

# Quality and safety traceability system of agricultural products based on Multi-agent

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**Abstract.** As essential consumer goods for daily life, agricultural products tend to go bad from the farm to the table. Therefore, people put forward higher requirements for the quality of agricultural products. How to manage and control the quality of agricultural products and to control the quality of agricultural products by chain type are the cores of scientific research. The purpose of combining Agent technology with agricultural product quality safety traceability system was to establish the quality and safety traceability system of agricultural products based on Multi-Agent in the study. Artificial intelligence, intelligent control and intelligent detection technologies were used effectively in the system. The framework of quality and safety traceability system of agricultural products proposed in this study can be used to analyze modules in the quality of agricultural products. Through a number of Agent refining divisions of labor, the quality safety early warning and supervision control for the supply chain of agricultural products was carried out. The performance evaluation system of agricultural product quality safety traceability system based on Multi-Agent was established, so as to provide a systematic evaluation basis for the quality supply of agricultural products.

**Keywords:** Multi-Agent, agricultural products, quality safety, artificial intelligence

## 1. Introduction

Scientific and technological progress has led to the gradual improvement of people's living standards, and people's demands for quality of life have been much higher than that in the past. The agricultural products are the consumer goods of people's daily life. From the farm to the table, agricultural products have undergone a great deal of transportation and storage. If there are management loopholes in any links, it will lead to agricultural products security problems exposed gradually [1]. In recent years,

exposure rate of the quality and security problems of agricultural products from media has increased. This has also caused the enterprises to pay attention to the whole process of supply chain management of agricultural products. The National Bureau of quality and safety has established a traceability policy for ensuring food safety monitoring for the general public. The original ecology of agricultural products is restored to the maximum extent in the picking stage. The system built will be able to control agricultural products throughout the implementation phase. At present, the quality and safety system of traceability in vegetable and meat cold chain has been established in our country. Moreover, the related research is also undergoing further research [2]. ISO

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standardized certification has defined the basic concept of traceability. Traceability means that food can track historical information about food in this supply chain as well as what happens when it is applied through the food raw material collection, processing, transportation, sale process in the process of recording mark [3]. In this regard, Japan conducted a relatively detailed research work. High quality meat products in Japan Kobe beef have always been popular because Japan has begun to imitate and establish the quality and safety traceability system similar to western countries from the beginning of 2003. By 2005, Japan had been able to extend the quality and safety traceability system for meat to vegetables and other kinds of product [4].

The traceability system of agricultural products in China started in 2000. The traceability management system of related agricultural products supply chain has been initially constructed. Experts have pointed out that the traceability of food supply chain is the lifeline of food safety, and is also the most effective way to control the quality and safety of prevention. At the same time, traceability is also one of the elements of the basic system construction of agricultural product supply management [5]. Beijing is the first city in China that claims to set up a green and safe consumption city. The basic principle of traceability is to inquire the code carrier, supply chains of agricultural and sideline products. However, the original single operating system can't realize the artificial intelligent flow management. Only through the information and network management can the quality traceability of the whole supply chain be realized [6]. However, in order to save basic manpower and material resources, and to save unnecessary waste of resources, the impact of many factors on production and management needs to be considered. After the development of artificial intelligence, Agent technology tends to mature application. The related Multi-Agent system can solve the traceability problems of quality, safety and supply chain of agricultural products [7]. However, there are many interdisciplinary fields involved in Multi-Agent systems, and it has a very close connection with the field of computer applications. Because of the artificial intelligence characteristic of Agent, it can warn against the quality hidden danger caused by the unexpected situation. It can help related administrative departments and enterprises to make decision in the operation process when facing quality and safety problems, and can improve safety management efficiency [8]. On the basis of computer artificial intelligence technology, combining the Multi-Agent

technology, this study puts forward a model of quality safety traceability system for agricultural products. At the same time, the corresponding performance evaluation system has been set up, which has practical significance in scientific research and practical application.

