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THE APPLICATION OF MACHINE LEARNING TO THE INNOVATIVE MANAGEMENT OF LARGE-SCALE PIG FARM

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Abstract

With the development of large-scale pig farming, the inherent equipment of intensive pig farms has been basically covered, and the breeding efficiency is close to the upper limit of manpower. Coupled with the difference in personnel skill proficiency and the increase in labor costs, it is necessary to further improve on the existing basis. Improving production efficiency has never been easy. The development of core technologies such as big data, Internet of Things, cloud computing, and data mining can integrate technologies or systems in various links, interconnect data, establish a complete set of data models and analysis systems, and realize the entire process of pig farming management. Greatly improve human labor efficiency and pig production efficiency. The emergence of artificial intelligence is a major change for the production and trade system of the future society, and it is also true for the pig industry. This study explores the application of core technologies in pig farms and obtains some new criteria, which will help improve machine learning capabilities, improve the level of artificial intelligence in pig farms, and improve pig farm productivity and management efficiency.

Keywords: Big data, Data mining, Artificial intelligence, Pig farm, Productivity.

1. INTRODUCTION

The pig industry accounts for 43.2% of the output value of China's animal husbandry. China's pork production and consumption have more than 50% of the world's share. The pig industry has become a pillar industry of China's animal husbandry (Yun, 2017). Pork price alone accounts for 2.5% of the CPI weight. In the United States, the top 10 hog production companies account for more than 40% of their production capacity. The degree of process standardization is also far higher than that of China, and the cost of pig raising in the United States is almost half lower than that in China (Brain, 2019). The intelligence level of China's pig industry is still far behind that of developed pig raising countries such as Denmark (Zhang,2019). At present, China's pig industry is transforming from labor-intensive to technological automation.

China's intelligent pig industry has experienced the following four stages (Zhou, 2021). The first stage is the stage of automatic equipment. The second stage is the management software system stage. The third stage is the lower stage of artificial intelligence (AI). The fourth stage is the advanced stage of artificial intelligence (AI). The use of data in these four stages is different. There is very little data collection and use in the automation stage. The key system stage of management focuses on the collection of data. There is a certain statistical analysis of the data of a single system, and the degree of dependence on horizontal data is not high. At the initial stage of AI, it focuses on the construction of a data collection platform. It has certain standards and requirements for data format, data structure, etc., has certain algorithms, and has a relatively high data utilization rate.

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The advanced stage of AI has high requirements for the quantity and quality of data, more accurate and intelligent algorithms, high reliance on big data and high utilization rate, and requires relatively professional data collection platforms, processing departments and technical personnel.

At present, the Chinese pig industry lacks research on major issues and factors affecting the management of large-scale pig farms. At the same time, there is a lack of knowledge to apply efficient modern technologies to solve major problems in large-scale pig farms.

This study focuses on the major issues and factors affecting the management of large-scale pig farms and how to use machine learning technology to solve major problems in the management of large-scale pig farms. Using quantitative and qualitative research methods, it explores the large-scale pig farming based on the application of modern technology The major issues and influencing factors of farm management and the use of machine learning to create innovative management models.

2. LITERATURE REVIEW AND RESEARCH FRAMEWORK

2.1 Literature review

Most of the literature and research results at home and abroad mainly focus on the use of machine learning in other fields of agriculture, the current situation and existing problems of the use of core technologies in domestic large-scale pig farms, the current status of domestic artificial intelligence applications and the use of artificial intelligence in pig farms prospects and problems in these areas.

1） The maturity of digital pig raising technology and the popularity of digital equipment affect the collection of basic data on large-scale pig farms

At present, artificial intelligence-based data collection technology and equipment are mature, but the actual application effects of core technology have not been tested and tested, and there are not enough successful cases to support the popularization of core technology and equipment in large-scale pig farms. Wang et al. (2021) maintain that a large number of concept technologies have not been verified and are difficult to implement, such as individual identification and tracking of pigs, pig face recognition, estrus identification, precision feeding, For new technologies and new solutions such as body temperature detection and video weight estimation, there are many scientific and technological teams that have developed a variety of products, but many products have ignored the complexity and arduousness of new products and new technologies in large-scale pig farms. They believe that these new technologies and new products have been implemented and successfully applied in laboratories, pilot large-scale pig farms, and other industries, and that the products and technologies can be considered mature and can be replicated and promoted. For this reason, when more large-scale pig farms are promoted and applied, unexpected problems will occur, which will have a great impact on the production management of large-scale pig farms and cause unnecessary economic losses.

