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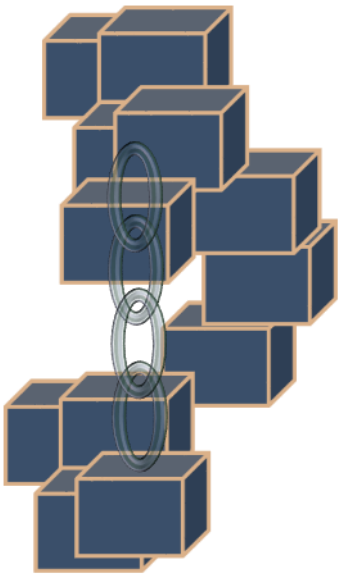
Traceability Based Value Chain Management in Meat Sector for Achieving Food Safety and Augmenting Exports



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Program Coordination

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MANAGE, Hyderabad

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MESSAGE

National Institute of Agricultural Extension Management (MANAGE), Hyderabad is an autonomous organization under the Ministry of Agriculture & Farmers Welfare, Government of India. The policies of liberalization and globalization of the economy and the level of agricultural technology becoming more sophisticated and complex, calls for major initiatives towards reorientation and modernization of the agricultural extension system. Effective ways of managing the extension system needed to be evolved and extension organizations enabled to transform the existing set up through professional guidance and training of critical manpower. MANAGE is the response to this imperative need. Agricultural extension to be effective, demands sound technological knowledge to the extension functionaries and therefore MANAGE has focused on training program on technological aspect in collaboration with ICAR institutions and state agriculture/veterinary universities, having expertise and facilities to organize technical training program for extension functionaries of state department.

In India, traceability continues as a hot topic for food manufacturing industry to ensure the safety of the domestic and global food supply, government regulations and brand protection demands from customers. In these days and age of global recall of product and strict compliance regulations from both government agencies and retail customers, traceability and recall procedures are most important than ever. Each segment of the food product manufacturing industry needs to ensure that their traceability efforts are up to the highest standard in order to protect brand image in market. These growing requirements are pushing food processors to maintain upstream and downstream traceability in supply chain.

It is a pleasure to note that, ICAR - National Research Centre on Meat and MANAGE, Hyderabad, Telangana is organizing a collaborative training program on “Traceability based value chain management in meat sector for achieving food safety and augmenting exports” from 12-14 July, 2022 and coming up with a joint publication as e-book on “Imparting Skill among Youth for Scientific Rearing of Livestock” as immediate outcome of the training program.

I wish the program be very purposeful and meaningful to the participants and also the e-book will be useful for stakeholders across the country. I extend my best wishes for success of the program and also I wish ICAR - National Research Centre on Meat, Hyderabad many more glorious years in service of Indian agriculture and allied sector ultimately benefitting the farmers. I would like to compliment the efforts of Dr. Shahaji Phand, Center Head-EAAS, MANAGE and the Director, ICAR - National Research Centre on Meat, Hyderabad for this valuable publication.

Dr. P. Chandra Shekara
Director General, MANAGE

FOREWORD

The livestock sector is playing a pivotal role in India for nutritional and livelihood security for the millions of people in the country. Globally food safety has been given utmost importance as annually 4.2 lakhs people get sick due to the consumption of infected food. India's buffalo and small ruminant meat have great demand in the international markets. However, our export has been too primarily to Asian countries to broaden our horizon we need to adopt the food recall and traceability in our livestock sector. With the advent of technology, animal identification using barcoded tags or QR codes will help in traceability and tracking of the origin of food which is the need of the hour. As most countries, they are following a traceability system and prefer to import commodities with traceability compliance. Hence this course is planned to impart the basics of traceability, how it works and record maintenance, data entry, etc. Further, it will also help in disseminating the knowledge and latest developments at the country and global level.

For boosting the livestock sector, using a traceability system, the Government of India through the Department of Animal Husbandry and Dairying, New Delhi has already initiated animal identification which can serve as a basis for animal breeding, disease control, and livestock produce traceability. Similarly, the Ministry of Commerce through APEDA is offering a provision to their registered processing establishments, to apply for Health Certificate through Meat.Net Online System, for each of their export consignment of meat products. National Dairy Development Board (NDDB) is implementing Information Network for Animal Productivity and Health (INAPH) and Maharashtra Government is implementing Maharashtra Animal Identification and Recording Authority (MAIRA) for achieving traceability. ICAR – National Research Centre on Meat, Hyderabad has established a traceability database through extensive research in meat traceability, which can be used as a prototype for creating all-encompassing meat traceability for India. For successful implementation of traceability, collaborative, concentric efforts are required. The topic of this training program is very apt for further increasing awareness among different stakeholders, researchers, and academia. I congratulate the Course Director and Coordinators for their persistent efforts and dedication.

S. B. Barbuddhe
Director, ICAR-NRCM

PREFACE

The continual efforts for Food safety and quality have led to the emergence of the traceability system. Of late traceability has paramount importance in quality assurance and global trading of food commodities. Further, Traceability has emerged as a vital yardstick for quality assurance in the meat value chain in recent years. For robust meat traceability system, identification of animals, registration of premises like farms and abattoirs, database for uploading of traceability information, and provision for retrieval of information as and when required are the important requirements.

There is a greater need to create awareness, and functioning of the traceability system amongst stakeholders. Therefore, three days training program on '**Traceability based value chain management in meat sector for achieving food safety and augmenting exports**' was organized during July, 12-14 2022 for wider dissemination of knowledge about meat traceability in the country and across the globe. This course has been designed to encompass all the components of meat traceability. This e-book is an outcome of a collaborative online training program.

Editors are grateful to the contributors for their complete and elaborate contributions on important topics. The Editors, desire and trust that this compilation will create awareness, educate researchers and stakeholders about the necessity of a traceability system for ensuring database, promoting export, food safety and thereby improving GDP from the livestock sector. We are especially grateful to MANAGE, Hyderabad for grating financial assistance for organizing the virtual training program and also facilitating the Publication. We are also beholden to the Director, ICAR-NRC on Meat, Hyderabad for his ardent interest, relentless encouragement, and valuable direction in the successful organization of this training program.

Editors

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CONTENTS

Chapter 1

MEAT TRACEABILITY: CONCEPT AND PRACTICE

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1.0 Introduction

Livestock traceability is the ability to and the mechanism designed for tracing an animal product along all steps in the production chain back to the holding of origin of the live animal from which the product was derived (FAO, 2007). Animal production involves a series of interconnected and networked activities. If these activities are managed by a centralized system; resultant networking would enable the scientific production of livestock products (Clemens, 2003). The emergence of the traceability concept is the consequence of a long line of developments in the improvement of food quality and safety management. In recent times it has emerged as a new index of quality and a basis for trade. Traceability is an interdisciplinary concept of promoting documented transparency in sustainable agriculture. "Traceable meat" means the meat is produced from an identified animal reared on a registered farm and has information pertaining to its origin and processing (Girish and Barbuddhe, 2020). Key drivers the for implementation of traceability by different countries are the control of contagious diseases like Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth Disease (FMD), and boosting the export prospects in the international markets. European Union countries were among the first to implement a mandatory livestock traceability system in 2000. Subsequently, other countries followed albeit in different formats (Girish et al., 2017). India is the largest buffalo meat exporting country in the world. Most of the meat is exported to developing countries. India can achieve export to developed countries if it can implement the farm-to-fork meat traceability system. Implementation of a traceability system will not only help in enhancing market access but will also help in complying with Food Safety and Standards (Food Recall Procedure) Regulation, 2017. FICCI's (2010) report also recommended the implementation of a traceability system in the Indian buffalo meat industry for augmenting exports and assuring quality.

This chapter is aimed at providing brief information about the background and progress made in the implementation of meat traceability in India.

2.0 Overview of the Indian export meat sector

India holds the highest number of buffaloes in the world possessing more than half of the global buffalo population. As per the 20th livestock census (2019), India possesses 110 million buffaloes. In the year 2019-20, India slaughtered 12.18 million buffaloes producing about 1.58 million tonnes of buffalo meat (BAHS, 2020) of which 1.15 MT was exported earning foreign exchange worth Rs 22,668 Crore. India is the top buffalo meat exporting country in the world. Of the total meat of 8.6 MT produced in the country, 50.06% was contributed by poultry, while, buffalo, goat, sheep, cattle, and pig contribute 19.05, 13.53, 8.36, 4.02, and 4.98 %, respectively. The top buffalo meat producing states in India are Uttar Pradesh, Maharashtra, Bihar, Andhra Pradesh, Telangana, Punjab, and Kerala in the same order. These seven states contribute to more than 92% of the buffalo meat produced in the country. The quantum and value of the buffalo meat exports is declining in the last six years and there is a need to conceptualize pragmatic policies and provide technological backstopping to arrest this trend. Traceability can be an important initiative in arresting this trend.

Table 1: Quantum and value of export of meat and meat products from India over the years

Product Name	2010-11		2015-16		2020-21	
	Quantity (MT)	Rs (Crore)	Quantity (MT)	Rs (Crore)	Quantity (MT)	Rs (Crore)
Buffalo meat	726655.00	8613.31	1314161.00	26681.55	1085615.00	23459.89
Poultry products	0.00	314.33	0.00	766.71	0.00	435.52
Animal casings	1804.72	33.24	206.36	17.02	13887.74	416.54
Sheep/Goat meat	12301.00	258.83	21952.00	837.76	7111.00	330.45
Other Meat	1029.00	9.51	0.00	0.00	895.00	18.07
Processed Meat	922.00	13.96	282.00	6.19	780.00	12.65
Total		**9,243.18**		**28,309.23**		**24673.12**

3.0 Benefits of implementing a livestock traceability system

The benefits of implementation of the farm-to-fork livestock traceability system (Girish et al. 2017) are as follows:

i) **Ownership ascertainment:** Once the animal is registered and ear tagged it will be easy for the livestock owner to prove his ownership. Apart from controlling theft, it will also help reduce the inconvenience associated with getting clearance for the transportation of animals.

ii) **Effective implementation of disease control programs:** If any disease-causing agent is detected in meat or during slaughter and packing, traceability will help track the farm of its origin. Once the source is identified, focused disease control programs can be implemented and farmers in the surrounding area can be alerted regarding the threats of the outbreak. Focused bio-security measures can yield better results in disease control than a blanket approach covering the entire area.

iii) **Implementation of developmental schemes:** In India, several schemes are being implemented by government agencies to promote animal husbandry thereby livelihood support to farmers. Often, a lack of information regarding livestock owners leads to arbitrary selection of beneficiaries which affects the effectiveness of the scheme. The centralized availability of information on farms/ premises and contact details will help in the effective formulation and efficient implementation of the government schemes.

iv) **Food quality assurance:** Traceability-based quality assurance programs can help record the physical, chemical & microbial quality of the meat in the abattoir. The information thus collected can help all stakeholders down the value chain to implement the required quality control system. It will also help in evaluating the efficacy of the animal health and disease control programs practiced in livestock rearing.

v) **Performance recording and increasing productivity:**

The selection of breeding stock must be based on the performance of the breeder animal and its progeny. A traceability database can provide software for the collection and updating of the performance of animals. Analysis of performance over a period of time can support decisions pertaining to breeding and feeding. The sustained practice of selection for breeding can improve the overall quality of the germplasm.

vi) **Livestock census:** India follows a quinquennial livestock census across the country. In the absence of registered farmers census involves huge cost and manpower. Availability of information on the centralized database will ease the effort and will increase the accuracy of the livestock census results.

vii) **Marketing of livestock products:** The traceability system can make available contact details of the farmers who wish to sell their animals and abattoir managers who wish to purchase the animals in its database. The centralized availability of information can help in avoiding middlemen and increasing the e-marketing practices in the meat industry.

viii) **Increase in market access and export opportunities.**

Developed countries especially European Union, Japan, Uruguay, Australia, etc have established a stringent livestock traceability system, and is supported by a legislative framework. Countries that export meat to these countries also need to follow a traceability system on par with domestic regulations. Traceback capability will enhance the confidence of consumers both in the domestic and international markets. In the long run, it will help tap the export potential by increasing market access to Indian meat and will create more income for all stakeholders.

