Establishment of Hanwoo (Korean Cattle, *Bos taurus*, Linn.) Traceability System Using Radio Frequency Identification (RF-ID)

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전자식별칩(RF-ID)을 이용한 한우 생산이력추적시스템 도입

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요 약

본 연구는 전자식별칩(RF-ID)를 활용한 생산이력추적 시스템을 도입하여 가축의 생산, 도축, 가공 및 유통단계에 있어 효율성을 증진시키고 소비자들에게 질 좋고 위생적인 한우육을 제공할 수 있도록 발전시키기 위하여 수행하였다. 생산이력추적 시스템의 기본이 되는 새로운 개체식별 바코드, 등록번호 및 농장번호를 고려하여 관리, 자료의 수집과 저장이 용이하도록 설계되었다. 특히 이 시스템은 1) 가축관리를 위하여 표준 전자 식별칩 (RF-ID), 표준이표, 마이크로칩 그리고 이표식별 장비를 제공하고, 2) 한우육 상표 보장을 통해 소비자를 보호하고 3) 품질 좋은 한우육을 생산하는 농가에게 인센티브를 제공하고 4) 국가적 개체관리에 있어 획일한 시스템을 제공하는데 그 목적이 있다. 몇몇 농가조합에 적용한 결과와 모 백화점에서 실시한 시범사업 결과 RF-ID 시스템 사용에 대한 가능성을 볼 수 있었다.

(**Key words :** Traceability, RF-ID, Hanwoo (Korean Beef Cattle))

Ⅰ. INTRODUCTION

Quality assurance for meat products is increasing due to the global scare on bovine spongiform encephalopathy (BSE). Consumers are worried about meat quality, its origin and integrity all through the food chain until consumption. Not to withstand the increased quality of life this placed paramount importance to food safety to guarantee healthy body and population.

In Korea, Hanwoo (Korean cattle) has been the major breed supplying about 69% of beef production and has been the major source of revenue for beef cattle farmers (Statistical Yearbook for Animal Researches in Korea, 2003). The production system of Hanwoo meat, passes several independent steps such as raising, slaughter, processing and finally marketing or distribution. However, ambiguous processing and

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post processing channels is prevalent. At present, the price of Hanwoo beef is five times higher than imported beef and beef from male Holstein Freisian and even culls from dairy. Moreover, the consumers still prefer Hanwoo despite its prohibitive price. However, they should be assured that the label on the meat product is the real Hanwoo beef. At present, there is no technological system in place that would assure consumers of the integrity of the meat product they are buying.

The information at each stage of the production system must be integrated for traceability. Traceability is viewed as an ability by which one may track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales or internally in one of the steps in the chain (Moe, 1998).

Consequently, an integrated measurement and sensor equipment using radio frequency technology identification (RF-ID) system is required for raising, slaughtering, processing and distribution steps and the system using RF equipment is also demanded for livestock management and information tracing at every stage of raising, slaughter, processing and distribution. Therefore, RF-ID was developed to integrate the information automatically (Fig. 1). All information at each stage was stored in central database where consumers can validate upon the purchase of meat thereby assuring product quality and integrity, hence this research was conducted.

