

## Using RFID Technology in Food Produce Traceability

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*Abstract:* - Food safety events occur frequently because of epizooty. Many countries build food traceability systems to solve these problems. However, the current food traceability system must be executed by paper work and need a lot of manpowers. It also cannot trace and tracking back the origin and destination of food. The fact that RFID technology can trace object, therefore, it can solve these problems.

The method of this research integrates RFID technology on the food produce traceability system. Using RFID technology will be easy to trace each object, not only for the goods lots. RFID technology can also record all events automatically and acquire the information about the food production by handheld devices.

The result of this paper is providing an integrated facility system for the entire food supply chain by RFID technology. The benefit of this research can trace the food production, and let consumers get the complete food production information to choose and buy the safety food.

*Key-Words:* RFID, Produce traceability, Food supply chain, Food safety.

### 1 Introduction

With the economy growth, the standards of living improve. That enables consumers pay much attention to the quality of food. In recently years, many governments try to build food traceability system to let their consumers know more detail production information. It can not only increase reliance upon the food, but also track the problems and trace the production flow when food safety events happened.

In America, Wal-mart announces its 100's providers must use RFID technology in 2005, and all providers must use in 2006. Besides, the passport of U.S.A. include a piece of RFID chip to save holder's name, national, sex, and etc.( Wang, N, Zhang, NQ, Wang, MH · 2006).

Heartlands hospital in England installed a RFID trace system to find out and identify patients by standard RFID tags. Besides, computer can display patients information automatic when doctor walk between patient and patient.

In Japan, government have a "e-Japan" plan, they plan to make food traceability system to popularize before 2010. and they try to make their standard become international standard.

In Taiwan, Taipei EasyCard is a well-known RFID solution. Besides, the wafer factories and

package factories in Taiwan also use RFID technology to track its wafer produce.

When SARS happened, ITRI installed the sensors in the hospitals, and let people in hospital to talk along RFID ID card. When someone fall ill, hospital can crystal know patient and activity path in 20 minutes. TMU also use RFID chips and clinical thermometer to trace patient and employee's status and contact history.

ITRI and Ministry of Economic Affairs, ROC establishes RFID research and application united.

In Taiwan, council of agriculture establish food traceability system positively. But consumer can get a little information about producing. Besides that, all food traceability information are recorded by farmer's hand. That information must key into information system by other.

The research proposes combine RFID technology and chicken food traceability system to:

1. Reduce manpower and time cost in record and read food traceability information. And make entire process more automatically.
2. Make food traceability information more detail and let entire process can be record and query.
3. Improve food traceability information safety and make them easier to read.

## 2 LITERATURE REVIEW

### 2.1 RFID

RFID, Radio Frequency Identification is combine tags, readers, middleware, and application system.

Through tags and readers establish communication, information system can control readers by middleware or ask readers read and write data to tags directly.

