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Investigation on the Path of Industrial Internet Promoting Digital Transformation and Upgrading of Agricultural Industry in Hebei Province

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Abstract: With the development of digital technology, the agricultural industry is gradually transitioning towards digitization and informatization, laying the foundation for improving agricultural efficiency, promoting agricultural industry upgrading, and improving the quality of agricultural products. At the current stage, the Digital Transformation (abbreviated as DT for convenience) of the agricultural industry still faces some problems, such as insufficient application capacity of digital technology, poor information sharing, data security and so on. In order to make the DT of the agricultural industry proceed smoothly, it is necessary to use the advantages of the industrial Internet to strengthen the application and promotion of digital technology, improve the ability of information sharing and collaboration, and strengthen data security. In this paper, the Internet technology would be studied to promote the agricultural DT and upgrading in Hebei Province. The effect of DT of agriculture in Hebei Province was analyzed by calculating the technological progress change index of each agricultural industry in 2015-2019. According to the statistical data, from 2015 to 2019, the average technological progress change index of forestry, plantation and aquaculture in Hebei Province was 1.0704, 1.1982 and 1.1894, respectively. These data showed that from 2015 to 2019, the technological progress change index of each agricultural industry in Hebei Province was greater than 1, indicating that the production level of these agricultural industries was improved, which also indicated that the measures taken by Hebei Province in agricultural DT were effective.

1. Introduction

With the continuous development and popularization of Internet technology, the DT of agricultural industry has become a topic of universal concern around the world, and has gradually become an important direction of agricultural development in various countries. Under this trend, how to use Internet technology to promote the DT of agricultural industry and improve the

efficiency and quality of Agricultural Production (abbreviated as AP for convenience) has important theoretical and practical significance. At present, there are many problems in AP, such as inefficient traditional planting management methods, information blockage, lack of standardization, and unstable quality. The application of Internet technology can combine multiple emerging technologies such as the Internet of Things, big data, artificial intelligence and AP, thus improving the sustainability and competitiveness of AP. Therefore, this paper aimed to explore the role of Internet technology in AP by studying the role of Internet technology in DT of agricultural industry, and provided new ideas and paths for promoting sustainable agricultural development.

According to relevant information, the following scholars' research on agricultural development is listed. Comprehensive rural development is an important means of achieving poverty reduction goals, and many agricultural projects related to poverty reduction have been initiated and achieved significant results. In addition, the opportunities brought by the constantly expanding agricultural product markets are often accompanied by the challenges of participating in these markets, which are key attributes of agricultural innovation and inclusive value chain development [1-2]. Clapp Jennifer studied global climate change from the perspectives of political economy, agriculture, and food systems, and believed that food and agriculture were the main causes of climate change and the industries most susceptible to its impact. How to handle the relationship between ecological and economic systems has become a complex and controversial political dynamic. Some people support initiatives related to "climate smart agriculture" and marine resources, attempting to address the interrelationships between these systems. Critics argue that these strategies only promote more policies that put pressure on the climate food system [3]. Olivares Barlin Orlando studied the sustainable AP of potatoes with the aim of identifying suitable agricultural areas for potato cultivation to achieve. He used the agricultural ecological zoning method of Food and Agriculture Organization of the United Nations to determine the physical characteristics of different regions through the analysis of climate and soil characteristics, and then fanned the crops to adapt to different environmental requirements [4]. The above research topic has studied agricultural development from multiple perspectives and has certain reference value for the research work of this topic.

After consulting the data, the following research literature on Internet and agricultural DT was found. Firstly, agriculture is facing increasing challenges due to factors such as population growth and climate change. Intelligent agriculture can use detailed digital information to guide decision-making on the agricultural value chain, thus helping to improve Agricultural productivity. In addition, designing sustainable agricultural systems through digital agriculture can balance the economic, environmental, and social aspects of sustainable food production [5-6]. Valiyev Akif pointed out that digitization was an innovative factor in the development of agriculture in Azerbaijan, and systematizes and proves the effectiveness of digitization. He identified key factors and obstacles to digitization through surveys of multiple agricultural enterprise executives, including costs, legislative procedures, and cybersecurity. The use of regression modeling methods confirmed the impact of digital factors on the innovative development of agricultural enterprises, and determined the level of digital development in the agricultural sector [7]. According to Haggag W. M, COVID-19 led to the global economic crisis, with particular attention to food safety. Therefore, in the direction and investment of agricultural digitization, it is necessary to combine the development of information and telecommunications technology. The application of digital technology is very important as it can improve the sustainability and productivity of the agricultural sector. Most countries have begun to adopt information and communication technologies to improve efficiency in the agricultural sector. These measures aim to cope with the impact of COVID-19 on rural services and agricultural development [8]. After carefully reading the above article, it can be understood that the research of the above scholars provides a good direction for the

research of this topic.

