Construction of Intelligent Traceability Management System of Yongbei Golden Pear

Yaqi Shi, Hongmei Gao*, Bianbian Xue

Department of Economics and Management, Tianjin Agricultural University, Tianjin, China
Corresponding author. Email: gaohongmei@126.com

ABSTRACT

As food safety incident occurs frequently, it is necessary to establish traceability system of agricultural products. Intelligent traceability management system can monitor the whole process of food production and effectively reduce the occurrence of food safety problems. Yongbei Golden Pear is introduced by Aodong Fruit and Vegetable Planting Specialized Cooperative in Tianjin. This paper takes the construction of Yongbei Golden Pear intelligent traceability system as an example to expound the importance of establishing agricultural products traceability system, the structure of Yongbei intelligent traceability system, and the construction of Yongbei Intelligent Cloud monitoring software system, providing reference for other fruit intelligent traceability management. It aims to improve the quality and safety traceability level of fruit agricultural products, so as to ensure the quality and safety of agricultural products, and then increase farmers' income.

Keywords: Agricultural products, Traceability system, Intelligence.

1. INTRODUCTION

In recent years, frequent food safety incidents have greatly reduced Chinese consumers' sense of security on food quality. Non-standard production and unclear responsibilities have demonstrated that there are a large number of risks existing in the supply chain. However, a sound traceability management system has not yet been established in China. The traceability management system can not only ensure the quality of food from the field to the table, but also track from the back to the front, through every step of the food processing process to the origin of the food [1]. Therefore, it is urgent to establish a sound traceability management system to track and trace the relevant information of the whole food supply chain, including food planting, production, sales and consumption, so as to ensure food safety.

2. OVERVIEW OF YONGBEI GOLDEN PEAR PRODUCTION

Yongbei Golden Pear is the first generation of late autumn yellow pear grafted variety Shalite Jinguo Pear developed by Henan Shangchanghe Fruit Industry Co., Ltd. Introduced by Tianjin Aodong Fruit and Vegetable Planting Specialized Cooperative, it was planted after Tianjin Municipal Committee approved the economic development plan of One Village, One Policy in Aodong Village in 2015. The quality of Yongbei Golden Pear was guaranteed because of its good variety and reputation. In addition, the brand influence of the Cooperative was expanded. Since September 2015, Aodong Village Committee has transferred 400 mu of land at the price of 1000 yuan per mu, including 350 mu for planting Golden Pear and 50 mu for developing facility agriculture. The land involves more than 80% of farmers in the village, planting nearly 60,000 Golden Pear trees, with a cumulative investment of 3.5 million yuan and registration of Yongbei trademark. In order to further develop the deep processing of the Pear, the Cooperative plans to intensify the research and development of processed products such as pear vinegar, pear syrup and pear beer, and use new technologies to create Golden Pear series products.

Tianjin Aodong Fruit and Vegetable Planting Specialized Cooperative was established with the support of Municipal-level Assistance Funds and State-owned Assets Supervision and Administration Commission of Tianjin People's Government Assistance Funds. It was jointly organized by Aodong Village, Shigezhuang Town, Wuqing District, covering more than 96% of the villagers in the village, with a registered capital of 10 million yuan. In 2011, the Establishment and Demonstration of Electronic ID Card

for Pollution-free Vegetables in Tianjin was launched, which provided technical support for ensuring safe vegetables. It mainly focused on facility agriculture and aquaculture. During the process of planting Golden Pear, Tianjin Aodong Fruit and Vegetable Planting Specialized Cooperative found that Golden Pear was adaptable and easy to cultivate, so it could be planted on a large scale. At the same time, Aodong Village is the main production area of Golden Pear in Tianjin, which is conducive to the implementation of monitoring management and standardized production scheme, and the establishment of quality and safety traceability system, so as to realize the tracking and tracing of the whole supply chain. The upstream and downstream traceability systems can be connected by the Internet to achieve information sharing [2].