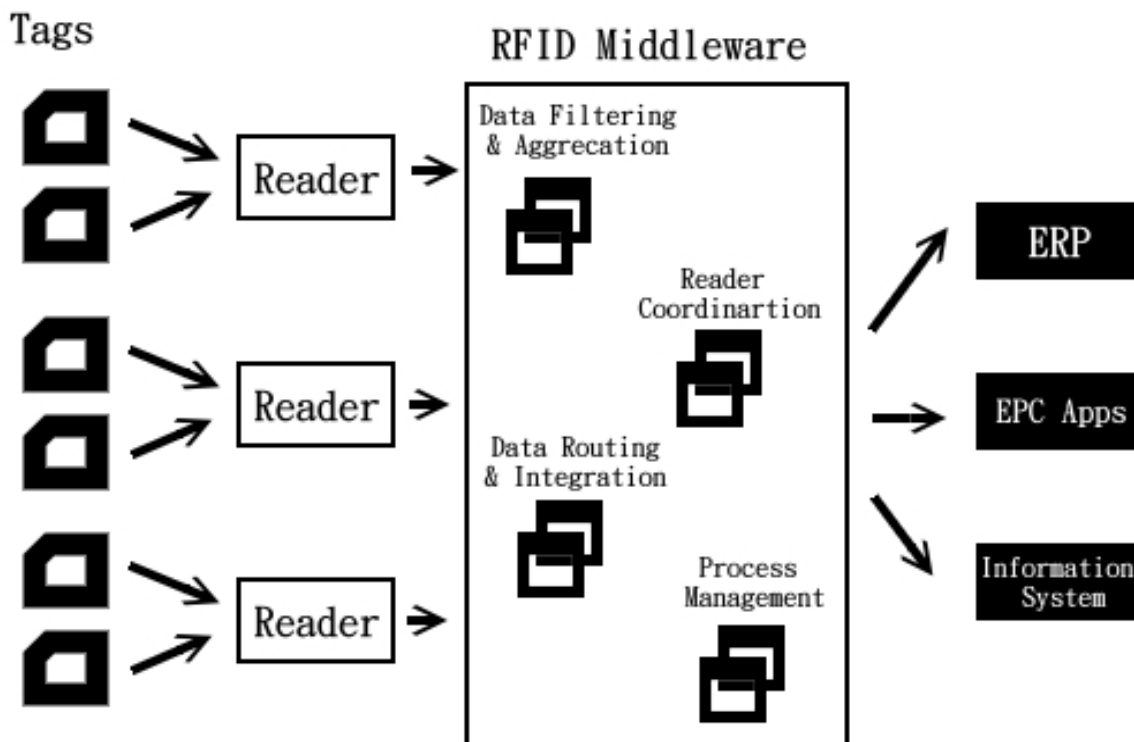


Fig.1 Architecture of RFID

### 2.2 Chicken food supply chain and safety management

Chicken food supply chain has several roles:

- (1) Chicken Farm: a chicken farm support chicken grows up from a baby chicken to a adult chicken.
- (2) Slaughter House: in slaughter house, chicken will be slaughter, slice, process,

and package.

- (3) Retailer: retailers price chicken product, and sell them to consumers.

Food safety system is the key to make consumer to trust food is safe. The food safety process in entire chicken food supply chain show as figure 2.

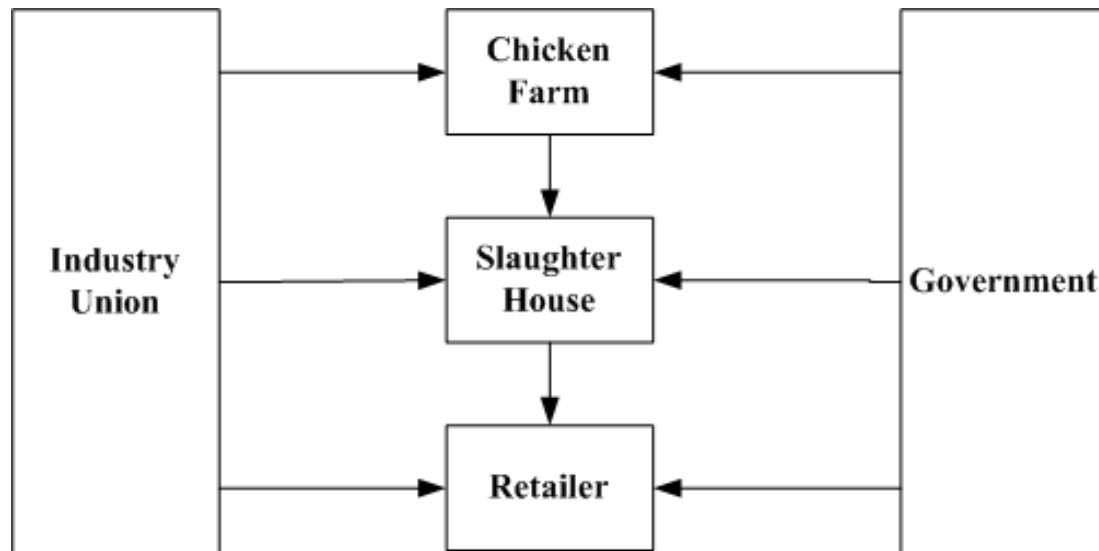


Fig.2 the process of producing hygiene and safety chicken

Besides every role of chicken food supply chain must build standard operation procedure to meet law about food safety, the third party certified and to meet HACCP request is more important.

### 2.3 Food traceability system

Food traceability system is to record all information include growing, breeding, processing, transporting, and selling [9].

Every role in food supply chain must record every producing data and mark on package to make food traceability system work. Food traceability system can help consumer purchasing safety food and track food safety causing more easily [2].

Therefore, food traceability system can let producer and consumer trace or track food producing information and:

- (1) Increasing trust of information: it is helpful proving mark by product identification management and relation of tags [1, 11].
- (2) Help to improve food safety: when food safety happened, FTS can lock and focus, trace producing process, and recycle product currently and fast [3, 10].
- (3) Improve business process: it can manage product by identification. It can make reserves management and quality management more effectively [4, 8, 12].
- (4) Marketing segment: the place of production is an important index of quality. If consumer think quality agricultural products producing by specific location is better. Food traceability system can help to prove.

