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Radio-frequency identification: A cost effective tool to improve livestock sector

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ABSTRACT

Animal identification has become necessary now-a-days in livestock management at global level due to outbreak of animal diseases like bovine spongiform encephalopathy (BSE) commonly known as mad cow disease, FMD and swine flu. Unique identification and tracking of livestock help in providing rapid and precise information about animals to take prompt action in controlling disease outbreak, ensuring quality livestock products for public health, mitigating the false insurance claims etc. In modern age, one of the important contributions of ICT in livestock sector is development of electronic tags for unique identification of animals by using RFID (radio-frequency identification) chips, which are cheap, unique and tamperproof. Through a magnetic reader one can get information about the animal, which includes date of birth, breed, milk yield, owner etc. Automatic identification of individual animal helps in improving the farm management practice and welfare of animals. Although RFID is being very widely used in many of the organised farms because of its unique advantages, it is not being recommended by any government agency. Once this chip (grain size) is implanted in the animal one can identify this animal anywhere in the country, thus reducing malpractices in the implementation of many government schemes.

Key words: Animal identification, RFID, Wireless sensor network

Millions of small and marginal farmers, and landless agriculture labour in India are dependent on livestock rearing as an additional source of income. Therefore, government agencies have initiated a number of animal welfare schemes from time to time. Success of these schemes depends on the availability of basic and performance data of individual animal and the demographic characteristics of the beneficiaries. Generally such data is neither recorded by the beneficiary farmers nor by the concerned agencies at field level leading to problems at the time of evaluation of these schemes.

In recent times, animal identification has become necessary in livestock management at global level due to outbreak of animal diseases bovine spongiform encephalopathy (BSE) commonly known as mad cow disease, FMD, swine flu, bird flu, etc. In addition sharp increase in fraud cases related to sale, purchase and insurance of animals also necessitates the appropriate identification of animals. Unique identification and tracking of livestock throughout their entire lifecycle provide reliable and effective system by making available rapid and precise information about the animals which help in taking prompt action in reducing the possibility of disease outbreak, theft of animals, ensuring the quality of livestock products and mitigating the false insurance claims etc.

Earlier identification of animal was done through a manual and mechanical process. In modern age, electronic tags have been developed for unique identification of animals by using RFID chips which are cheap, unique and tamperproof. Although RFID (radio-frequency identification) is widely used in organised farms, it is not being recommended by any government agency. Once this chip (grain size) is implanted in the animal one can identify this animal anywhere in the country, reducing malpractices in the implementation of many government schemes.

State governments with central assistance distribute milch cows to alleviate poverty and to increase milk production in the state concerned**.** Many SHGs have opted for cattle rearing as an income generating activity. There were several reports wherein this scheme did not yield the expected results instead led to national loss in terms of both morbidity and mortality. Malpractices such as wrong selection of beneficiary, wrong insurance claims, and transfer of money without actual transfer of animal could be checked with proper identification of the animal through RFID.

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This technology is also useful in taking care of protocol based health care of animals, heat detection and prevention and control of animal disease outbreaks at an early stage. Proper identification of animals through RFID also supports other animal husbandry programmes such as vaccinations, health monitoring, tracking of animals, planning for allocation of funds under incentive schemes to improve livestock quality in the country, etc.

Need and technology for animal identification

The need of identification of animals was felt to mark the ownership of domesticated animals by the animal owners. Various methods were used to identify animals in the past such as hot branding, freeze branding, ear cuts, tattoos, tail tagging and ear tagging (metal, plastic). RFID tags (electronic tags), bar-coded implantable chips or biometric methods such as muzzle prints, iris scanning and retinal imaging etc. are promising technologies for animal identification. Technology for animal identification must be — permanent; tamper-proof; unable to cause any harm to the animal; easy to apply, maintain, and read; capable of providing immediate access to data; and capable of including other relevant data such as health records and movement details. Over the period need of animal identification can be classified in 3 levels namely private, national and global levels for different reasons.