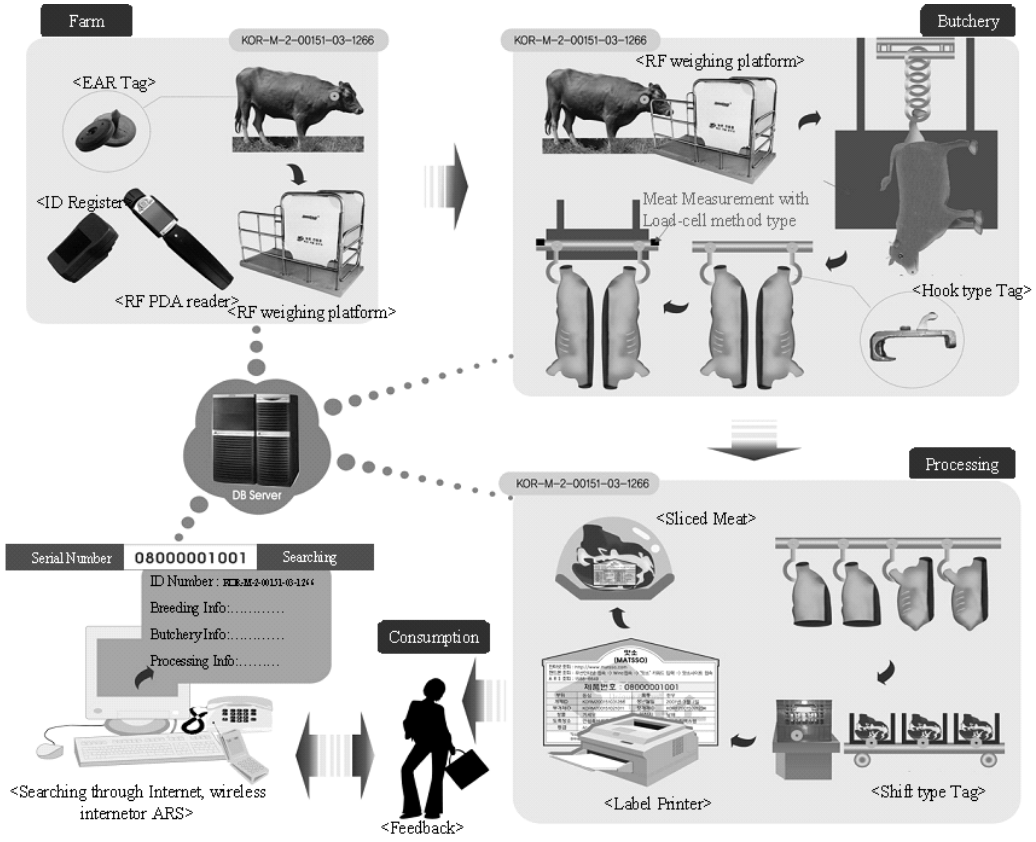

Fig. 1. System overview for Hanwoo traceability.

Ⅱ. MATERIALS AND METHODS

1. New Animal Identification System

A prerequisite for effective traceability is a unique and secure identification system that would be tamper proof and directly linked to a database.

Among the existing identification systems the registration number by breeding stock registration program and bar-code number by national cattle identification program are still available and fortunately the number of digits used for these program are less than 11. These identification systems can be converted into identification format recommended by International Committee for Animal Recording (ICAR) if some classification code is added. Total 16 digits identification code structure was proposed (Fig. 2). For animals born in Korea, after the ISO3166, three digits alphabetic country code (KOR) followed by 1 digit sex code (M/F), 1 digit classification code was introduced to indicate which identification program the following 11 digits number came from. Classification code 0, 1, and 2 meant that following 11 digits number came from national cattle identification program, breeding stock registration program and owner issuing number (for future need for farm registration), respectively. It was easy to implement this new identification system but some refinements have to be done in converting existing IDs to the new one. All 12 digits wereused for foreign animals so that the identification system conforms with the standard set by ICAR.

2. Development of Radio Frequency Identification (RD-ID) Tag

Bar-code printed on normal ear tag would become erroneous with bar-code reader because of contamination on bar-code area, therefore the animal ID has to be collected manually at each stage of the post production process. This manual collection was the source of errors in the traceability system. To prevent this error and offer convenience to handlers the cattle RF-ID (ear-tag type) was developed (Fig. 3). Commercial ear tag or RF-ID can hold only animal ID and online data access was necessary for further information, but if ear tag can hold more information in addition to ID, it would be more