At present, the Cooperative has established a long-term cooperative relationship with scientific research institutions. Therefore, it has equipped with scientific research personnel, scientific laboratories, experimental equipment, personnel training, etc. It is technically feasible to implement the system and provides conditions for the Cooperative in base construction, production management, technology transformation, popularization and application experiments, etc. by working with Information and Technology enterprises and scientific research institutes.

3. THE ESTABLISHMENT AND IMPORTANCE OF AGRICULTURAL PRODUCTS TRACEABILITY SYSTEM

3.1. Establishment of Agricultural Products Traceability System

On November 1, 2006, the Law of the People's Republic of China on the Quality and Safety of Agricultural Products was officially implemented, which clarified the basic principles of supervision in the whole process from farmland to dining table [3]. On June 30th, 2017, the National Agricultural Product Quality and Safety Traceability Management Information Platform was officially launched, marking the further progress of agricultural products traceability. The traceability system is implemented for agricultural products, which can track and trace the complete information of agricultural products in an efficient and reliable way, so as to ensure the quality and safety of agricultural products [4]. At present, the construction of agricultural product quality traceability system in China is still at the initial stage of exploration, and the pilot work is mainly carried out in certain specific regions, enterprises, and varieties, the results of which may not be generalizable. At present, the construction work must have a big picture to build a set of national standards for agricultural product quality traceability system, such as the connection of regulatory information and the

framework of traceability standards system, and timely improve the whole process supervision efficiency so that the traceability system can be widely used throughout the country.

Tianjin established a traceability system for some agricultural products in 2005. Then it gradually introduced electronic traceability system in 2007, establishing electronic files in vegetable planting areas, which initially realized the source and destination traceability of agricultural products. In 2008, it started to build the traceability system which covered bases, cooperatives and technology promotion departments, and achieved good application results. In 2009, consumers can use SMS, website and electronic touch screen to track the information of vegetables [5]. In 2011, the Establishment and Demonstration of Electronic ID Card for Pollution-free Vegetables in Tianjin was launched, which provided technical support for ensuring safe vegetables and achieved good results; The Ministry of Agriculture has taken Tianjin as one of the pilot areas of the Internet of Things since 2013, focusing on facility agriculture and aquaculture. It makes full use of technologies, such as two-dimensional codes and sensors, to establish a traceability system for the quality and safety of agricultural products. At the same time, it takes advantage of Internet resources to improve the docking and information sharing of upstream and downstream traceability systems in the supply chain, and provide a good basic environment for the traceability management of agricultural products in Tianjin.

3.2. The Importance of Establishing Agricultural Products Traceability System

Traceability is required in both international legislation (e.g. Eu: General Good Law) and national legislation (e.g. Us: FDA Food Safety Modernization Act), as well as in company internal contracts, and there is an increasing number of electronic systems on the market for handling traceability [6]. One of the important works of the CPC Central Committee and the State Council to ensure the quality and safety of agricultural products is to build a traceability system. In November 2018, the National Strategic Plan for Promoting Agriculture by Quality (2018-2022) proposed to strengthen the supervision and management of agricultural products to ensure the quality and safety of agricultural products, enhance agricultural monitoring nationwide, and improve the existing monitoring methods of agricultural products [7]. On January 2, 2020, Opinions on Grasping the Key Work in the Field of Agriculture, Countryside and Farmers to Ensure the Realization of a Well-off Society in an All-round Way on Schedule proposed to strengthen the supervision over the quality and safety of agricultural products and food safety in the whole process, and

establish a sound traceability system to ensure people's "safety on the tip of the tongue" [8].

Since Tianjin has implemented the traceability system of pollution-free vegetables, the quality of agricultural products has improved year by year, and no major agricultural product quality safety incidents have occurred. China's research on the traceability system of planting industry, especially fruits, mainly focuses on the research and development of technology, and there is no in-depth research from the aspect of economic management. However, the construction of intelligent traceability management system for different links of different fruits requires different teams to carry out practical application case studies. The growing threat of food safety and pollution has led to the huge demand for the revolutionary traceability system [9], according to the development status and trend of agricultural product traceability system in various countries, the implementation of agricultural product traceability system not only ensures the actual demand of agricultural product safety, but also makes an important step forward in food safety at present and in the future.