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Affix a unique identity mark to live pigs and pork products, collect, convert and record various production traceability information through the data collection management system, and upload the data to the traceability central database, and link live pigs and pork products with farmers and suppliers , Distributors, traders, etc. to establish associations to realize the tracking and traceability management of the production and distribution process of live pigs and their products through product barcodes (Cheng et al., 2021).

2）The development and use of data is not sufficient

Wang (2019) believes that artificial intelligence involves robots, language recognition, image recognition, natural language processing and expert systems. Artificial intelligence must rely on large amounts of data. For AI pig raising, it is first necessary to have a sufficient amount of pig raising related data. Without a unified data platform, it is difficult to conduct industry data benchmarking analysis, so that macro statistics of the industry can only be inferred from the national annual output and the estimated number of breeding sows, and there are large errors.

3）Funds, technology, and personnel limit the application of artificial intelligence technology and equipment in large-scale Pig Farms

Wang et al. (2021) believe that at present, my country has a large number of Internet professionals and a large number of breeding practitioners. However, as the Internet has become the new infrastructure of the industry, cross-border talents with both Internet and breeding experience are still extremely scarce. Wang (2019) maintain that data management software is easier to dismount and easier to launch。Artificial intelligence large-scale Pig Farms require a large number of AI intelligent technical workers to be trained and then employed, and sufficient intelligent technical talents are reserved to build intelligent large-scale Pig Farms. It is a wise move (Xiao,2019).

4）There are barriers between information technology companies and large-scale Pig Farms

The resource allocation of artificial intelligence pig raising technology in China needs to be further integrated. Such as Jingdong, Jack Ma, Tedrive Group, Alibaba Cloud, Dekang Group, Guangzhou Shadow, etc., although not national Scientific research institutions whose research results of artificial intelligence pig raising have surpassed the advanced level of international artificial intelligence pig raising technology and are the world's top scientific achievements. They can be published online in the top international journals "Nature" and "Science". The application of these advanced technologies to large-scale pig farms and their promotion to universities and scientific research institutions need to be further accelerated. (Xiao,2019).

2.2 Conceptual framework

The dependent variable of this study is productivity, the independent variables are core technology and artificial intelligence, and the mediator variables are biosafety, production management, environmental control, disease prevention and data management system, including 27 dimensions such as big data and data mining. For the conceptual framework, see Figure 2.1, through 16 hypotheses, this research studies the significant impact of core

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technology on artificial intelligence, and the significant impact of core technology and artificial intelligence on productivity through the intermediary variables.

