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Effects of AI on Smart Agriculture: A Case Study of Digital Agriculture Base

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Abstract: Smart agriculture in China still faces difficulties in the transformation of agricultural achievements by AI technology and the scattering of land. The current problems in smart agriculture are a serious shortage of talent, scattered data, a weak mass base, unfocused land and weak agricultural technology companies. To address the problems in the development of smart agriculture. Based on the earlier research, the hypothesis that AI technology plays a positive role in the development of smart agriculture. Combining case study and phenomenology of qualitative analysis theory, field observation, focus group discussion and in-depth interviews were used to conduct an in-depth qualitative analysis using the digital agriculture base as a typical smart agriculture construction. Artificial intelligence technology has been widely used in agricultural production, especially in the Digital Agriculture Base, and is an important part of the construction of smart agriculture. It has played a catalytic role in the development of the agricultural economy and the improvement of agricultural production efficiency. This paper explores the impact of AI technology on the development of smart agriculture, and the obstacles to implement AI technology into the construction of smart agriculture, with a view to propose strategies to sustainably promote the construction of smart agriculture. The results show that the hypothesis of AI technology has a positive effect on the construction of smart agriculture holds true.

Keywords: Artificial Intelligence; Case Study; Digital Agriculture Base; Smart agriculture

1. Introduction

1.1. Background of the Study

The integration of modern information technology and traditional agriculture, especially with the development of new generation of information technology such as AI (artificial intelligence), a new business form is being formed, namely smart agriculture [1]. At present, AI technology has developed applications in agriculture such as greenhouse plant cultivation, agricultural product quality and safety traceability [2].

Al team: "Agriculture powered by artificial intelligence (AI) technology will help reduce the labour of farmers and make the whole process more environmentally friendly.

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This will make it easier for people to access safer and healthier food [3]."

China is a large agricultural country and the market space is very large [4]. The application-based (hardware and network platforms and services) smart agriculture market alone is expected to reach US$18.45 billion by 2022, with a CAGR of 13.8% [5].

1.2. Problem Statement

The agriculture in China is a small-scale industry, the growth of smart agriculture is gradually increasing based on artificial intelligence technology [6].

Firstly, most farmers, who are towards the agricultural economy, have least basic computers with low internet facilities [7]. Secondly, scientific operations are not valid to perform certain agriculture through technology [8]. As stated by Yuan Longping's that agricultural development does not happen overnight [9].

1.3. Purpose and Significance

This paper uses the Digital Agriculture Base as a typical case study for the construction of smart agriculture. The impact of AI technology on the construction of smart agriculture is studied for qualitative analysis, and the hindrances to AI technology landing in the construction of smart agriculture are explored, with a view to proposing strategies to continuously promote the construction of smart agriculture.

Furthermore, qualitative analysis can be used to develop hypotheses and plans, while case studies, phenomenology and other methods can then be used to structure the investigation of digital farming base and draw in-depth conclusions. This will allow the practicality of these hypotheses and plans to be tested cross-sectionally in the future on a wider geographical scale.

2. Methodology

2.1 Research Scheme

The long-term and difficult-to-quantify nature of AI on agricultural projects dictates that the evaluation of projects must rely on a wide range of qualitative analysis methods [10]. The research scheme is shown in Fig. 1 below.
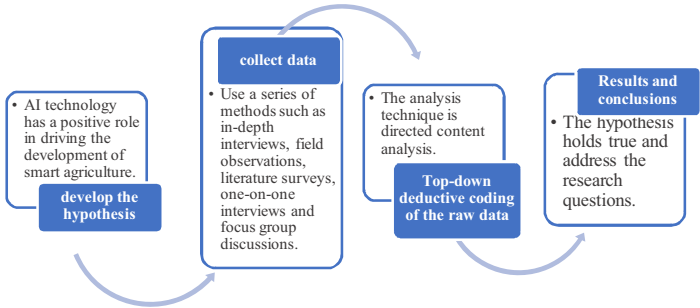

Figure 1. Research scheme

Firstly, to hypothesize that AI technology has a positive role in driving the development of smart agriculture. Later, data collection is done through a series of methods including in-depth interviews, field observations, literature surveys, one-on-one interviews and focus groups [11]. Further, based on the research questions and the theoretical framework of the study, top-down deductive coding of the raw data was carried out and the analysis technique used was directed content analysis.