4.0 Developments that have created enabling environment for the implementation of buffalo meat traceability in India

i) **INAPH supported the identification of dairy animals across India under NDDB:** Since 2017, the animal identification program for dairy animals was implemented across India. As of February 2022, about 200 million dairy animals have been ear tagged with bar-coded tags, and the corresponding information has been uploaded on the Information Network for Animal Productivity and Health (INAPH) database maintained by National Dairy Development Board, Anand.

ii) **Meat.Net for post-slaughter health certification in export abattoirs:** Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi monitors and controls the export of meat and meat products from India. There are about 70 APEDA registered export slaughterhouses in India. To meet the requirement of the importing countries, in the year 2014, Meat.Net database for post-slaughter traceability from the export slaughterhouses was established. All the export slaughterhouses thus follow post-slaughter traceability. By linking the information of Meat.Net with that of the INAPH database, farm-to-fork traceability can be achieved.

iii) **Aadhar Act, 2016:** 99% of the Indian population has been issued Aadhar card. Identified farmers will be the base information over which livestock population data can be linked for achieving livestock traceability.

iv) Raising education and literacy level: Traceability is information management. Increasing literacy and education level enables the implementation of the farm-to-fork traceability system.

v) Increasing mobile connectivity and penetration in rural areas: With increasing mobile connectivity, mobile phones can act as a handheld device for updating and retrieval of traceability information.

vi) **Digital India Program:** Indian Government is working intensively under the Digital India program to provide connectivity to every village in the country. Further, National Digital Livestock Mission services to livestock farmers are being provided using information technology tools. These facilities have created enabling environment for achieving traceability.

vii) **Foot and Mouth Disease Control Programme (FMDCP):** Govt of India is implementing FMD control program. It has been mandatory to tag the animals before FMD vaccination. This has ensured good coverage of the animal tagging.

5.0 Methods for identification of animals

Identification coding of animal or batch of animals by a suitable method and maintaining data of corresponding animal(s) to enable tracing trail of animal product is the core requirement of the traceability system. Retention of the code onto the animal throughout its lifetime is one of the challenges of the traceability system, especially in India where animals travel long distances for grazing. It must be ensured that the identification system followed must be resistant to varying environmental conditions, must be economical, easily applicable, and tamper-proof. Keeping these requirements in mind several animal identification methods are used across the world. Some of the methods used are branding, tattooing, visual tags, bar code tags, radio frequency identification devices (RFID) tags or implants, etc. Brief details of different methods used for the identification of animals are given in this chapter.

Characteristics of ideal identification systems:

The identification system must be easily readable even in the event of coming in contact with stains and moisture. Electronic identification enables reading of the numbers even when numbers are visually invisible. If the identification tag can be removed and reapplied it will lead to misrepresentations. RFID ear tags are developed in such a way that after application, they cannot be removed by any means. Hence, it can prevent malpractices. The identification system must not lead to unnecessary pain for animals. Tags must be centrally produced and distributed to needy farmers to maintain uniformity and to inscribe numbering patterns in tune with the approved national policy and International guidelines.

Different methods used for the identification of animals are as follows:

(a) Branding: Branding is a traditional method used for centuries. It is a method of placing permanent identification marks on the skin of animals by hot or cold means. Hot branding is done using a hot iron tool while cold branding is done using an iron tool cooled using liquid nitrogen. Cold branding is less painful compared to hot branding. As it is cheaper method branding is still widely practiced especially for identifying the owner of the animal. Some of the disadvantages of branding are: it devalues the hide; is difficult to read if used for long numbers; brands get distorted with the growth of animal; easy to copy; and painful to animals hence against animal welfare.

(b) Tattooing: It is a type of marking using indelible ink inserted into the dermis layer of the skin to change the pigment. Often for traceability purposes, tattooing is done on the inner part of the ear. It is usable only for confirmation of ownership. However, the readability of the tattoos is affected by the growth of animals, cleanliness, and change of ownership leading to multiple tattooing.

(c) Visual tagging: These are the simplest tagging system in which the number is printed onto plastic tags which are clearly visible. No electronic device is normally attached to it. Good quality tags applied skillfully can last for the life of the animal. However, poor-quality tags often fall out or get bleached making them unreadable. In European Union, animals are identified using visible plastic ear tags with laser-printed code. Ear tags are provided in duplicate to farmers so that they can be put on both ears which helps avoid confusion that may arise due to the falling of tags. Tags of different shapes, sizes, and thicknesses can be prepared depending on the type of animal to be tagged. The main disadvantage of this system is as the reading is done manually there may be some human errors. Hence, in recent days, visible tags have been developed which contain electronic RFID encoding at their base. This will enable reading both visual and electronic means.

(d) Bar-coded tags: A bar code is a machine-readable optical label that contains information regarding the item to which it is attached. Code can be read by a bar code scanner. However, if the barcode is combined with visible numbers, the tag can be read visually too. The possibility of human error can be eliminated by the use of scanners. One of the disadvantages of this system is scanning becomes difficult when tags get dirty which asks for cleaning of tags before

scanning. Bar code system involves additional involvement of cost as it requires a computer, compatible software, and scanners.

(e) **Radio Frequency Identification Devices (RFID):** A radio frequency identification device is a representative application of electronic technology with the advantage of convenience to read. Because it belongs to non-contact data reading automation technology it is not affected by a dirty environment. It also has the advantage of long-distance reading and high reading accuracy; RFID is one of the ideal options for animal identification as the chances of manipulation are very less.

(f) **Quick Response (QR) code-based tags:** QR codes are the matrix bar code system first designed for the automotive industry and are recently being used for animal identification. QR code uses four standardized encoding modes (numeric, alpha numeric, byte/binary, and kanji) to efficiently store data. Reading QR codes does not require sophisticated equipment. It can be easily read by downloading the software in mobile also. It is more convenient to use the QR codes in animal identification cards distributed to farmers.

6.0 Components of a livestock traceability system

The livestock value chain is a complex network of livestock rearers, traders, veterinary authorities, abattoir managers, retailers, consumers, etc. Integrating and networking all the players of the value chain is the basic requirement for implementing a livestock traceability system. Advanced information and communication technologies can support efforts in the networking of all stakeholders. Understanding different components for the effectiveness of traceability systems is a prerequisite for conceptualizing and implementing traceability. This chapter provides brief information about different components and the extent of their required involvement in the establishment of the traceability system.

6.1 Traceability implementation agency: The responsibility of establishing, running, and monitoring livestock traceability system has to be entrusted to a centralized agency at the national level. Tackling a variety of challenges involved in the coordination of the system necessitates establishing an empowered centralized agency. Agency must work for studying the value chain to understand ground realities, conceptualize a customized system in tune with International requirements, set up identification standards, issue identification codes, application to animals, and maintain the centralized database maintaining the information. Agency has to work in close contact with stakeholders for effective functioning.

6.2 Livestock owner: Premise/ holding registration and animal identification are the basic pre-requisite of the traceability system. The willingness of the livestock owner and his active involvement is extremely crucial. The owner needs to tag his animal and report birth, death, and movement of animals to concerned authorities. Keeping in mind the overall level of education among livestock holders system devised must be easily understandable, implementable, and preferably in vernacular language. An adequate support system must be put in place to make livestock owners understand the system and hand hold him in implementation. Ear tags and registration facility must be easily accessible to the owner. Financial support in terms of taking care of the cost of the consumables involved must be provided by the government at least in the initial stages. Utilization of the system for a range of service delivery like insurance, subsidies, loans, health management, etc will encourage the owner and makes him work actively for the success of the system.

6.3 Meat processors: Abattoir is the critical link in the livestock traceability system. Abattoirs receive animals from various sources for slaughter and meat production. If the slaughter animals received are tagged and registered, processors have to maintain identity during slaughtering, dressing, and packaging. Traceability code needs to be put on the label of meat packages to enable tracing back of the source of meat. Systems developed for traceability must take into account the complexities of slaughtering and dressing, number of persons involved, lower education level of personnel involved, speed of the processing time, convenience, and cost. Adequate checks and balances need to be put in place to ensure that labeling is appropriate and there are no errors in the coding system. Recording of quality of the meat and observations during ante & post-mortem inspection against the identification code of meat animals can work as valuable feedback for livestock owners to modify their rearing system.

6.4 Traders and transporters: Ideal traceability system requires that traders and transporters maintain records of the animals received and sold by them. They need to provide the animal transaction information and corresponding details at regular intervals to concerned authorities. Transporters must ensure that information regarding the animals which are transported is communicated to authorities before transporting them. Although they keep the animal for short period their active contribution is essential for the effective functioning of the livestock traceability system.

6.5 Consumers: Traceability involves cost and its implementation will add to the price of the products. Enhancing awareness regarding quality issues and the utility of traceability among

consumers will ensure that they pay extra for traceable livestock products in the interest of their health. If the consumers are ready to pay the extra price for the traceable meat industry will try to meet the requirements and will sustain the traceability initiatives in long term. At present awareness of the consumers on quality, issues are minimal which needs to be addressed through intensive awareness programs.

6.6 Legislation: The question of whether to make the traceability system mandatory or voluntary needs to be answered before initiating implementation. Voluntary systems are driven by consumer interest or importing country requirements. Whereas, mandatory systems require legislative backing. EU adopted a mandatory system as a consequence of incidences of BSE which seriously affected the profitability of the sector. Many countries are following a voluntary system. It is suggestible to make it voluntary initially and once the critical awareness is reached make it mandatory. To justify the cost of implementation of traceability system applications in all its forms needs to be exploited from the traceability system.

7.0 Livestock traceability initiatives in India

Multiple livestock traceability initiatives have been undertaken in India by different agencies. It's time to pool the experience of all these initiatives and develop a national database that can be used for traceability initiatives of the sector. In the year 1989, NDDB started progeny testing projects with various milk unions. Ear-tagging of animals with a unique tag ID was made compulsory for all the animals included in the programme. The data was entered in COBOL based information system during this programme. Later on, Govt. of India designated NDDB to maintain the system of issuing unique tag IDs for cattle and buffaloes for all the agencies in the country. NDDB designed Information Network for Animal Productivity and Health (INAPH) for the identification and performance recording of dairy animals in the year 2008 and was used in the genetic improvement programmes in various parts of the country. INAPH network was expanded across India by the Department of Animal Husbandry & Dairying in the year 2017. On the other hand, the Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi has launched Meat.Net for post-slaughter meat quality certification in the export abattoirs. Maharashtra Animal Identification and Recording Authority (MAIRA) implemented by Maharashtra Livestock Development Board, Pune was a state-specific initiative. INAPH and MAIRA do not have meat and abattoir components. While Meat.Net do not have a farm or backward traceability component in it. ICAR – National Research Center on Meat, Hyderabad has

developed a prototype database for achieving farm-to-fork meat traceability. At present ICAR – National Research Centre on Meat, Hyderabad is working to develop 'MeatTrace', a blockchain-based meat traceability system for the Indian buffalo meat sector in collaboration with Chainflux Pvt Ltd., Bangalore. The MeatTrace will be ready for exporters from June 2022.