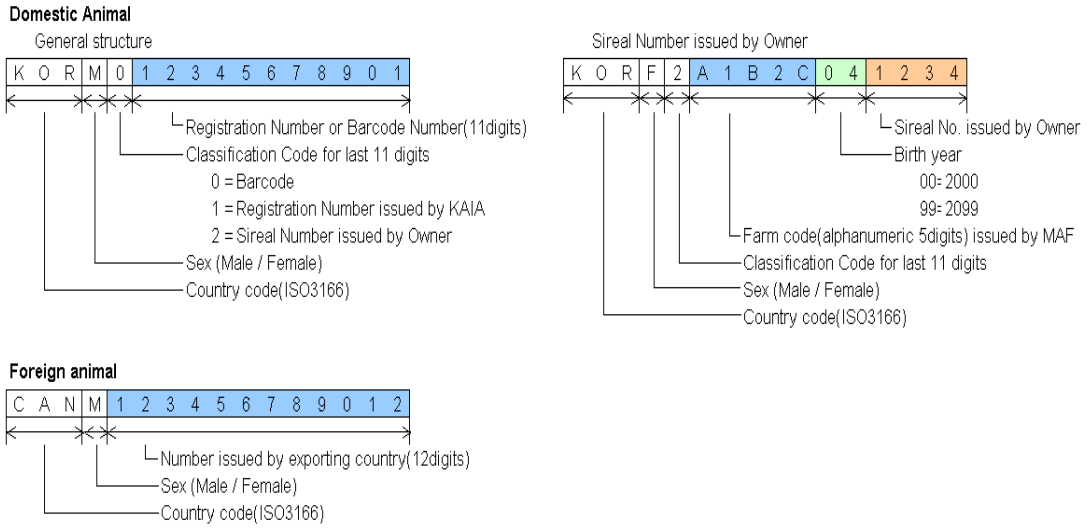

Fig. 2. Newly developed cattle identification code structure with 16 digit.

Fig. 3. RF-ID(Ear Tag).

convenient to access such information by reading the tag only. When the field data were not securely transferred to database, it could be used to store recent data so that unsynchronised data can be checked and transferred to database.

A read/writable RF-ID working at passive mode with 2048 bits memory was developed. It was designed as a male type that can be used with normal existing female ear tag. Therefore, farmers can recognize the identification number without the RF-terminal. The memory was partitioned to 5 pages: (1) Security page holding factory set unique identification number to prevent illegal duplication and reserved fields for ISO11784/5 standard format, (2) Identification page in which animal ID, parents' ID, birth day, farm and cooperative code, (3) Medical treatment page holding a few latest treatments with queue data structure, (4) Vaccine history page storing a few latest vaccination history with queue data structure, (5) Reserved page for future needs (such as GPS and DNA marker information).

During the programming of the ID code by the tag manufacturer a consistency check number is calculated from the die serial number and the ID code. This check number is stored in the 24 trailer bits of the ISO 11785 protocol. Fig. 4 shows PDA type RF-terminal, and using this terminal informations are reading to D/B.

3. Hanwoo Identification and Information System (HIIS)

The application of radio frequency technology to the individual livestock identification system so that livestock's health, disease history, age, and other information can be systematically managed by internet home page (Fig. 5 : Hanwoo Identification and Information System). The information of RF-terminal or RF-tag can be uploaded or downloaded through this Home-page and user types were devided into 3 : Supervisor, Farmer's cooperative and Farmer each had different permission for access.

Fig. 4. RF-Terminal and PDA Screens.

