organizational forms, talent reserves, policy support, and market performance [16]. Liu Rui and Deng Hui, from a systems theory perspective, viewed agricultural competitiveness as the synergistic outcome of multiple factors, including production factors, technological levels, institutional environments, and capital investment [17]. These studies provide multi-layered theoretical perspectives for understanding agricultural competitiveness.

3. Literature review

From the conceptual synthesis and analysis of digital agriculture and agricultural competitiveness, the following findings emerge.

3.1. The enhancement of digital agricultural competitiveness facilitates optimized resource allocation and reduced agricultural production costs

Through big data analytics, agricultural producers can more accurately comprehend market demand and price fluctuations, thereby making more informed production decisions. Concurrently, the application of IoT technologies enables real-time monitoring and precision management of agricultural production processes, effectively reducing resource waste and environmental pollution.

3.2. The improvement of digital agricultural competitiveness drives innovation in the agricultural industry

The adoption of next-generation information technologies fosters novel agricultural business models and formats, including agricultural e-commerce, crowdfunding, and insurance. These emerging models not only expand market opportunities for producers but also provide consumers with more convenient and safer agricultural product experiences.

3.3. Strengthening digital agricultural competitiveness enhances the global competitiveness of the agricultural sector

In the context of globalization, the agricultural industry faces intense international competition. Digital transformation enables productivity improvements, quality enhancement, and brand influence amplification, thereby securing greater competitive advantages in global markets

3.4. The advancement of digital agricultural competitiveness further promotes sustainable agricultural development

Through the application of a new generation of information technology, the agricultural industry can realize the economic utilization of resources, the protection and restoration of the environment, and the virtuous cycle of ecology, so as to realize the green, low-carbon, and circular development of the agricultural industry.

Based on the above analysis and existing research, this paper defines digital agricultural competitiveness as: in the field of modern agriculture, the advantages and capabilities demonstrated through the application of advanced digital technologies, information-based methods, and intelligent approaches to achieve optimized resource allocation, improved production efficiency, reduced production costs, enhanced agricultural product quality, strengthened agricultural innovation capacity, and reinforced marketing effectiveness.

This competitiveness is manifested not only across various stages of agricultural production but also throughout the entire industry chain, including processing, distribution, and sales of agricultural products. Digital agricultural competitiveness is a multidimensional, complex, and evolving comprehensive concept. It encompasses not only the digitization and intelligent transformation of agricultural production processes but also involves holistic coordination, information sharing, and resource optimization across the agricultural value chain. Its ultimate goal is to drive innovative development in the agricultural sector, enhance its competitiveness, and promote sustainable development through the application of next-generation digital technologies.

Disclosure statement

The author declares no conflict of interest.

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