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Current Research Situation and Development Countermeasures for Digital Orchards

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Abstract With the rapid development of modern information technology, digital technology has gradually penetrated into all fields and links of the agricultural industry. Digital orchard reflects the comprehensive application of digital technology in orchard management. This study surveys and analyzes the current development of digital orchard, clarifies the development status and existing problems, and comes up with reasonable recommendations, to provide a certain reference and guidance for the construction of digital orchard in Zibo City of Shandong Province.

Key words Digital orchard, Digital design, Current research status, Recommendations

1 Introduction

China is a large country of fruit tree planting, and its orchard area and fruit yield both rank first in the world[1]. The fruit industry is the third largest industry in China's planting industry after grain and vegetables, and plays an important role in China's rural economic development[2]. The fruit tree industry is a pillar industry of many regions, and it has also played a very important role in the great struggle against poverty. The current research contents of digital orchard mainly include digitalization of orchard production, intelligent management and control, digital management of fruit quality monitoring and traceability, fruit distribution and e-commerce. These aspects can effectively improve the problems existing in the traditional fruit industry in the past, such as low fruit yield, high pesticide residues, low level of mechanized management, and time-consuming and labor-intensive problems[2]. Fig. 1 illustrates the digital orchard mechanized automation equipment. Through the monitoring of the Internet of Things (IoT), information collection and operation guidance can be realized, which breaks the traditional manual operation, not only saves time and effort, but also provides more accurate information feedback. Confronted with the problems of traditional fruit industry development, the development of digital orchard is particularly important. Driven by the entire monitoring system of the IoT, traditional agriculture has entered the era of big data, and digital orchards will also be an inevitable trend in the development of the orchard industry.

2 Current situation of development of digital orchards

2.1 In foreign countries The world largest fruit-producing countries, in addition to China ranking first, there are other major fruit-producing countries, such as India, the United States, Mexico, *etc.* Most of their domestic farms have already achieved mechanization, automation, and intelligent management. Most orchards in Europe and the United States have already achieved mechanized management, and are currently developing toward specialization and intelligence. Taking the integrated management of water and fertilizer as an example, the utilization rate of water and fertilizer in foreign orchards is high. With long history of foreign water and fertilizer integration technology research, their technology is relatively mature, and they have basically realized the water and fertilizer integration management. Israel is one of the countries in the world where water resources are extremely scarce, and the per capita water resources are only 271 m^3. However, Israel has successfully built the "desert country" into an "agricultural powerhouse" by virtue of its advanced water and fertilizer integrated drip irrigation technology, and has become the leader and pioneer of the global drip irrigation and micro-spraying industry[3]. The water and fertilizer integration technology in the United States of America started earlier and developed rapidly. The United States of America is the country with the largest micro-irrigation area in the world. The United States of America mainly uses drip irrigation and sprinkler irrigation for water-saving irrigation in orchards, and generally uses intelligent control technology to precisely control the amount of irrigation water, uniformity, and fertilizer. The California state in the USA has now established a complete water and fertilizer integrated equipment and service system, which has become a typical example of the world's modern agricultural production system. In terms of pest control, Unmanned Aerial Vehicle (UAV) technology has been widely used in large orchards. Using to regularly cruise and take pictures between the rows of fruit trees, the orchard technicians observe the occurrence of diseases and insect pests indoors through the video

