

A Survey of Livestock Identification Systems

MARIA VLAD, ROXANA ANDREEA PARVULET, MADALIN STEFAN VLAD

Faculty of Automatic Control and Computers,
“Politehnica” University of Bucharest,
313, Spaiul Independentei, Sector 6, Bucharest,
ROMANIA

E-mail: maria@ac.pub.ro, roxana.parvulet@gmail.com, madalinv@ac.pub.ro

CARMEN ANA PIVODA

Institutul de Cercetare-Dezvoltare pentru Creșterea
Ovinelor și Caprinelor Palas,
248, I.C. Bratianu Str, Constanta,
ROMANIA

E-mail: icdoc@canals.ro

Abstract: - Animal identification by means of marking animals' bodies was first recorded 3,800 years ago, in the Code of Hammurabi, and throughout history, valuable animals such as horses have been identified to prevent thievery all over the world. Today, the reasons for identification of livestock include production management, control of disease outbreaks, establishment of ownership, requirements for export, and consumer demands. In the current global livestock environment, awareness, fear and recognition of animal borne diseases such as ‘mad cow disease’ have driven calls for reliable and effective systems for individual identification and tracking of livestock throughout the animals' entire lifecycle. Such systems empower authorities with rapid and precise information (such as the animals' farm of origin, cows it has been in contact with etc.), aiding them to take prompt and direct action to reduce the possibility of a disease outbreak. Radio Frequency Identification (RFID) is becoming globally recognized as the technology to implement animal identification, and has become a mandatory form of livestock management in many countries (such as Canada and Australia), as well as in the European Union, while other countries have begun trials of the technology (such as the United States of America).

Key-Words: - Livestock, traceability, identification, RFID, tag, wearable sensors

1 Introduction

Recent news stories have focused on tracking cattle from birth to finished product to control the risk of Mad Cow Disease, on tracking food shipments to reduce the risk of tampering, and on traceability systems to detail country of origin, animal welfare and genetic composition. Heightened awareness of food-related safety issues among today's food consumers, coupled with a more educated public, is driving the demand for more information about the vertical food supply chain and specifically, the origin and handling of the basic commodities and food products generated and consumed throughout the world. Recent animal health and foodborne illness scares in all parts of the globe are creating a demand for source verification, food safety and supply chain identification of food products [1].

Private-sector food firms are developing, implementing and maintaining substantial traceability systems designed to: (a) improve food supply management, (b) facilitate traceback for food safety and quality, and (c) differentiate and market foods with subtle or undetectable quality attributes.

2 Problem Formulation

The World Organization for Animal Health (OIE) defines animal identification as “the combination and linking of the identification and registration of an animal individually, with a unique identifier, or collectively by its epidemiological unit or group, with a unique group identifier” [2].

The OIE defines animal traceability as “the ability to follow an animal or group of animals during all stages of life” [2]; the OIE defines an

animal identification system as “the inclusion and linking of components such as identification of establishments/owners, the person(s) responsible for the animals, movements and other records with animal identification” [2].

Currently, many different types of animal identification technologies exist that may implement mechanical (e.g., tagging, branding, and tattooing), electronic (e.g., ear tags, ruminal boluses, and injectable transponders), and biometric (e.g., nose prints, DNA profiling, iris scanning, and retinal scanning) methods to identify and trace animals throughout their lives [3].

Since discovery of a cow with Bovine Spongiform Encephalitis (BSE) in December of 2003, animal identification and traceability programs have become very important. Across the globe, countries with advanced livestock industries have implemented animal identification programs that allow for the traceability of their commercial animal herds. Generally, nations adopted these programs to accommodate concerns relating to the safety of the food supply that stem from the outbreaks of BSE, commonly known as mad cow disease, in Great Britain, Canada, Japan and the United States. [4]

While many of these countries have not experienced cases of BSE within their own borders, the governments have decided to implement these programs to capture export opportunities and to restore faith in their domestic beef supply. As with many international issues that are addressed by the countries individually instead of on a global basis, the animal identification programs and their application varies widely between nations.

