

Analysis and design of vegetable quality and safety management system based on rfid technology

Zhou Mi

Graduate School of Business, University of the Visayas, Cebu Philippines 60000

Abstract: Vegetable quality and safety management is a significant approach for producers to improve the potential of the high-quality products in the market and enhance their ability to guarantee the food safety for the customer. These managements are also the key to effectively ensure the normal market circulation of agricultural products. This paper will base on the RFID technology and discuss about the crucial link in, including production, harvest, detection and packing. Then to establish the vegetable quality and safety management system based on RFID in order to implement an effective supervision and tracing to the whole process from production to packaging provider. It will increase the frequency and extend the scope of detection to the pesticide residue of vegetables products, and according to the test results, in a timely manner to decide whether it necessary to carry on the the corrective actions. In the introduction section of the paper, it will introduce the background and purpose of the research and analyze the necessity of the traceability system for agricultural products and the current research situation at home and abroad. It will analyze and design the system framework, system functions and database based on the requirements study and system design combined with the core functions and business processes of vegetable quality and safety management system. At the stage of implementation, with the assistance of RFID tags to uniquely identify the greenhouses and collecting tray so it will solve the issue of the incapability to trace back to the original production unit of the agricultural products. It will improve the accuracy of the traceability during the production process and implements the vegetable information acquisition system including production, harvest, detection, package management and quality and safety management. At the same time, the standards in production, harvest and inspection are integrated into the system management process to realize production and real-time monitoring on the purpose of the guarantee to the standardized production of vegetable products in the producing process and inspection of the product quality at the beginning. In the case of strict application of the system in accordance with the operating process, the quality and security of the vegetable products shall be valid guaranteed from the source of the production process. It can also enhance the core competitiveness of products and the trust in products from the customers. It will establish a fundamental base in the comprehensive performance of agricultural reclamation projects in the future.

Key words: RFID; Vegetable production; Quality Safety; Tracing Back

1 Introduction

This chapter makes a comprehensive analysis of the research background, research significance and research status at home and abroad of the vegetable quality and safety management system, and determines the research content and chapter structure of the article.

1.1 Research background and significance

Food safety concerns the daily life of the broad masses of people. With the development of the times, the acceleration of the pace of life, the scale and industrialization of agricultural production, food safety problems at home and abroad have become increasingly prominent, and food safety accidents emerge in endlessly. Especially in recent years, the frequent occurrence of food quality and safety crises, such as livestock and poultry diseases, serious pesticide residues in agricultural products and excessive bacteria in imported food materials, has seriously affected people's health and attracted worldwide attention. To solve the problem of food safety traceability is imperative, the key is how to establish an effective regulatory and certification system and

traceability system covering the entire food supply chain.

In 1997, Britain put forward the concept of traceability of agricultural product quality and safety due to mad cow disease, and in 2002, it promoted the European Union to promulgate the Basic Law on Food and other relevant laws, the core of which is to implement traceability regulations such as traceability of production process information for agricultural production enterprises. The United States promulgated the Bioterrorism Act in 2002, under the guidance of which the Food and Drug Administration of the United States enacted three important regulations, namely, Record-keeping Requirements, Production Facility Registration and Pre-shipment Notification of Imported Food Requirements, and Regulatory Detention Requirements. These regulations provide the technical and law enforcement basis for enterprises and law enforcers to implement food traceability. In May 2018, Wal-Mart launched a traceability promotion project for packaged vegetables in China. It is expected that by 2020, Wal-Mart's traceable packaged vegetables will account for 40% of the total vegetable category.

Chinese governments at all levels attach great importance

to food safety issues, and have formulated relevant standards from local governments to the State Council in order to smoothly promote the construction of traceability system for agricultural products. Laws and regulations such as the Law of the People's Republic of China on the Quality and Safety of Agricultural Products and the Food Safety Law of the People's Republic of China have been promulgated successively. In 2015, the General Office of the State Council issued the Opinions on Accelerating the Construction of Traceability System for Important Products (No.95, 2015), which clearly put forward the guiding ideology of accelerating the construction of traceability system for important products. In 2017, Jiangxi Province held a press conference to further explain the construction of Jiangxi Agricultural Reclamation Traceability Project on promoting the reform and development of the province's agricultural reclamation. As of 2017, a total of 58 cities in China have carried out pilot projects on the construction of traceability system for meat circulation, and 18 provinces (cities) have carried out pilot projects on the construction of traceability system for the circulation of Chinese medicinal materials, initially forming a nationwide traceability network.