Food traceability system starts from foreign. America government ask fresh food to import must

provide traceability information in 4 hours, or else they have right to destroy. (Smith, GC, Tatum, JD, Belk, KE, et al · 2005) in Europe, consumer start focus fresh food logistic and traceability, and ask to use EAN/UCC-128 barcode on packing. After European food safety law issuing, all food for selling must have information to trace back producer and processor and combine with EAN international barcode.

In Japan, government support food traceability system development. They focus on food safety and quality.

In Taiwan, council of agriculture try to popularize food traceability system and propose super markets and shopping mall in metropolis must sell agricultural products with food traceability information after 3 years. Consumer can buy agricultural product with food traceability information in more and more store.

## 3 THE ACTUAL STATE OF FOOD TRACEABILITY SYSTEM

### 3.1 Requirement of food traceability system

Food traceability system must meet requirement below in actually :( Pinto, DB, Castro, I, Vicente, AA · 2006)

- (1) guarantee traceability of food in every stage
- (2) consumer can know where the food come from
- (3) provider can know who buy the food
- (4) can trace back and track in real time
- (5) If government has necessary, it can provide necessary information for trace back and track.

The council of agriculture proposes the scope of food traceability system is:

- (1) To provide agricultural products' information of producing , processing, and selling through

internet and information technology.

- (2) Build agricultural product traceability system between producer and consumer to trace back agricultural product source.
- (3) Advance food supply chain information integrating by product identification technology.

Therefore, an effective food traceability system must to meet below requirement:

- (1) Operation process standardization from producing to selling: to standardize operation process in every stage in producing can help to management and develop information system.
- (2) Total quality management from producing to selling: only following out total quality management, food traceability system is workable.
- (3) Detailed record every status and event in entire supply chain: record every status and event in entire supply chain is not only helpful to trace back and trace, and also trust by consumer.
- (4) ability to two-way trace: it must have ability can trace back source and track destination to avoid event to enlarge and can focus trouble causing to put out.
- (5) Third party certified: third party to certify product in every stage is necessary.

To meet every national law: because product will sell to the other national, it must meet every national law.

### 3.2 The framework of actual food traceability system

In Taiwan, a food traceability system has been build for potato, rice, Chinese yam, grape, strawberry, and tea. Producer detailed record producing process, and upload to TAFT System by self or by farmers' association. And system will give trace number. After that, every final product must mark original trace number and transit to retailer. Consumer can get food traceability information by KIOSK or TAFT web site.

But the actual food traceability system only record information in producing stage. It doesn't record processing stage and logistic and selling stage. besides that, the actual food traceability system is only include producing organization management, data transfer, producing operation planning and management, reporting and barcode printing. And these function is only support farmers in producing stage.

### 3.3 The process of actual food traceability system

In producer view, the actual food traceability is recorded by below ways:

- (1) Paper form: farmers record all producing process on paper. After gathering, this information will input to information system by farmers or farmers' association.
- (2) By agriculture management system: council of agriculture developed "agriculture produce and sale management system" before. This system can help to record produce trace information.
- (3) By TAFA: formers can login to TAFA site to input produce trace information.
- (4) By production and marketing group or a farmers' association: farmers can record produce trace information by production and marketing group or a farmers' association.
- (5) By PDA: by PDA and GPS technology, farmers can locate where he is and record produce trace information by PDA.

In consumer's view, the actual food traceability is recorded by below ways:

- (1) By Internet: consumers can access TAFA web site and query after they purchased agricultural products with producing traceability information.
- (2) By KIOSK machine: consumers can query produce traceability information by KIOSK machine. It will show the information on screen.

## 4 An Integrate RFID CHICKEN PRODUCING TRACEABILITY SYSTEM

### 4.1 Question Analysis

The actual food traceability is not enough, because:

- (1) The information that be record in food supply chain for agricultural products is not completed: the information that record by the actual producing traceability system doesn't include manufacturing and selling stage.
- (2) The action to record is not current: because of paper work, the food traceability information must input to information system by operator.
- (3) Food traceability system is executing not certainty: producing and marketing group can print food traceability barcode itself. Some producing and marketing group use last printed barcode to paste on new product.
- (4) The food traceability information can't be more detail: the actual food traceability system can only record simple information about producing, but it can't be record more detail.
- (5) Tard to trace: only use label or barcode to

identify agricultural products is hard to search specific one agricultural product.