Constructing the traceability platform of agricultural product quality and safety is conducive to building the enterprise credit system and making the agricultural product quality and safety supervision mode achieve a breakthrough in the agricultural field. Through the big data platform, the credit information of agricultural products quality and safety of agriculture-related enterprises can be screened, and at the same time, the credit index evaluation system can be set up to evaluate agriculture-related enterprises, so as to establish and improve a systematic supervision and control system [10]. It can help relevant departments to carry out regulatory reform on the quality and safety of agricultural products. Big data can be used to conduct comprehensive and effective supervision on agricultural products in real-time.

Therefore, taking the construction of traceability system of Yongbei Golden Pear as an example, this paper analyzes the existing traceability standards of agricultural products quality and safety, introduces advanced experience and achievements at home and abroad, establishing a standardized and unified traceability system of agricultural products quality and safety, which provides a theoretical basis for the traceability system of fruit-based agricultural products and technical guidance for the government and enterprises, thus enabling consumers to have a deeper understanding of the production of agricultural products and improve their confidence on the consumptions of food.

4. CONSTRUCTION OF YONGBEI GOLDEN PEAR INTELLIGENT TRACEABILITY SYSTEM

4.1. Production Management Process of Yongbei Golden Pear

Through the investigation of the production process of Yongbei Golden Pear and the production management mode of the Cooperatives, this project analyzes the Internet of Things technology related to agricultural products and food traceability and logistics management. Combined with cloud big data analysis, it is found that the construction of the system should take advantage of modern advanced technology based on the production characteristics and conditions of Yongbei Golden Pear to build an intelligent traceability management system that meets its special needs, and finally realize the sharing of traceability information resources; At the same time, the intelligent traceability management system should be comprehensive, systematic, easy to use, stable and expandable, so as to achieve the purposes of automatic uploading and inquiry of traceability information of fresh agricultural products supply chain.

After actual investigation, it was found that there are three key problems in the production management process of Yongbei Golden Pear:

The first one is planting. At different times, Yongbei Golden Pear is in different growth stages, which needs to be matched with different planting operations. Yongbei Golden Pear belongs to dwarf and dense planting type. It can be planted 170 trees per mu, with a plant spacing of 1.5 meters and a row spacing of 3 meters. Generally, a tree is 1-2 meters high and begins to bear fruit when it is more than 20 cm above the ground. Moreover, it has strong adaptability and can thrive in various geographical environments. It can bear fruit when planted in the same year, but it cannot enter the full fruit period until three years after planting. The average weight of mature fruit can reach 0.5-1 kg, and the large fruit can reach more than 2 kg. It has the advantages of thin skin, white flesh, small kernel and no residue. The fructose content is as high as 16.8%. The planting time is from mid-October or after the soil is thawed in the spring of next year to before germination, and the fruit matures from September to October.

The second one is storage. The storage time of Yongbei Golden Pear is different in different periods and different storage conditions. The best preservation environment is 0-5℃, but it can be preserved for 6-8 months without deterioration even at normal temperature. In winter in Tianjin, even if the fruit is not picked after ripening, the Golden Pear left on the trees are still not frozen. Based on the above storage characteristics, Yongbei Golden Pear can be stored

under different conditions, which is very suitable for off-season sales and long-distance transportation. Since the temperature of Golden Pear is still high when it is harvested, it is generally not stored directly, and slow cooling measures are adopted. Only when the temperature of the Pear is close to 0℃ can it be put into storage. For the storage of the Pear, not only the temperature but also the ventilation should be controlled. Cold air should be introduced in the early stage to reduce the turbidity in the warehouse; In the middle stage, it is necessary to pay attention to antifreeze and heat preservation. As long as the temperature outside the warehouse is higher than the freezing temperature at noon, proper ventilation can be carried out; In the later period, when the temperature outside the warehouse rises, it is necessary to introduce cold air equipment to adjust the temperature inside the warehouse.