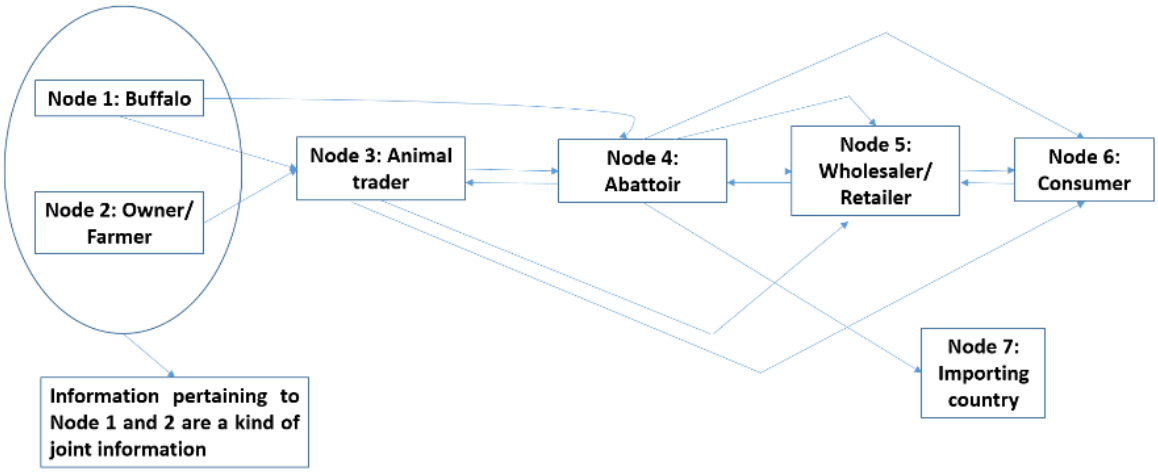

Fig. 1: Information flow in meat traceability network

8.0 Conclusions

India holds the highest number of livestock heads in the world. It also stands number one in total milk production. The country must now focus on quality to serve the domestic as well as export market, which in turn can improve the realized income for the farmer. Production to consumption system-based traceability system can help inculcate quality culture in the country. Support of information technology-based modules which are user-friendly and easily followed by the stakeholders will be the backbone of the whole system. Policymakers, researchers, and stakeholders must put collective efforts in this direction so that the animal identification program is used for all its possibilities. We also must learn from the implementation experiences of previous efforts within India as well as international programs to develop, pilot, and deploy at scale a robust traceability system that meets the unique needs of Indian settings.

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Chapter 2
LIVESTOCK TRACEABILITY AROUND THE WORLD

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The need for implementation of livestock traceability was felt across the world in the first decade of the 21st Century after the emergence of Bovine Spongiform Encephalopathy (BSE) and dioxin contamination of food products. The livestock traceability system is being followed in varying patterns in different countries like Japan, the European Union (a conglomeration of twenty-seven countries), Uruguay, Australia, New Zealand, etc. Australia has its National Livestock Identification System to keep track of livestock from birth to slaughterhouse. EU has its Trade Control and Expert System (TRACES). Uruguay has also designed a system called Traceability & Electronic Information System for the Beef Industry. In this chapter, brief details of the mode of implementation of livestock traceability systems in different countries are given.

Table 1: Overview of cattle traceability systems in different countries

Country	System name	Launch date	Mandatory	Motivation
Brazil	ERAS, SISBOV, and GTA	2002	For export animals. Unclear for rest	Control FMD and market access to the EU
Australia	NLIS (National Livestock Identification System)	1999	Yes	Market access, food safety, animal disease
United States	None	2012	For animals crossing state lines only	Control disease for animals crossing states
New Zealand	NAIT (National Animal Identification and Tracing)	2006	Yes	Market access and animal health
Canada	CCIA (Canadian Cattle Identification Agency)	2002	Yes	Market access accelerated with BSE
Argentina	Argentina Animal Health Information System – Sistema de Gestion Sanitaria (SGS)	2007	Yes, for young animals	Control FMD and market access

Uruguay	Division de Contralor de Semovientes (DICOSE) and National Livestock Information System	2006	Yes	Control FMD and market access
Japan	Cattle Traceability Law	2003	Yes	Response to BSE discovery
European Union	Each member state has its own system name	2000	Yes	Animal health and BSE response
Mexico	National Livestock Individual Animal Identification System	2003	No	Animal health, census, traceability
South Korea	South Korea beef traceability system	2004	Yes	Consumer food safety assurance and animal health

(Ted and Glynn, 2012)

2.1 Traceability in European Union

The EU is a conglomeration of 27 member countries that operate and negotiate as a unit. Traceability became a concern for the EU in the 1990s because of worries about bovine spongiform encephalopathy (BSE). Since the discovery of BSE in cattle as the probable cause of deadly human form, known as the new variant Creutzfeldt Jakob Disease (CJD) there was a large scale crisis in the European cattle sector. Between 1990 and 1999 there was a reduction of 6 % in sales of cattle meat in the EU. The British meat sector suffered the most from the crisis. In 2000, several discoveries of BSE were made in other European Countries, like France and Germany. By mid-February 2001, the consumption of cattle meat had dropped by as much as 80 % in several parts of Germany. This forced the EU to legislate a mandatory animal traceability system to protect consumers and producers. EU introduced its Trade Control and Expert System (TRACES), in April 2004. The system provides a central database to track the movement of animals within the EU and from third countries. Regulation EC 178/2002 Article 18 implies that a producer must know enough information (*i.e.* keep sufficient records) to be able to trace forward one step and trace back one step. Article 11 of Regulation EC 178/2002 adds that all food and feed imported into the EU for placement on the market must be at least equal to the EU standards. This means that to export to the EU, a product must be traceable in the same way that products are traceable in the EU. This regulation has caused all countries that want to export pork to the EU to develop

traceability programs that are compatible with the EU system. Since its implementation, the EU traceability system has become a model protocol for different countries.

The system for the identification and registration of bovine animals in the EU comprises the following elements:

(a) Ear tags to identify animals individually;

(b) Computerized databases;

(c) Animal passports;

(d) Individual registers are kept on each holding.

2.1.1 Identification of animals

Animals must be identified by one of the following methods: (a) two plastic or metallic ear tags; (b) one plastic or metallic ear tag together with brand marking; (c) a tattoo; or (d) an electronic identifier contained in a ruminal bolus. Commonly every animal is identified by an ear tag applied to each ear ('approved ear tags'). Ear tags bear the same unique identification code ('unique identification code'), which makes it possible to identify each animal individually together with the holding on which it was born. Ear tags shall be applied at the latest when the calf reaches the age of six months or when it is separated from its mother or when it leaves the holding. Birth and death of animals must be reported to authorities. The movement of the animal must be brought to the notice of the authorities. If any animal is not tagged and if it is not possible to prove the identification of the animal within two working days the animal will be destroyed under the supervision of Veterinary authorities without providing any compensation. If on one holding, the number of animals for which the identification and registration requirements are not fully complied with is more than 20 %, a restriction will be immediately imposed on the movement of all the animals present on the holding.

Ear tags include information on the Member State of origin together with information on the individual animal. The most appropriate codified form of such information is the two-letter country code together with a maximum of 12 digits. Bar codes could be authorized in addition to the country code and a maximum of 12 digits. Keepers shall be authorized to acquire in advance if they so wish and in compliance with the applicable national provisions, a number of ear tags proportionate to their needs for a period not exceeding one year. In the case of holdings which keep no more than five animals, the competent authority may not provide in advance more than

five pairs of ear tags. In case of replacements due to loss of tags, it must contain, in addition to the information provided for and distinct from it, a mark expressing in Roman numerals the version number of the replacement ear tag.

The characters forming the identification code on the ear tags are as follows:

(a) the first two positions shall identify the Member State of the holding where the animal is first identified *e.g.* Italy – IT, Austria – AT, Germany – GE

(b) the characters following the country code shall be numeric and shall not exceed 12 digits;

Ear tags must be made of flexible plastic material which is tamper-proof, easy to read, re-usable, and designed in such a way that they can remain attached to the animal without being harmful to it and must carry only non-removable inscriptions.

The model of the first ear tag shall be as follows:

(a) It shall consist of two parts, a male part, and a female part;

(b) The length of the ear tag shall be at least 45 mm for each part;

(c) The width of the ear tag shall be at least 55 mm for each part;

(d) The characters shall have a minimum height of 5 mm.

2.1.2 Passport

Every animal after tagging will be issued a passport which contains details of the owner, parental ear tag number, animal ear tag number, signature of the last keeper, name of issuing authority, and the date of issue of the passport. A passport containing the animal and ownership details must be obtained after tagging the animal. The information contained in the passport and the register should be in a form that allows animals to be traced. Whenever an animal is moved, it shall be accompanied by its passport.

In the case of the death of an animal, the passport shall be returned by the keeper to the competent authority within seven days after the death of the animal. Each animal keeper shall complete the passport immediately on arrival and prior to departure of each animal from the holding and ensure that the passport accompanies the animal. In case a calf under four weeks of age needs to be moved its navel must be healed. In such a case, member states may provide for it to be accompanied by a temporary passport containing necessary information approved by the competent authority.

The temporary passport shall be issued to the first keeper of the calf and shall be completed by each subsequent keeper with the exception of transporters. The keeper shall submit the

temporary passport to the competent authority before the animal is four weeks old, or within seven days following the event, if the animal dies or is slaughtered before it is four weeks old. Where the calf is still alive, the competent authority shall issue a final passport within 14 days of receipt of the temporary passport. Final passports shall record the details of all previous movements made by the calf as recorded on the temporary passport. The calf may not move more than twice between holdings, accompanied by a temporary passport.

2.1.3 Registers to be maintained in holding

The register kept on each holding shall contain at least the following information: date of birth of the animal on the holding, in the case of animals departing from the holding, the name, and address of the keeper, with the exception of the transporter, or the identification code of the holding, to whom/which the animal is being transferred, as well as the date of departure, in the case of animals arriving on the holding, the name and address of the keeper, with the exception of the transporter, or the identification code of the holding, from whom/which the animal was transferred, and the date of arrival and the name and signature of the representative of the competent authority checking the register and the dates on which such checks are carried out.

2.1.4 Inspection by authorities

The competent authority of each Member State should carry out on-the-spot inspections, which should in general be unannounced. Those inspections shall each year cover at least 10 % of holdings situated in the territory of each Member State.

2.1.5 Beef labeling

A compulsory beef labelling system was introduced and is obligatory in all Member States from 1 January 2000. Under this compulsory system, operators and organizations marketing beef should indicate on the label information about the beef and the point of the slaughter of the animal or animals from which that beef was derived. Under this compulsory system, operators and organizations marketing beef should, in addition, indicate on the label information concerning origin, in particular where the animal or animals from which the beef was derived were born, fattened, and slaughtered. Information additional to the information concerning where the animal or animals from which the beef was derived were born, fattened, and slaughtered may be provided

under the voluntary beef labeling system. The objective of labeling is to give maximum transparency in the marketing of beef.

2.1.6 Bovine animals when put out for summer grazing in mountain areas

Each pasture is given a specific registration code which must be registered in the national database for bovine animals. The person responsible for the pasture establishes a list of the bovine animals. This list must contain at least:

— the registration code of the pasture, and for each bovine animal:

— the individual identification number,

— the number of identifications of the holding of origin,

— the date of arrival at pasture,

— the estimated date of departure from the pasture.

The list must be validated by the veterinarian in charge of the control of the movement of bovine animals. The information contained in the list is introduced in the national database for bovine animals at the latest seven days after the date when the animals are moved to the pasture.

2.2 Livestock identification system in Australia

Australia introduced National Livestock Identification System (NLIS) for traceability of livestock in 1999 to track cattle during disease and food safety incidents. Since then it has expanded to enable not only cattle but also sheep and goats to be traced from property of birth to slaughter for biosecurity, meat safety, product integrity, and market access. NLIS Ltd operates the central NLIS Database for recording livestock movements and other transactions. Every farm owner needs to have an account in the NLIS database for updating the information. However, the farm owner some other person to update information on his behalf.