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## **2. Application of Agent technology and Multi-Agent system in agricultural product quality safety management system**

### *2.1. Basic concepts of Agent technology and Multi-Agent system*

At present, computer communication technology and internet technology are developing rapidly, which promotes the penetration and application of network technology in various industries. Agent technology based on artificial intelligence has also been discovered and paid more attention by researchers. This is a comprehensive research field with high combination of computer theory and application [9]. At the same time, some scholars have successfully applied Agent technology in the fields of industry and pharmacy, and obtained corresponding scientific research results. This has prompted more researchers to put more research into the reverse side of the computer management system of artificial intelligence. Agent does not have very clear scientific definitions, but researchers translate through systematic research processes. The main essential features are the ability to automate detection and management as well as emergency decision making systems. In addition, the

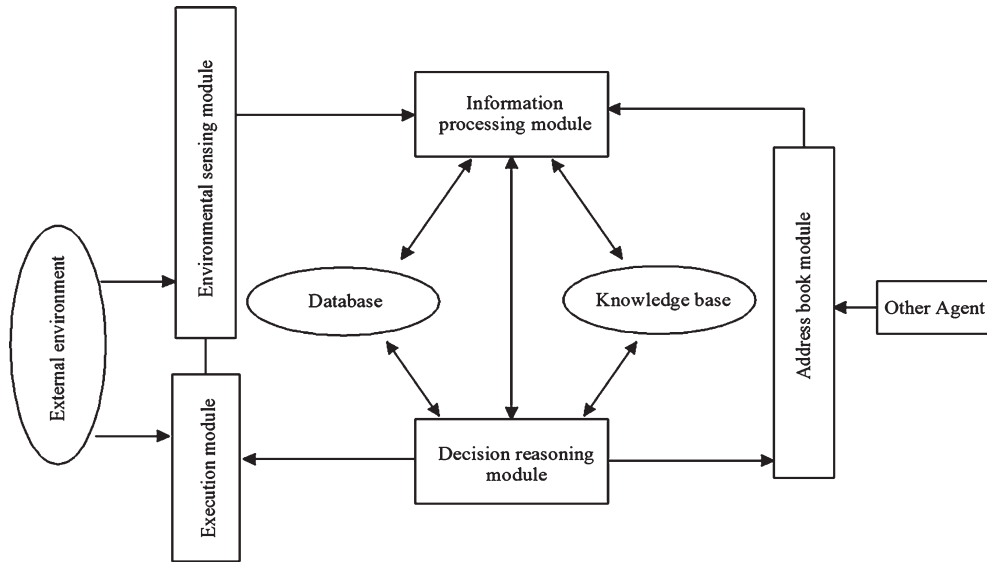


Fig. 1. Structure model of agent.

system also has the basic sensory and reaction characteristics of the human brain and nerves. That is to say, Agent can make conscious inferences and reactions, and have some reasoning and planning ability in dealing with some things. These are the research foundations of artificial intelligence [10]. Figure 1 is a structural model diagram of the Agent. It can be seen from Fig. 1 that the basic components of Agent include database, knowledge learning, storage space and corresponding application modules. Databases and repositories provide data for the system to handle problem. Agent can make intelligent decisions. Each module of Agent realizes the efficient combination with the external environment, and filters information and completes the artificial intelligent scientific decision and analysis automatically [11]. Agent's communication intelligence module can accept external information using KQML's language using technology. The processing modules are applied to store and analyze storage analysis problem, which creates an external reaction to the external environment.

The construction of Multi-Agent system is based on the combination of small Agents with different function layout. Because the independent Agent can't complete the whole set of intelligent work, it is necessary to divide the work to different Agent to accomplish different tasks and objectives [12]. The combination of many Agents into an integrated intelligent processing system is a model for standardizing and interacting with the model. In order to solve the

contradictions in the process of Multi-Agent systems with dealing with many Agents, the central processing unit is required to deploy in the whole information process. The integrated Agent system has a strong distribution feature, and it can flexibly decompose the problems encountered and improve the efficiency of processing problems. The system is adaptable and open and it is able to sense information and process information. In the process of decision making, communication language is combined with coordination mechanism to save the working resources of the backstage [13]. Integrated Agent system is a system with parallel structures that can communicate and collaborate effectively across different Agent systems. However, such systems can only deal with simpler models. The general federal structure can deal with the organizational structure of a system. The federal system can coordinate the different requirements by direct communication, and coordinate the middle information with one Agent, which reduces the communication cost and upgrades the system level [14]. The system with an intermediary system as the regulating structure has the best flexibility in the upgraded system, and plays the largest role in the Agent's own artificial intelligence. Because of the rapid pace of change in food consumption market at this stage, the traceability structure for the whole process is very demanding. It is the problem of the future computer network that can flexibly deal with the traceability of different situations [15]. Federation system architecture based media just meets the decisions

