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Abstract. Traceability system is regarded as an effective method to ensure quality safety of agricultural products by countries all over the world. In this study, based on the research of EAN·UCC system, UCC/EAN-128 bar code technology was applied in fruit safety traceability system, coding rule for traceable code was established, and the traceable label for fruit product was designed. By integrating database technology, network technology, bar code technology and GIS technology, a safe production and quality traceability system for fruit was established. The system standardized archival records of fruit production process, proved the level of production management and meet the right to know and right of option of the consumers.

Keywords: Traceability System, Fruit Quality, Bar Code, GIS

1   Introduction

Since 1970s, agricultural products security incidents happens frequently both in domestic or abroad, traceability system, as an effective method of controlling the quality of agricultural products, gets growing recognition from countries all over the world. EU, USA and Japan have unveiled laws and regulations requiring manufactured meat, fruits and vegetables sold in the countries said above shall be traceable. China is a large agricultural production country, constructing traceability system not only can provide high quality and safe agricultural products, but also is an important method break down trade barrier placed due to food security traceability by foreign countries, and plays an important role to promote the competitive strength of our agricultural products in international market.

   At present, the construction of China's agricultural products traceability system is in the initial stage. The research and experiment of food traceability system was carried out in Beijing, Shanghai, and Shandong etc., for example, "Shanghai Edible Agricultural and Sideline Products Quality Safety Information Query System" was set up in Shanghai, "Beef Product Tracking and Traceability Automatic Identification Technology Application Demonstration System" was built in Beijing, and in Shandong Shouguang, "The Vegetables Traceability Information System" was in application [1]. But most of the existing research focuses on animal product and vegetable, and the traceability information can only be presented in the form of text.

In this study, a safe production and quality traceability system was established to implement quality tracing for fruit. The system combines traditional quality safety traceability with GIS to realize the visualization of fruit quality safety information, and provides a new way for the construction of the fruit quality traceability.

2   System Framework

The management of fruit quality is concentrated on two aspects. First, in order to strengthen the management of fruit production process and improve the quality of fruit, the product archive is set up and stored in a database, which record the information of field parcel, soil nutrient, planting personnel, production process and etc. Second, According to some coding rules, traceable bar code that with fruit archives information is generated, and fruit quality traceability platform is constructed with the technology of database, network, GIS and .net to solve the fruit quality safety information asymmetry and responsibility.

By inputting the traceable code of fruit at the platform, a consumer can clearly know the varieties of fruit, producing area, soil, water and other environmental situation, and the pesticide, fertilizer, various inputs information in the fruit production management process, thus meet consumers' right to know and option, and their rights and interests are protected. For the producers, they can record and manage all kinds of information in the fruit production process systematically and by standard, establish and perfect the production management archive records, standardize production behavior, continuously improve product quality to ensure product safety.

3   System Function Design

According to the above system framework, the fruit quality and safety traceability system mainly consists of producing environmental management, fruit production management, traceability information encoding and traceability information query, to make the producing environmental visualization, production process electronization, and ensure the problems can be traced.

3.1   Producing Environmental Management

Ecological environment of producing area is one of basic factors that have influence on fruit quality. Environmental management mainly takes effective management to information such as location, soil, water and air etc., and establishes pre-production, in-production and post-production database for environment of producing area.

3.2 Management for Fruit Production

Production management may directly effects quality security of fruit, so it is very important to collect correct and detailed information of production management. Every field parcel is assigned a scientific and reasonable numbers, the corresponding information such as soil nutrition, soil fertility, weather, varieties of fruit, planting area, planting personnel, and information in production management such as watering, fertilizing, pruning, pesticide delivery and harvesting are recorded. All the information constructs detailed and complete production management database, and provides the basic data for fruit traceability.

3.3 Coding for Traceability Information

The key point of making fruit quality traceable is to confirm the "identity " of fruit, based on the research of coding standard and method, this paper makes coding scheme for fruit according to characteristics of fruit, meanwhile realizes traceable label of fruit, and realizes tracking identification.

3.4 Query of Traceability Information

Establish traceability platform for quality security of fruit, information such as location and environment of producing area, status of pesticide and fertilizer use, varieties of fruit and harvest, etc. can be easily queried.

4 System Realization

In order to ensure the quality and promote the competitive strength of fruit, a safe production and quality traceability system was implemented with the technologies of database, network, bar code and GIS.

4.1 Database Construction

Data is the basic that ensures system running correctly. The traceability system consists of two types of data, one is spatial data the other is attribute data. Spatial data shall be mainly obtained by the interpretation of remote sensing image and GPS measurement at site, including information of terrain, administrative division, water system, road and field parcel etc.; Attribute data include information of soil nutrient, soil fertility, diseases and pests, pesticide use, water nutrient management and product inspection etc..Tables designed in the attribute database are as follows: table of environment and climate, table of field parcel, table of fertilizing information, table of irrigation information, table of disease and pest control, table of fruit quality detection and table of user information etc. All the information provided above is saved in the database, and which is the core and base of the fruit traceability system.

The characteristics of the spatial data and attribute data require respective transactions on the storage and management of data. Spatial data is divided into different layers according to the characteristic of surface features, and is managed in the form of ".shp" files; Attribute data is saved in the SQL Server2005 with information associated by ID code with spatial data, for example, field parcel could be linked with the attribute database when the identification field "fieldid" is put into the layer of the soil nutrient distribution.

