Application of Radio Frequency Identification (RFID) Technology in Dairy Herd Management

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Abstract

Animal identification is a process to identify and track animals. It is done for a variety of reasons including verification of ownership, biosecurity control, record keeping, efficient farm management, registration, insurance and presentation of theft of animals. Identification of animal in livestock enterprise is of immense importance to draw attention regarding their status in production as well as performance. Thus, proper identification of animal is very important for understanding the need of record keeping and will provide a base to improve the management of herd. The use of RFID for automation will also aid to minimize labour input, thus allowing each farmer to cater for more cows, or enabling farmers to have more time to spend on other activities – either way, maximizing results from their input.

Keywords: RFID, Dairy Herd management

Introduction

In India now dairy is not a subsidiary occupation of farmer rather than it has taken the shape of industry. The livestock sector achieve on average growth rate of 4.8% during the eleventh five-year plan. In India, the growth in milk production is due to the crossbred cattle which contribute about 20% of the total raw milk. Dairy farmers are maintaining large number of animals and many large commercial dairy farms are being established. For better efficiency of the dairy farms identification of animals and at the same time maintain production and reproduction records of these huge number of animals is necessary. Therefore, it becomes essential to have an accurate, convenient, and rapid method of identifying cattle identities in order to reduce error caused by visual identification, mistakes in handwriting and incorrect computer input of cattle identification number to ensure that the collected records are credible and accurate.
Application of electronic animal identification technologies is a growing trend in the livestock industry and plays an important role in the future prospects. There is still a gap regarding electronic animal identification for the purposes of improving total farm management practices, especially on dairy farms in India (Trevarthen, 2007).

Radio frequency identification (RFID) is one of the advanced and efficient identification technologies in recent years and is widely adopted by various dairy industries. RFID can improve the automatic data collection by taking advantage of electronic transmission technology that provides quick access to dairy herd information and utilized for improving the feeding and managemental practices (Prasad et al., 2013).

Components of RFID

RFID consist of three components and they are as follows: (1) Transponder (2) Trans-receiver (3) Herdsman’s software (Data accumulator) (McAllister et al., 2000).

1. **Transponder**: Transponder is implanted inside the body. Transponder is having silicon chip and an antenna. Silicon chip having 12 digits for identification of animal and 3 digits, for country code. There are two types of RFID. (1) Active device (2) Passive device.

Active transponder has own power, where passive device does not have its own power source and is activated by outside source called transceiver/reader. Passive are smaller in size, lighter and have longer life time (Kampers et al., 1999). There are various types of transponder:-

i. **Ear tags**: The ear tag transponder is one inch in diameter and can be embodied in plastic (Sherwin, 1990; Stark et al., 1998). In addition to the button tags there is a visual tag. However read write technology is also available. Information stored is strictly accordance with the ISO standards.

ii. **Bolus**: The bolus transponders are covered by a capsule of biomedical glass and injected under the skin (Gruys et al., 1993; Lambooij et al., 1995) introduced orally into the forestomach of ruminants (Fallon and Rogers, 1996; Hasker and Bassingthwaigte, 1996; Caja et al., 1999) through a balling gun. Bolus is irretrievable until the time of slaughter. Boluses showed higher readability (99.5) than electronic tag (89.8%) (Garin et al., 2003).

iii. **Collar**: Electronic collar are similar to that of neck chain, except they have an attached tag with an electronic number that can be read by a scanner. Electronic collars are easy to use, but they can become a nuisance and can cause choking if they are not adjusted properly to the growth of the animal or if they become hooked on protrusions.
iv. Microchips: Microchips are a form of identification that involves the implanting of an electronic chip, with a miniature radio transponder and antenna, under the skin of an animal near the neck between the shoulder blades, or near the base of the ear (Diez et al., 1994).

Each of these devices provides the same functionality, reliability and accuracy, and is intended to last for the lifetime of the cow. The chosen RFID device with tag should be attached to the animal immediately after birth (or several days thereafter) can be utilized for farm management practices immediately.