China is a big country of agricultural production, but the characteristics of agricultural production in China are contrary to the large-scale, centralized and industrialized production in foreign countries. Most of the production links are scattered in space, the degree of large-scale operation is low, the standardized production conditions are poor, the products are not labeled and the circulation management is chaotic, and it is difficult to investigate the responsibility for the problems. At present, the construction of traceability system of agricultural products in China is in its infancy, and the existing research is mostly concentrated in the areas of high consumption level such as high value-added livestock, grain and oil, aquatic products, fruit products and so on, and can only be traced back to processing enterprises.

Barcode technology has been used to identify all kinds of agricultural products, but there are great differences between vegetable products and livestock products in production process, packaging style, identification and marking. Livestock products focus on individual identification, and a single product can be used as an independent identification, while vegetable products are mostly composed of multiple product packages to form a larger package, which leads to multiple identifications in a single identification process of vegetable products, so a wide range of identification technologies are needed to improve the identification efficiency. Vegetables generally do not need cold chain transportation in production and sales, and the supply chain distribution of seasonal vegetables in production and sales links is basically within the jurisdiction of the same province or even the same city, so the planting environment and planting standards in different regions are difficult to be the same, and the planting process relies too much on farmers' experience and chemical fertilizers and pesticides. There are few studies on traceability of vegetable quality and safety in China, and there is a lack of comprehensive discussion on how to effectively combine product traceability with quality and safety management. In addition, the domestic traceability system is mostly established for agricultural products sales enterprises, often ignoring the tracking and traceability of the production stage of products, and the production stage of agricultural products is the hardest hit area of quality problems, historical cases such as Sanlu milk powder case, lean meat powder case show that production safety can not

be effectively supervised. Then the traceability of processing and marketing enterprises in the middle and lower reaches will lose its significance.

In recent years, the rapid development of Radio Frequency Identification (RFID) technology has provided a new technical means to solve the problems of commodity coding and traceability. Compared with barcode technology, RFID has the advantages of large data storage capacity, long service life, long reading distance, multi-target identification, reusability and strong environmental adaptability. At present, RFID technology is widely used in many fields in China, such as identity information identification, transportation management, assembly line production automation, security access inspection, warehouse management and so on. Using RFID technology as a bridge to connect agricultural products with information systems can effectively integrate the planting, harvesting, inspection, packaging and information systems of agricultural products in the production stage, realize product traceability, and provide the most efficient way of supervision for food safety.

Develop a vegetable quality and safety management system based on RFID technology, develop an application system around the main links of planting, harvesting and inspection in the vegetable production process, realize the digitalization, high efficiency, systematization and networking of vegetable quality and safety supervision, improve and unify vegetable production standards, and enhance the production of production enterprises. The supervision level and work efficiency of relevant departments can truly realize the traceability of the whole process from vegetable production to packaging. The system uses C # language as a programming platform, MySQL database storage, in accordance with the software development process for each business function module needs analysis, system design, programming and testing.

1.2 Research status at home and abroad

At the government level, due to the importance of product quality in key industries such as food and medicine, in order to protect the basic rights and interests of consumers, most governments adopt legislation to force the establishment of commodity traceability system.

The source of the quality and safety of agricultural products lies in the effective control of the production process, which is the key to the whole traceability system. Field servo systems based on RFID technology have been used in the United States and Japan, which can monitor soil acidity and alkalinity, temperature and humidity, sunshine, wind speed, rainfall and other micro-meteorology through sensors combined with RFID technology. Agricultural products are systematically recorded in detail in all aspects of production, processing, storage, transportation and sales, and RFID tags are pasted on agricultural products. It improves the collection speed and information sharing degree of product information in the origin, wholesale market and retail market, and improves the logistics efficiency of agricultural products. As early as 2007, strawberry merchants in California used RFID technology to develop an Internet of Things system for real-time monitoring of strawberry growth. In order to breed better varieties, the system monitors and traces air and soil data through RFID tags on sensors, maintains the best growth environment for strawberries in greenhouses, and automatically controls operations such as watering, spraying and temperature adjustment. The

Arizona Institute of Plant Science and Technology uses RFID and GPS technology to help farmers determine the fertility of lettuce, tracking when and where lettuce is harvested and when it is stored in the freezer.