This paper studied the effect of Internet technology on the DT and upgrading of agricultural industry. The research results showed that Internet technology played a significant role in the DT and upgrading of agricultural industry, and achieved significant results. Through the application of Internet technology, AP could achieve accurate management, efficient production and intelligent services, which injected new impetus into the improvement of total factor productivity. The innovation of this paper was that it used the change index of technological progress and the change index of technological efficiency to analyze the effect of agricultural DT, which made the research results more scientific.

2. Investigation on DT of Agriculture

2.1 Importance of Agricultural DT

Agricultural DT refers to the process of applying modern information technology to AP, management, marketing and other aspects to improve AP efficiency and promote sustainable agricultural development [9-10]. In addition, DT has far-reaching significance and value for promoting sustainable agricultural development, and can accelerate the coordinated development of economy, society and environment. In general, the importance of agricultural DT lies in the following aspects:

(1) Improving AP efficiency

DT can bring many improvements to AP, the most significant of which is to improve production efficiency [11-12]. Through the application of digital technology, AP processes can be optimized and simplified, thereby improving farmers' work efficiency and production efficiency. In addition, digital decision-making can also help farmers more accurately assess market demand and crop growth conditions, in order to develop more scientific production plans for them. These measures can not only reduce input costs, but also increase returns, making AP more sustainable, stable, and prosperous.

(2) Optimizing resource utilization

DT has brought a new idea of fine management to agricultural management, which can realize the optimal utilization of agricultural resources, thus achieving the goal of efficiency, economy and environmental protection [13-14]. Through the application of digital technology, farmers can achieve precise monitoring and regulation of various production resources, enabling more rational allocation and utilization of agricultural resources. For example, through digital data analysis and prediction, AP plans can be scientifically formulated to avoid resource waste and duplicate investment; Real time perception and optimization of AP processes can also be achieved through remote monitoring and intelligent management, thereby improving resource utilization efficiency. The advantage of DT is that it can provide more intelligent, efficient, accurate and flexible support for agricultural management, and inject new power and vitality into the sustainable development of agriculture.

(3) Accelerating the process of agricultural modernization

The promotion and application of DT can not only bring many improvements to AP, but also accelerate the process of agricultural modernization. With the support of DT, AP would automatically derive more advanced, intelligent and efficient models and models, laying a solid foundation for agricultural modernization. Specifically, DT can provide more comprehensive, accurate and rapid technical support for AP, making AP gradually become an industry with modern characteristics. For example, in areas such as planting, breeding, processing, and sales, digital technology can provide support, improve the technological content and competitiveness of production, and make agriculture more modern, market-oriented, and industrialized. In a word, the

DT has played a vital role in promoting the process of agricultural modernization, providing infinite possibilities for agricultural development.

(4) Promoting sustainable agricultural development

DT plays an irreplaceable role in promoting sustainable agricultural development. On the one hand, DT can provide more intelligent, efficient and accurate technical support for AP, and promote the greening, environmental protection and safety of AP. Through the application of digital technology, various goals such as resource conservation, pollution control, and ecological protection can be achieved in the AP process, thus making sustainable agricultural development a reality. On the other hand, DT can also optimize infrastructure construction, and improve resource utilization efficiency, so as to promote agricultural technology innovation and intellectual property protection and constantly cultivate new products, new markets and new opportunities in the industry. It can bring greater development space and market competitiveness to farmers and enterprises, and further promote sustainable agricultural development.