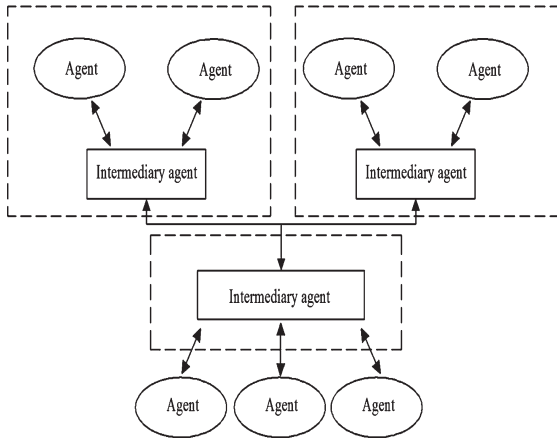


Fig. 2. The federal structure Agent formed in an intermediary manner.

of this kind of problems. The increasing number of system Agent and optimizing the allocation of resources are the keys to the system structure and function, it can be seen in Fig. 2.

2.2. Agricultural products traceability system development

The quality safety of agricultural products has always been a concern of all walks of life, because agricultural products are the necessities of daily life for ordinary people. Some seasonal vegetables and cold chain transport of agricultural products are even more indispensable. The whole operation management chain has the problems of transportation cycle control, storage cycle and sales cycle. Therefore,

the quality traceability chain of agricultural products has some risks [16]. Figure 3 is a structural diagram of a traceability chain for agricultural products. It can be seen from Fig. 3 that agricultural products have some difficulties in the control of transportation and information funds, so the influence of quality can't be ignored. The actual processes are still relatively more from farmers' production to wholesalers' transportation and distribution until the process of distribution through a distribution channel. In the increasingly competitive environment, the quality and safety assurance of agricultural products requires a certain quality traceability system to guarantee. There are many benefits distribution problems and management concepts in the traceability system of agricultural products. Therefore, the conflicts of some goals may lead to the poor quality of agricultural products [17]. Without the support of big data on the internet, the timeliness of agricultural products is still relatively low. Meanwhile, the cost of agricultural products storage and transportation is relatively high, and the artificial intelligent information sharing mechanism is not perfect. This leads to great quality and safety problems in the supply chain management of the whole agricultural products [18]. Computer artificial intelligence data mining technology is used to carry out information exchange between enterprises, which can help mutual understanding and trust. This provides a great technical support for the construction of a unified management supply chain of the traceability system of agricultural product quality.

The overall operation of agricultural products quality safety depends on the development mechanism

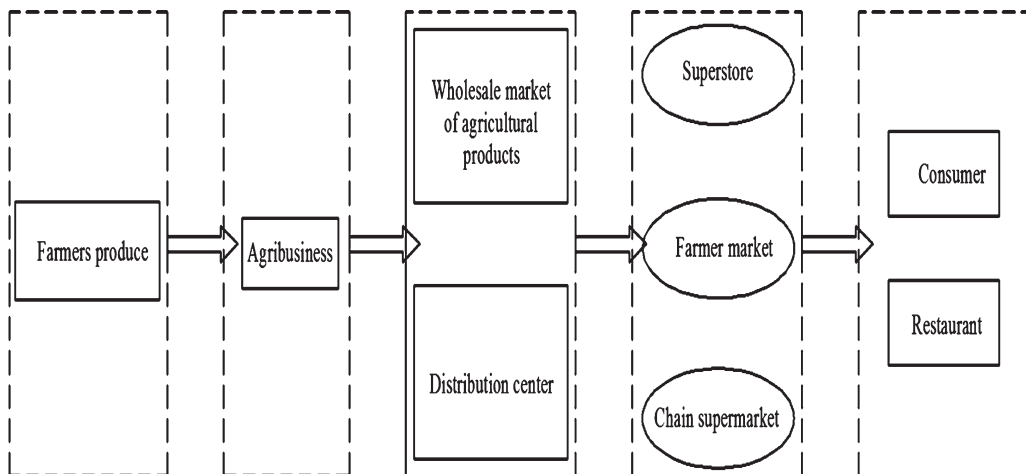


Fig. 3. The traceability of agricultural products, the structure of the chain.