Since its launch in 2004, China's traceability system has adopted bar code, two-dimensional code and RFID technology. The research and application of RFID technology in the traceability management of drugs and valuables has been in a mature stage, but the application of RFID technology in the traceability management of agricultural products is later than that of western developed countries, both research and application are only in the initial stage. In 2006, the RFID pig project was piloted in Qionglai, Sichuan Province. The first batch of pigs were raised with RFID technology to record production, processing and sales information. Consumers can query the pork information through relevant websites. During the 2008 Olympic Games in China, the Olympic food entering Beijing was traced by bar code. In 2009, the General Office of the Ministry of Agriculture issued a circular on the issuance of the Measures for the Management of Traceability Labels for Agricultural Reclamation Agricultural Products (Trial Implementation), aiming at standardizing the management of traceability labels for agricultural products and uniformly issuing bar code traceability labels. Based on references and news materials, it can be seen that compared with livestock products, vegetable products were mainly based on bar code technology in the early application of traceability. With the development of high-tech industry, RFID technology has gradually matured, and the application of agricultural products traceability has developed from traditional meat products to vegetable safety management. Vegetable circulation process traceability based on barcode-RFID correlation has been applied in Tianjin, and the research and construction of "organic vegetable traceability management system" based on RFID technology has been carried out in Shandong, Shanghai and other places.

1.3 Research content and structure

In this paper, RFID technology as a bridge to link the vegetable quality and safety management and information systems, in-depth analysis of the research status at home and abroad, combined with China's unique national conditions, to build a food quality and safety management system based on RFID technology. With low cost and modern technology, the supervision informationization and source traceability of vegetable production, harvesting, testing and packaging are realized.

This paper describes the analysis and design of vegetable quality and safety management system, which is divided into seven chapters. The following is the main content of each chapter.

Chapter 1 Introduction. The research background, research significance and research status at home and abroad of vegetable quality and safety management system are comprehensively analyzed, and the research content and chapter structure of the article are determined.

Chapter 2 Introduction to related technologies. Vegetable quality and safety management system uses RFID technology, C# development language, MySQL database as the information storage database.

Chapter 3 System requirement analysis. Comprehensive analysis of vegetable quality and safety management system business processes, system use case analysis.

Chapter 4 System design. According to the requirement analysis, the system design goal, system architecture, system operation process and system database design are determined.

Chapter 5 System implementation. RFID readers and tags are selected, the storage structure of RFID tags is designed, and the functional modules of the system are implemented and tested.

Chapter 6 Summary and outlook. The analysis and design of the vegetable quality and safety management system were summarized, and the shortcomings of the system and the follow-up optimization were prospected.

2 Introduction to related technologies

This chapter mainly introduces the related technologies used in the development of vegetable quality and safety management system, including RFID technology, C# language, MySQL database.

2.1 Introduction to RFID Technology

Radio Frequency Identification (RFID) is an electromagnetic induction technology based on the principle of radio frequency. Contactless two-way communication via radio or microwave signals to identify specific targets and read and write data. Its technical principle inherits the concept of radar. Communication by Means of Reflection of Energy, by Harry Stockman, Proceedings of the Institute of Radio Engineers, 1948 Reflected Power "has established the theoretical foundation of Radio Frequency Identification.". RFID technology began to appear in the 1980s. With the maturity of integrated circuit miniaturization and scale technology, the volume of RFID system has been decreasing, and since then it has entered the practical stage. Until the 1990s, RFID technology continues to be constantly improved, recognition distance and accuracy continue to increase, can achieve long-distance automatic identification, began to gradually emerge in all walks of life.