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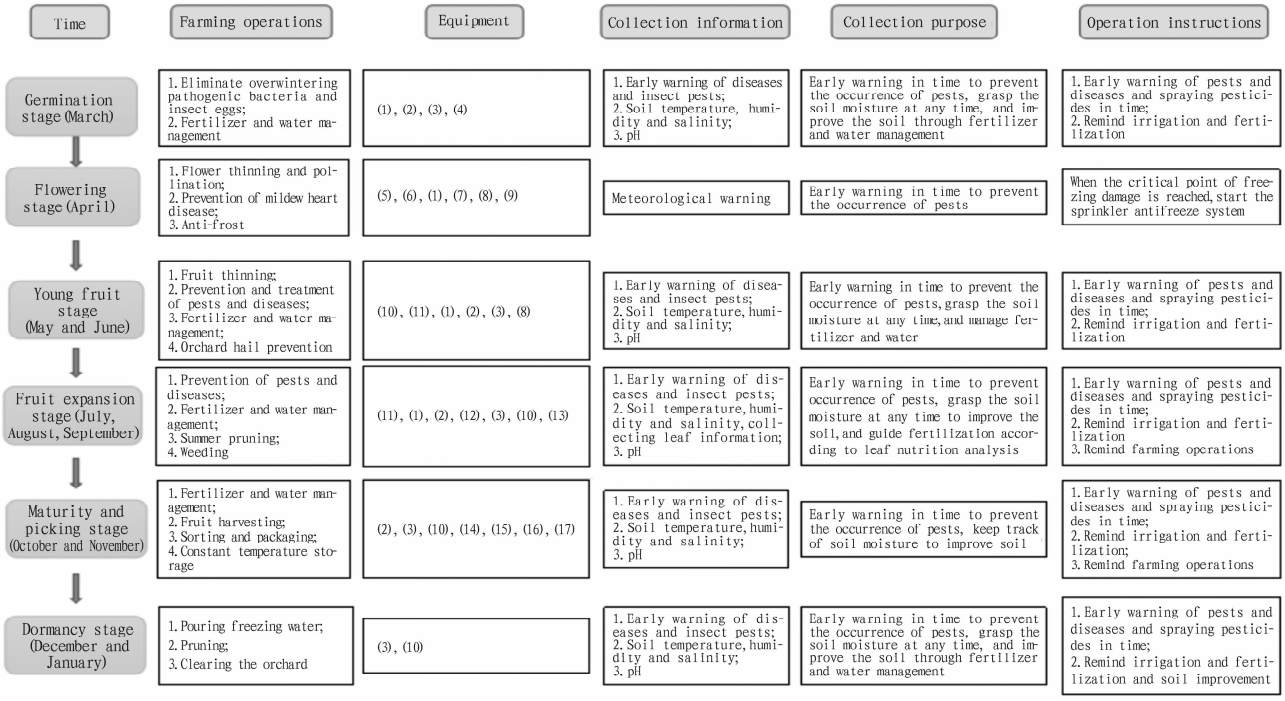
sent by the UAV, so as to determine the strategy of spraying prevention and control, avoiding the defect that the technicians cannot find the problem in time due to the large area[4].

2.2 Current situations in China As the world largest fruit producer, China's orchard mechanization rate is lower than 30%. Taking the integrated management of water and fertilizer as an example, China is a large agricultural country with a long history of irrigation. However, due to the serious waste of water resources caused by the traditional irrigation mode, China is also a country with serious shortage of water resources, water saving is particularly important. In recent years, with the development of agriculture, China's water and fertilizer integration technology has become increasingly mature, and the application scale of domestic water and fertilizer integration equipment is also expanding. China's water and fertilizer integration technology started relatively late, but with the increase in market demand, more and more domestic companies have begun to conduct research on water and fertilizer integration technology, making domestic water and fertilizer integration equipment develop towards intelligence, automation and precision[4].



Note: (1) large mist spraying machine, (2) automatic soil moisture monitoring equipment, (3) integrated water and fertilizer equipment, (4) early warning of diseases and insect pests, (5) large branch flower thinning machinery, (6) releasing bees, (7) automatic low-temperature collection equipment, (8) orchard protection net; (9) automatic water spraying equipment, (10) automatic orchard operation platform, (11) intelligent disease and pest monitoring and forecasting equipment, (12) leaf nutrition analysis, (13) orchard weeder, (14) automatic sorting and packaging equipment, (15) constant temperature equipment, (16) controlled atmosphere (CA) equipment storage, (17) fruit quality and safety risk detection and traceability.