- (6) Tan not identify one agricultural product: the actual food traceability system can only identify a batch agricultural product.

### 4.2 Requirement Analysis

After combine RFID technology, the food traceability system can cover entire food supply chain. After the food traceability expands, we must think and solve these problems:

- (1) The information of food traceability recording and storage in every stage: how to record and storage the information of food traceability and reduce people work?
- (2) How to identify food and where they come from: to identify food and where they come from is base of food traceability system. So identify food in process stage is very important. How to setup the identification between Food and semi-finished goods is most important thing.
- (3) Let food traceability system be executed

actually: how to combine RFID technology to avoid prior sector says situation and make entire process more automatically is very important.

- (4) To operate in coordination and record inner check and outside check: inner check and out check is necessary to ensure food safety.
- (5) How to trace and track food effectively: when food safety event occurred, trace and track where foods come from and where to go is most important.

### 4.3 System design

#### 4.3.1 System architecture

The system combines RFID and information system to monitor chicken from breeding, processing and selling stage. In the system, there are four roles. They are a chicken farm, a slaughter house and processing factory, and a retailer. The system will meet the four role requirement in food traceability information management and provide a central management system to gather together the information.

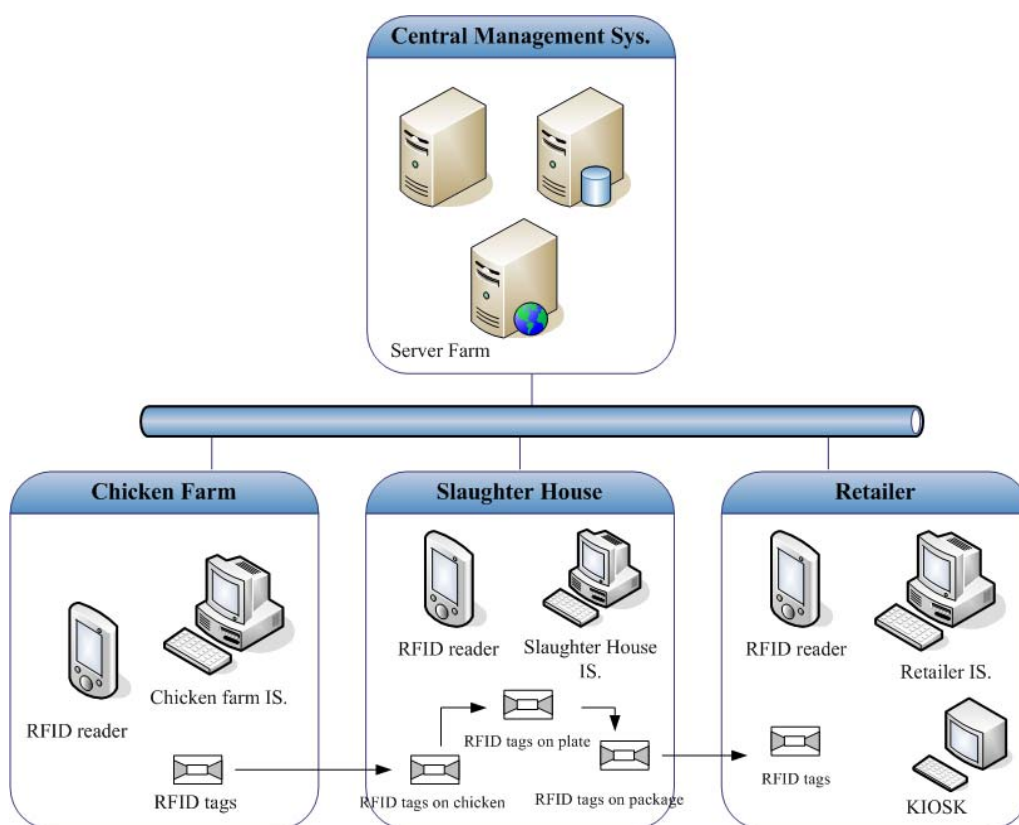


Fig.3 System Architecture

The system is a three-tier architecture. Show as fig.3, RFID reader and RFID tags on chicken is applied food supply chain to read and write food traceability information. Besides that, retailer has a KIOSK machine to let consumer query the

information of food traceability. In second tier, the information system of every role in food supply chain can management the information of food traceability and make entire supply chain process more automatically. In third tier, there is a central

management system. The system will receive the food traceability information from every role in food supply chain. When food safety event occur, government can fill out the chicken.