The planning documents related to the development of RFID industry in China mainly include the Eleventh Five-Year Plan for the Development of Information Industry Science and Technology and the Outline of Medium and Long-term Planning for 2020, the Outline of National Medium and Long-term Science and Technology Development Plan 2006-2020, the Plan for the Adjustment and Revitalization of Electronic Information Industry 2009-2011, The National High-tech Research and Development Plan (863 Plan) and the 12th Five-Year Plan for the Development of the Internet of Things.

2.1.1 Working principle of RFID

The basic principle of RFID technology is to use the transmission characteristics of radio frequency signal and space coupling (inductance or electromagnetic coupling) or radar reflection to realize the automatic identification of the identified object.

The basic components of RFID system include Tag and Reader, and a complete system also needs data transmission and processing system. The working principle is that when the responder enters the radio frequency signal range of the reader-writer, the responder is activated after the induced current obtained by the antenna is boosted by the booster circuit, and meanwhile, the responder feeds back the information carried by itself to the reader-writer through the antenna; The reader receives the signal transmitted from the responder through the antenna, and transmits

the signal to the processing system for relevant processing after modulation and demodulation; And that proces system analyzes and process the signals, performs corresponding operation, and finally sends the signals back to the responder through the reader-writer.

2.1.2 RFID characteristics

RFID tag is a high-tech product in the field of tags. Its technical characteristics go beyond the functions of traditional tags. It is the excellent crystallization of radio technology and computer technology in the field of tags.

RFID tags have good comprehensive performance, and its advantages are mainly reflected in:

1.RFID readers use radio waves to read information on multiple tags automatically and quickly, and are not affected by the movement of the target.

2.RFID tags can be designed in any shape and size, and can be easily embedded or attached to different types of products.

3.The RFID tag is composed of an antenna and an integrated circuit chip. The chip contains a memory module, which can store a certain amount of data, and combined with encryption technology, it is difficult to fake the information stored internally.

4.The RFID tag does not need to be contacted with a reader to be read, has strong adaptability to the environment, and can be used normally in a severe environment.

5.The RFID tag can be repeatedly used under the condition that the RFID tag is intact and not damaged, so that the use cost is reduced, and the RFID tag can be applied to different places by adding, modifying and deleting the data in the tag, which is different from a bar code which is disposable and cannot change the information in the tag.

6.With the development of science and technology, domestic chip manufacturers have begun to pay attention to the mass production of RFID tags, and the cost of purchasing RFID tags in batches has been as low as 0.2 yuan.

2.2 Introduction to C # Winform

C # is a new object-oriented, high-level programming language running on the.NET Framework released by Microsoft in 2000. It is the latest achievement of Anders Hejlsberg, a researcher of Microsoft. It is a very popular object-oriented programming language, which allows programmers to quickly write a variety of applications based on the Microsoft. NET platform.

The Winform program of B/S mode developed by C # under Windows platform has little difference in development cost with C/S mode web page, but has great advantage in development difficulty. In addition to ASP. Net, other languages have derived more and more complex development frameworks, which are simply too many to see. It can be said that these frameworks not only improve the efficiency of developers, but also increase the irregular time and energy for developers to learn various frameworks, and increase the unpredictable difficulty for later maintenance.

The Winform program reads the data from the database directly on the form of the client, while the B/S structure software first reads the data from the database, and then converts it into a web page and returns it to the client browser, so the speed is self-evident. And C # Winform program can make full use of the underlying resources of Windows, such as the call of ports and various hardware resources, which is incomparable to B/S structure software.

2.3 Introduction to MySQL Database

MySQL database is one of the most popular relational database systems. It is developed by MySQL AB, a Swedish company, and is currently a product of Oracle. MySQL is widely used in various small and medium-sized enterprises and government information systems by virtue of its open source and support for multi-language connection operation. MySQL uses the standard SQL query language, and through the built-in thread-based fast and stable memory allocation system, it can efficiently process tens of millions of data, and can be used continuously without worrying about its stability.

The MySQL database runs in a centralized mode and relies heavily on the computing performance of a single node. Although the version of MySQL changes frequently, the new version is not fully compatible with the old version, and the performance of multi-table query is not good. However, due to the small installation volume, fast single table query speed, open source software, fast running speed and low development cost in the case of sufficient hardware resources. The MySQL database can meet the business needs of the system.