of the whole industry. The ability to build online information sharing and build trust among businesses are the foundations of development. It is necessary to set constraints on economic development in an objective and subjective way. The main difficulty is to provide technical support for negotiation so as to improve the standardized management of the system [19]. Computer information technology has been widely used in various fields, and countless contributions in various fields are numerous. This provides some great help for the transformation of some high-tech enterprises. The actual process of agricultural products quality safety requires traceability and understanding of the different sectors between the various nodes of the system. The future traceability system will be able to complete the single order operation of the order. The new high-tech technology itself has been exploited and transformed into efficient internet information flow. The nodes on each traceability system can interact with each other, which provide professional guidance for the supervision of the quality of agricultural products [20]. Through consulting the materials, it is found that the technology management has great technical space. Researchers in computer science have been extensively concerned about and responding to such problems. According to the characteristics of freedom and adjustment of Agent technology, coordination can be carried out at each node to overcome some technical problems in themselves, which plays an irreplaceable role in the superiority. The management technology based on internet Agent can solve some negotiation problems of traceability structure, and make the supply link of the whole product more effective and stable.

### 3. Research on the construction of agricultural product traceability system security model based on Multi-Agent

According to the function change of the system on the whole quality and safety supply chain of the agricultural products, the active units of each node are set up as intelligent processing Agent. Artificial intelligent management modules are used to complete the communication network communication timely and effectively. Multi-Agent is integrated into the whole supply chain management system and a quality traceability model is established, which is shown in Fig. 4. The construction of functional modules in Fig. 4 is based on the Agent modules of the consultation center, supply center, manufacturing center and distribution center of the agricultural products.

Design models of Agent modules of each module play a key role in node communication for the establishment of traceability system. For processing and storage of future transit information, it provides data that can be stored and identified. This also includes the intelligent response of the Agent of each transit node. If the reaction is not explained, the decision problem is dealt with. The Agent of the deployment center can check in a timely manner, which can reduce unnecessary losses. Figure 5 is a schematic diagram of the Agent module structure of the coordination center module.

Data storage includes model base and knowledge base. They all need holistic intelligent ordering and inventory optimization. Computer calculation and optimization algorithm are used to solve and find the optimal path solution. The quality and safety traceability system of agricultural products needs decision

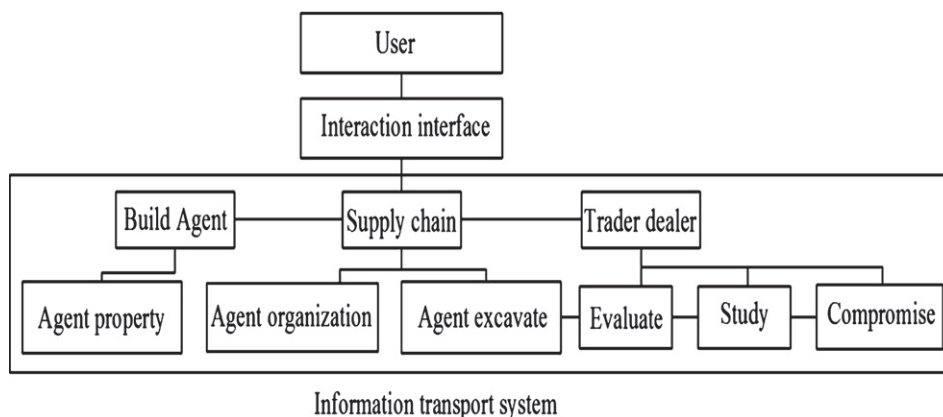


Fig. 4. Quality traceability model based on Multi-Agent.