The system data flow is below:

- (1) Initial data input for chicken
- (2) Read chicken information from RFID tags
- (3) Write chicken information to RFID tags
- (4) Upload the information to information system
- (5) Upload the information to central management system
- (6) Query the food traceability from the central management system

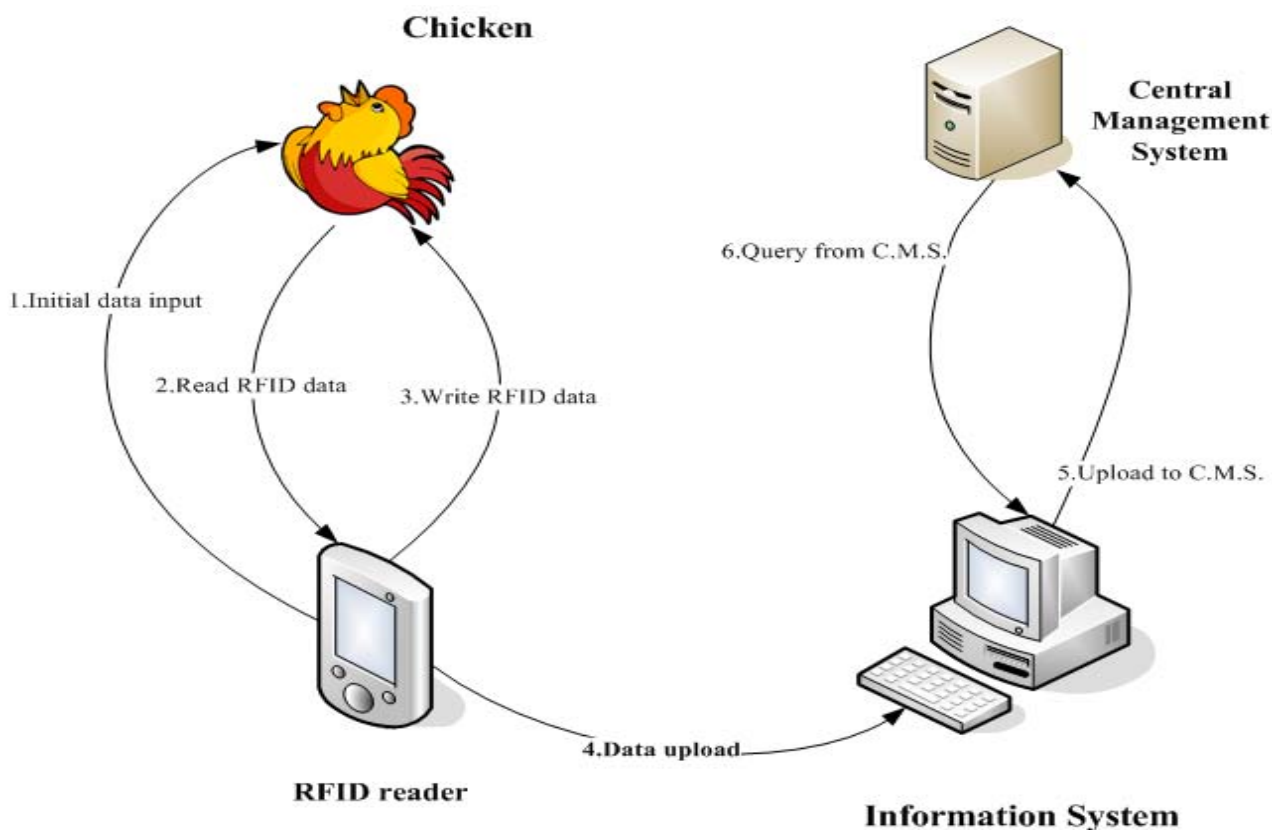


Fig. 4 Trace and Track process

#### 4.3.3 in Processing Stage

First, a quarantine station will check chicken is OK. If chicken have problem, we can use RFID to identify problem chicken. And then, chicken will be bloodletting and cut and slice.

Cut and slice is very important. In the step, we must let sliced department and original chicken relation. After that, we must let package production and sliced department relation.

#### 4.3.4 in Retail Stage

If products have preserving requirement, it must use RFID reader and temperature measure equipment in

#### 4.3.2 in Production Stage

In production stage, we must let chicken have RFID tags first. And then, we can identify chicken by RFID tags, record chicken basic information.

And then, the chicken farm will measure chicken's weight, grow status, record what chicken ate. This information can record by RFID equipment. When chicken is sick, the chicken farm can also record medical treatment information by RFID equipment.

transport to record too high temperature or other situation.