Fig. 1 Mechanized automation equipment for digital orchard

In Wuming District, Nanning City, Guangxi Zhuang Autonomous Region, a grape farmer used the "Grape Steward" mobile Application to grow grapes in a "user-friendly" way, increasing his annual income by 200 000 yuan. Suzhou City in Anhui Province has developed a new management model on the finger of the "Digital Orchard" management system. When fruit farmers encounter technical problems, they can invite experts to consult remotely through the expert online consultation system to answer questions. Haiyang City in Shandong Province launched the "fruit tree subscription" sales model. Consumers can subscribe the fruit trees for a period of one year, and get to know the daily life of the orchard and the growth of fruit trees through the Internet. Owners can go to the orchard at any time to check the growth of fruit trees and experience the growth process of fruit trees in a close distance. Since 2015, the Digital Orchard innovation project implemented by Dangshan County in Anhui Province has injected "IoT, Cloud Computing, Big Data, and the Internet" into the fruit industry, and established an information management platform for the entire chain of planting, production, and sales[4]. The intelligent data acquisition recorder is ready to collect data information such as wind speed, wind direction, soil humidity, temperature, light, *etc.*, so that fruit farmers can plant fruit trees in a more scientific and rational manner. The fruit implements one code per fruit. Consumers only need to scan the code to know the life of the fruit and the types and amounts of pesticides used. This not only allows consumers to buy with peace of mind, but also to eat with peace of mind. Fig. 2 to Fig. 5 shows the intelligent management system of "Digital Orchard" in Dangshan County.

Fig. 2 Interface of Digital Orchard

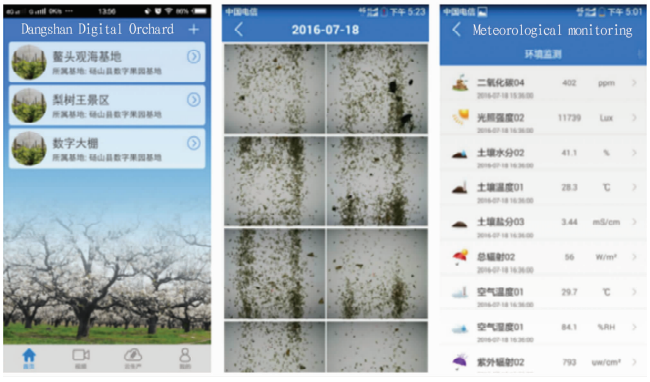


Fig. 3 Monitoring the orchard through mobile App anytime and anywhere

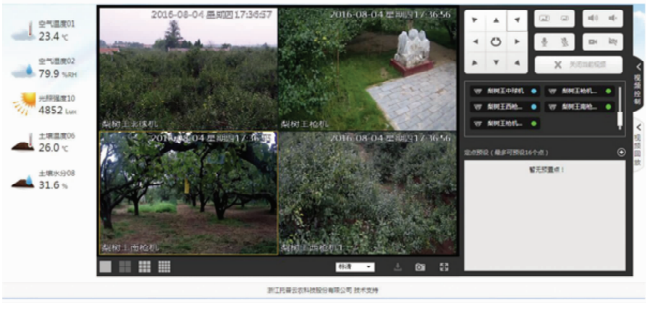


Fig. 4 Interface of orchard monitoring system

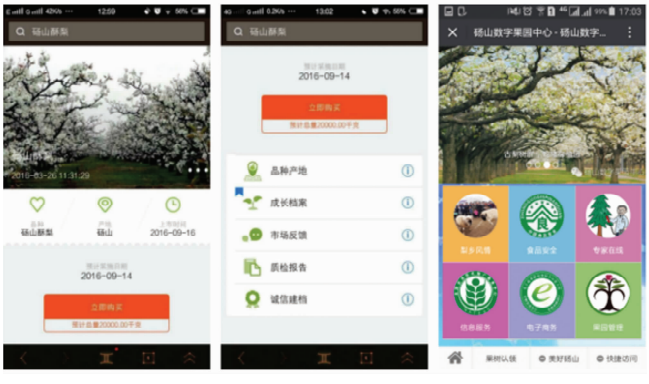


Fig. 5 Agricultural product quality traceability system and WeChat business platform