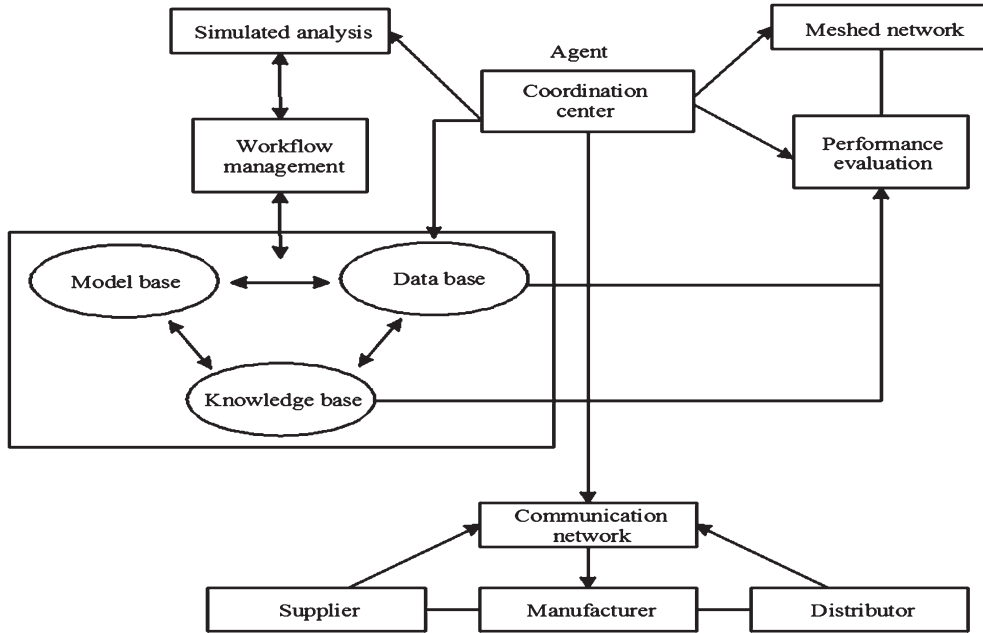


Fig. 5. Schematic diagram of Agent module structure of coordination center module.

support from each supply node. Artificial intelligent data processing is helpful to the traceability of the overall safety information. The running data, the daily production log, the knowledge base of the database and the decision making structure of the database can make the final decision according to the data information of the decision making layer.

Based on the traceability safety system of Multi-Agent agricultural products, the roles of suppliers are mainly concentrated in the upper stage. Lower level customers need suppliers to provide customers with raw materials of agricultural products. This supply module provides the traceability system with the effective management of production plans and orders for agricultural products, and develops logistics activities, which is shown in Fig. 6. It can be seen from Fig. 6 that the order management of Agent began to deal with various order information from the beginning of the order for agricultural products. If the stock has the agricultural product spare delivery information, it will send out the delivery request information intelligently. After receiving the delivery instruction, the shipment Agent will select with artificial intelligence according to the inventory situation. If the inventory information is not enough, it will intelligently produce production plan instruction to production Agent. After the production plan for Agent has been completed, the unified production is carried out. The quality of the whole process

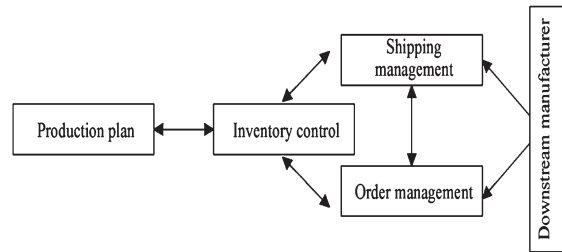


Fig. 6. Arrange the plan according to the production arrangement.

has strict system cognition and control with strong traceability.

The processing module of the system is the core position of quality and safety system traceability, because the module controls the purchasing of raw materials, the production and processing of agricultural products, and it makes the qualified agricultural products distributed to the suppliers. The transfer of these channels has a greater impact on the quality of agricultural products. Figure 7 is a schematic diagram of a processing module control system module of agricultural products. The processing module summarizes the traceability system, and is unified deployed by Agent. The progress that from the order collection and supply of the upper structure to the artificial intelligence processing of raw materials until the final distribution to the suppliers is the optimized solving process through the amount of computers,

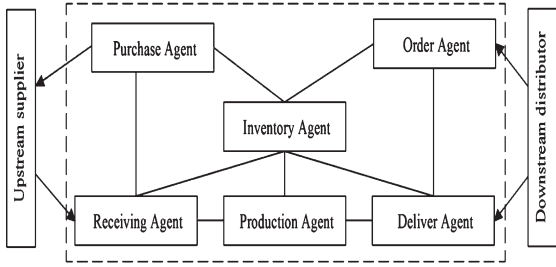


Fig. 7. Schematic diagram of processing module control system module for agricultural products.

which improves the control efficiency of quality and safety. Quality traceability has been elevated to a level.