2.4 Summary of this chapter

This chapter mainly introduces the main development technology of the vegetable quality and safety management system, which is based on RFID technology as the data carrier, C # as the development language, MVC mode for development, and MySQL database for data information storage.

3 System Requirement Analysis

Requirement analysis is an important activity in the software planning stage, and it is also an important stage in the software life cycle. In this stage, the actual functional needs of the system are analyzed, rather than how to implement them. The main content of this chapter is the system business process and use case analysis.

3.1 System business process analysis

Vegetable quality and safety management process includes four functional modules, namely, quality and safety management, harvesting information collection management, testing and packaging management, and production information collection management. The following will analyze the four functional modules respectively.

3.1.1 Analysis of production information collection management process

The collection and management of vegetable production information includes the use of production standards formulated by quality and safety management, strict control of environmental changes in production bases, planting process management, pest and weed control, pesticide and fertilizer input, so as to make vegetable products meet the relevant inspection standards and ensure the quality and safety of vegetables from the source.

The collection and management of vegetable production information mainly includes the following processes:

1.Manage and maintain the production base information, production information, production personnel information and other data, including the size of the production base, technical director, soil fertility and moisture content, planting date and other information.

2. Manage and maintain the data of fertilization and pesticide application. The data include the name of the supplier, the name of the variety, the date of production and the validity period of the fertilizer and pesticide.

3. Add or modify the basic data for the planting process information management. The data includes the control measures of diseases, pests and weeds, irrigation times, irrigation amount, the use and operation of production materials and other information for recording and management.

The collection and management process of vegetable production information mainly includes irrigation measures, pest control measures and fertilization measures. The key points of management are as follows:

1. Fertilization management

Fertilization management is mainly aimed at the management of adding fertilizer to vegetables during the growth of vegetables. It mainly records the following information: fertilizer number, fertilizer name, fertilizer application time, fertilizer application concentration, employee number and land number.

In the inspection of vegetable growth, if it is determined that the fertilization instruction is required, the staff will carry out fertilization management, first receive the corresponding fertilizer according to the inspection situation and configure it to the corresponding concentration, then fertilize, record the fertilizer information and store it in the database.

2. Pest control management

The pest control management is mainly aimed at the management of pesticide dissemination on vegetables in the process of vegetable growth, and mainly records the following information: pesticide number, pesticide name, pesticide dissemination time, pesticide concentration, employee number and land number.

In the inspection of vegetable growth, if it is determined that the pesticide spreading instruction is required, the staff will carry out the pesticide spreading management, first receive the corresponding pesticide according to the inspection situation and configure it to the corresponding concentration, then spread it, record the pesticide information and store it in the database.

3. Irrigation management

In the process of vegetable planting, the planting environment has a great impact on the quality and growth of vegetables. Irrigation management is not only to irrigate the land, but also to detect the vegetable planting environment. In order to effectively manage the vegetable planting environment, the system detects and records the environmental data at regular intervals. It mainly records the following information: soil moisture content, soil PH value, soil heavy metal content, air temperature, air humidity, light amount, carbon dioxide concentration and other environmental information.

3.1.2 Analysis of harvesting information collection management process

Harvesting information collection management uses harvesting standards formulated by quality and safety management to manage vegetable harvesting, obtain and input harvesting stage information such as greenhouse information and harvesting tray information to the system, and standardize the management of vegetable harvesting information.

Before harvesting vegetables, it is necessary to check whether the vegetables meet the harvesting standards and detect

the residual pesticides, and postpone the harvesting of vegetables that fail to pass the harvesting standards. The information of plots and greenhouses has been read by harvesting standard vegetables and classified into harvesting trays for grade evaluation, and the harvesting information has been written into the RFID tag of harvesting trays. The RFID tag writes the following information: harvest time, vegetable batch, harvest tray number, and quality rating.