Private level

- Mark of ownership and distinction from other farm animals
- Protection against theft
- Segregating the animals into different groups (young, dry, milking, pregnant etc.)
- Nutritional and health care of individual animals
- Behaviour monitoring of individual animals
- Early disease diagnosis of individual animals
- Automatic farm operations (recording of milking data, weight, feeding etc.).

National level

- Improving the milk production through selective breeding
- Animal disease control and eradication
- Herd improvement programmes
- Progeny testing of bulls at field level
- Settlement of insurance claims
- Keeping track on sale-purchase of animals
- Monitoring movement of animals from one place to another
- Vaccination and de-worming programmes
- Implementing the government or industry policies
- Consumer confidence in livestock products traceability.

Global level

- Public health
- Controlling the outbreak of animal disease
- Better access to international market for meat and dairy exporters.

RFID technology

Radio frequency identification (RFID) may be defined as "A system that transmits the identity (in form of a unique serial number) of an object (or person) wirelessly using radio waves" (*RFID Journal* 2005). This technology is commonly implemented using RFID tags (also known as transponders) mounted or attached on objects and readers/ writers (also known as interrogators). RFID tags consist of 2 parts - an integrated circuit (containing unique code, memory for storing and processing of data, modulating and demodulating radio signals etc.) and antenna for receiving and transmitting signals. These components are enclosed in a temperproof plastic cover of different sizes and shapes.

RFID readers/ writers have 3 components - an antenna, a transceiver and a decoder. RFID readers can differ quite considerably in their complexity, form, and price, depending upon the type of tags being supported and the functions to be fulfilled. Readers can be large and fixed or small, hand-held devices embedded or attached with mobile devices (PDA, laptop, palmtop, tablet, PC etc.). Read range for a portable reader is generally less than the range of a fixed reader. The effective read range of a reader is determined by the size of the antenna, the efficiency of that antenna, and the power of the transmitter.

Necessary elements for functioning of a RFID system are – tags (device that is associated with animal), reader (device to read data from tags), and the software to process and link obtained data (from tag and reader) to retrieve meaningful information from larger databases. When a tag is brought in the reading range of a reader, the reader captures the data stored on tag and forwards to the host computer. The reader sends out a radio signal, and the tag responds to identify itself. The reader then converts the signals returned from the tag into data that can be passed on to an information processing system to filter, categorize, analyze, and enable action, based on the identifying information.

Technologically, RFID tags can be categorised into active and passive tags. Active tags contain a power source (in form of battery) and transmitter to enable transmission. On identification of external source i.e. RFID reader (or interrogator), active tags transmit the data to reader. Passive tags do not have power source and require external electromagnetic field to generate enough power (generally from RFID reader's signal) to initiate data transmission. Tags can also be classified based on the storage capabilities as read-only, read-write, or a combination of both, where some data (such as a unique identification number or electronic product code (EPC)) is permanent, and additional memory is available for data to be added or updated later. Most RFID tags have very limited memory capacity (generally 96 or 128 bits at present).

Table 1. Characteristics of RFID tags

Type of RFID tags	Battery	Frequency	Read range	Size
Active	Yes	455MHz5.80GHz 2.45GHz	20–100 m	Coin size
Passive	No	LF: 124–134.2kHz, 140–148.5kHz	0.33 m	In form of paper sheet; smallest size: 0.05mm × 0.05mm
		HF: 13.56MHz	1 m	
		UHF:860–960MHz	3.3 m	

More technical details of RFID tags are given in Table 1.

A significant increase in the usage of RFID technology is seen in recent years. Mainly the reduction in cost, increased reliability of data communication between tags and reader, greater reading range, faster data transfer speed and stable international standard of RFID are few important key factors in the growing popularity of RFID technology. The size of RFID tags has also miniaturized over the period. The smallest RFID chip (dust particle size) is of 0.05mm × 0.05mm size (Hitachi 2003). Currently RFID technology is being used in many areas of livestock sector such as enterprise supply chain management to improve efficiency of inventory tracking and management, animal identification, etc. Researchers at Bristol University successfully glued RFID micro transponders on live ants to study their behaviour (Ants' Home 2009).