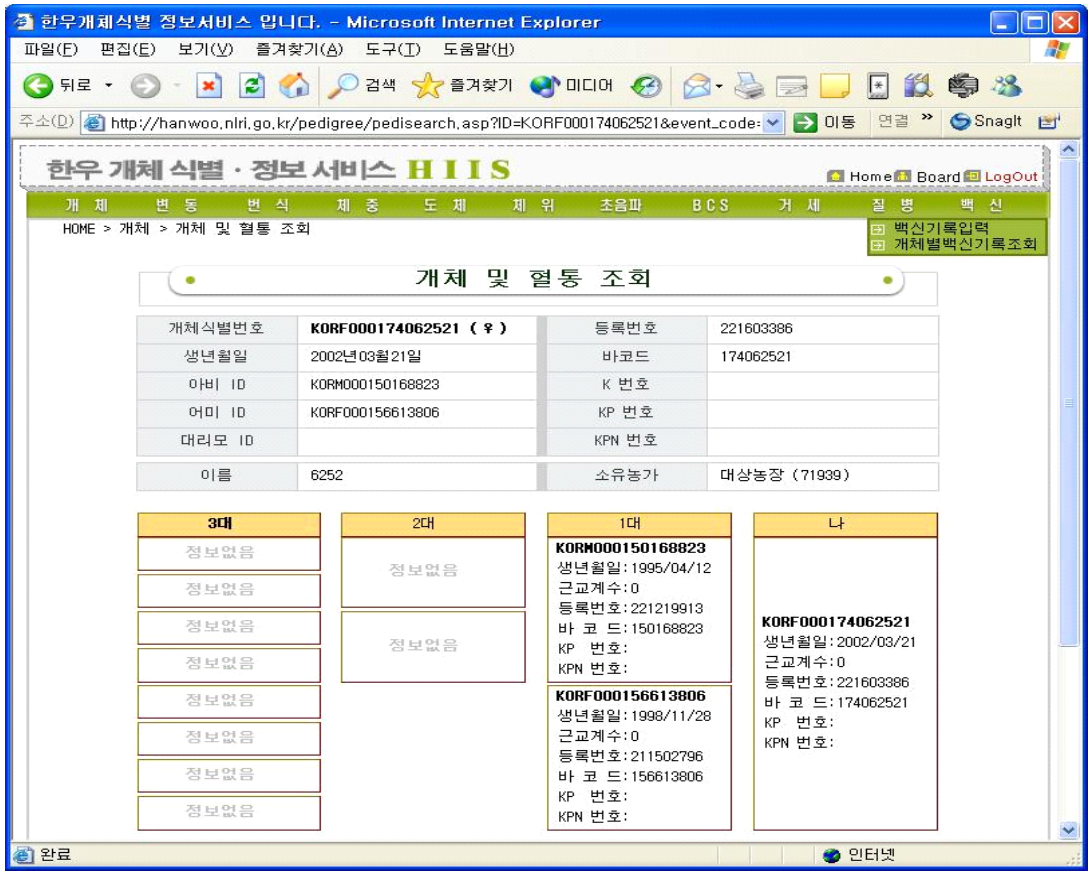

Fig. 5. Data base systems for Hanwoo identification and information (HIIS : Hanwoo Identification and Information System).

4. Tracing at slaughterhouse and processing plant

When the RF-ID tagged animal passed through the automatic scale to measure liveweight, its identification was read and recorded with its liveweight. The identified animal ID was transferred to the hanger (hook) and maintained through slaughter house up to packaging house and then printed on the label for packaged meat. Packaging information with animal ID at the packaging house was transferred to product & circulation database so that the product can be handled by database. Unique serial number (managed read-only RF chip) was assigned to each packaged meat with animal ID to guarantee product quality and integrity (Fig. 6 & 7).

5. Information transparency for consumers

One of the main purpose of traceability was to give transparent information to the consumer. Consumers can easily query about information of labeled packed meat. For this reason, Automatic Response System (ARS system) and Internet home page (Fig. 8) was developed. In the meat shop or at home consumers just input the identification number and the consumers can read and trace the history of the meat pertaining to the farm the animal was raised, where it was butchered and the processing house it was packed. Consumers' opinion of the meat can then be feedback to

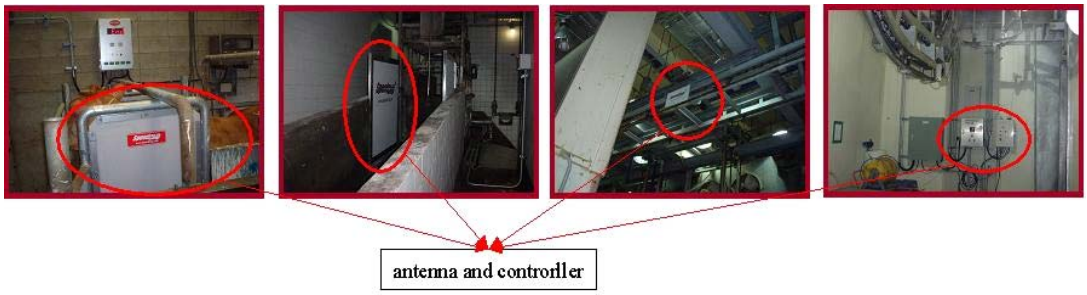

Fig. 6. Antenna and controller for traceability at slaughterhouse.

Fig. 7. Antenna and controller for traceability at processing plants.

Fig. 8. Information query at retail shop.

farmers, slaughterhouses, processing plants and retail shops.

Ⅲ. RESULT AND DISCUSSION

In this research, the Hanwoo traceability system using RF-ID and male type R/W RF-ID and facilities were developed. The carcass tracing and management system for slaughter house using RF and IT technology was developed. These systems have been running since July 2003 and several farmers'cooperatives and Lotte Department Store have been involved in this research. According to the Lotte Department Store, sales performance was not affected compared with other department stores during the serious beef sales depression period caused by BSE.