2. Trans-receiver/Reader/Interrogators/Scanner: The trans-receiver is a device which sends electronic signals to the tag, the tag is charged and replies with the stored information. There are two basic readers (1) Portable/Handheld and (2) Fixed reader. The handheld can be powered by rechargeable battery (Blasi et al, 2003).

   i. Fixed RFID reader: Fixed RFID reader is used at a position in which a farmer wishes to utilize an animal RFID number on a regular basis. These provide a reliable and robust source of identification. These can be used in conjunction with other devices to enable a subsequent action or series of actions to be performed, or decisions to be automatically made. For example, fixed readers may be utilized for the (1) purposes of identifying an animal as soon as it enters the milking parlor, and subsequently recording the time and date (2) to record a cow’s milk production (in association with milk meters),(3) to identify cows required for drafting gate operations etc. (4) provides the possibility for the basis for a wide range of optional operations to be conducted within the dairy that require individual identification of cows (e.g. automatic feeding etc).

   ii. Portable RFID reader/Handheld reader: This may enable actions identification of animals in the field.

   Portable readers are capable of reading the RFID tag of a animal in the field and displaying the animals RFID number on a small digital screen in-built into the portable reader, and possibly providing an audible reading of the identification number e.g. the Allflex Compact Reader.

   A portable RFID reader could be attached to a personal digital assistant (PDA), which is loaded with herd management software and the data stored on the farms central herd management software application can be copied to this PDA – effectively providing a
mobile copy of the herd information. Utilizing this arrangement, the farmer can then scan a cow’s RFID tag with the portable RFID scanner and the identity and information pertaining to that cow can be provided on the screen of the PDA. The farmer can then use the PDA similar to how they would utilize their host desktop computer, being able to browse the animal’s information and should also be allowed to record and update animal information on-site. For example, a farmer could give an animal a penicillin injection – to record this, they simply scan the RFID tag of the treated cow, then use their PDA to record the details of that injection.

Such data recording and updates may be immediately reflected in the central herd management software if the portable device has a direct network link to it (e.g. wireless network). Alternatively, if a direct link to the software is not possible, the updated information could be retained in the portable device, and uploaded to the herd management database at a later time when the device can gain a direct link to the network (i.e. transfer via network cable). Either way, the farmer will be receiving the benefits of being able to easily and rapidly retrieve and view data in the field, while also enabling simple, accurate and timely data recording. Such an arrangement would also remove the duplication of effort that is currently required on both the Strong and Cochrane farms for recording information to their herd management applications - as farmers would not be required to manually record this data in the field before entering it again into the herd management software at a later time.

3. Herdman Software: It consists of laptop and computer which work as data accumulator. It contains the software that allows communication with the readers. This is required for the communication with data accumulator, where software is necessary. Herd management software provides mechanisms for farmers to store individual cow data into a database. Data can be entered into this software application manually via an easy to use, standardized interface, or alternatively, data can be automatically entered through the use of other digital devices (such as milk meters, cow weight scales) linked to this database. Such herd management software also provides RFID devices with the information required to make a decision or conduct an action.

4. Digital device network – wireless/wired/hybrid: A digital device network is required so as to enable the communication of devices between one another that is RFID readers and the central herd management software. There are essentially three methods of establishing such a network –
wired, wireless or hybrid. Each has their own advantages and disadvantages. The selection of the implementation type will depend upon the characteristics and preferences of individual dairy farms (Trevarthen and Michael, 2008).

Now a day’s farmers are utilizing wireless networks. This will enable an array of devices, to be linked directly to real-time data in the herd management database. Various devices include the mainstream computer network devices, such as PDAs (Personal Digital Assistants), laptops, desktop, personal computers and printers, also provide the vital links to dairy farm devices, such as RFID readers, milking controller units, feed management units, drafting gates etc.