When product selling, consumer can take the product to KIOSK machine to understand the food traceability information of the product.

#### 4.3.5 Trace and track function

To trace and track chicken is most important function of food traceability system. When food safety event occur, we can only input the chicken ID number or product ID number and then system can output the information of food traceability. These information can help government to control food safety event. Show as figure 5.

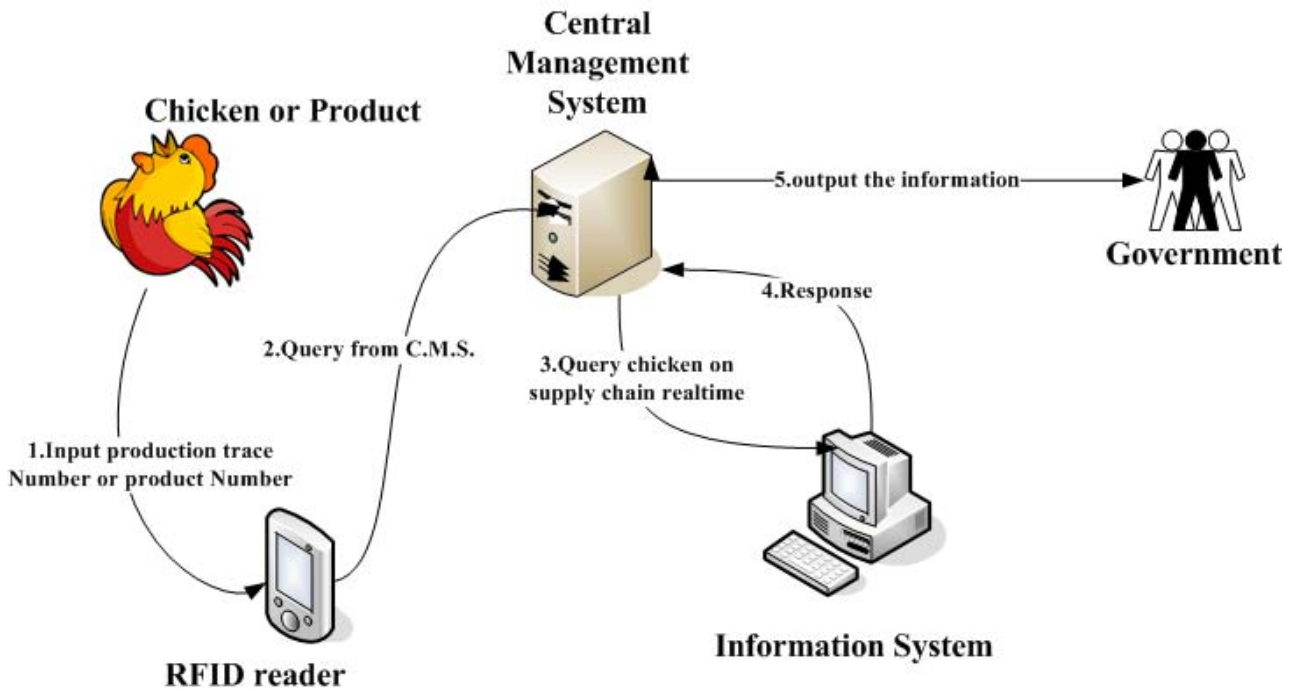


Fig.5 Trace and Track process

## 5 PROTOTYPE IMPLEMENT

### 5.1 System development

Prototype use PDA and Web site. So we use VB 2005 to control RIFD reader and use ASP.Net to control web site. And use MS SQL 2000 as database.

Entire hardware environment shows as figure 6. We use two pc and a PDA. One pc runs food traceability system. The other runs database. PDA control RFID reader.