Advantages of RFID

RFID provides many advantages over other electronic identification technologies such as barcodes. Specifically RFID has following advantages:

- Unique individual identifier
- Store more information
- No operating costs once implemented
- No line of sight required
- Durability
- High-speed for data reading and simultaneous reading of data from multiple transponders effectively
- Strong machine readability (does not affect reading accuracy and performance in case of surface damage, dirt, dampness etc.).

Animal identification using RFID

Animal identification is one of the most common applications of RFID technology. This technology is being utilised globally for implementing individual whole-of-life identification and tracking system for livestock. In livestock industry, mainly 4 types of RFID tags are used depending on placement of tags on animal body for identification — collar tags: attached/ mounted on collar of animals; ear tags: attached/ tagged on the animal's ear; boluses: boluses are capsules where a transponder is mounted within an acid resistant cylindrical capsule, and is placed permanently in the animal stomach; injectable glass tags: tags are injected under the skin.

RFID tags to be used in animals should be small, lightweight, robust and have operational life span greater than that of the relevant animal. All these kinds of tags are being used to identify animals. However, International Committee for Animal Recording (ICAR) – recommend three-way RFID ear tags (visual laser-printed, bar-coded and microchip-embedded). These tags are commonly used in India because of their obvious advantages. It is easy to implant and operate, easy to identify, visually readable, non hazardous to animals, tamper proof etc. These tags can also be fraudulently removed from the animals. Bolus and injectable tags are inserted in the body of cattle so these are not visible and cannot be removed but on the other hand they have constraints such as difficult to implant, high cost, low reading range and difficult to locate.

For several reasons electro-com white paper (electro-com) suggested the use of passive tags of LF 134.2 kHz frequency for animal identification (better read accuracy in LF than HF and UHF, relatively inexpensive, can read through liquids and metal. Moreover this frequency band is licence free to use in all countries. ISO 11784 and 11785 international standards regulate the radio frequency identification of animals with regards to code structure, protocols and technical concept. The central aim of these standards is to facilitate communication with transponders from a wide range of manufacturers with a common receiver.

ICAR Technical Series 9 (Pauw *et al.* 2004) recommandes a unique 15-character identification RFID tags code. Unique numbers of animals form the basis of information and recording (I&R) system. To avoid communication errors, the animal or holding ID should be as small as possible with the constraint that a minimum turn-over period of 100 years should be provided. Due to lack of experience, the beneficiary often tries to put additional information into the number such as birth region, breed and municipality code etc. The additional information is not advisable to store on chip as it looses its value with time and significantly inflates the number of digits and therefore leads to additional communication errors as well as to higher costs for ear tag handling and distribution. The internal animal ID used within the database or on barcodes should be represented by an appropriate 15-digits ISO code (3-digit country code, followed by '00' and the 10 digit animal ID, where leading

'0' fill up to 10 digits) in order to provide world wide uniqueness and to match with numbering system applied in many other countries.

Advantages of animal identification in farm management

Animal identification and performance recording are critical for efficient farm management. Increase in herd size makes it difficult for the farm manager to remember and to record data on various aspects of individual animals. Manual recording of data is labour intensive, erroneous and costly, therefore, efficient management of dairy farms require automatic identification system. With advances in electro-mechanical devices and computer technology and reduction in prices, electronic tags, computers and mobile devices are gaining popularity for automatic animal identification and data management. Animal identification helps in automation of dairy farm operation and better management of individual animal records (Pires 2002, Eradus *et al.* 1995). Specific advantages are as follows:

- Easy and automatic identification and tracking
- Increases the efficiency and productivity
- Cost effective (by reducing labour requirement etc.)
- Automatic identification can further be linked to larger databases and information processing interface for recording and processing information
- Implementation of electronic feeding system
- Animal health control
- Behaviour recording
- Automatic gating in group housing facilities
- Tracing back of stolen/ strayed animals
- Whole-life traceability of animal from origin to abattoir
- Disease control
- Settlement of insurance claims.