2.2.1 Cattle identification and traceability

- Cattle producers must apply NLIS accredited radio frequency identification devices (RFID) ear tags or a rumen bolus to each cattle bred on their property.
- When cattle move from one location to another, their devices are scanned electronically with a tag reader, or the NLISID number is read visually and the number is noted. The consignment's

movement details are then recorded on the NLIS database and automatic notifications of the movement are sent to the appropriate account holders and authorities via email.

- If cattle are bought or sold through a sale yard or sold to an abattoir, the sale yard or abattoir must record the movement.
- If cattle are bought or sold privately, the person who receives the cattle is responsible for notifying the database of the movement.
- If cattle move between properties, the movements must be recorded on the database, even if the properties have the same owner.

2.2.2 Sheep

Sheep and managed goats must be identified with an NLIS visual or RFID ear tag before they leave the property on which they were born (exemptions are given for dairy, show, feral or unmanaged goats in some states). If animals are identified with a visual tag, their movements can only be tracked on a mob basis. If animals are identified with an RFID tag, and the tag numbers are supplied to the NLIS database when a movement is recorded, their movements can be traced on an individual basis.

2.3 Livestock traceability system in Japan

The first case of Bovine Spongiform Encephalopathy (BSE) was reported in Japan in August 2001. Consequently, consumption of beef reduced by 58 % in just two months forcing the industry and the government to take serious steps regarding livestock traceability. A project was initiated on an emergency basis and by March 2013 all 4.5 million bovines were ear tagged with unique identification numbers. From 01st January 2003 (date of enforcement of the law) it was made mandatory for all cattle owners/ keepers to apply ear tags with unique identification codes on to bovines and report a birth, death, and transportation details to National Livestock Breeding Centre (NLBC). In June 2003, Japan passed legislation requiring traceability from the farm through the retail sale. Under the new law, processors, distributors, and retailers will be required to provide traceability information from the slaughterhouse to the retail outlet by December 1, 2004. The law applied to beef muscle meats and excluded offal, trimmings, ground beef, and processed products. Wholesalers and retailers need to provide traceability information by individual animal or by lot numbers. Penalties for noncompliance ranged from warnings to fines and making violators' names public. The government assisted (low-interest loans and credits) to

help companies cover the cost of the computer and labeling technologies required to implement the system.

In the retail sector, traceability emerged as a marketing tool to "make consumers feel good" about the meats they purchase. Japanese consumers were critical of the government's role in handling the BSE crisis and other food-related problems. Supermarkets seized the opportunity to fill the gap in consumer confidence about the government's ability to protect the safety and quality of the food supply. Traceability was incorporated into assurance programs as a way to create trust, ease consumer anxiety, and assure consumers that "this" supermarket chain can provide the safest food. In a culture where the loss of reputation is often of greater concern than litigation, supermarkets stake their reputations on being able to provide safe food. To supply these supermarkets, producers must stake their reputations as well.

2.4 Livestock traceability system in Uruguay

Uruguay, a South American country has established one of the model traceability systems for its livestock. The country realized the importance of traceability after the outbreak of Foot & Mouth Disease (FMD) which seriously affected beef marketed from its country. As Uruguay exports, 75 % of its meat produced it was inevitable for it to address the issue of disease outbreaks and implement traceability-based health management and quality assurance system to enhance the confidence of consumers and importing countries. Uruguay has some 45,000 stock farmers, 25% of whom run family operations. Some 80% of the cattle belong to 20% of the producers. Traceability for individual animals became mandatory by law in September 2006, and the roll-out of the scheme nationwide was completed in June 2011. Producers received training from the government regarding the implementation issues.

When the animal is born farmer has to send a request to concerned authorities to provide identification tags. Once the request is received two tags per cattle (one is electronic and the other is for visual identification) are sent by mail within 24 hours along with the name of the business and the number of tags being sent. The farmer only needs to add the gender, breed, and age of the animals and return the document to authorities who will scan and put the document into the electronic system. Each of the country's livestock producers has a unique registration number, linked to the rural records office, which makes it possible to locate each producer in real-time. In

meat processing and packing plants, the products obtained from the animals are labeled with bar codes linking them to the herd from which they originated. This identification is retained practically up to the point of sale. Consequent to the implementation of a comprehensive traceability system the prices paid to Uruguayan meat became higher than those paid for the production of direct competitors like Australia, Brazil, and Argentina. The country's exports are now shipped to over 100 markets around the world.

Chapter 3
ROLE OF INFORMATION NETWORK FOR ANIMAL PRODUCTIVITY AND HEALTH (INAPH) IN TRACEABILITY IN MEAT VALUE CHAIN – AN INSIGHT

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E-mail: nileshn@nddb.coop

Introduction

Fork-to-farm traceability is emerging as a very important concept in the food market, in terms of food safety. Consumers desire to trace any product that is being purchased, to its origin. Meat pieces available on the shelf, are especially needed to be labeled to enable the consumers to track the origin of the livestock. Especially, international trade is affected if effective traceability measures are not in place.

Apart from market demand, maintaining sound traceability can help in various ways. When we can trace back disease occurrence, we can know the origin of the disease and then can design various control measures effectively. We can also certify and provide evidence to the customers on the measures taken to prevent diseases. This becomes particularly important for promoting one-health. We can easily find out the origin of contaminants like acaricides and antibiotics in the food product and thus penalize/incentivize producers based on the market demand.

Demonstrating an effective traceability system provides evidence of control measures taken to ensure food safety; which increases customer confidence. It further complies with regulations of various countries and thus facilitates earning more revenue from our products through export markets. A huge livestock population with very small animal holding makes it challenging to ensure traceability in the livestock sector in India. Countrywide free movement of livestock across such huge geography makes it difficult to trace back the origin of the meat beyond the slaughterhouse as there have been no regulations to ensure the identification of the animals entering slaughterhouses. Addressing these issues would require a solution that is uniform and enforced across the country and can record every aspect of traceability.

An effective traceability system for livestock products would require the following information.

- Unique identification of animals, having biometric identification over and above unique ear tag or RFID based identification would be ideal.

- Parameters related to species/breed/strain of the animal
- Location of animal
- Age of animal
- Information on movements of the animal
- Information on all the vaccinations and treatments
- Information on pre-slaughter parameters – reproductive status, physical deformities, etc.
- Information on post-slaughter parameters like carcass examination details.
- A comprehensive system to uniquely identify each piece of meat/product from slaughter to shelf. AND
- System for storage of reference sample or DNA of the animal to be able to resolve customer complaints by matching with a reference sample.

Information Network for Animal Productivity and Health (INAPH) developed by NDDB for implementing Genetic Improvement programmes and recording animal health, and vaccination related transactions and also to provide nutrition related advice to farmers for balanced and cost effective feeding of livestock, can be very effectively used to track the origin of the animal, its movement throughout the life, health issues, treatment given, etc. from farm to slaughterhouse. In addition to this, a connecting system originating from the slaughter house to consumer needs to be developed which is a missing link at present.

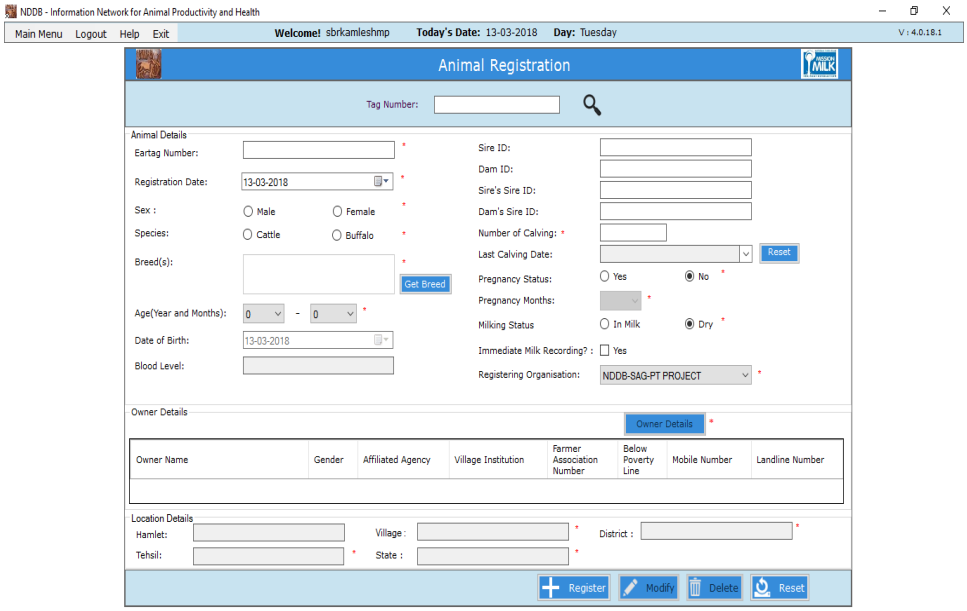
INAPH is a bunch of software that works in harmony and helps in capturing any intervention done on cattle and buffaloes. The main concept implemented in INAHP is a recording of all the transactions against the unique identification number of an animal. The unique ID is a 12-digit number created following guidelines of the International Committee for Animal Recording (ICAR). The ICAR guidelines prescribe 15-digit identification number where in first 3 digits are the country of origin of an animal. The 12-digit ID used in INAPH has an internal arrangement to pre-fix India's country code thus making data compatible with international system. Among 12 digits first 11 digits are running serial numbers and the 12^{th} digit is a check digit that is derived based on the first 11 digits. This makes it easy to validate the correctness of the number entered in the system.

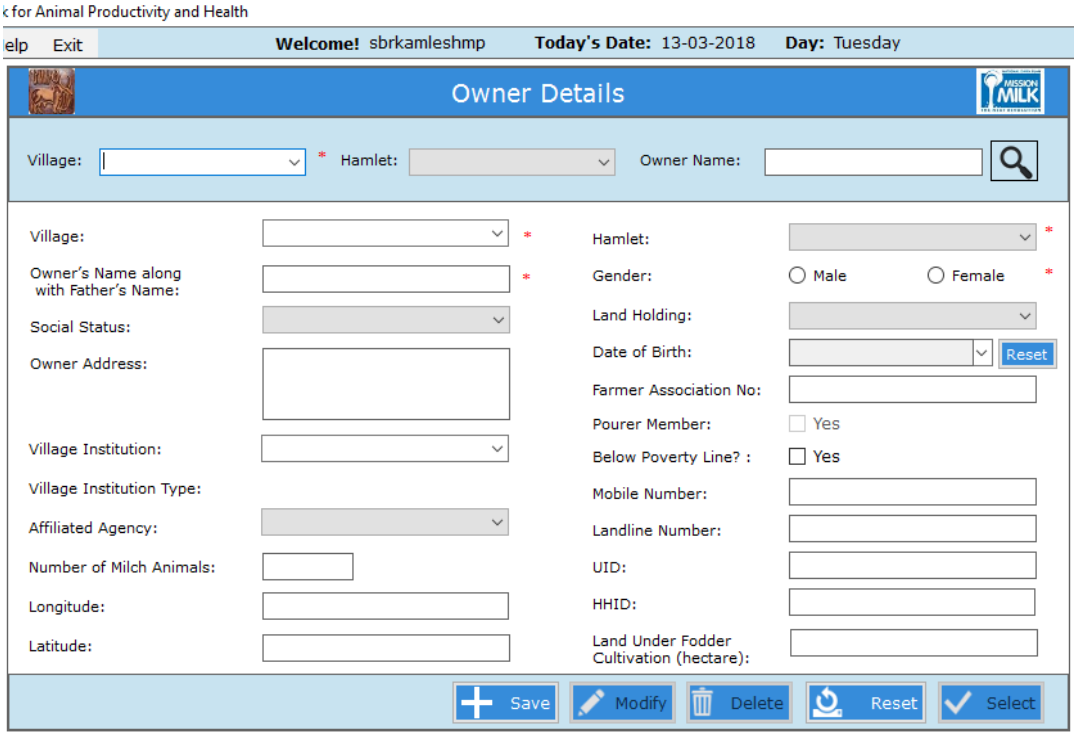
This 12-digit ID is normally printed on plastic ear tags and applied to the animal's ear. This can also be incorporated into RFID or any other form of the animal identification system. Since animal movement is very frequent across the states and districts, the ID number does not incorporate location information. However, when the animal is registered in the INAPH system, the location of the animal is registered along with ID and thus it is easily linked to geography.