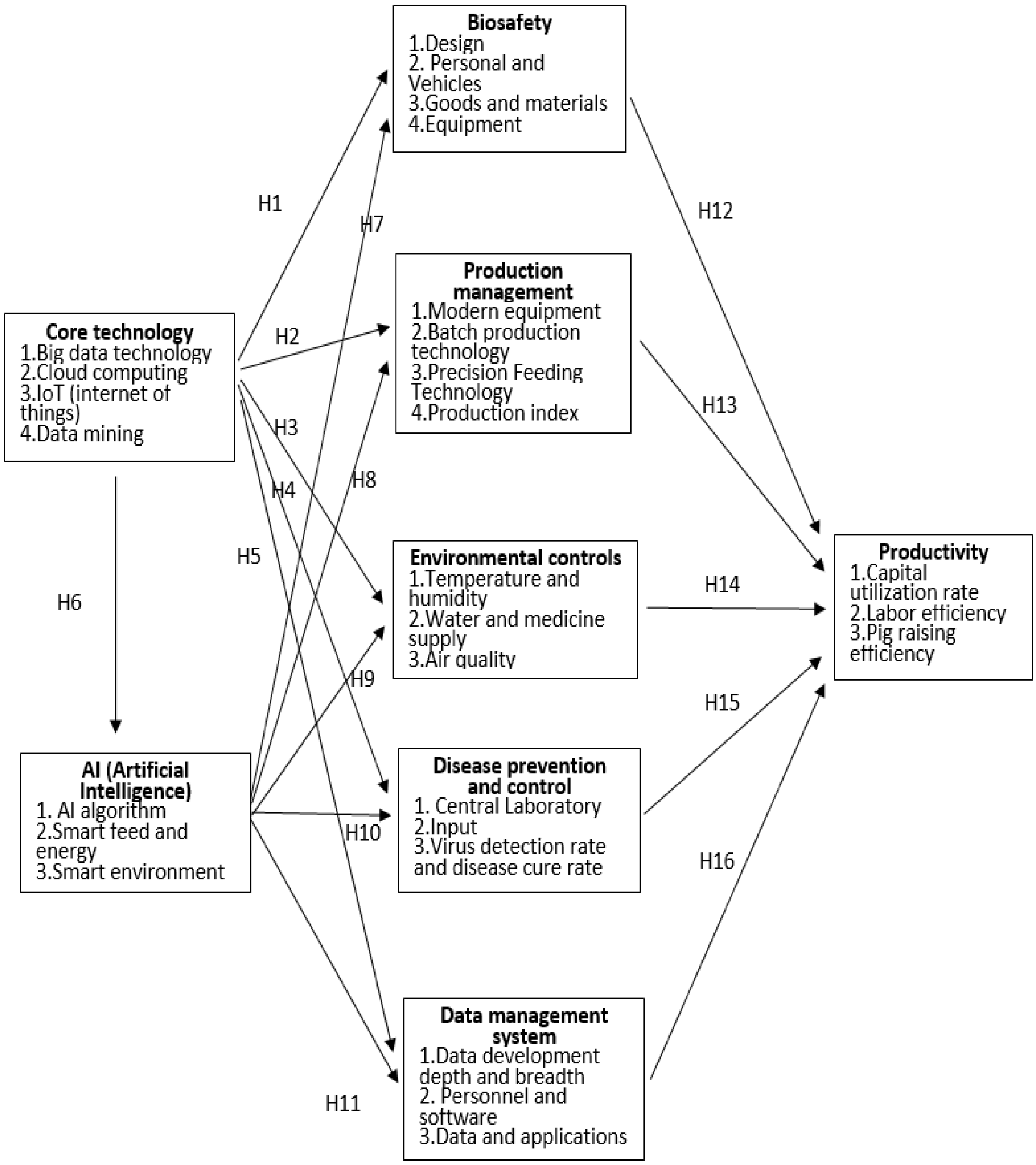

Figure 2.1: Conceptual framework

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3. RESEARCH METHODOLOGY

This study contacts a mixed research method and consists of three steps.

Step 1 is Experimental Research method. Through observation, interviews and group focus meetings, we explored the current situation of large-scale pig farms in Henan Province, the main factors affecting their productivity and management efficiency, and create a model based on machine learning and artificial intelligence technology.

Step 2 is Quantitative Research. A total of 453 valid questionnaires were recovered through the sampling survey. Using SPSS and Amos to analyze the data, establish the structural equation research model, get the research hypothesis and model fitting test, the effect is good.

Step 3 is Qualitative Research. Qualitative research is divided into two steps. In the first step, the core technology has a significant impact on artificial intelligence without checking the standards, and 36 interview results are obtained, and the relationship between scalars is analyzed. In the second step, 15 experts are interviewed. Conducted in-depth interviews, used NVivo for three-level coding, and explored the dimensions of core technology and intelligence. Finally, the results of qualitative and quantitative research showed agreement.

4. RESEARCH RESULTS

The results of the quantitative and qualitative research are as follows.

4.1 Descriptive analysis

The main statistical descriptions of this study are shown in Table 3.1 below.