World-wide animal identification schemes

In the wake of outbreak of contagious and zoonotic diseases like BSE (mad cow), FMD, swine flu and bird flu, countries all over the world are implementing policies and procedures of animal identification to ensure whole-of-life traceability of individual animals to provide safe livestock products to protect public and animal health. The EU, US, Canada, Uruguay, Botswana, China, Australia and New Zealand have either enacted or in the process of legislation requiring all livestock to be tagged with RFID tags for animal identification and traceability. EU and Australia are pioneer in implementing animal identification policies. Australian NLIS (National Livestock Identification Scheme) is the largest implementation scheme of animal tracking in the world.

Patni Top (Patni Top 2010), a software company, developed a high-tech "Animal Traceability" system, using RFID technology for a client to meet new European and US government regulations and to expand leadership in the South American market. The system has ability to trace meat products from "Plate" right to the animal with access to all relevant information including its feeding data, parentage and other vital information helped to provide customers with an assurance of getting disease-free products. Client deployed the "Animal Traceability" system successfully in the UK, France, Australia, Uruguay, Brazil and Chile.

Status in India

India ranks first in livestock population and milk production in the world. The Government of India is implementing various schemes to improve the genetic potentiality of these animals but the results are not very encouraging. One of the important constraints is non availability of performance data of individual animal at village level. Experts all over the world stressed the need for performance recording of animals as the core requirement for productivity enhancement. Data showed that the countries that have started recording of performance data have doubled the productivity of animals in 25 years (Samad 2010). Record keeping on pedigree, production, reproduction, feed, health and costs is essential for sound decision-making in selection of animals with greater genetic producing ability to develop a better future herd.

The Government of India has been promoting cattle insurance for more than three decades, but higher premiums due to increased incidence of fraud have kept livestock owners on the sidelines. In fact, less than 10% of the cattle in India are insured (Brockman *et al.* 2010, Sharma *et al.* 2010). Cattle insurance has always been a loss making business to the cattle owners. Many times the cattle owners (in association with veterinary doctors, bank staff, insurance surveyor etc.) claimed insurance for the cattle which they do not own. It is estimated that around ¼ th claim cases are fraudulent (Brockman *et al.* 2010). Now many insurance companies are starting to use RFID technology to keep track of cattle and to reduce the incidence of fraud in cattle insurance. Accordingly, the veterinarians move to the door step of the cattle owners with laptops and RFID readers, for registration and recording of animal data, and the processing of cattle insurance (if required) is done almost immediately. This technology has benefited the cattle owners with prompt delivery of insurance policies, reduced rate of premium, better healthcare of animals, etc.

Some organised farms in private sector in India have adopted RFID based animal identification and farm automation management system, e.g. Chitale Dairy in Pune, Lakshya Dairy in Haryana and Kopordem Farm at Valpoi in Sattari Taluk in North Goa. Sangamner Milk Union, Maharashtra has decided to attach RFID tags to 100,000 animals in near future to begin tracking and to ensure accuracy of the data related to each animal. Most of the RFID based solutions for identification and farm management in India are being provided by multi-national companies like DeLevel and Westfilia. which are very costly and closed

system. Various insurance companies and research groups are making efforts to develop RFID based animal identification, data recording and complete farm management system applicable for small holding dairy farmers at low cost.

Examples where the technology is being implemented successfully are given in Table 2.