A hybrid network involves some components of the network utilizing direct wired connections to the herd management software and server application, while other devices are provided with portable abilities. This may be the preferred option where there are devices that are intended to be permanently placed in a position, while other devices require portability. Utilizing the hybrid approach, portable devices can be connected to the network and subsequently the central herd management database at regular intervals (e.g. daily), where they can download the latest information from the central herd management database. The farmer can then remove these devices from the network, and take this device with them out into the field, where they can use this device to view, record updates or modify existing data. However, any changes made will only be reflected in their local portable version of the database at the time of recording. The farmer must then return to base, and attach the device to the central network again to upload the data they recorded while in the field onto the wired central herd management database (synchronizing data between the two).

The decision of using wireless, wired or hybrid networks must be based on the requirements and a cost-benefit analysis. It is believed that as wireless technologies advance in the future, providing greater capability and functionality while reducing costs, and will become the predominant network type. The network established by the Cochrane’s to link their RFID readers to their dairy software (and herd management software), feed dispensers and drafting gates provide a strong example of the use and value that such networks can provide. While this network is currently completely wired, it could also be easily adaptable to support mobile devices (such as PDAs) in a hybrid arrangement, to enable an even greater range of abilities in the future (Trevarthen and Michael, 2007).

**How RFID Works**
The scanning antennas can be permanently affixed to a surface. Handheld antennas are also available. They can be taken whatever uses you need; for example, you can fix them into a door frame to accept data from persons or objects passing through it.

When an RFID tag passes through the field of the scanning antenna, it detects the activation signal from the antenna, that "wakes up" the RFID chip, and it transmits the information on its microchip to be picked up by the scanning antenna. RFID tags are of two types-

**Active RFID tags** have their own power source; the advantage of these tags is that the reader can get the signal from a distance. Life span of these devices is less than 10 years.

**Passive RFID tags** do not require batteries, and are smaller in size and have a virtually unlimited life span (Tan *et al.*, 2007).

**Implication in Animal Science**

For efficient management of large herd operational RFID can be a tool for the dairy farmer through which the farmer can obtain the profitable milk production by automatic weighting, automatic milking, reproduction management and health monitoring. It can be very good tool for the insurance and tracking animal in the field. RFID technology is quick, easy and accurate. It is difficult to replicate /counterfeit. It is more efficient management, time and labour saving. It is dynamically data storage and data can easily view, analyze, manipulate & sort.

**a. Automatic Weighing**: The weight of cows is another significant factor that can be used to determine the overall health of a cow. The weighing scale may be placed at the entrance in the shed of the dairy, which is associated with a permanent RFID reader, enabling each animal to be identified before standing on the scales and their resulting weight to be recorded in the herd management database. The weighing balance is associated with load bars present on the base of weighing balance, which is connected to fixed scanner either by wireless network or through wires; the scanner information comes on display, which is finally stored in computer. Alternately, mobile readers can be used whose information can be send in computer by means of blue tooth software present in mobile reader. Later, this data can be viewed and analyzed by the dairy farmer. e.g. animal may loss weight when she is not given (or is not eating) enough food to satisfy her energy requirements to continue producing high quantities of milk. However, a loss of body weight may also occur if a cow falls sick, feed intake is restricted etc.

**b. Automatic Milk Recording**: Milk is the primary product for the farmer and it is important to know how much milk each cow is producing and likewise, to have a source of feedback to
establish what factors enable your cows to produce the maximum amount of milk. Milk meters provide this valuable ability, measuring the amount of milk each cow provides at every milking session.

In this method milking of cows is carried by machine milking which is connected to sampler in which the milk drawn from cow is filled by machine, the sampler is connected to milk analyzer which finally passes all the information to computer which includes electrical conductivity, temperature, chemical composition, Colour, SCC (somatic cell count) and particle size.

When a cow enters the walk way entrance of the milking parlor, the computer screen at the parlor displays such information as unique cow’s number, last milk yield, somatic cell count, and disease with medicinal treatment information for milking workers to pay attention (James, 2004).