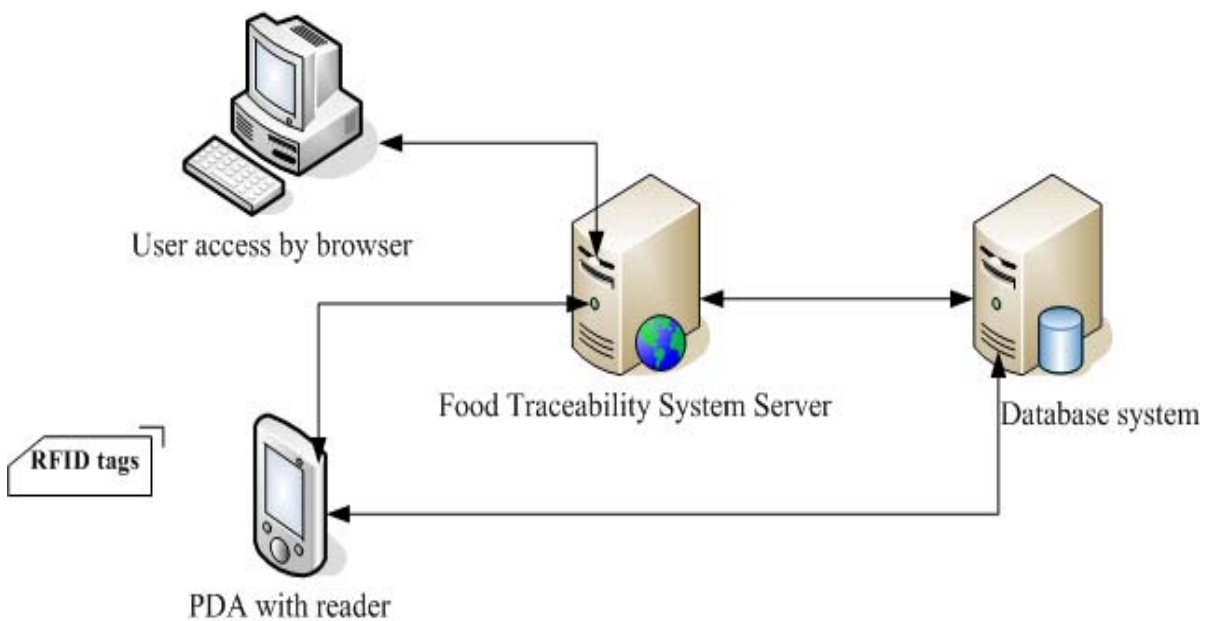


Fig.6 The prototype system environment and architecture

### 5.2 System Function Implement

#### 1. Chicken Breeding Record

After chicken have RFID tags, we can record every event and status of chicken, show as Fig.7.



- Step 1: before an injection, use reader to get chicken id from RFID tags
- Step 2: input breeding information on PDA screen
- Step 3: storage the record



Fig.7 Input Chicken Breeding Record

2. Chicken Living Process

Screen can display chicken that already searched and unsearched chicken can also display on screen to help to catch chicken. Show as figure 8.



Fig. 8 chicken leaving process

System can gather together the information from entire supply chain. Show as figure 9.

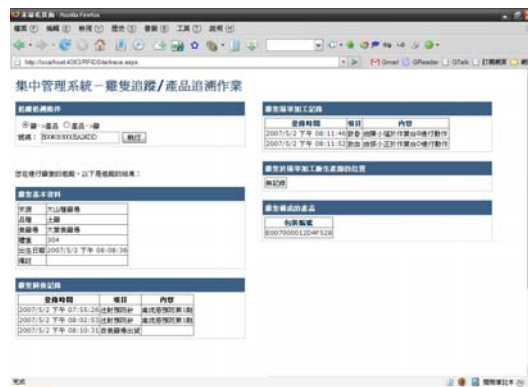


Fig. 9 Chicken trace function

When product have problem, we can use product trace function:

- Step 1: input product ID
- Step 2: system will output product trace information

System will gather together entire supply chain information and analysis. And then output chicken location and chicken basic information.

5.3 Analysis and comparison

1. Benefit analysis

A combine RFID chicken food traceability system can:

- (1) Completely record agricultural product status and information in supply chain: in every stage in supply chain build RFID food traceability system can help to more automatically and detail record agricultural product information
- (2) Make food traceability information more currently: many processes can replace by machine. These let food traceability information more currently.
- (3) Easier to identify, search, trace and track chicken and the information: combining RFID technology can relation between chicken and the information. And can help to trace back and track where food to go. These will help food more safety

2. Compare of the actual and the combine RFID food traceability system

Table 1 compares of the actual and the combine RFID food traceability system

	The actual food traceability system	The combine RFID food traceability system
Scope	Only production stage	Entire supply chain
Way to record	Most use paper to record	Handhold device and combine machine
Ability identify	Identify by batch	Identify by one
Ability of trace and track	Bad	Easier, faster to get trace and track information



Of the actual food traceability system, the chicken farm use paper form to record chicken breeding information easy. Then input to computer. Before chicken leaving, give them barcode to identify.

Of the combine RFID food traceability system, we can record all information in RFID tags and reduce error occurred.

## 6 Conclusion

Food traceability system is system to trace food and information. The combine RFID food traceability system can help to trace problem food and let consumer get food complete information and purchase safety.