2.2 Research Framework

Three research subjects were selected: government agricultural department, rural cooperatives (farmers), and cooperative enterprises. The research framework is shown in Fig. 2 below.
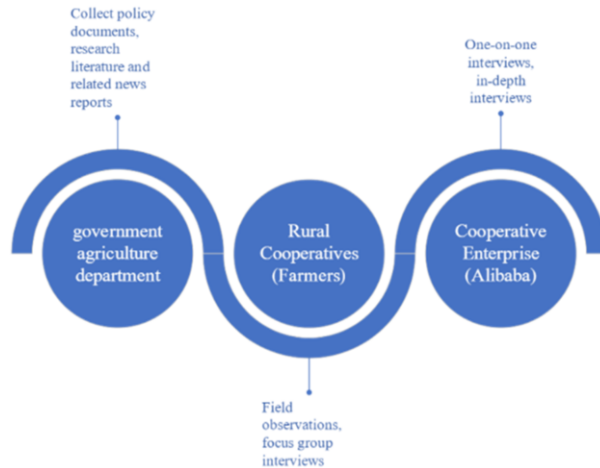

Figure 2. Three target groups and data collection methods

2.3 Participant and Setting

For the government agriculture department as the first target group, the interviewees of this project were limited to the relevant staff in the relevant grassroots government departments who were involved in the digital agriculture base cooperation, a total of ten people, while the rest were not included in the interviews.

For the rural cooperatives (farmers) as the second target group, a total of five digital Agriculture bases were visited. In the focus groups, one group consisted of ten people, with six groups in total. The focus groups were composed of local villagers, family farmers, rural cooperative leaders, and rural science and technology service providers.

For the cooperative enterprise as the third target group, this interviewee population consisted of two categories. One category is the staff of digital agriculture base division, who are responsible for communicating with the local government and planning the development direction of the base, with a total of eight people interviewed. The other category is the Digital agriculture base production department staff, who are responsible for assisting farmers to master AI production technology and work with rural cooperatives to deepen agricultural production, with a total of eight people interviewed.

2.4 Data Collection

The initial codes set was developed based on the research hypothesis and the existing research framework of the research questions.

The data collection method for the government agricultural departments is one-to-one in-depth interviews. The interview outline is shown in the table 1 below.

Table 1. Interview outline for the government agricultural departments

Question Order	Category of questions (CODE)	Interview questions
1	The current status of artificial intelligence technology promotion	Is there any application of artificial intelligence technology in agricultural production?
2	The current status of artificial intelligence technology promotion	How is the promotion?
3	The importance of artificial intelligence technology	Has agricultural economic income increased after the use of artificial intelligence technology?
4	The importance of artificial intelligence technology	Do the costs of promoting AI technology outweigh the benefits?
5	Successful Models and Experiences of Digital Agriculture Bases	What are the current digital agriculture bases? What is the enthusiasm of the farmers to sign the contract?
6	Successful Models and Experiences of Digital Agriculture Bases	Does the government approve of the promotion of AI technology in agricultural production? Do you want to continue supporting?
7	Obstacles to the promotion of artificial intelligence	What problems exist in the process of promoting artificial intelligence technology?
8	Obstacles to the promotion of artificial intelligence	What policies has the government introduced to address these issues?

Data collection with government staff focused on the current status of attitudes and promotion of support for AI technology into agricultural production, and the current status of the operation of the Digital Agriculture Base.

For the research object of rural cooperatives (farmers), data collection methods are field observation and focus group discussion. A total of 5 digital agriculture bases were visited, and the AI equipment and usage of each agricultural base were recorded in detail. Due to the different educational background of each interviewee, semi-structured discussions were adopted during the group discussion, and there was no clear answer requirement for all the discussion questions. The warm and pleasant environment allows participants to speak freely. The interview outline is shown in the table 2 below.

Table 2. Discussion outline for the focus group

Question Order	Category of questions (CODE)	discussion questions
1	The current status of artificial intelligence technology promotion	Are those artificial intelligence devices in the base in use?
2	The current status of artificial intelligence technology promotion	What are the functions of artificial intelligence devices? Can it be used proficiently?