Based on the construction of Multi-Agent agricultural product quality safety traceability system, the construction of above functional modules is completed. The coordination and integration of several functional modules are carried out to further recognize the application function of Multi-Agent in agricultural product quality safety traceability system. The flow chart of design and operation is shown in Fig. 8.

The increase in the quantity of orders for agricultural products may increase the risk of quality problems. Therefore, the traceability and optimization of the production order model for agricultural

products should also be optimized in the process of establishing the model of traceability system for quality and safety of agricultural products. This is because the higher the backlog and the longer the preservation of agricultural products, it will greatly increase the quality and safety issues through the entire supply chain transformation to ordinary buyers. Therefore, optimizing the running efficiency of the model is helpful to the safety traceability of agricultural products.

The quantitative expression of intelligent solution of data mining for inventory in the supply chain of agricultural products is:

$$P_{ij}^k(t) = \frac{[\tau_{ij}(t)]^\alpha [\eta_{ij}(t)]^\beta}{\sum_{i \in a} [\tau_{ij}(t)]^\alpha [\eta_{ij}(t)]^\beta} \quad (1)$$

The formula assumes that M ants are distributed into the network structure. Each ant represents the distributor of agricultural products Agent, and  $\eta_{ij}(t)$  is the visible degree of the order quantity of agricultural products. The process of calculation can be regarded as constant.  $\tau_{ij}(t)$  orders the order of agricultural products in the market along the i point to the j point path strength, and  $p_{ij}^t(t)$  indicates the probability of the transfer of the order quantity of the agricultural products distributor at the t moment, and t is the time.

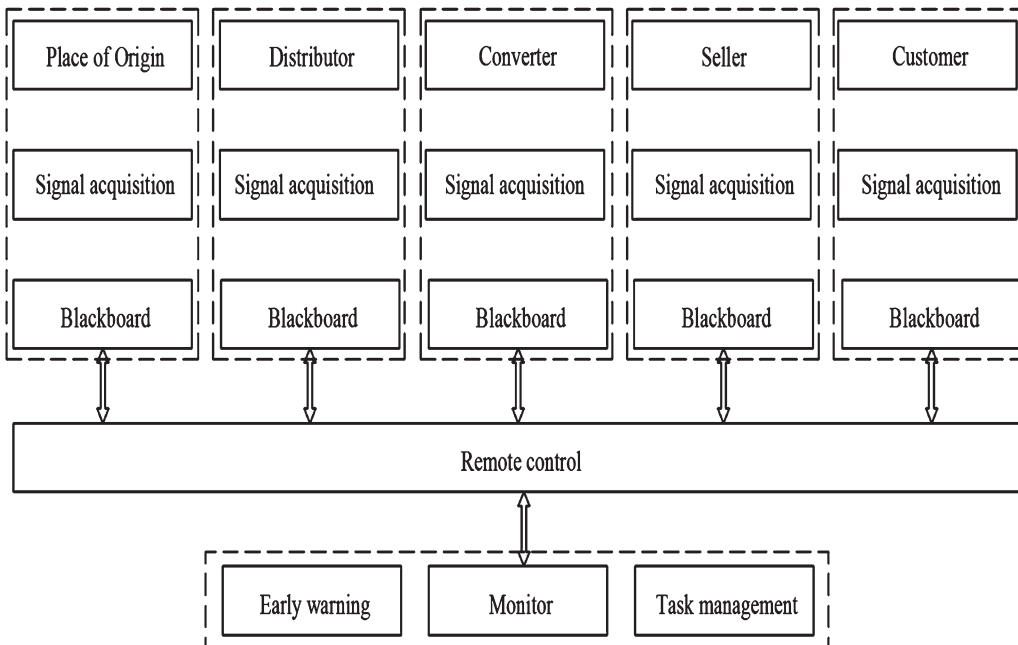


Fig. 8. Structure diagram of traceability system of agricultural product quality and safety based on Multi-Agent.