2.3 Current situations in Zibo City In June 2020, China's first "Hema (Digital Farming) City" settled in Zibo. Hema City is a demonstration city of Alibaba's digital agriculture and it will effectively promote the transformation and upgrading of Zibo's agricultural and rural digital, information-based and intelligent development. This is also the action taken by Zibo City to give full play to digital empowerment, a powerful engine of rural revitalization. The cooperation between Alibaba and Yiyuan County under the jurisdiction of Zibo City took the Yiyuan apple industry as the entry point, and was committed to promoting the quality and efficiency of the Yiyuan apple industry, empowering local e-commerce companies, and promoting the rapid development of the apple industry. The project was equipped with two intelligent sorting production lines for apples and big cherries, and a series of digital cold storages were installed, realizing the functions of commercialization processing, quality control and sorting of agricultural products sold online, packaging and distribution, and unified delivery, making it a digital agricultural collection and processing center with centralized procurement and cross-regional distribution capabilities in the north China[5]. The "Ecological Unmanned Farm Zhongyi Smart Orchard" in Yiyuan County of Zibo City was jointly developed by Shandong Zhongyi Modern Smart Agriculture Co., Ltd. and Academician Lan Yubin's team. It is the first ecological unmanned smart orchard in China. The orchard is equipped with water and fertilizer integration, net house cultivation, drip irrigation system, agricultural environment monitoring, soil and meteorological monitoring, traceability of agricultural products, pest monitoring and early warning, and intelligent agricultural machinery management, integrating precision agricultural aviation application technology, biological prevention and control, green circular agriculture, orchard robots, artificial intelligence, 5G communications, IoT, big data, cloud computing and other new high technologies, as well as the technical integration and process reconstruction of the whole chain of apple planting, and realizing comprehensive perception and interconnection of people, objects and information. Zhongyi Smart Orchard uses intelligent surveying and mapping UAV for orchard surveying and mapping, which can accurately calculate and count the number of fruit trees and orchard area, and can accurately locate the location information of each orchard. By comparing a large number of pictures of fruit trees, AI can evaluate the size, age, and growth of fruit trees, so as to help fruit farmers stop losses in time and increase the fruit yield. The use of high-tech UAV plant protection instead of manual work not only saves manpower and improves efficiency, but also saves water and pesticides. The separation of human and pesticide avoids the danger of pesticide poisoning. Using the smart orchard management system can understand the changes in the orchard in real time, carry out information-based, digital, and intelligent management of the orchard, increase the yield and improve efficiency, and further liberate the digital productivity of the orchard.

3 Existing problems in digital orchards

3.1 Insufficient understanding of digital orchard construction In recent years, with the popularization of digital and intelligent equipment, and the 14th Five-Year Plan clearly proposing to promote the construction of digital industrialization and industrial digitalization, more and more enterprises and orchards have started to respond to the call of the state to use digital and intelligent

equipment. However, many enterprises and parks only have a superficial understanding of digital orchards. They simply think that the introduction of digital and intelligent equipment is digitalization, and they have not built a system for digital orchards.

3.2 Low level of mechanization and intelligence Although China is the largest fruit producing country in the world, most of the orchards are small and scattered. The initial investment cost of purchasing mechanized equipment is high, which is difficult for fruit growers to accept, resulting in less than 30% of mechanization utilization of orchards. In addition, the variety of fruit types and the complex planting environment are also the reasons for the low level of mechanization in orchard operations.

3.3 Shortage of talents People engaged in orchard work generally have low scientific and cultural quality, the rural labor force is small, and the problem of aging is serious. It is difficult for them to accept new technologies and new knowledge, and they largely rely on experience and traditional planting methods in orchard planting. The introduction and training mechanism of orchards for scientific and technological talents is not perfect, and the lack of professional training for fruit farmers limits the application and promotion of digital technology in the orchards.