The third is one transportation. Because of its own characteristics and planting mode, Yongbei Golden Pear is easy to be damaged. Its peel is thin, especially the bagged ones. Therefore, anti-vibration measures should be taken to avoid mechanical damage during transportation, and the environment such as temperature, humidity and carbon dioxide concentration during transportation should be monitored and controlled. Yongbei Golden Pear belongs to fresh fruit, so the transportation time should be as short as possible to reduce the loss in transportation.

4.2. Construction Idea of Yongbei Golden Pear Intelligent Traceability System

Scientific, reasonable and specific operation is needed to build the traceability system of fruit and vegetable agricultural products. The overall framework of the intelligent traceability system of Yongbei Golden Pear is established according to the following ideas.

4.2.1. Establish an Automatic Field Monitoring System.

The monitoring and management system of field production environment in the intelligent traceability system of Yongbei Golden Pear mainly collects various environmental parameters, including air humidity temperature, carbon dioxide concentration, soil water content and sunshine luminosity, by the automatic sensor network nodes. The field production environment monitoring and management system can adopt the combination of short-distance wireless sensor network nodes and long-distance wireless sensor network nodes [11]. Several monitoring groups form a wireless sensor network for field data collection, and complete the monitoring of the whole orchard. Each sensor node transmits the collected data to the database through the

wireless transmission network for consumers to trace the source through the inquiry system.

4.4.2. Construct the Traceability System of Production Process.

The production process traceability system mainly includes three parts: plot management, input management and production operation management. The standardized management of the production process of Yongbei Golden Pear was established according to the analysis of the production process of Yongbei Golden Pear in the early stage. It is an important measure to ensure the quality of fruit, make information transparent, and make it easy to query and trace through the network, which can greatly simplify the recording and electronic work of field operations.

4.2.3. Build a Monitoring System for Warehousing and Transportation.

As Yongbei Golden Pear is perishable and difficult to store, the record and control of storage and transportation has become an important link in the whole traceability of Jinguo Pear, in order to ensure the four-season supply and cooperate with off-season sales and cross-regional sales.

Planting, processing, warehousing and transportation are interconnected in blockchain technology. According to Figure 1, the overall framework of intelligent traceability system for Yongbei Golden Pear is established [12]. The standard system consists of three aspects: field production environment monitoring and management system, intelligent production process traceability system and automatic monitoring system for storage and transportation.
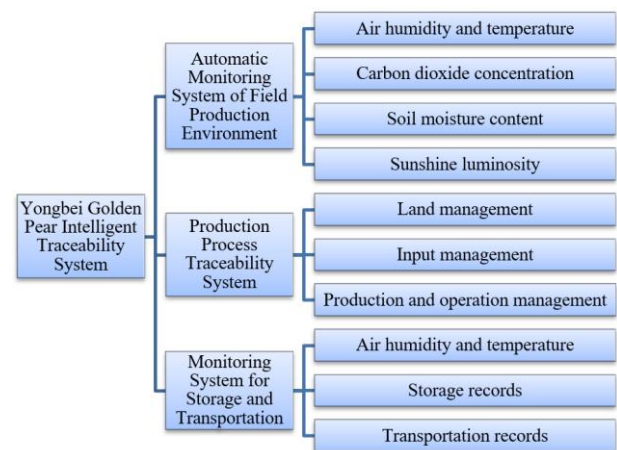

Figure 1 Framework of Yongbei Golden Pear Intelligent Traceability System

5. CONSTRUCTION OF INTELLIGENT CLOUD MONITORING SOFTWARE SYSTEM FOR YONGBEI GOLDEN PEAR

5.1. Construction Content

Build a smart cloud monitoring center, including a monitoring cabinet (including video equipment, communication equipment, acquisition and transmission equipment, etc.), a video monitoring computer and a large-screen TV, and a rental cloud server, including management functions such as data acquisition, transmission, video acquisition, transmission and monitoring;