Because the quantity of order is less than the amount of stock in stock, the whole security system will issue an alarm. Because of the consideration of the local optimum quality, the artificial intelligence Agent module will send out the risk signal of inventory quality. Quality inventory needs to be assessed after each order is completed. The quality update expression is as follows:

$$\tau_{ij}(t + \delta) = (1 - \delta)\tau_{ij}(t) + \Delta\tau_{ij}(t + \delta) \quad (2)$$

$$\tau_{ij}(t + \delta) = \sum_{k=1}^m [\tau_{ij}(t + \delta)]^k \quad (3)$$

In the formula,  $\Delta\tau_{ij}$  represents the amount accumulated by a distributor of agricultural products during cyclic delivery of information.

#### 4. Feasibility evaluation analysis results and discussion of safety traceability system based on Multi-Agent agricultural product quality

##### 4.1. Evaluation and analysis results

The quality and safety traceability system constructed on the basis of Multi-Agent agricultural products can better control the quality and safety of the supply chain of agricultural products. At the same time, it needs a performance assessment and evaluation to restrain subsystem management. The selection of evaluation indexes has a great influence on the operation of the system, and Fig. 9 is the result of the evaluation system. The supply chain of agricultural products constitutes many restriction factors for suppliers and distribution manufacturers according to control logistics and information capital flow. The target is a dynamic network of complex structures. The overall Multi-Agent quality safety traceability system should be understood as a whole system. It not only meets the traceability function, but also achieves the system's comprehensiveness and reliability. The method of evaluation should be qualitative and quantitative, and quantitative analysis is more convincing. Qualitative analysis leads the conclusion to general function. The quality traceability of agricultural products requires the full process of Agent intelligent traceability of agricultural products. According to the Agent process of the signal acquisition, the authenticity and effectiveness of data are ensured.

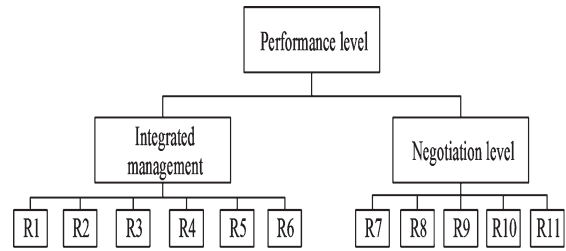


Fig. 9. Results of evaluation system of quality traceability system.

R1 in Fig. 9 is the return on equity of the Multi-agent agricultural supply chain, the traceable index can reflect the profitability of firms in the supply chain, the greater the value of the index is, the better the operation of the enterprise is, which indicates that the supply chain management level is high, and the probability of quality problems in agricultural products is low; R2 is the asset turnover probability, this index is a positive indicator, the enterprise with high capital management level is high, and the quality of agricultural products is guaranteed; R3 is the inventory turnover rate, the smaller the index is, the smaller the inventory of enterprises is, and the quality of agricultural products stored is not easy to degenerate; R4 is the enterprise's increase rate of business revenue, the index shows that after the application of Agent technology, sales index rises, and supply management capabilities improve; R5 is the profit growth rate and R6 is the decrease probability of operating cost, the above two indexes can reflect the operation ability of the enterprise and reflect the quality and safety of the products on the side; R7 is the absolute deviation rate of production and sale and R8 is the absolute deviation rate of production, the smaller the R7 and R8 are, the better operational capacity of the company is; R9 is the supply growth rate of raw materials, the larger the index is, the better the coordination ability of the supply chain after the adoption of Agent technology is; R10 is sales growth rate and R11 is the satisfaction level of information sharing, these two indicators are positive indicators, the higher the index is, the higher the quality and safety factor of agricultural products is.