This article discusses the programs that have been implemented by certain countries. Within this discussion, issues are addressed when information was available, including a brief history of the program, its stated purpose, how the program addresses producer liability and confidentiality, and who bears the cost burden of the program’s implementation.

2.1 Where did it all start?

The public announcement in 1996 of a likely association between new-variant Creutzfeldt - Jakob disease (vCJD) in humans and BSE had a significant negative impact on consumer confidence in beef. In response, the Council of the EU introduced regulations concerning the identification and registration of bovine animals and the labeling of beef products. This was followed in 2000 by Regulation (EC) No 1760/00 which set out the

elements of the European cattle identification and registration system[5].

The key requirements of Regulation (EC) No 1760/00 are:

- Every bovine animal must be registered and individually identified using one ear tag in each ear.
- Individual paper passports are required for all bovine animals and passports must accompany the animals when they move.
- The governments of the Member States must be informed of each animal movement.
- Member States must maintain a computerized cattle tracing database
- Animal keepers must maintain up-to-date registers of on-farm bovine animals.
- Supporting amendments and regulations concerning implementation have since followed.

The EU has introduced separate regulations requiring electronic individual identification for pets, horses, sheep and goats and is actively exploring the introduction of electronic identification for cattle within the EU.

3 Problem Solution

The purpose of the National Animal Identification and Tracing System is to safeguard the country’s brand and farmers’ income by protecting market access for the country’s animal products through enhancing regulatory and consumer confidence in the country’s ability to manage biosecurity and food safety risks.

NLITS is a system to enable the rapid and accurate tracing of animals from birth to slaughter, and to provide key information related to these animals and the properties on which they have resided.

A growing number of countries around the world have implemented systems for providing or improving existing livestock identification and tracing. Many of these systems are meeting similar objectives but are doing so with differing specifications and ways of operating. The purposes of this document are to:

1. Describe the most important attributes of a selected number of these systems.
2. Highlight key strengths or shortcomings associated with each system.
3. Make recommendations for how NLITS can make best use of this information in the design of a comprehensive identification and tracing system for cattle.

This review is not exhaustive, in that not every aspect of every relevant system in the world is discussed. The countries that have been selected for review are either recognized as being at the forefront of introducing these types of systems, have particularly well characterized systems, or are believed to be representative of the best systems that are in place in their particular geographic region.

3.1. Great Britain

A computerized Cattle Tracing System (CTS) was launched in Great Britain in 1998 as part of further efforts to retain consumer confidence in beef. The system was introduced as part of the Government's strategy for eradicating bovine spongiform encephalopathy (BSE) and for lifting the European Community ban on exports. All bovine animals are required to be identified with a primary and secondary ear tag within 20 days of birth. Secondary tags may include radio frequency identification (RFID) chips at the owner's discretion. Cattle registration involves applying for a paper passport within seven days of tagging. Cattle are not permitted to leave their current location without a paper passport. Keepers of cattle must notify CTS within three days of a movement and within seven days of a death – many of these notifications are performed using paper forms [6].

All bovine animals are required to be identified with a primary and secondary ear tag within 20 days of birth and in the case of dairy animals, primary tags must be applied within 36 hours. Secondary tags may include RFID chips at the owner's discretion[16]. Keepers are only permitted to maintain one year's worth of tags at any one time and must order ear tags from government approved manufacturers. These manufacturers notify the CTS computerized Ear Tag Allocation System (ETAS) and are then allocated sequential numbers for each tag, incorporating the farmer's individual herd mark and unique farm address code (CPH). This process aims to ensure that duplicate tags cannot be produced.

Cattle are registered through the process of applying for a paper passport, which must be made within seven days of tagging.