2.2 Main Process of Agricultural DT

Agricultural DT can involve a variety of technical means, such as the Internet of Things, cloud computing, artificial intelligence, Big data analysis, etc. [15-16]. By adopting digital technology, AP can achieve precise management, improve resource utilization efficiency, and reduce production costs. At the same time, digital technology can help farmers understand market demand and price changes in real time, reduce the cost of circulation, and bring more benefits to farmers. In addition, digital technology can also assist agricultural researchers in predicting pests and diseases, assessing soil fertility, and improving crop quality and yield [17-18]. The main process is as follows:

(1) Data collection

In the process of agricultural DT, collecting a large number of agricultural data is the first and crucial step. These agricultural data include meteorological data, crop growth data, soil condition data, agricultural machinery operation data, etc. They can be automatically collected through sensors, monitoring equipment and other means, and real-time data transmission can be achieved through cloud computing and Internet of Things technology [19]. At the same time, combining artificial intelligence and other technologies can also achieve more in-depth data mining and analysis, providing more scientific guidance for AP.

(2) Data analysis

The collected agricultural data needs to be scientifically analyzed and processed in order to better guide AP. By utilizing technologies such as data mining, machine learning, and artificial intelligence, functions such as data classification, prediction, and decision-making can be achieved, thereby improving production efficiency and economic benefits. For example, by analyzing and modeling historical meteorological data, it is possible to predict future climate change trends and make reasonable planning and adjustments in AP. In addition, machine learning technology can be used to analyze and predict soil fertility status, develop corresponding fertilization plans, and optimize crop growth environment to improve yield and quality.

(3) Decision support

The results of reference data analysis can provide scientific basis and decision-making support for AP and management. For example, combining the latest Precision agriculture technology, more targeted pesticides can be used to better protect crops, and optimize crop planting methods to improve production efficiency and quality. In addition, data analysis and modeling can be used to study the mutual influence of factors such as meteorology, soil, and plant diseases and pests, further guiding and optimizing AP decisions.

(4) Digital management

Digital management is of great significance for modern AP and operation. It can digitize all aspects of AP and operation, including planting, fertilization, irrigation, picking, sales, etc. Through the Internet of Things and cloud computing technology, the automation, intelligence, and informatization of production processes are achieved, thereby improving AP efficiency and quality. Taking planting as an example, sensors and controllers can be used to monitor soil temperature, humidity, lighting and other information in real-time. Based on the data analysis results, precise fertilization and irrigation can be carried out to further improve the growth speed and yield of plants. In addition, the use of drones and satellite remote sensing technology for land inspections and investigations can provide a more accurate understanding of crop growth and conditions, timely detection of pests and diseases, and prevention and control measures. In the picking and sales process, using electronic labeling technology to trace agricultural products can prevent counterfeit and shoddy products from entering the market, ensuring the health and safety of consumers.

The main process of agricultural DT is shown in Figure 1.

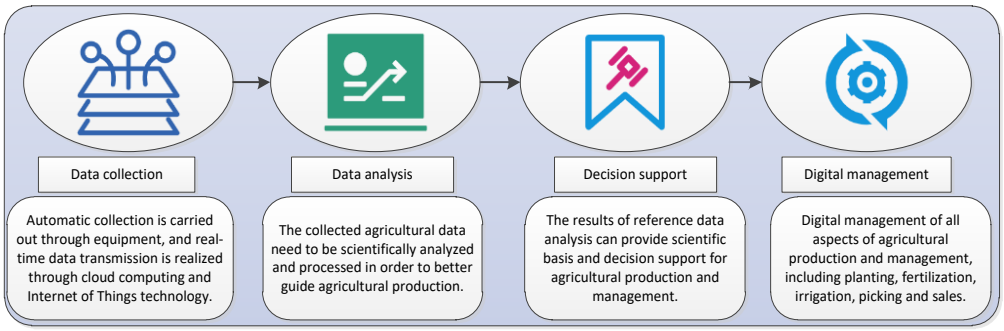

Figure 1: Main process of agricultural DT

3. Role of Internet Technology in Agricultural Digitization

Agricultural digitization refers to the use of digital technology to connect various links of AP, and the visualization, digitization, and intelligence of the entire AP process through information technology such as big data and data analysis, enhancing the efficiency, quality, and sustainability of AP [20]. Internet technology plays a very important role in agricultural digitization. Firstly, internet technology can improve farmers' access to information. Through internet technology, farmers can learn about weather, market prices, policies and regulations, and adjust AP methods in a timely manner to improve production efficiency. In addition, farmers can sell agricultural products through the internet, open up broader sales channels, and obtain better economic benefits.