Cost benefit analysis

With increase in usage of RFID technology cost is getting reduced; cost of RFID tags (ear tags) varies from Rs 50 to 170/ piece depending on the quality and type of tags. The cost of a reader varies from Rs 2,500 to Rs 40,000 depending

Table 2. Farms with sucessful RFID systems

Organization	Chitale Dairy, Pune
Start Date	Initiated to give unique identity to each of their cattle in August 1996
Functional Area	Farm animal management and automation using RFID
Operational Area	Pune, Maharashtra, India
Project Description	Started as a pilot project to explore ways for improving cattle productivity with around 100 cows and buffaloes and is now spreading fast, helped by the benefits demonstrated over past many years. Already, the dairy has tagged nearly 7,000 cows and buffaloes around Sangli village. Plan is to tag around 50,000 animals over the next five years in its catchment area. Every week, a supervisor from Chitale's Dairy visits farmer's home with a hand held mobile computing device attached with RFID reader to record and update the relevant inputs about the buffaloes' health, nutritional needs, etc. Then, from a centralised control room at the Chitale Farm, veterinary experts are assigned their daily visits based on the data collected from the field. All inputs are then sent to a herd management software system which provides real-time updates about the buffaloes, helping relevant supervisors and dairy managers to take appropriate action.
Result/ benefits	Controlled feeding process, early diagnosis of illness and pedigree analysis of cows and buffaloes resulted in 3-4 times better milk yield than the national average at Chitale Farm. National milk yield for buffaloes is around 800 litre/lactation, at Chitale's farm the productivity is nearly 2,500 litre/ lactation. By predicting problems illness can be mitigated—the focus is now on better health management and not sickness.
Problems faced	Initial resistance from the farmers but later on seeing the benefits cooperating in implementing the technology.
	Source: http://epaper.timesofindia.com/Default/Layout/Includes/ETNEW/ArtWin.asp? and http://www.rfidjournal.com/article/view/7621

ITGI Pasudhan Bima (Livestock Insurance)

Organization	IFFCO-Tokio General Insurance Co. Ltd. (ITGI), a joint venture between Indian Farmers Fertilizer Cooperative Ltd (IFFCO), and Tokio Marine and Nichido Fire Inc of Japan.
Start Date	August 2009
Functional Area	Livestock Insurance
Operational Area	Gujarat, Maharashtra, Punjab, Rajasthan and Odisha
Project Description	The project aims to test a model to reduce fraud by using an identification device placed under the skin of the animal (based on RFID technology). The project targets more than 25,000 poor farmers and their families in the states of Gujarat, Punjab, Maharashtra, Rajasthan and Odisha who depend on livestock as a main source of income.
Result/ benefits	• Using RFID technology enabled IFFCO-Tokio to change the current tagging process and brought a check on insuring nonexistent or sick cattle. • RFID has helped in correct identification of the animal. • Current claim settlement time is around 10 days which is much lesser than earlier time of 30 days to issue insurance policy. • Reduction in claims: Reduction figures can be stated only after 1-2 product cycles; however, current claims ratio is much lower than the one experienced before with traditional tags. • The technology does not increase stress for cattle. • By and large, the cattle owners are accepting the new technology as the process is clear and transparent to make a claim.
Problems faced	There is a visible resistance to new technology from certain quarters as it is no longer possible to make fraudulent claims.

Source: (Micro Insurance Facility 2009)

(Table 2. concluded)