Technologies such as RF-ID use radio signals and integrated into a prototype recording system. As reported by Schwagele (2005) product identiers (tags) are not currently in widespread use, and are expensive compared to bar-code. Matrix code are 2D, but information is stored by blanking out areas of a defined array rather than in bars. These codes are generally only used in specialist applications, including the marking of very small components. Scanners can operate with a 90% success rate where contamination levels are kept below 10% and bar codes are kept clean and undamaged. The performance of the laser scanner is such that any level of contamination will substantially reduce read success rate. Studies undertaken by Watts, Miller and Godwin (2003) indicate that the RF-id achieved a successful reads over 98% of the time unprotected and reused tags.

According to the recent research, this system can be combined with biotechnology like DNA marker (Arana et al., 2002) to make it a perfect system. Traceability system is based on the trust of the consumer thereby ensuring integrity of the product. It is the government's role to assure that systems manager provide the needed information in using such technology.

In Korea, a number of farmers still regard the traceability system as a marketing tool, and information campaign has to be launched to guarantee the success of traceability. However, there are still many problems to be solved such as international standard code for animal identification, disease, vaccine, sex, breed code, product code, to make it an international traceability system.

Ⅳ. CONCLUSION

The use of RF-ID for traceability system of Hanwoo was feasible as demonstrated by some users. In order for the technology to have wide application to the industry for global competitiveness, there would be some modifications to conform to global nomenclatures.

Ⅴ. ABSTRACT

This study was conducted to develop a traceability system for systematic animal identification to increase efficiency of animal production, post production and processing to ensure that quality and sanitary meat products reach the consumers of the entire country. The new animal identification traceability system was designed for easy management, data collection and storage considering bar code, registration number and farm number.

Specifically the system aimed 1) To provide standard radio frequency technology identification (RF-ID) for livestock management, standard of ear tag, microchip and ear tag identification equipment, 2) To guarantee meat product label thereby safeguarding the consumers 3) To give incentives to farmers for producing quality meat products and 4) To provide unified system for national livestock management.

Results of the research which started in July 2003 which was used by several farmers' cooperatives and Department Store revealed the feasibility of using the RF-ID system although much will be done to conform to global nomenclatures.

Ⅵ. ACKNOWLEDGEMENT

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Ⅶ. REFERENCES

1. Arana, A., Soret, B., Lasa, I. and Alfonso, L. 2002. Meat traceability using DNA markers: application to the beef industry. Meat Science 61(2002) 367-373.
2. ICAR. 2001. Interbull guidelines for national & international genetic evaluation systems in dairy cattle with focus on production traits. IBB28.
3. ISO. 1996. Radio-frequency identification of animals-Code structure. ISO11784:1996(E).
4. Jansen-Vullers, M. H., Dorp, C. A. van and Beulens, A. J. M. 2003. Managing traceability information in manufacture. International Journal of Information Management 23(2003) 395-413.
5. Latouche, K., Rainelli, P. and Vermersch, D. 1998. Food safety issues and the BSE scare: some lessons from the French case. Food Policy. Vol 23(5):347-356.
6. McGrann, J. and Wiseman, H. 2001. Animal traceability across national frontiers in the European Union. Rev. Sci. tech. Off. Int. Epiz., 20(2):406-412.

7. Moe, T. 1998. Perspectives on traceability in food manufacture. Food and Science Technology. 1998(9):211-214.
8. National Identification Development Team, 2003. Protecting American animal agriculture. http://www.usaip.info.
9. Philips Semiconductors. 2003. HITAG S data sheet. http://www.semiconductors.philips.com.
10. RFIDNEWS. 2001. Exemptions to ISO11784 and ISO11785 currently under review in WG3. http://www.rfidnews.com
11. Schwagele, F. 2005. Traceability from a European perspective. Meat Sci. 71:164-173.
12. Statistical Yearbook for Animal Researches in Korea. 2003. Animal Genetic and Evaluation Laboratory, National Livestock Research Institute, Rural Development Administration, Rep. of Korea
13. Watts, A. J., Miller, P. C. H. and Godwin, R. J. 2003. Automatically recording sprayer inputs to improve traceability and control. In Proceedings of the 2003 BCPC Crop Science and Technology Conference (pp. 323-328). Glasgow: BCPC publications UK.

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