In India, farmers own 2-3 bovines per household. Due to this, their information requirement is very limited. They can remember and recall productivity, reproduction events, and disease incidence of each animal without keeping any written or digital records. Also, services based on data usage are not in practice in India. Due to this, farmers normally do not use any digital platform to record events occurring in the lifetime of animals. This makes it difficult to collect information required for various purposes. INAPH platform is designed to capture animal-wise information by the service providers. Each service provider can capture any intervention carried out on animals like breeding, treatment, vaccination, production measurement, growth measurement, movement, sale, the birth of calf, death, etc. which creates the life history of animals. While providing services, samples from animals are taken for various purposes and sent to laboratories. Labs then enter results in the lab module in INAPH and thus this information is also integrated into the life history of animals. Thus, if entering all interventions by service providers is made mandatory, individual animal-wise life history is created.

A service provider that reaches first to the animal for providing any service, registers the animal in the INAPH system. This transaction captures the animal's species, breed, location, owner

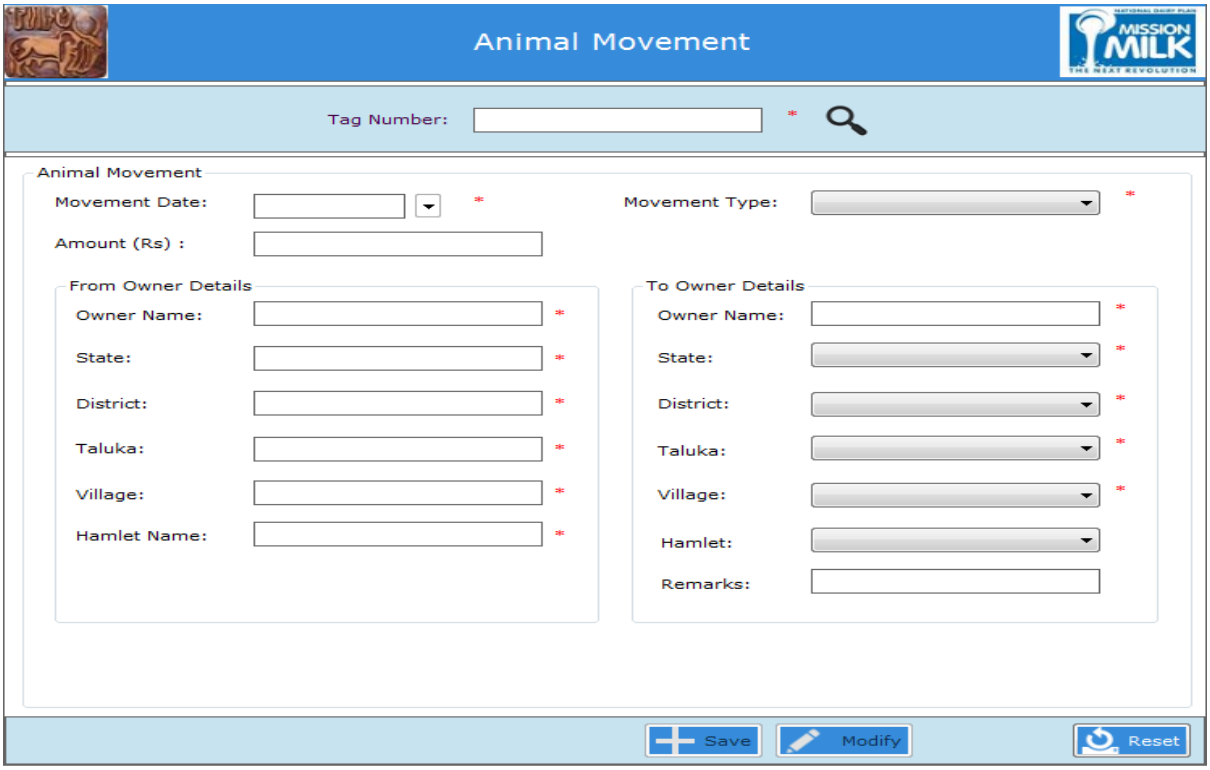
information, animal pedigree, and physiological status. Registration of animals is once in a lifetime activity for a particular animal. This information is then available to any other service provider during subsequent services.



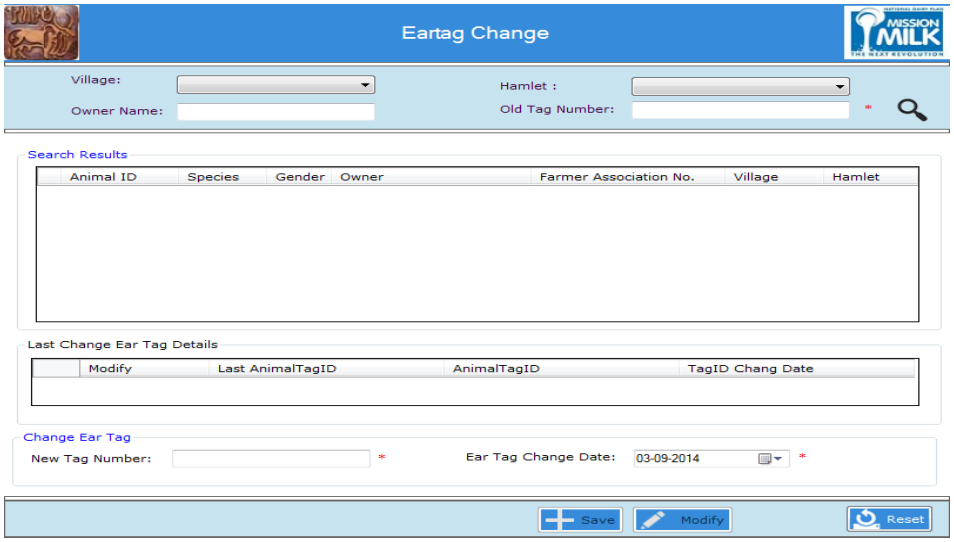


Another way of on-boarding of animals in the INAPH system is through calving transactions made after successful Artificial Insemination. In this case, the exact date of birth of an animal is also

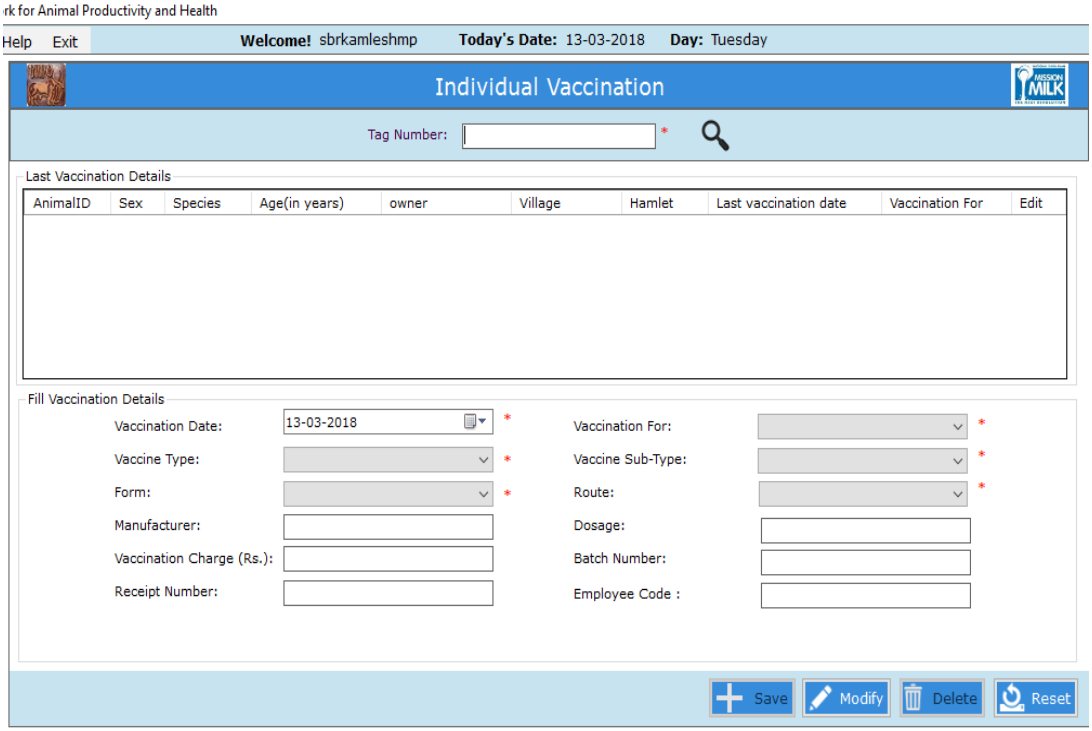
captured along with pedigree information. This makes it very useful for establishing the origin of animals as well as the relation of a registered calf with its Dam, Sire, Sibs, etc. When the animal is sold to another farmer, any service provider can record this transaction. During this new location where the animal is sold is also recorded. In case, the animal sold transaction is not captured by any service provider but if the animal is presented for any service to a service provider in the new area, the service provider can enter the details of the new owner and location through re-registration functionality in INAPH system. There is the provision of recording any death, culling, etc. in the system. Thus, it makes it possible to record the movement of animals during their lifetime and we can generate animal passports using this information.

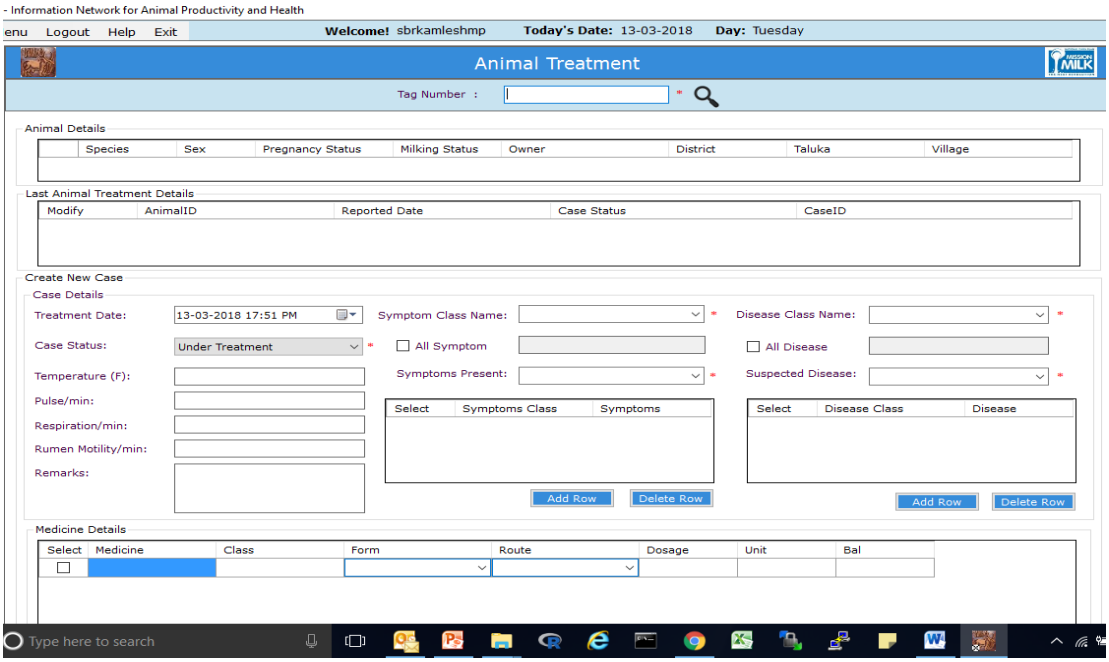


There can be incidences where an animal's ear tag is lost due to various reasons. In such a case, a new ear tag is applied on the animal's ear for visual identification, and using the ear-tag change functionality of INAPH old tag is mapped with the new tag and thus entire history of the animal is transferred to the new tag. While the old tag number is retained in the database but it is not allowed to be re-used to maintain the uniqueness of the animal's identity.