Cattle are not permitted to leave their current location without a paper passport, which makes moving unregistered calves illegal. Keepers of cattle are obliged to notify CTS within three days of a movement and within seven days of a death. Currently, keepers are only required to record half of each movement, i.e. the fact that an animal has moved either off of or onto their premises, without

the requirement to specify the destination or source of the animal(s), respectively. This is achieved either by completing and submitting paper movement cards or by using CTS Online, which provides farmers with the ability to conduct many of the required functions, including birth and death registrations and movement reporting, using the internet.

In addition, animal keepers are required to keep an on-farm record of all animals and their movements.

3.1.1 Main advantages and shortcomings associated with the system

The partial reliance upon paper-based recording results in a large number of errors, omissions and anomalies being introduced into the centralized database. Other evidence suggests that the processes associated with the allocation and use of the unique property identifier (CPH number) also contribute significantly to problems of data quality.

Issues associated with the prioritization of data reconciliation tasks following the rollout of CTS led to a build-up of erroneous movement records within the system.

Both the NAO and Defra reports also highlight that the requirement for senders and recipients of animals to record only half of the movement results in many movements which cannot be adequately paired, with significant effects on data quality.

The system is of limited use for fast moving diseases. The turnaround time between completion of paper records in the field, postage, data input and data extraction is such that interrogating CTS during an incursion of a fast moving disease is not useful.

The system is expensive. The CTS is expensive to run owing to the level of inaccuracy and continued use of non-electronic methods of information transmission.

3.2 Australia

The driver behind the development of the National Livestock Identification System (NLIS) has been the need to facilitate and ensure export access to European markets. NLIS became operational in 2000 and is run by Meat and Livestock Australia on behalf of SAFEMEAT, a joint industry and government partnership initiative. Recording of cattle movements became mandatory in all states and territories by 1 July 2006.

NLIS rules require that all cattle must be tagged with an approved low-frequency RFID device prior to moving from the property of birth. The unique tag number incorporates the Property Identification

Code (PIC) that links the tag to the property for which it was purchased. When cattle are moved, the recipient is required to notify the NLIS database of the movement, including the source property PIC, thereby allowing whole-of-life traceability to be established for each animal [6].

NLIS rules require that all cattle must be tagged with an approved device (ear tag or rumen bolus) prior to moving from the property of birth, otherwise there is no requirement to apply the device. NLIS devices incorporate low-frequency (LF) radio frequency identification (RFID) chips enabling them to be read electronically.[7]

Each device is allocated a unique number, encoded in the RFID chip and repeated on the surface of the device as a visible identifier, hence for ear tags the number can be read both visually and electronically. Rumen boluses cannot be read visually and are unpopular and less commonly used as approved devices than ear tags. There is no requirement to inform the NLIS database that devices have been applied to an animal.

The unique tag number incorporates the Property Identification Code (PIC), which links the tag to the property for which it was purchased.

When animals are moved, the recipient is required to notify the NLIS database of the movement, including the source property, identified by the PIC. In the case of animals purchased at sale yards, the sale yard is required to notify NLIS rather than the recipient. The majority of movements therefore, involve either sale yards or slaughterhouses performing the required reporting. The different Australian states and territories have differing requirements in terms of the timeframes within which various types of notification to the system are required[8].

Parties can interact with the system using the online NLIS database into which movement details can be manually entered. Alternatively, information captured by electronically scanning the RFID devices of the moving animals can be fed directly to the NLIS database, considerably reducing the administrative burden and errors associated with movement recording – this is predominantly how sale yards and abattoirs interact with NLIS.

Not all recipients of animals have the ability to make use of the online NLIS database, and for this reason NLIS also accepts notifications on paper forms submitted by fax. A further alternative is to electronically scan the devices of animals and to transfer this information from the reader to a Bluetooth enabled mobile telephone, which in turn can send the information direct to NLIS. Any of the

functions above may be performed on behalf of the animal keeper by an approved agent.

There is no requirement to report the deaths of tagged animals to NLIS unless the death occurs at a sale yard or slaughterhouse or in transit between either of these types of premises.