Our results are:

- (1) Build a combine RFID food traceability system: the system can record production information more automatically, and expand the scope to entire supply chain.
- (2) The system can complete record every status and data of agricultural product, and let the system be execute more actually.
- (3) Chicken and product can relation closely by RFID. These help food production and identify

### References:

- [1] Norman Azah Anir, Md Nasir Mohd Hairul Nizam and Azmi Masliyah, "RFID Tag for Halal Food Tracking in Malaysia: Users Perceptions and Opportunities", *7th WSEAS International Conference on TELECOMMUNICATIONS and INFORMATICS (TELE-INFO '08)*, 2008
- [2] Francesca Oliva, Roberto Revetria, "A System Dynamic Model To Support Cold Chain Management In Food Supply Chain", *12th WSEAS International Conference on SYSTEMS*, 2008
- [3] Seraj Yousef Abed, "Improving Productivity in Food Processing Industries Using Simulation - A Case Study", *12th WSEAS International Conference on SYSTEMS*, 2008
- [4] Yuh-Wen Chen, Pei-Yu Wu, Chao-Wen Chen and Jih-Bing Sheu, "Empirical Study of a Multi-objective Medical Decision System for Aviation Disaster", *WSEAS TRANSACTIONS on Business and Economics*, Vol.5(4), 2008
- [5] Dulce Antunes, Graca Miguel, Alcinda Neves, "Sustainable Postharvest Handling of Horticultural Products", *WSEAS TRANSACTIONS on ENVIRONMENT and DEVELOPMENT*, Vol. 3 (6), pp111-116, 2007
- [6] Madalin Stefan Vlad, Valentin Sgarciu, "A RFID System Designed for Intelligent Manufacturing Process", *WSEAS TRANSACTIONS on Information Science & Applications*, Vol.4(1), pp36-41, 2007
- [7] Hyung Rim Choi, Nam Kyu Park, Byung Joo Park, Dong Ho Yoo, Hae Kyoung Kwon, Joong Jo Shin. "Design of RFID Technology-Based Automated Gate System in a Container Terminal", *WSEAS TRANSACTIONS on System*, Vol.5(9), pp2155-2163, 2006
- [8] Ruey-Shun Chen, Hsien-Chih Wang and C.C. Chen, "A Dynamic Workflow For Manufacturing Execution System for semiconductor Industry", *WSEAS Transactions on Computers*, Issue 10, Volume 5, pp.245-248, 2006
- [9] Linus U.Opara, "Traceability in agriculture and food supply chain: a review of basic concepts, technological implications, and future prospects", *Food, Agriculture & Environment*, Vol.1 (1), pp101-106, 2003
- [10] Wim Verbeke & Ronald W. Ward, "Consumer interest in information cues denoting quality, traceability and origin:", *Food Quality and Preference*, Vol.17 (6), pp453-467, 2006
- [11] McMeekin, TA, Author, Reprint Author McMeekin T. A. McMeekin, T. A., Baranyi, J, et al., "Information systems in food safety management", *International Journal of Food Microbiology*, Vol.112 (3), pp181-194, 2006
- [12] Yamanouchi, K, Author, Kazuya, Yoshikawa, Y, et al., "Bovine spongiform encephalopathy (BSE) safety measures in Japan", *Journal of Veterinary Medical Science*, Vol.69 (1), 2007
- [13] Gellynck, X, Author, Reprint Author Gellynck Xavier Gellynck, Xavier, Verbeke, W, et al., "Pathways to increase consumer trust in meat as a safe and wholesome food", *Meat Science*, Vol.74 (1), pp161-171, 2006
- [14] Pinto, DB, Castro, I, "The use of TIC's as a managing tool for traceability in the food industry", *Food Research International*, Vol.39 (7), p772-781, 2006
- [15] van der Vorst, JGAJ, "Product traceability in food-supply chains", *Accreditation and Quality Assurance: Journal for Quality, Comparability and Reliability in Chemical Measurement*, Vol.11 (1-2), pp33-37, 2006

- [16] Wang, N, Zhang, NQ, Wang, MH, " Wireless sensors in agriculture and food industry - Recent development and future perspective" , *Computers and Electronics in Agriculture* , Vol.50 (1), pp1-14, 2006
- [17] Schwagele, F, " Traceability from a European perspective" , *Meat Science*, Vol.71 (1) , pp164-173 , 2005
- [18] Smith, GC, Tatum, JD, Belk, KE, et al., " Traceability from a US perspective" , *Meat Science*, Vol.71 (1), pp174-193, 2005