INAPH has a provision to record vaccinations and treatment given to the animal. This makes it easy for disease traceability and helps in establishing control measures taken for control of disease like Foot and Mouth Disease in livestock. This will immensely help in the export of livestock products.





While recording treatment transactions, antibiotics used are also recorded. Each transaction is recorded along with the date of intervention. Using this information, withdrawal periods to be observed after the use of certain drugs can be ascertained at the time of slaughter.

Since all the data is stored in the database on a common server, it is easy for all stakeholders to retrieve and analyze the information from various angles. The information is made available online through the INAPH-MIS portal. For traceability purposes, animal's life history can be retrieved by the Animal Management report.

16-Jun-2022

INAPH Individual Animal History Sheet

Animal TagID: 105097372366 **Registration Dt:** 02-Aug-2017 **Birth Date:** 02-Apr-2012

Organization: NDDB-SAG-PT PROJECT **Owner:** PATEL ARVINDBHAI MANGALBHAI

Breed: HF, Gir **Species:** Cattle **Hamlet:** NAVI BORAL **Mobile No:**

Location: Borol (Bayad, ARVALLI, GUJARAT) **EBV_MilkYield:**

Status: Alive-F **DamID:** **SireID:**

Date	Transaction	Description
02-Aug-2017	Registration	Age at Registration: 5 Years, 4 Months;Lactation Completed: 5;Pregnant: Yes; Pregnancy Period: 8 Months; Immediate MR: No; Owner: PATEL ARVINDBHAI MANGALBHAI; User:sbrhiteshgp
15-Aug-2017	AI	Lactation:2 - AIType:Test - BullID:ALM-HG-40008 - User:sbrhiteshgp
25-Nov-2017	PD	PDStatus:Y - User:sbrhiteshgp
20-May-2018	Calving	Lactation:2 - Type:Single Female - Ease:Normal - Calf:F, 105097372880 - User:sbrhiteshgp
16-Jul-2018	Health	CaseID:14052019051827316 - Disease:Fever - User:sbrbyd11
09-Aug-2018	AI	Lactation:3 - AIType:Test - BullID:ULD-HFGR-885 - User:sbrhiteshgp
02-Sep-2018	AI	Lactation:3 - AIType:Test - BullID:ULD-HFGR-875 - User:sbrhiteshgp
03-Nov-2018	AI	Lactation:3 - AIType:Test - BullID:ULD-HFGR-940 - User:sbrhiteshgp
16-Nov-2018	Health	CaseID:15052019094825221 - Disease:Clinical Mastitis - User:sbrbyd11

02-Jan-2019	Health	CaseID:16012019084320906 - Disease:SCM-CMT - User:sbrhiteshgp
23-Feb-2019	PD	PDStatus:Y - User:sbrhiteshgp
25-Aug-2019	Calving	Lactation:3 - Type:Single Female - Ease:Slight Pull - Calf:F, 340109498828 - User:sbrhiteshgp
16-Sep-2019	Health	CaseID:6072020022312300 - Disease:Fever - User:sbrbyd11
13-Nov-2019	AI	Lactation:4 - AIType:Test - BullID:BAF-DURVAS - User:sbrhiteshgp
07-Jan-2020	Health	CaseID:26022020060443360 - Disease:SCM-CMT - User:sbrhiteshgp
20-Feb-2020	PD	PDStatus:Y - User:sbrhiteshgp
02-Mar-2020	Health	CaseID:26032020105603972 - Disease:SCM-CMT - User:sbrhiteshgp
25-Aug-2020	Calving	Lactation:4 - Type:Single Female - Ease:Normal - Calf:F, 340109509840 - User:sbrhiteshgp
20-Oct-2020	Health	CaseID:11112020082057590 - Disease:SCM-CMT - User:sbrhiteshgp
29-Nov-2020	AI	Lactation:5 - AIType:Test - BullID:DHO-KA16633 - User:sbrhiteshgp
27-Feb-2021	PD	PDStatus:Y - User:sbrhiteshgp
06-Sep-2021	Health	CaseID:20092021044351828 - Disease:SCM-CMT - User:sbrhiteshgp
16-Sep-2021	Health	CaseID:20092021044419688 - Disease:SCM-CMT - User:sbrhiteshgp
25-Sep-2021	Calving	Lactation:5 - Type:Single Female - Ease:Normal - Calf:F, 340145208503 - User:sbrhiteshgp
07-Oct-2021	MR	Lactation:5 - RecordNo:1 - DayYield(Kg):19.76, SampleBoxNo.:305606, SampleBottleNo.:470 - Fat%:4.30 - User:sbrnaviborolmr
12-Nov-2021	MR	Lactation:5 - RecordNo:2 - DayYield(Kg):21.35, SampleBoxNo.:305606, SampleBottleNo.:583 - Fat%:4.80 - User:sbrnaviborolmr
08-Dec-2021	MR	Lactation:5 - RecordNo:3 - DayYield(Kg):20.38, SampleBoxNo.:305606, SampleBottleNo.:675 - Fat%:4.70 - User:sbrnaviborolmr
09-Dec-2021	AI	Lactation:6 - AIType:Test - BullID:SAG-HX-10065 - User:sbrhiteshgp
08-Jan-2022	MR	Lactation:5 - RecordNo:4 - DayYield(Kg):19.50, SampleBoxNo.:305606, SampleBottleNo.:793 - Fat%:5.10 - User:sbrnaviborolmr
10-Feb-2022	MR	Lactation:5 - RecordNo:5 - DayYield(Kg):17.22, SampleBoxNo.:305606, SampleBottleNo.:901 - Fat%:3.70 - User:sbrnaviborolmr
12-Mar-2022	MR	Lactation:5 - RecordNo:6 - DayYield(Kg):15.18, SampleBoxNo.:305606, SampleBottleNo.:1075 - Fat%:3.70 - User:sbrnaviborolmr

At present, the Government of India has taken a mission to register all the bovines in the INAPH system. So far more than 21 Crore out of 30 crore bovines have already been registered in INAPH. All the service providers are encouraged to use INAPH for their day-to-day activities so that a national database can be built up for animals. There is an immense opportunity if all slaughterhouses are provided access to this database and post-slaughter information are entered into the system. This will ensure farm-to-fork traceability of animal products in the country and will help to boost export.

Chapter 4
OVERVIEW OF WEB-BASED MEAT TRACEABILITY SYSTEM ESTABLISHED BY NATIONAL RESEARCH CENTRE ON MEAT, HYDERABAD

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[1]ICAR – National Research Centre on Meat Chengicherla, Hyderabad 500 092
[2]Infovet Pvt. Ltd., Bangalore
E-mail: girishlpt@gmail.com

4.1 Introduction

India is the number one buffalo meat exporter in the world. However, most of our meat export is restricted to developing countries only. The country can enhance market access in the International market by implementing a traceability-based quality assurance system in the meat industry. Earlier initiatives in the country for livestock traceability were focused more on performance recording with little emphasis on registering the abattoirs and developing traceability labeling requirements on meat packages. To address this issue National Research Centre on Meat, Hyderabad has developed and pilot implemented a model meat traceability system under the Indian Council of Agricultural Research funded research project, 'Developing traceability model for buffalo meat industry for quality assurance and augmenting exports. As part of the project, the Centre has developed a livestock traceability database that enables the storage of information about animals, farms, and abattoirs in the web-based server system. The database provides provision for enrolment of animals, farms, abattoirs, veterinarians, and meat processing plants. It enables real-time updating and retrieval of information. The database provides provision for the recording of the performance of animals and different farm activities like insemination, pregnancy diagnosis (PD), calving, weight gain, milking, drying, vaccination, deworming, feeding, feeding, purchase, sales and medication. It provides provision for the creation of a farm activity reminder system for efficient management of the herd. In the abattoir, information regarding ante & post-mortem inspection can be recorded and uploaded to the database. The centre can provide all the support required to farms and abattoirs in implementing the system. The system was developed with the technical support of Infovet Pvt Ltd., Mumbai. Although the system was developed with buffalo meat in mind, the model can be used for other meat animals also with minor modifications. This chapter provides brief information on the utility and mode of usage of the database by stakeholders.

4.2 Designing traceability code:

Traceability of meat requires identification of the animal, animal farm, abattoir, meat product processing plant, and retail units. All the functional units need to be coded and corresponding information to be stored in the data warehouse for retrieval as per traceability requirements.

4.2.1 Identification of buffaloes

Individual buffaloes which have been registered will be given a fifteen-digit traceability code (*e.g.* 900220000000278) allotted by International Council for Animal Identification & Recording (ICAR). The code is internationally accepted and will suit the requirement of importing countries. The code in India can be taken from National Dairy Development Board (NDDB) or through authorized private agencies. A firm 'Identis Tech Solutions Pvt. Ltd, Hyderabad' was identified and Radio Frequency Identification Tags along with allotted numbers were procured. Code can be put on to buffalo ears using radio frequency identification devices (RFID) ear tags.

Figure 1: RFID ear Applicator, ear tags, and reader

4.2.2 Identification code for animal farm, abattoir, meat product processing plant, etc.

There are no guidelines or internationally accepted norms for identification codes for buffalo farms/ premises. Hence, a format for coding was developed keeping in mind ease of

identification and allotting and the code is based on Postal Index (PIN) as a base. The identification code devised and its different portions are as mentioned below:

e.g. 500092(01/02/03/04/05/06)001

Code has three different components

Component 1: First six numbers will be the PIN of the location of the farm/ abattoir/ processing plant/ retail unit.

Component 2: Next two numbers will indicate the type of operation.

01: Buffalo farm;

02: Abattoir;

03: Meat product processing plant;

04: Abattoir with processing;

05: Meat retail unit;

06: Meat product retail unit;

07: Meat & products retail unit;

Component 3: Last three numbers will be the serial numbers of the farm/ firm allotted upon registration. e.g. First buffalo farm enrolled in Chengicherla, Hyderabad with pin code 500092 will have the following code: 50009201001. The first abattoir in Chengicherla, Hyderabad will get code: 50009202001

Advantages of pin code-based method of coding of farm/premises/firm

- Postal Index Number is allotted by postal departments across India and is easy to find and understand by any person involved.
- It will also be easy to find the location based on the initial six codes as most people are well versed with PIN codes of common places.
- A single format for farm, abattoir, processing plant and the retail unit will help in easy allotment of numbers.

4.2.3 Traceability labeling of meat packages

Traceability code can be put on to the meat packages after slaughter by barcoding. Using the code, the retailer and the consumer can trace back the origin of meat through SMS messaging or through an internet database. Bar code produced is water and low-temperature resistant which enables its retention during various processing and storage conditions of meat.

Figure 2: Bar code stickers and bar code reader

4.3 Designing and launching a web-based meat traceability system

A survey was undertaken to understand the buffalo farming system including its value chain. A Survey of thirty buffalo dairy farms was carried out in Hyderabad, Warangal, Ludhiana, Nagpur, and Solapur. A survey was focused on operational steps in buffalo farms, management methods, slaughter facilities, marketing channels, etc. Several abattoirs were visited to understand the processing steps. Based on the survey results, discussions, and information collected, the documentation system was finalized and the web-based database for traceability was designed. The database was designed to support the uploading of information pertaining to animal farms, abattoirs, processing plants, and retail units. In addition, the provision for retrieval of the information by the consumer was studied.