3.2.1 Main advantages and shortcomings associated with the system

A number of exercises and independent reviews into the performance of the NLIS system have been conducted, including the Cowcatcher exercises, a review of the NLIS database and a review of the operation of NLIS conducted in 2006. These reports, together with personal communications have contributed to the observations set out below.

The administrative burden is relatively low.

The fact that animals do not have to be registered and only recipients are required to record movements means that the system requires very little engagement from many animal keepers. This is particularly the case for keepers who have chosen to invest in and use electronic data capture technology.

The NLIS system accurately captures and processes information supplied to it. An audit of the NLIS database conducted in 2004 found that the system accurately captures and processes information that is supplied to it.

RFID technology enables accurate and rapid data capture for use in emergency situations. The Cowcatcher exercises demonstrated that the system could meet rigorous, defined performance standards in a simulated emergency exercise, such as determining the location(s) where a specified animal was resident during the previous 30 days within 24 hours. This level of performance is not practically achievable without electronic recording and submission of data enabled by RFID or technology with equivalent functionality.

Teething problems were associated with the introduction of RFID enabling technology, particularly with panel readers. Over time, these issues were resolved and the read failure rate of RFID ear tags is currently estimated to be below 1 percent – this is considered to be acceptable at an operational level in Australia.

3.3 United States of America

The National Animal Identification System (NAIS) is administered by Veterinary Services, which is a division of the Animal and Plant Health Inspection Service, which, in turn, is an agency of the United States Department of Agriculture (USDA). The

NAIS system has been structured as a Federal-State-industry partnership, with responsibility for implementation of NAIS being shared amongst industry groups, private companies, State and Tribal governments, and USDA[9].

The NAIS program is moving through an initial implementation period where participation is currently voluntary, with full program implementation to be under a phased-in plan. Producers opting for registration of their animals under NAIS will have their animals identified either individually with a unique Animal Identification Number; or, if their animals are managed and moved through the production chain as a group, their animals will be identified with a Group/Lot Identification Number[11].

The NAIS guiding principles aim to progress the development of an animal identification system that:

- is uniform in terms of NAIS being based on national data standards;
- is flexible in terms of allowing producers to use NAIS in coordination with production management systems and marketing incentives;
- is inclusive in terms of NAIS being developed for animals that will benefit from rapid tracing in the event of a disease concern;
- is co-operative in terms of both public and private funding being required for NAIS to become fully operational; and has secured, reliable, confidential information in terms of what is essential and sufficient for animal identification and tracing.

NAIS will be established gradually through the integration of the following three components.

Animal Identification – individual or group identification that remains with the animal for its lifetime

Producers opting for registration of their animals under NAIS will have their animals identified either individually with a unique Animal Identification Number (AIN); or, if their animals are managed and moved through the production chain as a group, their animals will be identified with a Group/Lot

3.3.1 Main advantages and shortcomings associated with the system

Multispecies approach adopted from the outset

Unlike similar systems in other countries, NAIS has been developed with the stated intention of covering the majority of production livestock species – poultry, pigs, sheep, cattle and horses. From a purely epidemiological perspective, this is encouraging although it has contributed to

difficulties with respect to implementation and communication.

A voluntary system may lead to inconsistencies at a national level. The current voluntary status of NAIS allows USDA, producers, and industry to work out the system details of the NAIS program and to measure ongoing progress. However, States may choose to individually implement components of NAIS at the State level and any resulting inconsistencies between States may potentially erode stakeholder confidence in the effectiveness of NAIS and promote concerns about equitable sharing of responsibilities.

3.4 European Union's Solution

At the European level, the European Committee for Standardization promotes the development of international standards for identification technology and automatic data collection.

The European Telecommunications Standards Institute has developed specific standards for RFID which operate at Ultra High Frequencies, as well as generic standards for the short range devices, applicable to equipment operating in areas of low (LF) and high (HF) frequency and with microwaves which can be used for RFID.