Institute of Financial Management and Research (IFMR), Dairy Network Enterprise (DNE) and Ergo-HDFC GIC Ltd.	
Organisation	Institute of Financial Management and Research (IFMR), Dairy Network Enterprise (DNE) and Ergo-HDFC GIC Ltd.
Year of Initiation	April 2009
Functional Area	Livestock Insurance and performance recording of animals
Operational Area	Thanjavur,Tamil Nadu
Project Description	The objective of the project is to provide an easy to buy, instantly generated livestock insurance policy with risk for fraud is at a minimum. The system was deployed and validated in a cluster of 5,000 dairy animals spread over more than 10 villages with an average of 2 to 3 animals per farmer in Thanjavur district, Tamil Nadu, India. The system is user-friendly and easy to operate in that the animals' insurance registration and issuance of policy documents can be done in a single farm visit. The system comprises (a) an RFID tag or insert; (b) an RFID reader; (c) a PDA/mini laptop with custom software installed; (d) a USB modem internet connection; and (e) a central data server on web platform with dedicated server-level software. The unique feature of the system is that the veterinary health worker (VHW) is able to register and enter new records only when the RFID reader connected to a mini laptop is within reading range of the associated RFID tag. This also authenticates visit by VHW. System can also be used for collecting periodic animal records and sending SMS 'alerts' to the farmers.
Result/ benefits	• The online policy disbursal on the same day for covering the farmer without delay once the insurance policy has been purchased. • Low premium due to reduction in mortality rate by integrating the insurance schemes vaccination and de-worming of animals. • Better animal health management by timely execution of protocol based veterinary and animal husbandry services. • Initial economic analysis suggested that the investment cost would be recovered even if fraudulent claims of around 0.5% of the insured animals can be prevented. • Cheating by farmers is difficult due to inbuilt mechanism in the system.
Problems faced	VHW must have to visit farmer's house personally for recording data.
Source: (Samad *et al.* 2010, IFMR 2009).	

IIT-Delhi and NDRI, Karnal Project: Development of wireless sensor network for animal management	
Organisation	IIT-Delhi and NDRI, Karnal Project: Development of wireless sensor network for animal management; Funding Agency: NAIP, ICAR
Year of Initiation	July 2008
Functional Area	Animal identification, Management and behaviour recording
Operational Area	NDRI, Karnal
Project Description	Attempts were made to develop a wireless ad hoc sensor network (WSN) to identify the animals' uniquely through sensors nodes and to monitor behaviour of animals which include the movement (3D), jumping, position, temperature etc. Such data are required to monitor the behavioural changes in the animals which in turn help in (i) heat detection, (ii) early diagnosis of ailments like mastitis, lameness etc., and (iii) also in assessing the comfort zone of animals, group behaviour etc. Data transmission will be in ad hoc manner instead of fixed base station. It is also proposed to develop Smart Bucket with weight and Temp, pH and conductivity sensor to collect all the information regularly and will transmit the information to the central server for data recording and analysis for health management of animals. Another technological intervention is creation of virtual herds through use of wireless sensor ad hoc networks in village. Sensor node can be tagged on to all animals of the village and data will be transmitted to central server considering the whole village as a single herd. Alert messages could be transmitted to a local veterinarian about the health status of individual animals. Creation of virtual herd enables a single veterinarian to provide health care to large number of animals efficiently which ultimately benefits the cattle owners.
Result/ Benefits	• IIT, Delhi has demonstrated the temperature and humidity sensor based mist controller and water trough to control water flow based animal proximity sensor which have been installed in cattle yard for testing. • Models are being developed to analyse the animal behaviour.
Problems faced	• Difficult and time consuming purchase procedures. • Slackness in government officials towards innovative work. • Bureaucracy.

Table 3. Cost-benefit analysis of the secured identification and recording system for small-hold dairy farmers. Source: Reference (Abdul Samada *et al.* 2010)

Items	Investment cost (INR)*		
	Unit cost	Units	Cost/benefit**
RFID ear tag with visual duplicate tag	50	5,000	250,000
RFID reader with interface to mini-laptop	2,000	5	10,000
Mini-laptop for veterinary health worker	14,000	5	70,000
Local Server along with web-server space	30,000	1	30,000
Software for mini-laptop and data server	-	-	355,000
Internet connectivity to all the VHWs	5,000	5	25,000

*Original cost in USD was converted into INR considering conversion rate INR 50 per USD.

**Considering the cost of each fraudulent claim as INR25,000 , the cost can be recovered if 30 such claims are prevented which is 0.6% of the insured animals.

on the capabilities and features of reader/ writer (Table 3). For example a simple hand held reader costs Rs 2,500 which can read and display the RFID tag number. Certain firms are providing RFID tags and readers at a very competitive rate in India. RFID products manufactured by Indian companies are quite low cost but quality and durability are not quite satisfactory. Therefore there is such huge variation in its price range. Besides, expenditure is involved in providing a laptop for field visits, software, central database server, internet infrastructure, manpower, for implementing the animal identification and performance recording system.