3.1.3 Analysis of inspection and packaging management process

The inspection and packaging management module uses the inspection standard formulated by the quality and safety management to inspect the harvested vegetable products, returns the vegetables that fail to pass the inspection standard to the inspection process and evaluates the production process, and enters the packaging classification for the vegetable products that meet the inspection standard, and associates the production information with the harvesting information to produce traceability information.

The inspection and packaging management module is based on the national standards and related industry standards, the harvested vegetables are detected for the second time, the vegetables are distinguished according to the quality level after reaching the acceptance standard, and the vegetables are packaged according to different specifications and styles, and the RFID tags are embedded in the packages. And write that vegetable production information, the harvesting information and the inspection information into the RFID tag. The following information is written in the RFID tag: product identification, product name, standard number of the product, name of the manufacturer, place of origin, specification, net content, planting date, fertilization information, irrigation information, pesticide application information, harvesting date and packaging date. The packaging style is differentiated according to the needs of the seller. The packaging type is divided into retail small package and wholesale large package. The small package adopts single product identification and the large package adopts batch identification. If the identification information is associated with the quality and safety management information, it can be traced back to the production process, otherwise it can not be traced back to the production process.

3.1.4 Analysis of quality and safety management process

Quality and safety management is used to standardize the standards and systems of production links by formulating and implementing technical standards for packaging, testing, harvesting, production and production environment.

The quality and safety management module can formulate and audit the standards of various production links of different varieties of vegetables. Technicians shall submit various technical standards, which shall be reviewed by the production manager, and the standards shall be adopted after the professional review is passed. Those who fail to pass the review shall return to the technical formulation process. According to the relevant technical standards of vegetable production, production enterprises should unify the operation norms of production links.

4 System design

This chapter mainly discusses the system requirements analysis of the previous chapter, and elaborates on the system design objectives and principles, system architecture, function

module design and database design.

4.1 System design objectives and principles

Based on RFID technology, this paper focuses on the main links of vegetable production, harvesting, testing and packaging, and establishes a vegetable quality and safety management system based on RFID technology to achieve effective supervision and traceability of vegetables from production to packaging. It is committed to improving the supervision ability and level of the supervision team, protecting consumers' right to know, finding problems in time and dealing with them in time for the quality and safety of vegetable products, so as to prevent them from happening.

The following principles shall be followed in the design:

1. Easy to use

The users of the system are ordinary farmers with low educational level, so the design of the system must be combined with the user's habits, so that the interface is simple and the operation is convenient. At the same time, we should consider reducing the cost of learning as much as possible and reducing the burden of users.

2. The function is perfect

The system combines RFID technology to improve the traceability data of production links, and has an expansion interface to facilitate docking with government regulatory authorities.

3. And that safety is high

The identity of the basic information collection operator of the system is complex, and each system and management module need to assign different permissions strictly according to the permission management, so as to ensure that the business confidential information involved in the system can not be illegally disclosed.

4.2 Overall system architecture design

The vegetable quality and safety management system based on RFID uses the C/S structure of client and server, and Microsoft's C # technology route for system programming. Form a four-layer structure system including user layer, service application layer, system support layer and data service layer.

1. User layer

According to the different business needs of the system, the user layer sets up five user permissions, namely, farmers, testing personnel, production administrators, packaging personnel and enterprise leaders, and restricts the permissions of different users of the platform through strict permission allocation.

2. Service application layer

The business application layer has designed different function modules for the business functions of each link of the system, including production information management, harvesting management, inspection and packaging management, and quality and safety management.

3. System support layer

The data acquisition module of the system support layer adopts the packaged middleware provided by the supplier, and realizes the combination of the business module and the RFID component, as well as the authority management, data backup and user management.

4. Data service layer

Be responsible for the access and storage of data information, and realize the addition, deletion and modification of the database. Ensure the security of data through periodic data backup.

4.3 System function design

The function design of the system is divided into four modules: production information management, harvesting information management, calibration and packaging management, quality and safety management.

4.3.1 Design of production information collection function

The production information collection module is the basic information module of the four modules of the system, and the main information in the system comes from this module.

The user enters the production information collection management, locks the number of the greenhouse by scanning the greenhouse RFID tag, manages the production information in the greenhouse, and records the production record information through the greenhouse RFID tag, wherein the information comprises greenhouse RFID tag information, pest control information, fertilization information, pesticide application information and other information. And keep synchronization with the database.