The Commission appeals to the European standardization bodies so that, in cooperation with forums and consortia of the specialized industry, to ensure that European and international standards are in accordance with the European requirements, especially regarding issues such as privacy, security, property rights (intellectual authority), to identify standardization gaps, and to provide a proper framework for the development of future RFID standards.

The lack of standardization and harmonization of frequency allocation is an obstacle to the development of this industry. ANSI and ISO have worked together to develop RFID standards and have adopted such standards for applications such as animal tracking (ISO 11784 and 11785) and the tracking of goods in a supply chain (ISO 18000 - 3 and ISO 18000-6).

4 Conclusion

A common theme that runs through each of these programs is the primary objective to preserve the safety and integrity of a meat supply that is part of a far-reaching marketplace. The meat and livestock industry are requiring more information to insure that a product is supplied that meets consumers' demands. Mechanisms and systems for

identification vary greatly between the countries, showing that there is more than one possible means of achieving animal identification goals. Regardless of whether the stated objective of the animal identification program is to increase consumer confidence through greater information, or gain greater access to international markets, such as with the Australian program, the ultimate goal of a safe and wholesome meat supply behind the various approaches to animal identification rings true across international borders.

References:

[1] M. B. Bowling, D. L. Pendell, D. L. Morris, Y. Yoon, K. Katoh, K. E. Belk, G. C. Smith, Identification and Traceability of Cattle in Selected Countries Outside of North America, *Professional Animal Scientist*, No. 24, 2008, pp. 287-294.

[2] World Organization for Animal Health (OIE), General Definitions, *Terrestrial Animal Health Code*, Article 1.1.1.1., 2006.

[3] J. Marchant, Secure Animal Identification and Source Verification", *JM Communications*, 2002.

[4] E. Pendergrass, A Comparison of International Animal Identification Programs, *The National Agricultural Law Center*, 2007.

[5] I. Cuiñas, L. Catarinucci, M. Trebar, "RFID from Farm to Fork: traceability along the complete food chain", *Progress In Electromagnetic Research Symposium*, 2011.

[6] The Ministry of Agriculture and Forestry New Zealand, Review of Selected Cattle Identification and Tracing Systems Worldwide, *MAF Biosecurity New Zealand Information Paper*, 2009.

[7] G.C. Smith, Saunders L., International Identification, Traceability and Verification: The key drivers and the impact on the global food industry, *International Livestock Congress*, 2005.

[8] G.S. Becker. Animal identification and meat traceability, *CRS Report for Congress*, 2007.

[9] R. Schnepf, Animal Identification: Overview and Issues, *CRS Report for Congress*, 2009.

Table 1: Animal Identification and Tracing Systems – Summary by Country

ATTRIBUTE	Great Britain	Australia	USA
System name	CTS (Cattle Tracing System)	NLIS (National Livestock Identification System)	NAIS (National Animal Identification System)
Organisation (administrator)	British Cattle Movement Service (BCMS part of Defra)	Meat & Livestock Australia	Veterinary Services (VS) – a division of the Animal & Plant Health Inspection Service (APHIS), US Dept of Agriculture (USDA).
Date commenced	1998	2002	Conception in 2002 and framework for implementation in 2004
Drivers for Establishment	BSE control and restore consumer confidence in beef	Residue tracing, biosecurity, enhance market access	Potential rise of an outbreak of a foreign or domestic animal disease.
Cattle Individual ID	Yes	Yes	Yes
Type of identifier (ear unless specified)	Visual; RFID	RFID	Pilot studies confirm RFID to be technology to deliver NAIS requirements; RFID optional.
Animal Registration required	Yes	Yes	Yes – currently voluntary
Animal Registration (when)	with 30 days of birth	When moved	Yes – currently voluntary
Movements recorded electronically	Paper telephone and electronic data submission	Yes	Yes
Database management centralized	Yes	Yes	Yes
Current status	RFID tagging due to EU regulation	Real time recording, extending attributes	As of 10/8/08, approximately 33.2% of livestock premises registered under NAIS.