4.4 Information flow in the system

4.4.1 Information Flow: To enable a flow of information central data server was created which would maintain the country data. To facilitate easy access to the software platform, a web-based software application was developed. This enables all the authorized persons including farmers to access the data. This would enhance the transparency and hence credibility of the database. For accessing the software platform, the stakeholder should open the website http://www.livestocktraceindia.com.

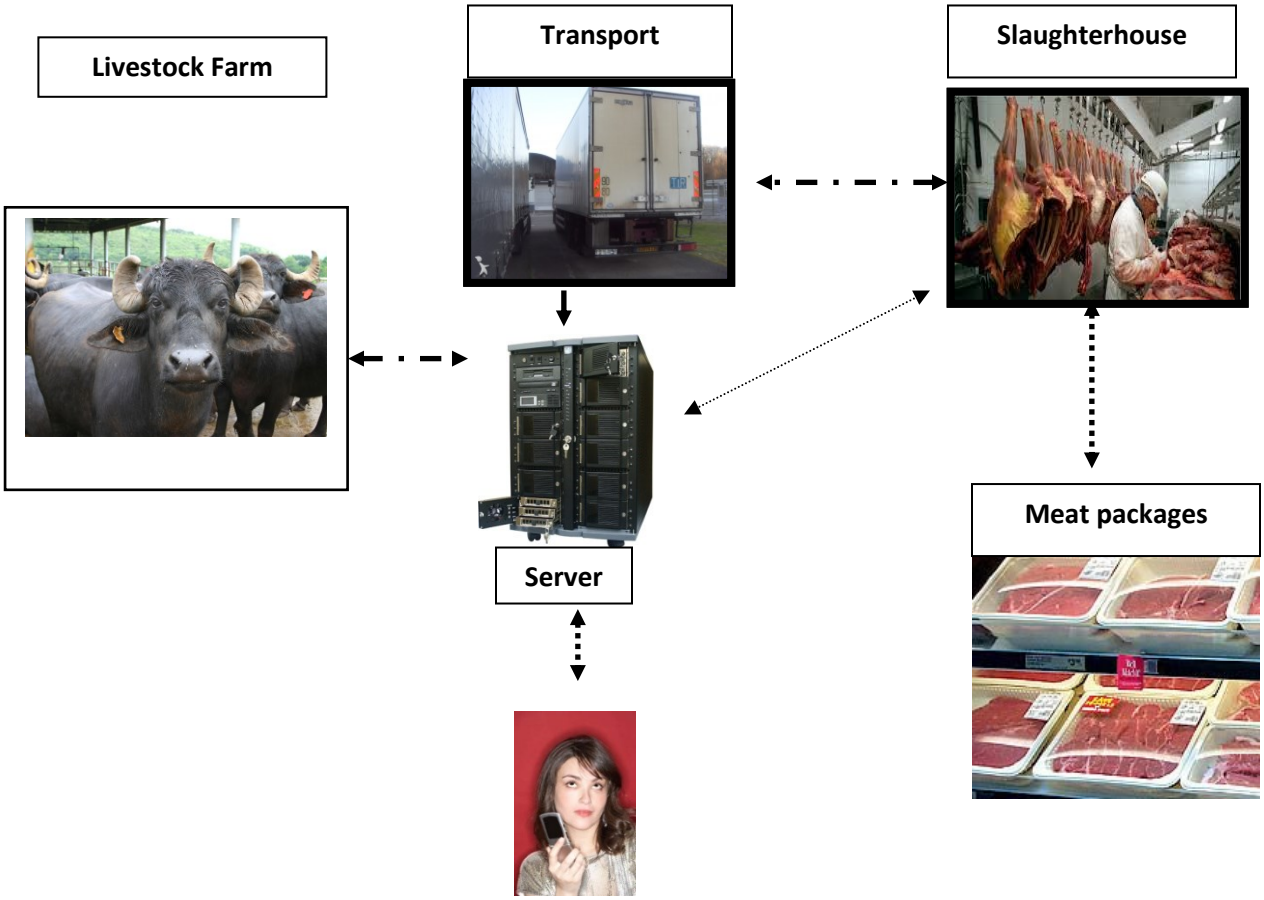

Figure 3: Overview of a meat traceability system.

4.5 Online registration: For online access to livestock traceability functions, first start your internet, use any browser, and type http://www.livestocktraceindia.com/index.asp

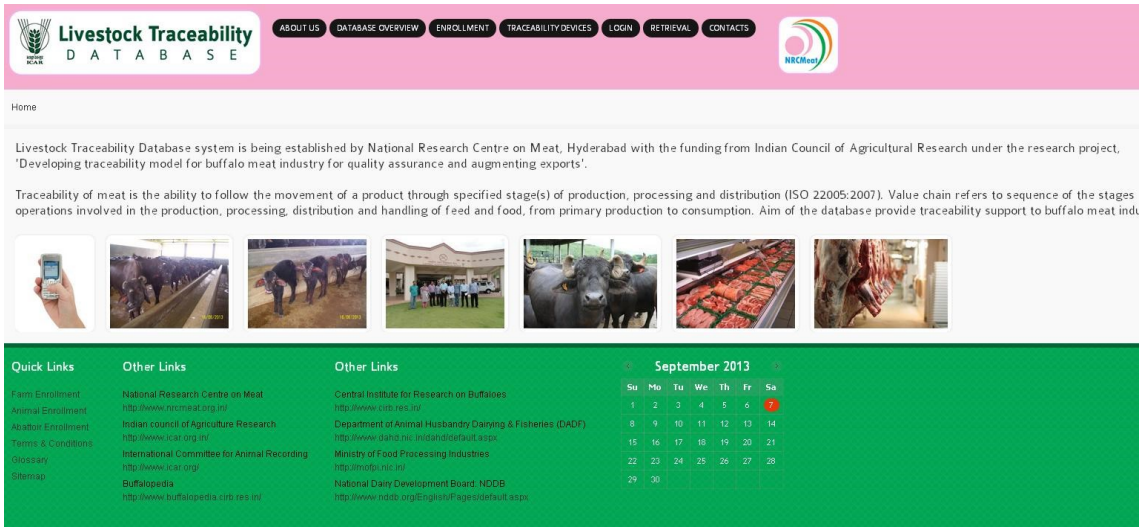

Figure 4: Home page of the livestock traceability database (www.livestocktraceindia.com)

4.6 Enrolments

4.6.1 Farm/Premises Registration: Farm/premises registration here is defined as the place where the animals are kept (even if temporarily, for example, dairy farm or college farm). The registration is done to trace the types of animals reared in premises but also to get in touch with the owner or caretaker of the animals, in case some intervention is needed. To enroll click the 'enrollment' link on the home page and select the 'farm' link. Required information can be filled in and the form can be submitted which will go to an administrator for approval and for allotment of a unique farm/ premises identification number. Upon approval from the administrator, the farmer will get an e-mail message following which he can log on to the site and enroll animals and utilize *Herdman* software. In the future all premises-related activity records can be updated and maintained using the log-in id generated.

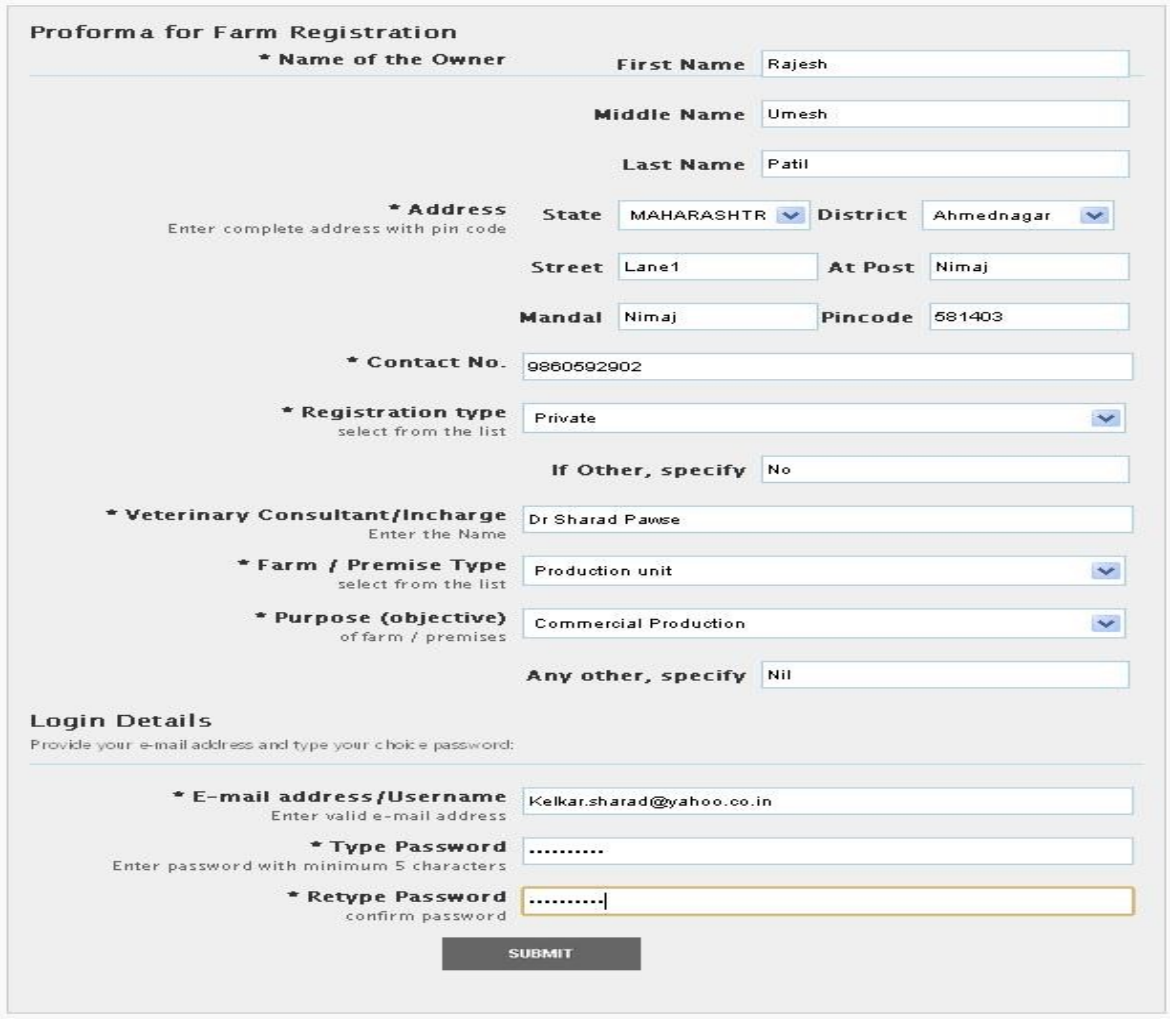

Figure 5: Farm enrollment form

4.6.2 Animal Registration

The individual animal is considered as the unit of data recording. It is important that the domestic livestock are uniquely identified and registered in the database. Animal ear tags encoded with ICAR-approved identification numbers can be obtained from many agencies. After applying the tags to animals' registration can be done on the database regarding the animals. The health, breeding, and milk record of the identified animal can be maintained on the database.