4.3.2 Harvesting information management function design

The harvesting information management module is responsible for the information collection of the harvesting process, and its main function is to collect the production history information and fill in the harvesting information.

A user enters the harvesting management module, obtains the production record information stored in the tag by scanning the greenhouse RFID tag, simultaneously scans the RFID tag of the harvesting tray to obtain the number of the harvesting tray, and fills in information such as harvesting time, harvesting place, harvesting personnel and the like. And that harvest history information and the production history information are recorded through the RFID tag of the harvest tray and are kept synchronous with the basic database.

4.3.3 Design of inspection and packaging management function

The inspection and packaging management module is responsible for the information collection of product inspection and packaging process. The main functions of the module include collecting production history information, harvesting history information, filling in inspection and packaging information and generating traceability information.

A user enters that inspection management, obtain the production history information and the harvesting history information by scanning the RFID label of the harvesting tray, fill in the inspection information and the packaging information, and produces a traceability code. The traceability information is stored on an RFID tag attached to the package and kept in sync with the underlying database.

4.3.4 Quality and safety management function design

The last link of the four modules of the quality and safety management module is the key to the whole system, and all the standards of other modules are formulated in this module. Module functions include the formulation and implementation of production-related standards, harvest-related standards, detection-related standards, and traceability information verification.

5 System implementation

This chapter focuses on RFID tag selection, storage design and system implementation.

5.1 RFID tag selection

RFID tags come in many different shapes, sizes, and operating frequencies. In practical application, the application of RFID system should consider many factors that affect the performance of the system, such as location, distance, temperature, humidity, interference and so on.。 Untested RFID system, the overall performance of the system is not clear, may affect the actual application effect, and even undermine the end user's confidence in the RFID technology itself.

The radio frequency standard of RFID electronic tag has formulated different protocols such as ISO14443A/14443B/ISO15693, which correspond to different types of tags. According to the classification of power supply state, it can be divided into two categories: "active" and "passive". According to the working frequency, it can be divided into low frequency (125KHz ~ 135KHz), high frequency (13.56MHz), ultra-high frequency (868MHz ~ 915MHz) and microwave (2.45GHz ~ 5.8GHz). The characteristics of different RFID systems are very different, and the maturity is also different, so the application scope of the system is also different. At present, the main RFID infrastructure in China is

```

1 using System;
2 using System.Collections.Generic;
3 using System.Text;
4 using MySql.Data.MySqlClient;
5
6 namespace CHEXC.GoodMenhod
7 {
8     public class getMySQLConnection
9     {
10         string G_Str_ConnectionString = "server=192.168.1.107;user id=cyx;password=barry891127;database=db_CSManage";
11         MySqlConnection G_Con;
12         public getMySQLConnection()
13         {
14
15         }
16         public MySqlConnection GetCon()
17         {
18             G_Con = new MySqlConnection(G_Str_ConnectionString);
19             G_Con.Open();
20             return G_Con;
21         }
22     }
23 }

```

5.3.2 System login and main interface

The system login interface is used to log in the vegetable quality and safety management system. If the login name and password are input in the login interface and pass the verification, the login interface will be automatically closed if the main interface of the system fails. The main interface of the system includes basic files, planting management, harvesting management, acceptance and packaging management, quality and safety management and other modules, which are used for users with different permissions to enter different modules for operation. When entering the main interface of the system, it automatically detects whether the RFID reader is connected and displays the connection status.

5.3.3 Supplier information management

Supplier information management is a part of the basic file module. All production material supplier information management can be added, modified and deleted in this module. Users can add, delete and modify supplier information, product name, supplier manager, production address and other information according to actual production needs.

based on high frequency technology, and the completely domestic passive RFID tag of 13.56MHz is the mainstream choice in the practical application of traceability management.

Considering the read-write distance and preventing tag read-write conflict, the high frequency 13.56MHz passive RFID tag is adopted, the internal chip is NTAG216 provided by NXP, and the communication protocol standard is ISO14443A.