4.2   Coding Rule for Traceable Code

The traceable code of fruit is the "identity" or "symbol" defined for the tracing and recognition in some way. As the Global Identification System, EAN·UCC has offered a complete set of code system used for marking goods or services in the supply chain, which could be used for the marking of agricultural products.

The traceable code of the system has been designed with UCC/EAN-128 bar code, and the information of fruit production and companies is corresponded with special bar code. When the traceable code on the fruit packing is typed into the tracing service system of the website, corresponding information shall be quickly searched. Fruit with different traceable code shall be with different quality and safety information in the fruit management, and the same kind of fruit produced on the same field parcel and within the same time shall be with same safety information, so the fruit of the same lot is with the same and only traceable code [2]. The traceable code consists of three parts: fruit identification code, production date and source entity reference code [3-5] .

Fruit Identification Code. The corresponding code data of AI (01) is a global trade item number (GTIN). GTIN is the only global marking number used for trading products [6]; the coding format is as Fig. 1.

$$X_{14} \quad X_{13}X_{12}X_{11}X_{10}X_9X_8X_7X_6X_5X_4X_3X_2 \quad X_1$$

Indicator   Company Prefix   Item Reference Number   Check code
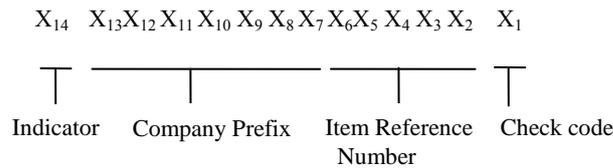
Fig. 1. Coding format of GTIN

Any company tending to realize the tracking and tracing of fruit has to firstly establish and make use of its own GTIN. The company prefix is distributed and managed by GS1 China in order that the code distributed is the only one in the world. The first three digits are the prefix code, and the prefix code distributed to GS1 China by GS1 is from 690 to 695 [7].

Item reference number is distributed by the company obtaining a company prefix, and each different trade item earns the only specific item reference number. The fruit kind code is taken as the item reference number based on the fruit categories in the

system, and in order that the system shall be used for the quality tracing of vegetable products, X_6 is designed as main categories of goods, such as 1 standing for fruit and 2 standing for vegetable; X_5X_4 represents Sub category, such as 01 standing for pear and 02 standing for apple; X_3X_2 represents a specific fruit, such as 10 standing for white pear of Beijing. Therefore, the item reference number of this kind of pear is 10110.

The check code is produced by a calculation of its first 13 figures according to certain methods, used for automatically checking the accuracy of the 13 figures when scanning the bar code in order to ensure the code validity.

Code of Production Date. The production date could be judged according to the implication of AI (11). The production date means the date of producing, processing or packing. Considering the fruit, the production date is just the date of picking, and the code structure shall be of YYMMDD format.

Source Entity Reference Code. The source entity reference code identifier AI (251) represents the primary source of the trade item [8-9]. Field parcel code is used for tracing the primary source of the fruit in the system. The field parcel code which shall be unique is distributed by the production company itself. The field parcel code in the system consists of seven figures, the first two standing for the town with the next two standing for the administrative village and the last three standing for the field parcel position, such as 0105006 representing the No. 006 field parcel of Danli Village of Miaofengshan town.

4.3   Design and Realization of the Traceable Label

The traceable label also includes the goods name, producing area and other information consumers concerned in form of the text besides the traceable code.

Fig. 2. Traceable label of fruit

Fig.2 is an example of the fruit traceable label, the most below is the traceable code meaning the White pear of Beijing was picked on NO. 006 field parcel of Danli Village of Miaofengshan town on Sept. 12, 2010 and the company prefix is 6911326.

4.4   Construction of the Traceable Platform

SuperMap is taken as the GIS software platform, .NET and SQL Server database are used for the system development. B/S architecture is used in the system and a traceable platform is offered to the public in the form of a website. Information about the fruit could be traced after the traceable code has been typed into the platform.

According to the traceable code, the system shall directly illustrate the concrete position of the field parcel of the fruit, and also information such as the corresponding county name, town name and village name could be found. As illustrated in Fig. 3, consumers could learn that the field parcel is in the Danli village, Miaofengshan town of Mentougou District, Beijing. When the user clicks the field parcel on the map, information such as planting personnel, water, air, soil nutrient, fertilizer use, pesticide delivery and product inspection could be queried.

Fig. 3. Chart of traceability result—information of field parcel

5   Conclusion

The system uses bar code technology, GIS technology, network technology and the database to achieve the "from farm to fork" traceability of fruit. The production process records are standardized to ensure fruit quality and safety, the competitiveness of fruit is improved and the consumer's safety awareness about the food is enhanced. Specifically in the following points:

First, production management database is constructed to standardize production behavior, and which provides basic data for fruit traceability system.

Second, in order to identify fruit, the traceable code for fruit is designed with UCC/EAN-128 bar code, and the traceable label includes the information of production date, goods name, producing area and etc.

Third, a traceable platform is offered to the public, consumers may access the website to trace the related information.

Last, traditional quality traceability is combined with GIS, and that realizes the visualization of fruit quality safety information.

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