Build a video monitoring system with five cloud cameras, which are distributed in the diagonal position of the orchard and other representative areas, and the camera range can be adjusted; 5 fixed-point cameras are used to monitor each two rows of fruit trees on the edge of a tree, recording the growth and changes of the fruit tree all year round;

Build a space environment information acquisition system, including a set of real-time parameters such as air temperature, humidity, illumination, carbon dioxide concentration, PAR photoionization particle values, etc.;

Establish a soil conductivity and humidity acquisition system, setting up four soil conductivity measurements in the orchard to measure soil humidity, soil temperature and soil conductivity;

Establish a position information collection system, arranging two position information collection devices in the key monitoring area;

Establish a Yongbei Golden Pear Smart Cloud Monitoring System, which monitors the data of orchard with mobile APP, and can view the historical curve of collected data of orchard.

According to the development of orchard, the system can be extended to add control equipment, control points, monitoring points.

5.2. Design Layout

The layout of monitoring points in the whole orchard and key monitoring areas is shown in Figure 2.

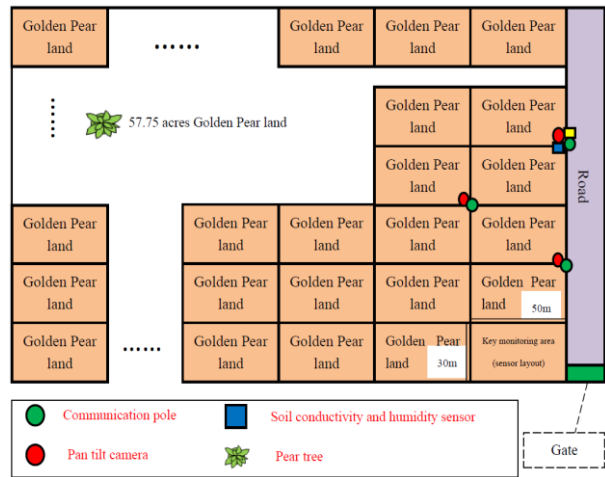The layout of sensors in key monitoring areas of orchard is shown in Fig.3.

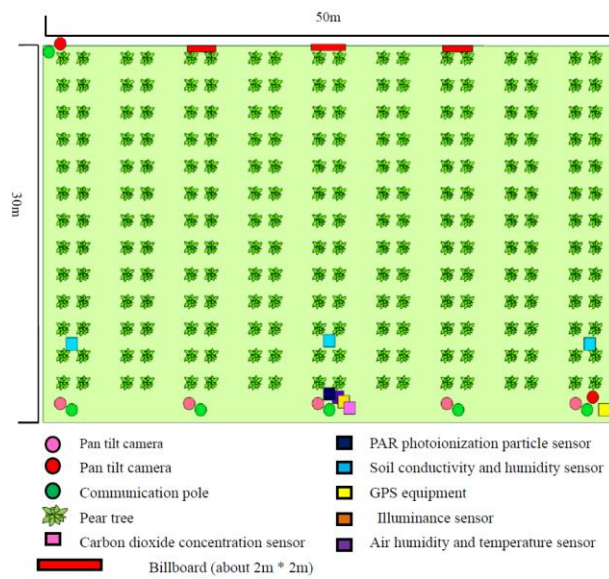**Figure 2** Overall Sensor Layout of Orchard

Figure 3 Layout of Sensors in Key Monitoring Areas of Orchard

6. CONCLUSION

With the development of social economy, people's living standards are constantly improving. Therefore, the management of food quality and safety should be strengthened to make consumers reassured. The application of traceability technology makes information transparent, which is a quality guarantee for consumers. Therefore, it is more important to strengthen traceability technology. Based on the construction of intelligent traceability management system, this paper draws the following conclusions:

(1) Traditional agricultural product quality and safety management methods are to supervise the processing of agricultural products, but it is lack of supervision on different links of the whole agricultural supply chain. The intelligent traceability management system ensures the visual supervision of the traceability of agricultural products, ensures the information of

different links in the agricultural supply chain is open and transparent, and effectively supervises the quality and safety of agricultural products.