Secondly, internet technology can optimize agricultural supply chain management. By establishing a digital supply chain system, every step of AP from farmland to dining tables can be accurately managed and monitored, avoiding resource waste and loss. Digitization of the supply chain can also improve logistics efficiency, shorten goods transportation time, reduce losses and costs. Finally, internet technology can also promote agricultural innovation and development. For example, the application of big data and artificial intelligence technology can analyze AP data and improve the precision and accuracy of decision-making. Meanwhile, through a digital traceability system, food safety can be guaranteed and consumer trust can be improved.

4. Investigation on DT of Agriculture in Hebei Province

Since the implementation of agricultural DT in Hebei Province, remarkable achievements have been made. The application of digital technology has made AP in Hebei Province more precise, efficient, intelligent, and sustainable. According to statistics, from 2015 to 2019, Hebei Province

took a series of measures to promote the DT of agriculture, and the gross agricultural product has been significantly improved. The specific data is shown in Table 1.

Table 1: Gross agricultural product of Hebei Province (in 100 million yuan)

Industry type	2015	2016	2017	2018	2019
Forestry	12.7	12.8	13.2	13.8	14.3
Crop farming	2732.3	2880.6	3224.5	3718.4	4027.3
Breeding industry	1583.5	1867.2	2119.5	2355.5	2593.7

From the information in Table 1, it can be seen that the gross agricultural product of Hebei Province showed a rising trend during 2015-2019, especially the gross agricultural product of Plantation and breeding industry increased significantly. This is because Hebei Province has taken a series of measures to promote agricultural DT, making AP more accurate, efficient, intelligent and sustainable.

In order to more accurately describe the achievements of agricultural DT, the change index of technological progress and the change index of technological efficiency are used to describe. The expression for the TC index of technological progress change is as follows:

$$TC = \sqrt{\frac{D_0^t(x_k^{t+1}, y_k^{t+1})}{D_0^{t+1}(x_k^{t+1}, y_k^{t+1})} * \frac{D_0^t(x_k^t, y_k^t)}{D_0^t(x_k^t, y_k^t)}} \quad (1)$$

Among them, x_k^t and y_k^t respectively represent the input and output of the kth industrial decision-making unit during period t. $D_0^t(x_k^{t+1}, y_k^{t+1})$ represents the distance function based on output in period t. TC represents the contribution of technological progress and innovation. When its value is greater than 1, it indicates that the technology has made progress and innovation.

The expression for the technical efficiency change index EC is as follows:

$$EC = \frac{D_0^{t+1}(x_k^{t+1}, y_k^{t+1})}{D_0^t(x_k^t, y_k^t)} \quad (2)$$

Among them, when the value of EC is greater than 1, it indicates that the increase in industrial production level improves total factor productivity, and vice versa, it would worsen it.

Firstly, from 2015 to 2019, the technological progress change index of various agricultural industries in Hebei Province was calculated and statistically analyzed. The detailed data is shown in Figure 2.

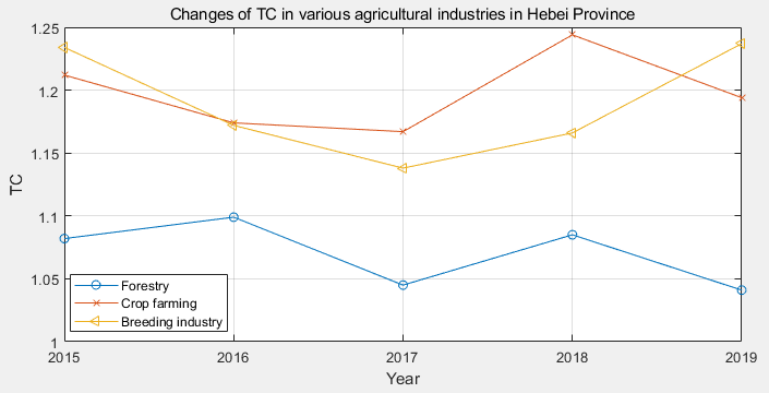

Figure 2: Index of technological progress changes in various agricultural industries in Hebei Province

According to the data in Figure 2, it could be seen that during 2015-2019, the average technological progress change index of forestry, plantation and aquaculture in Hebei Province was 1.0704, 1.1982 and 1.1894 respectively. These data indicated that between 2015 and 2019, the

agricultural industry in Hebei Province made certain technological progress and innovation.