As per the cost and benefit analysis presented by Samad *et al*. (2010), the implementation of such a system is economically beneficial because the cost of investment can be recovered even if 1% of fraudulent claims are prevented due to availability of accurate and reliable data. They have implemented such system in 5,000 dairy animals spread over more than 10 villages with an average of 2 to 3 animals per farmer in Thanjavur district, Tamil Nadu, India. The cost of maintenance of the system can be met from the improved services that would enhance productivity, minimize losses due to management errors and enhanced market price of the animals due to availability of data.

Evidence of constraints in uptake

Despite the negative contribution of the milch animal distribution scheme the policy makers are still promoting and implementing this scheme in all parts of the country. Induction of cows is taken up in almost all the states to enhance milk production in the respective states as it is theoretically easy to increase milk production by adding cows to the existing lot.

1. Several well intentioned efforts (schemes such as IRDP, NREP, RLEGP and JRY) were implemented as the objective of enduring poverty alleviation could not be achieved (Dantwala 1996) because inappropriate selection of beneficiaries on many occasions lead to failure of the schemes (Maheshwari 1995).
2. Another problem with these schemes is that sometimes high yielding animals are given to farmers with no previous knowledge and experience of rearing high yielding animal management. High yielding animals require high plane of nutrition as well as scientific management to exploit their production potential. But when such cows are given to those who have little or no experience in dairy cattle management it may result in low yields and at times due to improper care and management the animal may get dismayed and die. It is necessary to look into the experience and skill of the beneficiary before the animal is given to him or her. It is also not uncommon to notice that the same beneficiary will be getting the cows due to lack of proper identification of animal. As a rule all the animals purchased are to be tagged (plastic) and insured. But this tagging is not a foolproof method of identification. Hence, the scope for malpractices exists.

India lags behind many countries in implementing schemes for unique identification and performance recording of animals. However some state government agencies, NGOs and private firms are making efforts at small scale to implement the animal identification schemes in respective states. At national level the government has yet to formulate such policy. High cost, lack of trained manpower, non transparency in working, fear of exposure of malpractices, increasing number of non performers and non willing workers in the setup are the main factors for delay in implementing RFID based solutions in Government and public funded agencies. Still this technology is under the development phase and is being standardised. A few insurance companies have used the RFID technology under pilot project mode (research, monitoring and evaluation) to understand the problems and constraints of this technology in India. However, the instances of usages of RFID technology in insurance sector for insurance of livestock are increasing which were earlier thought to be a losing proposition.

Major issues related to implementation of unique

identification and performance recording system in India are:

- Proper infrastructure required.
- Large number of animals, which are scattered in rural areas - wide geography.
- Animal holding low - small herd size.
- Multi-species - cows, buffaloes, goat etc.
- Multi-breeds - with different economic parameters.
- Availability of IT tools and infrastructure is to be improved.
- Computer-literacy in rural animal health workers is to be increased.
- Field workers have to improve services and supervision .
- Discontinuity in services and policies.
- Concerned persons are to be made more accountable.
- Increase in cost of inputs (labour, equipments, maintenance etc.) by adopting the latest technology leads to high cost of production of milk.
- Initial cost goes very high though in long run it may nullify the effect. Only financially sound parties (organised farms) can afford.
- Most farm operations are carried out by unskilled labour which, are reluctant to learn and adopt new technology.
- Skilled workers do not want to work with animals as it is not considered a dignified job.

Some issues in adopting the RFID technology

- Technology is still expensive
- RFID performance is affected by antenna patterns
- Environmental interference and tag orientations (readers cannot communicate effectively with tags that are oriented perpendicular to reader antenna)
- Rogue interrogators (information in RFID tags can be read by any interrogator)
- Issues of privacy and secrecy of data
- Frequency jamming may halt the whole system.