The remote communication of quality safety traceability system of agricultural product based on Multi-Agent needs the supply from remote signal acquisition and communication module support of GPRS signal. When the security signal does appear specific problems, the function module in the early warning stage will put forward corresponding measures through the control module to ensure that



agricultural products to users are safe and traceable. Real time monitoring and early warning Agent module is the core structure of monitoring agricultural products. The biggest task is to manage and control the response data of each warning module in front. When the basic information of the monitoring object in front has been warned, the management will request the response to the warning information. The status data is obtained from the acquisition phase of the signal to feed back to the management module after establishing the early-warning model of the diagnosis. When potential unsafe factors are encountered, instructions are issued. The production process of agricultural products is controlled the quality, at the same time, the safety hazards of the same batch of agricultural products are warned. And immediate measures are taken to ensure the quality and safety of agricultural products.

The arrangement of the later system is also one of the model building schemes of Multi-Agent agricultural quality traceability system. It includes the storage and analysis function of historical data of Agent artificial intelligence in functional modules. These analysis functions include querying and deleting historical information, providing traceability security management and monitoring data for the quality and safety of agricultural products.

#### 4.2. Discussion

With the blowout type development of information technology, the development mode of economic globalization covers all industries. The market competition environment direction has put forward high requirements and strict standards for various industries. Agricultural products are necessary components of the daily consumption of ordinary people. However, the storage time of agricultural products is shorter than other commodities, which is prone to deterioration. With the improvement of the quality of life, people put forward higher requirements for the quality of agricultural products. This study considers that farm produce goes through the complete flow from farms to tables from the process of land production to the supply of intermediate supplies and until they are delivered to consumers. However, there is no complete system to control the quality of agricultural products clearly in the process of complex refinement. The production, processing and transportation of agricultural products may have a negative effect on agricultural products. Therefore, agricultural products have gone bad since they came out of the fields

and have not yet entered the dining table. In order to solve the quality problems to carry out the quality traceability, they all begin to trace the problem from consuming or buying bad products for consumers. However, after the root of the problem has been found, the process of control can't be controlled effectively. The quality traceability system used more is RFID computer technology currently. The mature application of this technology can realize the collection, storage and transportation process of the whole information of the supply chain. In addition, this study combines Multi-Agent technology to carryout artificial intelligence system traceability construction of the supply chain of agricultural products so that the emergence of agricultural products security. The system will realize the inference of the artificial intelligence algorithm of the computer and find the link of the problem, and put forward the reasonable diagnosis and decision after the diagnosis of the security problem.

#### 5. Conclusions

The quality of agricultural products is a sensitive topic of current social concern. The supply chain management of agricultural products has also been the biggest obstacle to enhance the timeliness of agricultural products. In order to improve the traceability of the quality and safety of agricultural products, a traceability system of agricultural product quality and safety based on Multi-Agent was constructed in this study. The system effectively integrates the intelligence and reasoning features of Agent, the coordinated organization of multiple Agents can help the system to respond with the fastest response and speed, and the operation stability of the whole system is relatively strong. Since the Agent independent processing capacity was limited, the multi-Agent coordinated organization idea was adopted in the research, and the linkage system construction of many Agent function modules was carried out. Traceability system can play the advantages of multiple Agent comprehensive processing problems, and use Multi-Agent technology to trace the quality and safety of agricultural products, which can avoid many problems. Multi-Agent linked quality and safety traceability system proposed in this paper combined artificial intelligence analysis technology, automatic control technology, and data mining and processing detection technology. The system can accomplish the collaboration of

many functions, and it is of theoretical and practical significance to guarantee the quality and safety of agricultural products by artificial intelligence tracing the defects of agricultural products. Due to the lack of specific operational cases, the research results of this research can be theoretically analyzed and evaluated. However, limited by macro and micro factors in practice, the optimization of the system needs a lot of work.

## Acknowledgments

This work was supported by the National Natural Science Foundation of China “On Government Regulation of Technology Diffusion of Agricultural Product Quality Safety Based on Nonlinear Perspective” (No. 71573161); Shandong Natural Science Foundation “on Nonlinear Regulation of Agricultural Product Quality Safety” (No. ZR2015GL008); China Postdoctoral Science Foundation “A Study on Government Regulation of Technological Diffusion Based on Fiscal Decentralization” (No. 2016M600303); Shandong Social Science Foundation “on Cyber Misbehavior of College Students and Solution Strategies in Micro Era”.

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