Similarly, from 2015 to 2019, the technical efficiency change index of various agricultural industries in Hebei Province was calculated and statistically analyzed. The detailed data is shown in Figure 3.

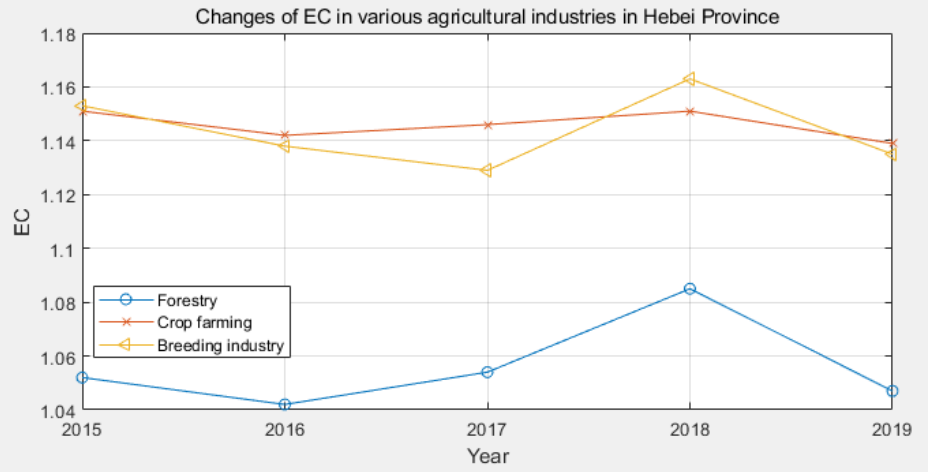

Figure 3: Index of technological efficiency changes in various agricultural industries in Hebei Province

According to the data in Figure 3, during 2015-2019, the average technical efficiency change index of forestry, plantation and aquaculture in Hebei Province was 1.056, 1.1458 and 1.1436, respectively. This showed that the production level of these three agricultural industries was improved, and the agricultural DT of Hebei Province achieved better results.

5. Conclusions

"Research on the path of Internet promoting DT and upgrading of agricultural industry" is an important research on agricultural industry upgrading in the current digital era. With the rapid development of information technology, the application of the Internet in the field of agriculture is becoming increasingly widespread. It has become an inevitable trend to transform traditional AP methods into modern digital AP methods. DT can help agricultural enterprises and farmers improve production efficiency and efficiency, promote sustainable agricultural development, and accelerate economic and social development in rural areas. This study aimed to explore the ways and strategies of DT, with a view to providing better guidance for the agricultural industry to rise to a new stage. The research results showed that since the implementation of agricultural DT in Hebei Province, the gross agricultural product showed a rising trend in 2015-2019. Therefore, the cooperation between the Internet and agriculture became one of the important factors to promote the faster development and promotion of agricultural DT. However, there were still some deficiencies in the study of the role of DT. First, in the process of DT, the infrastructure construction and digital technology application capacity in some rural areas were relatively weak, leading to the lag of digital process and regional differences. Secondly, farmers' digital skills and quality levels were uneven, and different groups might face different challenges in the face of DT.

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References

[1] Rusliyadi, Muhamad, and Wang Libin. "Agriculture development programs for poverty reduction evidences from Indonesia and China-comparative study case." Asian Journal of Agriculture and Rural Development 8.2 (2018): 104-118.

[2] Devaux, Andre, Maximo Torero, Jason Donovan, Douglas Horton. "Agricultural innovation and inclusive value-chain development: a review." Journal of Agribusiness in Developing and Emerging Economies 8.1 (2018): 99-123.

[3] Clapp, Jennifer, Peter Newell, and Zoe W. Brent. "The global political economy of climate change, agriculture and food systems." The Journal of Peasant Studies 45.1 (2018): 80-88.