3	The importance of artificial intelligence technology	Is the introduction of new AI devices welcome?
4	The importance of artificial intelligence technology	Has personal income increased after using artificial intelligence equipment?
5	The importance of artificial intelligence technology	Is the use of AI equipment more costly or more profitable?
6	Successful Models and Experiences of Digital Agriculture Bases	Farmers directly sign contracts with enterprises? Or contract with enterprises as a unit of rural cooperatives?
7	Successful Models and Experiences of Digital Agriculture Bases	Does the government maintain a supportive attitude in the process of signing the cooperation agreement? Will the government help move the contract forward?

For the research object of the cooperative enterprise, the method of data collection is one-on-one structured interview. A total of 18 people were interviewed. The part of interview outline is shown in the table 3 below.

Table 3. Interview outline for the cooperative enterprise

Question Order	Category of questions (CODE)	Interview questions
1	The current status of artificial intelligence technology promotion	Does Alibaba attach importance to the signing of digital agricultural bases?
2	The current status of artificial intelligence technology promotion	Which office of the government agriculture department should you communicate with?
3	The importance of artificial intelligence technology	Is the government positive about the introduction of new AI devices?
4	The importance of artificial intelligence technology	Are rural cooperatives positive about the introduction of new AI devices?
5	The importance of artificial intelligence technology	Is the introduction of AI equipment and technology helpful for signing cooperation?
6	Successful Models and Experiences of Digital Agriculture Bases	Does the company directly sign contracts with farmers? Or contract with enterprises as a unit of rural cooperatives?
7	Successful Models and Experiences of Digital Agriculture Bases	Does the government maintain a supportive attitude in the process of signing the cooperation agreement? Will the government help move the contract forward?
8	Obstacles to the promotion of artificial intelligence	What problems exist in the introduction of artificial intelligence technology?
9	Obstacles to the promotion of artificial intelligence	What specific measures do enterprises take to deal with problems in the introduction of AI technology?

2.5 Data Analysis

The data analysis is carried out by top-down deductive coding, and then directed content analysis is used for theme constructing and data translation. Start by developing a codebook with an initial code set. Read through the data and assign excerpts to the code. In the process of theme constructing, the data is encoded in multiple rounds, and the codes are grouped according to themes, looking for concepts and theories that are meaningful to the research question.

Through the case studies, observations, and records of the five digital agriculture bases, the development of artificial intelligence technology and future needs will be understood in a planned, systematic and thorough manner.

3. Results and Discussion

3.1 The Experimental Results of AI Usage

The experimental results show that AI technology has been widely used in actual agricultural production. The data collected from five digital agricultural bases. After long-term data collection, the experimental results record in detail the use of AI technology and related equipment in the agricultural field. It is concluded that the digital agricultural base needs different artificial intelligence technologies, and seeks solutions to liaise and cooperate with the digital agriculture base team to carry out modular integration of the collected. The experimental results are shown in the table 4 below.

Table 4. AI Experimental results of technology and equipment use survey

Case code	A: Agriculture Base	B: Henan Nanle Digital Agriculture Base	C: Henan Linying Digital Agriculture Base	D: Hebi National Digital Agriculture Base	E: Puyang National Digital Agriculture Base
observation records of artificial intelligence equipment	smart greenhouse, Environmental monitoring equipment, drone, Intelligent decision-making platform, Intelligent decision-making platform	smart greenhouse, drones, environmental monitoring equipment, Smart Irrigation System	smart greenhouse, drones, environmental monitoring equipment, Intelligent control platform	smart greenhouseUAV, environmental monitoring equipment, intelligent decision-making platform	smart greenhouse, UAV, environmental monitoring equipment, intelligent decision-making platform
Visitor	Township cadres, enterprise technical leaders	Officials of Agriculture Bureau, Head of Enterprise Industry Department	Head of Rural Cooperative, Head of Enterprise Division	Agriculture Bureau cadre, Alibaba Group Rural Business Department Western Henan Regional Manager	Head of Rural Cooperative, Regional Manager of Western Henan, Rural Business Department
Number of visits	6 times	5 times	6 times	8 times	8 times