3.4 Weak publicity efforts At present, only scholars, leaders and large growers who pay attention to the development of digital orchards have some understanding of digital orchards. Most people are unfamiliar with the definition and planting mode of digital orchards. For example, many local people in Dangshan County do not know that there is such a successful "digital orchard" around them. The reason why most people don't know much about digital orchard or even heard of it is because the publicity is weak. Furthermore, the sales of fruit are basically online, and the use area is small, which makes many people who do not use the Internet and do not understand e-commerce think that digital orchards have nothing to do with them.

4 Recommendations for the development of digital orchards

4.1 Accelerating the construction of digital orchards The construction of digital orchards should be guided by the government, allowing enterprises using intelligent equipment to file with relevant departments. It is recommended to carry out regular digital construction training to deepen the enterprises' understanding of digital orchard construction, and to guide the development of the enterprises themselves, so that they can build their own digital management system. At the same time of carrying out training, it is recommended to publicize the government's new policy on digital orchard construction, so that enterprises can keep up with the pace of the times and avoid development lag caused by lack of information.

4.2 Integrating resources It is recommended to make full use of the IoT and big data to integrate the current resource information. The government should actively guide to increase subsidies for the purchase of orchard machinery and equipment. By improving the mechanization of the orchard, it is expected to use intelligent machinery and equipment to complete most of the operations in the orchard, such as tree fertilization, branch pruning, fruit bagging, pest control, intertillage weeding, fruit harvesting, *etc.*, to create good growth conditions for fruit trees, so as to improve fruit quality[6].

4.3 Attaching importance to the talent cultivation It is recommended to hire relevant experts to train practitioners on the idea of "Internet +" and digital orchard knowledge, so as to improve the professional level and overall quality of personnel. Young people have a strong ability to accept new things and make decisions, and most of the e-commerce workers are young people. Therefore, it is recommended to formulate corresponding support policies to allow more young people to take root in the rural areas and engage in the construction of digital orchards.

4.4 Making innovation in the publicity methods In the stage of rapid development of new media, it is necessary to take full advantage of the current online publicity methods to expand online sales channels. At the same time of publicity, it is necessary to reflect the characteristics and advantages of the digital orchard, combine the digital orchard with e-commerce, and use e-commerce for publicity, sales and transportation. For offline sales, it is recommended to develop immersive experience services, allowing consumers to visit the orchards to observe the planting process and pick them by themselves to improve consumer participation and product reputation.

5 Conclusions

Digital orchard is a new emerging concept. Although digital technology has not yet been popularized, digital orchard has got rid of the situation of high labor intensity, low productivity and dependence on experience brought about by traditional orchard planting, making the fruit industry start to embark on a road of stable production, low production, low energy consumption and high efficiency. The application and research of digital orchard has been on the way. The development of digital orchard networking, intelligence, and mechanization is also the inevitable result of the reform and innovation of traditional orchards.

References

[1] SHU HR. A study on the sustainable development strategy of China's fruit tree industry[J]. Deciduous Fruits, 2012, 44(1): 1-4. (in Chinese).

[2] ZHOU GM. Research and development of China's digital orchard[J]. Agriculture Network Information, 2012(1): 10-12. (in Chinese).

[3] HAN Y, ZHANG HM, SONG YP, *et al.* Research progress and development trend of water and fertilizer integrated equipment in orchards at home and abroad[J]. Journal of Chinese Agricultural Mechanization, 2020, 41(8): 191-195. (in Chinese).

[4] ZHONG G. High-end atmospheric grade technology of apple production in the United States of America[J]. Pesticide Market News, 2017(2): 66. (in Chinese).

[5] Central Shandong News. Shandong's first "Alibaba Digital Agriculture Digital Orchard" settled in Yiyuan, Zibo[EB/OL]. [2020-10-25]. https://baijiahao.baidu.com/s?id=1681488202769274338&wfr=spider&for=pc. (in Chinese).

[6] CHEN YF. China's Food Supply and Demand and Forecast[M]. Beijing: China Agriculture Press, 2004. [EB/OL]. [2020-10-13]. http://www.xinhuanet.com/info/2020-10/13/c_139437033.htm. (in Chinese).