[4] Olivares, Barlin Orlando, and Rafael Ángel Hernández. "Ecoterritorial sectorization for the sustainable agricultural production of potato (Solanum tuberosum L.) in Carabobo, Venezuela." Ciencia y Tecnología Agropecuaria 20.2 (2019): 323-354.

[5] Iaksch, Jaqueline, Ederson Fernandes, and Milton Borsato. "Digitalization and Big data in smart farming–a review." Journal of Management Analytics 8.2 (2021): 333-349.

[6] Basso, Bruno, and John Antle. "Digital agriculture to design sustainable agricultural systems." Nature Sustainability 3.4 (2020): 254-256.

[7] Valiyev, Akif, Famil Vali oglu Rustamov, Ruhiyya Adilqizi Huseynova, Mehpara Sattarqizi Orujova, Sevil Nizami Musayeva. "The digitalization effectiveness as an innovative factor development of the agriculture in Azerbaijan." Journal of Eastern European and Central Asian Research (JEECAR) 9.2 (2022): 194-205.

[8] Haggag, W. M. "Agricultural digitalization and rural development in COVID-19 response plans: A review Article." International Journal of Agricultural Technology 17.1 (2021): 67-74.

[9] Trukhachev, Vladimir, Bobrishev, A., Khokhlova, E., Ivashova, V., & Fedisko, O. "Personnel training for the agricultural sector in terms of digital transformation of the economy: Trends, prospects and limitations." International Journal of Civil Engineering and Technology 10.1 (2019): 2145-2155.

[10] Lugonja, Darko, Mladen Jurišić, Ivan Plaščak, Dorijan Radočaj. "Smart Agriculture Development and Its Contribution to the Sustainable Digital Transformation of the Agri-Food Sector." Tehnički glasnik 16.2 (2022): 264-267.

[11] Fountas, Spyros, Borja Espejo-García; Aikaterini Kasimati; Nikolaos Mylonas; Nicoleta Darra. "The future of digital agriculture: technologies and opportunities." IT professional 22.1 (2020): 24-28.

[12] Klerkx, Laurens. "Advisory services and transformation, plurality and disruption of agriculture and food systems: towards a new research agenda for agricultural education and extension studies." The Journal of Agricultural Education and Extension 26.2 (2020): 131-140.

[13] Dudin, Mihail Nikolaevich, Ksenia Pavlovna Pavlova, Evgenia Evgenevna Frolova, Tatiana Mihailovna Samusenko, Iuliia Yuryevna Popova. "Information technologies as an incentive for Russian agriculture." Scientific Papers Series "Management, Economic Engineering in Agriculture and Rural Development 18.1 (2018): 143-152.

[14] Saudi, Mohd Haizam Mohd. "Industrial, commercial, and agricultural energy consumption and economic growth leading to environmental degradation." Ekoloji 28.107 (2019): 299-310.

[15] Naresh, Muthunoori and P, Munaswamy. "Smart agriculture system using IoT technology." International journal of recent technology and engineering 7.5 (2019): 98-102.

[16] Thakur, Divyansh. "Applicability of wireless sensor networks in precision agriculture: A review." Wireless Personal Communications 107.1 (2019): 471-512.

[17] Birner, Regina, Thomas Daum, and Carl Pray. "Who drives the digital revolution in agriculture? A review of supply-side trends, players and challenges." Applied economic perspectives and policy 43.4 (2021): 1260-1285.

[18] Chernova, Olga Anatolyevna, Mitrofanova, Inna Vasilievna; Adamickova, Izabela; Kleitman, Elena Valerjevna. "Digitalization of Agricultural Industry–the Vector of Strategic Development of Agro-industrial Regions in Russia." AGRIS on-line Papers in Economics and Informatics 14.665-2022-509 (2022): 45-58.

[19] Friha, Othmane. "Internet of things for the future of smart agriculture: A comprehensive survey of emerging technologies." IEEE/CAA Journal of Automatica Sinica 8.4 (2021): 718-752.

[20] Huang, Yanbo, Chen Zhongxin, Yu Tao, Huang Xiangzhi, Gu Xingfa. "Agricultural remote sensing big data: Management and applications." Journal of Integrative Agriculture 17.9 (2018): 1915-1931.