Table 4.1: Descriptive Analysis Form

	N	Min	Max	Mean	St. Deviation
Biosafety	453	1.23	4.85	3.445	0.846
Production management	453	1.17	4.75	3.460	0.867
Environmental controls	453	1.22	5.00	3.430	0.878
Disease prevention and control	453	1.11	4.89	3.425	0.895
AI (Artificial Intelligence)	453	1.27	4.82	3.496	0.845
Core technology	453	1.27	4.80	3.446	0.876
Data management system	453	1.25	4.92	3.462	0.834
Productivity	453	1.13	4.75	3.442	0.883

It can be seen from the above table that the mean values of biosafety, production management, environmental control, disease prevention and control, artificial intelligence, core technology, data management system and productivity are all greater than 3.4, indicating that these variables are highly recognized, especially production.

For management and artificial intelligence and data management systems, the average value exceeds 3.46. This indicates that the participation of these aspects of data is relatively good. Observing the range and standard deviation data in the above table, it can be seen that these variables are relatively stable and the degree of data dispersion is not high.

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4.2 Correlation analysis

The Pearson Correlation Coefficient of this study is shown in the table 3.2 as follows.

Table 4.2: Pearson Correlation Coefficient

	Biosafety	Production management	Environmental controls	Disease prevention and control	Data management system	Core technology	AI (Artificial Intelligence)	Productivity
Biosafety	1							
Production management	0.417**	1						
Environmental controls	0.427**	0.484**	1					
Disease prevention and control	0.405**	0.430**	0.404**	1				
Data management system	0.407**	0.497**	0.439**	0.433**	1			
Core technology	0.434**	0.490**	0.431**	0.391**	0.463**	1		
AI (Artificial Intelligence)	0.382**	0.467**	0.453**	0.472**	0.485**	0.492**	1	
Productivity	0.422**	0.424**	0.419**	0.431**	0.478**	0.397**	0.491**	1
** Correlation is significant at the 0.01 level (two-tailed).								

From the above table, it can be seen that. Artificial intelligence and core technology, indicating that there is a significant positive correlation between the two. The correlation coefficients between core data and biological safety, production management, environmental control, disease prevention and control, and data management systems are all over 0, indicating that there is a significant positive correlation between them. The correlation coefficients between artificial intelligence and biological safety, production management, environmental control, disease prevention and control, and data management systems are all over 0, indicating that there is a significant positive correlation between them. The correlation coefficients among biosafety, production management, environmental control, disease control, data management system and productivity all exceed 0, indicating that there is a significant positive correlation among them. The correlation coefficients among biosafety, production management, environmental control, disease prevention and control, and data management systems all exceed 0, indicating that there is a significant positive correlation among them.

4.3 Analysis of Structural Equation Results

4.3.1 Model fitting

The main model fitting index is shown in the table 4.3 as follows.

Table 4.3: Model Fit Metrics

Index	χ2	df	χ2/df	GFI	RMSEA	RMR	CFI	NFI	TLI
Judgment Standard	-	-	<3	>0.9	<0.10	<0.08	>0.9	>0.9	>0.9
Value	498.394	308	1.618	0.919	0.037	0.054	0.979	0.948	0.976

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From Table 4.3, it can be seen that the chi square degree of freedom ratio is less than 3, the RMSEA value is less than 0.1, and the values of various indicators such as GFl, NFl, TLl, and CFl are all greater than 0.9. All indicators of the structural equation model meet the excellent standard, indicating that the data can fit the model well.

4.3.2 Mediating Role

The following is a test of the mediation effect, and the data are shown in the table 4.4 as follows.

Table 4.4: Intermediary Checklist

Path		Estimate	BC (95% confidence interval)		P
			Lower	Upper	
Direct effect	Core technology-> Data management system	0.261	0.099	0.437	0.001
	Core technology-> Disease prevention and control	0.182	0.015	0.364	0.034
	Core technology-> Environmental controls	0.246	0.080	0.421	0.004
	Core technology-> Production management	0.331	0.144	0.520	0.001
	Core technology-> Biosafety	0.280	0.113	0.460	0.001
Indirect effect	Core technology->AI (Artificial Intelligence)-> Data management system	0.242	0.149	0.380	0.000
	Core technology->AI (Artificial Intelligence)-> Disease prevention and control	0.270	0.170	0.408	0.000
	Core technology->AI (Artificial Intelligence)-> Environmental controls	0.241	0.150	0.384	0.000
	Core technology->AI (Artificial Intelligence)-> Production management	0.222	0.131	0.367	0.000
	Core technology->AI (Artificial Intelligence)-> Biosafety	0.169	0.083	0.294	0.000
Total effect	Core technology-> Data management system	0.502	0.376	0.632	0.000
	Core technology-> Disease prevention and control	0.452	0.327	0.585	0.000
	Core technology-> Environmental controls	0.487	0.364	0.614	0.000
	Core technology-> Production management	0.553	0.426	0.679	0.000
	Core technology-> Biosafety	0.450	0.324	0.576	0.000