It is believed that the implementation of these devices could become an integral component of dairy farming in the future. As previously alluded to, a great benefit that milk meters provide is the ability for farmers to achieve a complete cycle of information. Currently, farmers are able to control and measure many aspects of a cow’s environment and lifestyle. However, without milk meters, farmers are unable to accurately gauge how varying certain elements in a cow’s environment may affect their milk production.

c. Milking controller unit: Milking controller units are essential equipment for all modern dairy operations. This is the device that controls the suction and suckling motion of the milking cups attached to the teats of each cow. It is recommended that RFID technology, combined with herd management software be incorporated in all future implementations of milking controller units. Combining these technologies will provide a range of enhanced options and capabilities for the operation of the milking controller unit.

d. Health and Reproduction monitoring: RFID helps in health monitoring like monitoring health of herd (physiological parameters, mastitis) and individual medication and vaccination records. Sick animal identified at early stage and segregated for treatment (Eradus and Jansen, 2009).

e. Temperature monitoring: RFID microchips can read the temperature of the cow along with the cow’s unique identification number (Higgins, 2003; Hostettor, 2003).
Wireless Temperature Sensor is embedded in specially-designed rumen bolus and requires no batteries. It resides permanently inside the cow and automatically measures a cow's core temperature providing advance alerts of critical changes in temperatures which may allow early detection of sickness, estrus, heat stress, and the onset of calving (parturition).

A rise in temperature may also indicate that the animal is in estrous period and also activity of animal will be increase upto 30% to 400%. Activity is measured by ankle pedometer or activity meter. This will provide opportunity to the farmer to artificially inseminate the cow (Smith and Saunders, 2005).

f. Insurance: A silicon chip implanted in the cattle can deal with bogus insurance claims.

g. Traceability system and tracking system: This is a combination of Global Positioning System (GPS) and RFID technology. This will help in enhance farm management capabilities. It is proposed that GPS technology be included in RFID tags in to tracing cattle movements, and locate individual cows with a single program (Karnjanatwe, 2005).

Obviously, with a small herd size, this is not a particularly prominent issue (as farmers will be able to know cow locations from their own knowledge of the herd and cow movements), however as herd size increases, GPS location ability becomes increasingly valuable. This ability is further enhanced as the farmer may be able to use a PDA or other mobile device to display a map of their farm and pinpoint the cow’s location within this farm layout. Utilizing this approach, farmers can be guided to the exact location of any cow they desire.

It is in farmer’s best interest to minimize the risk of such incidents, which a GPS system utilizing plotted boundaries can facilitate. Similarly, the combination of GPS with RFID will aid to prevent and detect any theft of animal. Additionally, proof of identification and ownership of each cow can be provided via the RFID capability of such devices.

Furthermore, software could be designed to detect individual cow movement. This may include if a cow does not move as much as it is expected (based upon the historical location chronicle of the cow), or likewise, if it is moving significantly more than expected or usual. If a cow is moving significantly less than usual, this could be a strong sign of illness, and certainly something worthy of a farmer’s investigation. Additionally, this tracking may also be used as a mechanism for detecting when cows are in heat. When a cow is in heat their activity (movement) will increase by up to eight times the normal rate. Thus, if a cow’s movement is detected to be abnormally
high, this may be a strong sign that she is in heat, and thus notification of this should be provided to the farmer. This system can be used for tracing movements and locate wild animals.

**Conclusion**

The use of RFID will assist farmers to maximize their productivity – an important aim in the modern competitive dairy industry. It is expected that the new farm management practices enabled by RFID will allow farmers to increase the volume and possibly the quality of milk output from their herd. This may be achieved through improved practices to monitor the health of their herd – thus minimizing illness and subsequent low production of cows, speeding up the milking process – thus enabling the cows to return to the paddocks quicker, optimizing feed to suit each cow production and stage of lactation cycle etc. The use of RFID for automation will also aid to minimize labour input, thus allowing each farmer to cater for more cows, or enabling farmers to have more time to spend on other activities – either way, maximizing results from their input.

**References**