DISCUSSION

The importance of secure electronic animal identification devices in livestock development was highlighted by several researchers (Eradus and Jansen 1999, Pires 2002, Pauw 2004, Samad *et al.* 2010, Voulodimos 2010 and Rao 2012). This has lead to the development of cost effective RFID animal identification devices which include thinnest chip named "powder or dust"; LF and HF tags for use in livestock. They serve as foolproof mechanism to identify the animal anywhere on the globe, thus help in improving the performance of animals, tracing the animal diseases, mitigating the fraudulent cases and quick settlement of claims in livestock insurance and animal ownership. Realising the potentiality of RFID technology in livestock sector, many organizations have been successfully implementing several projects to help the livestock owners in the country which include IFFCO -Tokio General Insurance Company the livestock sector in five states of India, Institute of Financial Management and Research (IFMR), Dairy Network Enterprise (DNE) and Ergo-HDFC GIC Ltd in Tanjavur district of Tamil Nadu. Prominent dairy entrepreneurs are exploiting the potentiality of this technology. Despite its various advantages the use of RFID tools in India is very low. Following are the policy interventions suggested to enhance the use of these tools which would help the livestock owners in particular and livestock sector in general.

Policy interventions

1. Identification and performance recording of animals is necessary for genetic improvement of local breeds which is the urgent need of time therefore, an approach and policy is required at national level to store data of all animals in distributed way, which can further be linked to national database.
   a. To bring about uniformity in identification and data recording, the state government should establish Animal Identification and Recording Authority based on the pattern of Maharashtra state which is the first state to set up Maharashtra Animal Identification and Recording Authority (MAIRA) under its Livestock Development Board.
   b. The state Government should maintain a state-level data server for access to all the stakeholders.
   c. The data should be recorded at the point of its generation that is farm premises and transferred to local / regional or state data server.
   d. The primary individual animal data would be property of the farmer but aggregate data would be public-property.
2. It is important that Government of India makes it mandatory to at least computerise the record keeping system of all organised dairy farms if not possible to use RFID based solutions.
3. The Government of India must make it mandatory that all the animals purchased under any government scheme must be identified with RFID chip which is unique and tamper- proof to reduce malpractices in the transfer or death of animals.
4. There should be specialized insurance company for animal insurance to take care of animal health care (especially vaccination and de-worming) of insured animals. This will increase the confidence of animal owners in insuring their animals. The meagre percentage of animals insured by all the insurance agencies put together is an indication that the livestock owners are not taking advantage of the insurance schemes.
5. Integrating the cattle insurance schemes with RFID base animal management programmes will help in reducing the time period in issuing the livestock

insurance policies and premium by reducing the fraud claims and improving the animal health.

6. Insurance agencies and state Government should work on preventing bacterial, viral and metabolic and parasitic diseases outbreak. RFID technology can help in keeping track of animal vaccination and health details and controlling disease outbreak.
7. The government should enforce the creation of virtual herd through wireless sensor networks at village levels to monitor health and movement of animals in more efficient way for small dairy farmers. This will lead to increased productivity at low cost.

The implementation of e-livestock policies, which is technologically feasible will benefit the stakeholders in many ways:

- will bring transparency in government programmes
- will help in selection of right beneficiaries for right programmes
- precision livestock farming will reduce input costs
- improvement in protocol based veterinary and extension services
- policy makers would have access to dynamic data for better monitoring, planning and forecasting
- animals would be marketed with traceable records, better prices to farmers.

RFID technology for unique identification of animals is easy to use and best among other comparable technologies. Identification and recording of animals using radio frequency identification [RFID] chips has a lot of merit for reducing malpractices related to implementation of government programmes in the animal husbandry sector and insurance and also in recording the breed, yield and behaviour of animals. However, it warrants further research for its wider application especially for the small holders keeping one or two animals.

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