If the 95% confidence interval does not contain 0, it means that the path is significantly established, and if it contains 0, then it is not established. From the above table, it can be seen that the direct effect, indirect effect, and total effect do not contain 0, indicating that the path is all established, and all mediation is partial mediation.

4.3.3 Results of Hypotheses

This study determined the relationship between Core technology and AI (Artificial Intelligence), The Relationship between Core technology and Biosafety, Production management, Environmental controls, Disease prevention and control, Data management system; The Relationship between AI (Artificial Intelligence) and Biosafety, Production management, Environmental controls, Disease prevention and control, Data management system; The Relationship between Biosafety, Production management, Environmental controls, Disease prevention and control, Data management system and Productivity.

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Core technology has a significant impact on biosecurity, production management, disease prevention and control, environmental control and data management systems, which is consistent with the research results of Wang et al. (2023). Using the Internet platform to realize digital and intelligent management of animal husbandry, Promote the transformation of livestock breeding from traditional extensive to knowledge-based and technology-based (Chai, 2020; Zhu, et al., 2011; Huang, 2015; Chen, 2021; Yang, 2018). Artificial intelligence has a significant impact on biosecurity, production management, disease prevention, environmental control, and data management systems, which is consistent with the deep integration of artificial intelligence technology and pig industry advocated by Zhang (2017). Chen (2020) advocated the use of computer vision and deep learning technology to replace traditional manual observation methods to improve the yield and quality of pig products. Wang (2022) believes that the continuous emergence of domestic pig raising intelligent equipment or system manufacturers and platforms has promoted the development of pig raising intelligence in my country.

Biosecurity, production management, disease prevention, environmental control, and data management systems have a significant impact on the productivity of pig farms. Large-scale pig farms are based on core technology and artificial intelligence to build biosecurity prevention and control measures, and the efficiency of production management is remarkable. The improvement of environmental control and disease prevention and control, the continuous improvement of data management system, and the deepening of data development and application can significantly improve the productivity of large-scale pig farms (Fu, 2016; Xing, et al., 2019; Chen, 2022; Chen, 2012; Li, et al., 2023).

4.3.4 Exploring Criteria for Core Technology and Artificial Intelligence

Using the three-level coding level of the grounded theory research approach, this study explores the specific dimensions of core technology and AI technology adopted by pig farms. Among them, core technology includes four dimensions of big data technology, data mining, Internet of Things and cloud computing, and AI technology includes three dimensions of AI algorithm, intelligent environment detection, and intelligent feed and energy system. Current research shows that artificial intelligence technology and equipment are mature, but the application of core technology in the pig industry has not been fully tested. Most of the existing research is to explore the application of specific technologies in pig farm management. For example, the Internet of Things platform can help carry out precise management with the help of deep learning, visual processing and other technologies. The temperature and humidity sensors can help monitor the environment of pig houses and realize pig house management. intelligent management. Existing research on the application of pig raising technology is relatively scattered, focusing on the functions and applications of specific technologies, failing to analyze the standard dimensions of the application of core technologies and AI technologies in the pig raising industry from a macro-pervasive perspective. It is not conducive to systematically expounding the application of modern technology in the pig industry.

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5. CONCLUSION AND DISCUSSION

5.1 Research conclusion

5.1.1 Productivity of large-scale pig farms and factors affecting each variable

This study established an innovative management model, with core technology and artificial intelligence as independent variables, which act on five intermediary variables of pig farm operation, biosecurity, production management, disease prevention, environmental control, and data management system. Under the influence of biosecurity, industrial management, disease prevention, environmental control and data management, the influence is more obvious.