3.2 The Experimental Results of Problems in Smart Agriculture

Through qualitative analysis, it is found that at present, China's smart agriculture is facing four obstacles. The experimental results are shown in the Fig. 3 below.
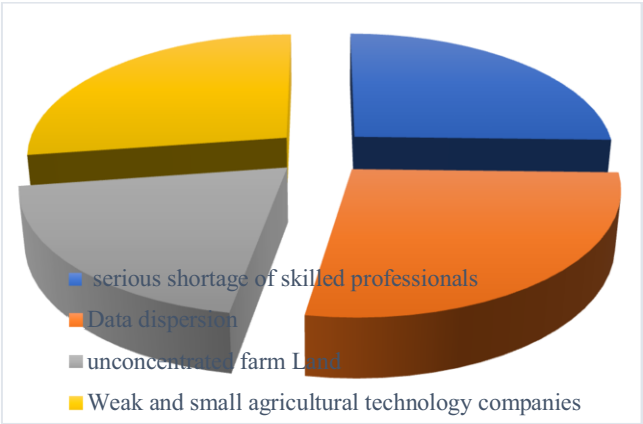
Figure 3. Three target groups and data collection methods

3.3 The Experimental Results of Policy Support for AI Agricultural Technology

The results show the social, environmental and economic impact of AI technology on agriculture, as shown in the Fig. 4 below.
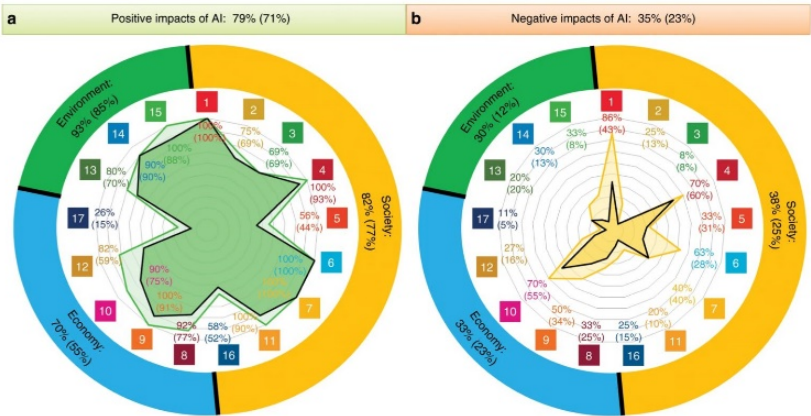

Figure 4. Results of the influences of AI on smart agriculture

4. Conclusions

The hypothesis confirms that artificial intelligence technology has a positive effect on the construction of smart agriculture, and the research questions are all concluded. Artificial intelligence technology has received strong policy support from the government in agricultural production, and has been positively recognized by rural cooperatives, which has played a role in promoting the development of agricultural economy and the improvement of agricultural production efficiency. AI technology has been widely used in the digital agriculture base and is an important part of the construction of smart agriculture.

References

[1] Mccaig M , Rezania D , Dara R , et al. Framing the response to IoT in agriculture: A discourse analysis[J]. Agricultural Systems, 2023..

[2] Li Yinan, Zoomlion uses AI to empower smart agriculture, (8), July 2022.

[3] Mitra A , Vangipuram S , Bapatla A K , et al. Everything You wanted to Know about Smart Agriculture[J]. 2022.

[4] Song Qian, On the development of artificial intelligence in 2021, Computer and Network, 47(9), 1, 2021.

[5] Anugwa I Q , Onwubuya E A , Chah J M , et al. Farmers' preferences and willingness to pay for climate-smart agricultural technologies on rice production in Nigeria. 2022.

[6] Zhou Daoqi, "Intelligent" Sensors to Ensure Vineyard Harvest, Modern Science and Technology Translation Cong (Harbin) (3), 49-49, 2023.

[7] Shirsath P B , Aggarwal P K , Thornton P K , et al. Prioritizing climate-smart agricultural land use options at a regional scale[J]. Agricultural Systems, 2016:174-183.

[8] Liu Ziheng, & Zhou Jiagui, Japan's "u-japan" plan and development status, Journal of University Libraries (3), 38-43, 2023.

[9] Li Wenjia, Research on the current situation and problems of agricultural technology extension in Xuzhou, (Doctoral dissertation, Guangxi University), 2016.

[10] Zhang Binli, & Bian Xingchao, Comprehensive benefit assessment of smart agriculture in Heilongjiang Province based on ahp. China Agricultural Resources and Zoning (2), 7, 2019.

[11] Anonymous, Henan Province issued the "Three-Year Action Plan for Rural Revitalization Supported by Science and Technology in Henan Province", Henan Science and Technology, 2019