(2) Considering the particularity of agricultural product production, its traceability system is composed of three aspects: field production environment monitoring and management system, intelligent production process traceability system, and automatic monitoring system for storage and transportation, so as to realize the whole-process monitoring of agricultural product planting, production and market from the source.

(3) The intelligent traceability system of Yongbei Golden Pear constructed in this paper can provide some reference for the establishment of intelligent traceability management of other fruits.

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REFERENCES

[1] Vinay Kumar, Reema Thareja. Goal Structured Requirement Engineering and Traceability Model for Data Warehouses[J]. International Journal of Information Technology and Computer Science, 2013, 11(1):78-85, DOI: 10.5815/ijitcs.2013.12.10.

[2] Karim Zarour,Nacereddine Zarour. Data Center Strategy to Increase Medical Information Sharing in Hospital Information Systems[J]. International Journal of Information Engineering and Electronic Business, 2013, 5(1): 33-39, DOI: 10.5815/ijieeb.2013.01.04.

[3] Gbadamosi Babatunde, Adeniyi Abidemi Emmanuel, Ogundokun Roseline Oluwaseun, Oladosu Bukola Bunmi, Anyaiwe Ehiedu Precious. Impact of Climatic Change on Agricultural Product Yield Using K-Means and Multiple Linear Regressions[J]. International Journal of Education and Management Engineering, 2019, 5(8): 16-26, DOI: 10.5815/ijeme.2019.03.02.

[4] Ganjar Alfian, Jongtae Rhee, Hyejung Ahn, Jaeho Lee, Umar Farooq, Muhammad Fazal Ijaz, M. Alex Syaekhoni. Integration of RFID, wireless sensor networks, and data mining in an e-pedigree food traceability system[J]. Journal of Food Engineering, 2017, (5): 212. DOI: 10.1016/j.jfoodeng.2017.05.008.

[5] Hui Cai. Operation status, Problems and Countermeasures of Agricultural Products Traceability System - Taking Tianjin as an Example[J]. Modern Food, 2019, (6): 6-9. "in Chinese" DOI: 10.16736/j.cnki.cn41-1434/ts.2019.06.003.

[6] Petter Olsen, Melania Borit. The components of a food traceability system[J]. Trends in Food Science & Technology, 2018,77. DOI: 10.1016/j.tifs.2018.05.004.

[7] Yazhou Shi. Interpretation of the National Strategic Plan for Revitalizing Agriculture by Quality (2018-2022)[J]. Shanxi Agricultural Economy, 2020, (6): 28-29. "in Chinese" DOI: 10.16675/j.cnki.cn14-1065/f.2020.06.011.

[8] Opinions of the Central Committee of the Communist Party of China and the State Council on the key work in the field of agriculture, rural areas and farmers to ensure the realization of an all-round well-off society as scheduled[J]. China Farmers' Cooperatives, 2020, (3):7-12."in Chinese".

[9] Deepak Prashar, Nishant Jha, Sudan Jha, Yongju Lee, Gyanendra Prasad Joshi. Blockchain-Based Traceability and Visibility for Agricultural Products: A Decentralized Way of Ensuring Food Safety in India[J]. Sustainability, 2020,12(8): 155-157. DOI: 10.3390/su12083497.

[10] Hui Wang. Current situation and Countermeasures of Informatization Construction of Agricultural Product Quality and Safety Supervision[J]. Agricultural Engineering, 2019, l9(8): 41-43. "in Chinese"

[11] Jun Li. Construction and Application of Intelligent Traceability Management System for Yongbei Golden Pear[D]. Tianjin: Tianjin Agricultural University, 2019. "in Chinese"

[12] Liang Shi, Fuhong Zhang, Wenjun Liu. Research on Traceability System of Fruits and Vegetables Agricultural Products based on Blockchain[J]. Rural Economy and Science-Technology, 2019, (30): 66-169. "in Chinese"