From the perspective of the impact of core technology, artificial intelligence, and biosecurity on productivity, large-scale pig farms have high density of pig houses and large-scale breeding, and biosecurity has a greater risk of large-scale death of pigs. Therefore, the impact of biosecurity on productivity is significant and immediate. In terms of the impact of core technology, artificial intelligence and production management on productivity, the modern equipment used in production management, the determination of batch production equipment and batch data, the equipment used in precision feeding technology, and the main measures of production indicators, under the influence The combination of core technology and artificial intelligence can show an increase in pig farm productivity. From the perspective of the impact of core technology, artificial intelligence and environmental control on productivity, core technology and artificial intelligence play an important role in the detection and control of temperature, humidity and air quality in pig houses, as well as water conservancy construction. Supply and drug delivery system. Therefore, good environmental control can provide good productivity. From the perspective of the impact of core technology, artificial intelligence, and disease prevention on productivity, core technologies such as big data technology and Internet of Things technology have affected the accuracy of laboratory core testing equipment and testing technology, and capital investment has affected laboratory core testing equipment and Accuracy of detection techniques. The purchase of expensive smart devices will ultimately affect the accuracy of virus and bacteria detection and the cure rate of diseases. It is self-evident that disease prevention directly affects productivity. From the perspective of the impact of core technologies, artificial intelligence, and data management systems on productivity, technologies such as big data technology, cloud computing, and data mining require a fully functional data management system, and the configuration of data managers and management software also affects data management. Applying a good data management system can significantly increase farm productivity.

5.1.2 Large-scale pig farm machine learning model

In this study, the core technology includes four dimensions of big data technology, data mining, Internet of Things and cloud computing, quantitative and qualitative analysis and research of Volume, Value, Variety, Velocity, Veracity of big data, massive resources of cloud computing, and things The intelligence and convenience of networking, data mining in classification, evaluation, prediction, correlation grouping or association rules, clustering. Large-scale pig farms can use this core technology to improve the level of machine learning, help pig farms

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establish production management platforms including intelligent computing platforms, intelligent feeding and energy management, and intelligent environments, and improve biosecurity through high-level artificial intelligence , production management, environmental control, disease prevention and data management systems, which reduces production and management costs, improves labor productivity and management efficiency, and ultimately helps pig raising productivity.

5.2 Research discussion

Accordingly, this study first analyzes the application of core technology and AI technology in the pig industry from the perspective of framework construction. Specifically, big data technology, data mining technology, Internet of Things and cloud computing technology are the four major aspects of pig farm core technology, of which big data technology is the foundation, mainly used to collect pig growth status, health status, pig house Environmental and other data, through the establishment of appropriate prediction models, predict pig growth trends, health risks, etc., to help make better management decisions. Applying big data technology to environmental indicators can help better adjust to a suitable growth environment and promote the healthy growth of pigs.

AI technology includes three parts: AI algorithm, intelligent environment monitoring, and intelligent feed and energy system. Among them, the AI algorithm is the foundation, which helps to carry out image recognition and voice recognition, analyze the behavior trajectory and health status of pigs, and prevent and control possible risks in advance. By developing a personalized recommendation system, establishing a pig growth model, an intelligent decision-making model, a decision support system, etc., the AI algorithm helps to carry out personalized feeding management according to pig weight, growth stage and other indicators, and provides optimal feeding for farms. Breeding strategies and management programs to improve production efficiency and economic benefits.

5.3 Research findings

With the development of large-scale farming, the inherent equipment of intensive farms has been basically covered, and the farming efficiency is close to the upper limit of manpower. Coupled with the difference in personnel skill proficiency and the increase in labor costs, we want to further improve production efficiency on the existing basis It's not easy. The development of big data, Internet of Things, cloud computing, blockchain and other technologies can integrate the technologies or systems of various links, interconnect data, establish a complete set of data models and analysis systems, and realize the whole process management of the pig industry. Greatly improve human labor efficiency and pig production efficiency. The emergence of artificial intelligence is a major change for the production and trade system of the future society, and it is also true for the pig industry. Existing digital technologies and systems are more about solving single events or problems, such as environmental monitoring of the breeding process, pig status abnormal identification, precision nutrition， intelligent breeding, health management, production management; trade links such as raw material procurement, intelligent weight estimation and inventory, distance sales.

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