5.2 RFID tag storage design

RFID tags have globally unique TID identification and storage spaces of different sizes. TID identification can be used to uniquely mark objects in the system to ensure the uniqueness of objects. In this paper, the TID identifier is used as the unique ID to associate all data; The article number corresponding to the RFID tag is written in the user storage area. In this study, the chip is mainly used for the identification of greenhouse and harvesting tray, which are used to record production information and harvesting information respectively.

5.3 System function realization

5.3.1 Database Connection

The system is connected to the system database through ADO.NET driver for MySQL components, and can be called by various programs through the preparation of public class get MySQL connection. CS. The specific code is as follows.

Click the Add button to enter the data addition mode, where you can enter the name of the supplier, the name of the person in charge, and the contact number.

Click the Save button to save the supplier information into the database.

5.3.4 Employee Information

The employee basic information module is a part of the basic file module. All employee information management can be added, modified and deleted in this module. The user can modify the information according to the actual management needs, including employee name, date of birth, department, etc.

Click the Add button to enter the data addition mode, where you can enter the employee name, system login name, etc.

Click the Save button to save the employee information into the database.

5.3.5 Harvesting management

The harvesting management module is a connecting module in the vegetable quality and safety management system, the user collects the production history information to the RFID tag of

the harvesting tray, and the harvesting management system reads the RFID tag information of the harvesting tray and writes the harvesting information. Click to add the system to automatically generate the harvesting number, and automatically read the production record number, harvesting quantity and production number corresponding to the RFID tag of the harvesting tray. And that collect information is written through the RFID reader-writer.

Click the Add button to enter the data addition mode. You can enter the harvest time, harvest location, harvest quantity, etc. The production record number can be read by clicking the "Read" button to read the number stored in the RFID tag.

Click the Save button to save the harvesting information into the database.

5.3.6 Acceptance information management

Acceptance information management is a part of the inspection and packaging process. Users check and accept the products obtained from the harvesting tray, take samples for testing, and click Add to automatically read the harvesting number, harvesting plot number, harvesting date, harvesting quantity, production record number, etc. Of the RFID tag of the harvesting tray. And that check information is written through the RFID reader-writer.

Click the Add button to enter the data addition mode, and you can enter the harvest record number, production plot name, sample number, inspection results, etc.

Click the Save button to save the inspection information into the database.

5.3.7 Query of Traceability Information

Traceability information query is a part of the quality and safety management process. Users can query the history information of the whole process from production to packaging according to the history number generated after production information collection, harvesting information management, inspection and packaging management. Query conditions include product number, production record number, harvest record number, etc.

6 Summary and Outlook

6.1 Summary

The vegetable quality and safety management system based

on RFID technology has established a unified standard and traceability management from vegetable production to packaging through the digitalization of information technology. It improves the simple and crude product image of vegetable products, and also provides information monitoring and guarantee for food safety that consumers care about. By strictly recording the information of the production process and associating the harvesting information with the testing and packaging information, the system can trace back to the source.

Through the formulation of quality and safety standards, vegetable producers and operators have strengthened the internal quality inspection mechanism of enterprises, improved the core competitiveness of products in the market, and achieved good social effects.

This paper has the following advantages:

1. RFID tags are used to establish the information connection of production-harvesting-detection-packaging process, which ensures the whole process monitoring of production enterprises.

2. Through the TID identification of RFID tag, the basic production unit is bound uniquely, and the problem of tracing agricultural products to the basic production unit is solved by cooperating with various information collection systems.

3. The production standard is integrated into the production link, so that the implementation process can be prompted in real time, and the probability of defective products can be effectively controlled in the traceability management.

6.2 Outlook

Due to the limited development time, the implementation of the system is still a beta version. With the popularization of agricultural informatization, the quality and safety management of vegetables has been paid more and more attention, and the research on the application of production management system will be more and more in-depth, until it extends to the whole process of "producer-consumer". The system also needs further planning, expansion and upgrading, the establishment of vegetable quality and safety traceability system, and the effective supervision of vegetables from production base to consumers through RFID technology. Based on the traceability center database, the traceability query of products can be realized on different platforms such as websites and mobile phones. There is still a lot of work to be done in the future.

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