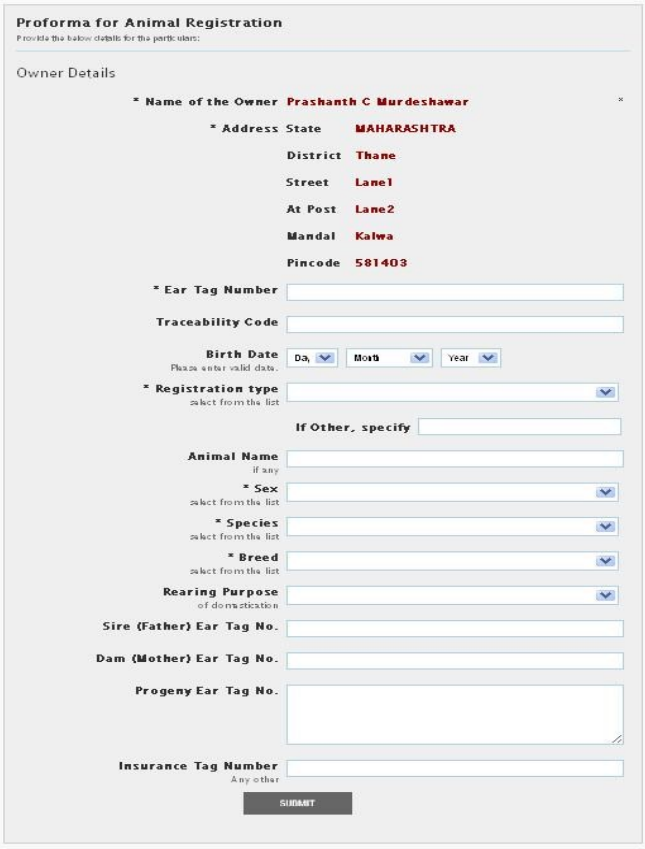

Figure 6: Animal enrollment form

The traceability code of animals and its maintenance throughout the value chain will help tracing back the meat to its source of origin. For registering animals first you need to login through Farm/Premise user id and password. After login, click on the button 'Animal Enrollment' which will open up 'Proforma for animal registration'. Details of animals can be fed in the system using the proforma.

It is extremely easy to create the individual files of each animal on the farm using the 'Herdman management' link. Before starting this, you need to keep the information about the animal ready. This should be done farmer-wise. The farmer needs to keep the following information about animals ready so that registration of the animal can be accomplished fast.

ID number (identification number), that is the ear tag number.

Sex: Whether that animal is female or male.

Species: Species of animals e*.g.,* buffalo, sheep, goat, etc.

Breed: Breed to which animal belongs to *e.g.* Murrah, Bhadawari, etc.

Date of birth/Age: In case you know the exact date or approximate age (closer to months), either of these can be entered. In case you are entering the age, then the date of birth will be calculated and updated.

Parity/lactation number: Herdman takes Heifer as '0' parity and then subsequent parities are calculated. This means that the parity and lactation number would be similar for animals registered in this program.

Date of the last calving: In case the animal is lactating or else if you know approximate 'Days-in Milk' this can be entered and the program would calculate the date of calving from this information.

Milk produced: In the case of milking animals, total milk yielded as on the day of registration.

In the case of a pregnant animal the last estrus date on which animal was inseminated or mated. If this is not known then the approximate gestation days, from which the program will calculate the last heat and insemination date and this will be updated once you save the information and exit from the registration form. A farmer must quickly build up the current parity record as early as possible. Otherwise, the information becomes old and the physiological status of the animals would change.

4.6.3 Abattoir Registration: Abattoir is a facility where animals are slaughtered scientifically. Abattoirs can be registered online. For online registration, the required information in the 'abattoir' enrolment form can be filled and the form can be submitted to the administrator for approval and

for allotting identification code. After filling in all the information click on submit button for information submission.

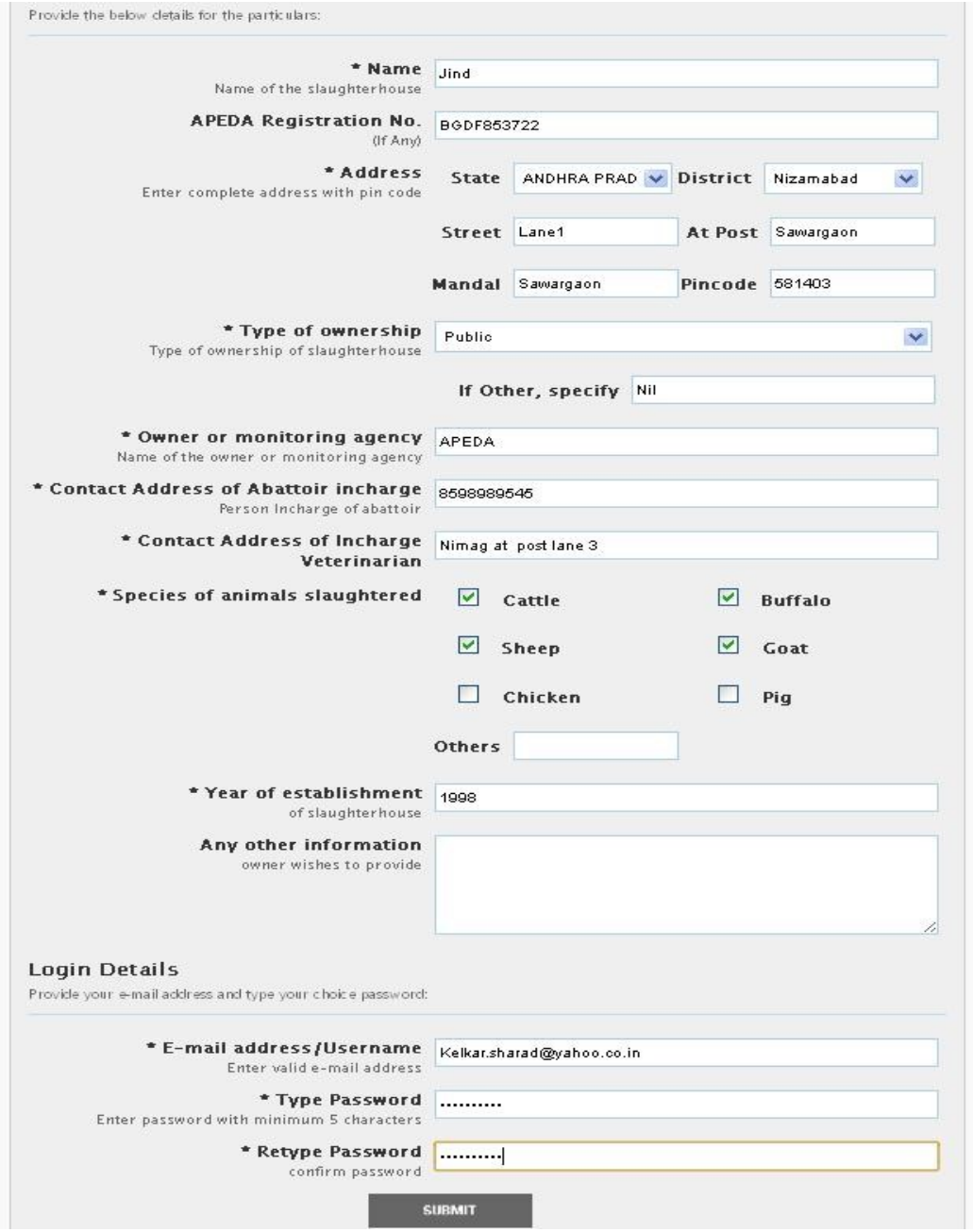

Figure 7: Abattoir registration form

4.6.4 Abattoir entry

The database provides provision for entering findings or information pertaining to slaughtered animals. While packaging, meat can be packaged with either individual animals or as

the batch number. If the batch number is to be given on meat packages ear tag number of every animal which part of the batch needs to be mentioned. A veterinarian can enter the details of animal, antemortem, and post-mortem findings in real time using handheld device. Else, a form can be filled by hand by the Veterinarian which can be uploaded to the database by the computer operator.

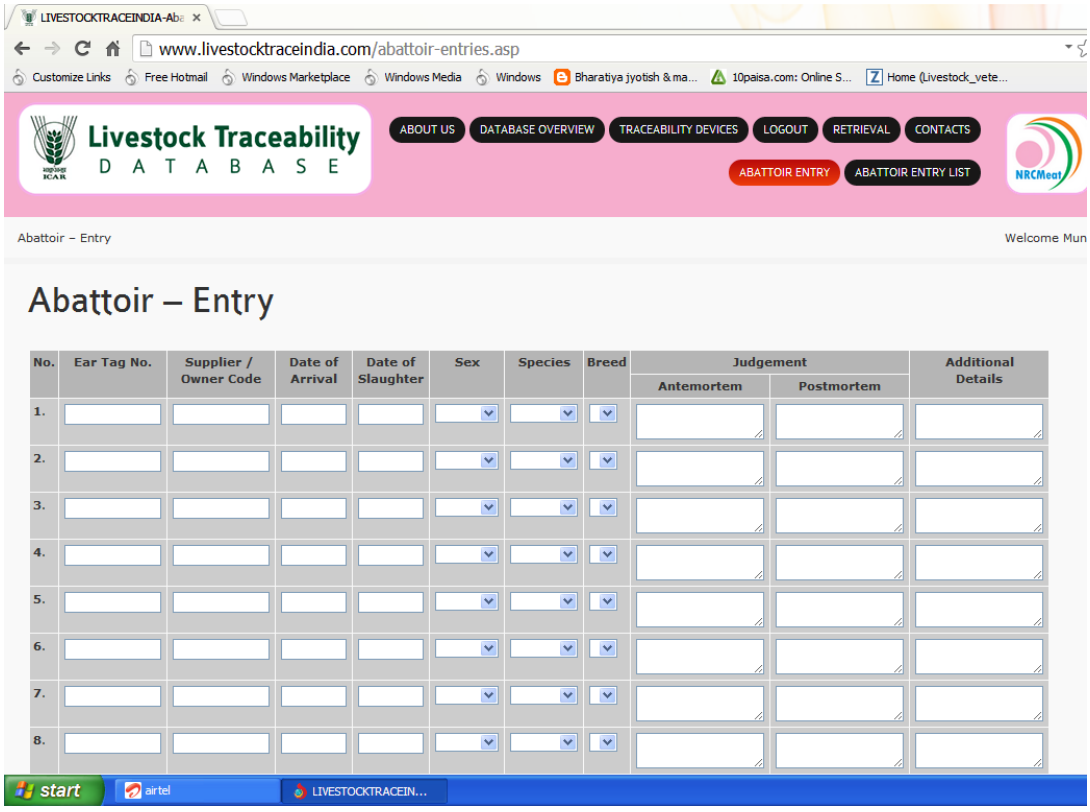

Figure 8: Slaughter details entry from

4.7 Administrator Module: The administrator needs to approve the abattoir, farm/premise, animal, and veterinarian after entry by the stakeholders. Administrators can also create species and breed information in the formats. Only authorized persons can enter as administrators to manage the information. Information is monitored and assembled in appropriate form using the administrator module.

4.8 Animal-related data for scientific management for farm

Vaccination: Normally, all the animals in the premises are vaccinated hence it is possible to develop premises-based vaccination maps for any given area. To enter vaccination details, enter

in the premises registration page and click 'Vaccination', enter all the details, and click 'Save' to save the data on the server.

Disease outbreak reporting: In case of any disease outbreak, the premises-based data can be entered. The outbreak data entry can be done only by an authorized officer. Once the data is entered the alerts are generated for the outbreak investigation agency, which after investigations finally authorizes the data updating on the server. It may be noted that unless the outbreak is finally confirmed by the authorized officer, the outbreak is not officially updated on the server.

Disease incidence: There is also the facility for reporting diseases of economic importance, such as mastitis, a hereditary disease in calves, tuberculosis, abortions, etc. The diseases to be reported can be decided and entered into the server by the 'Administrator'. For entry of the disease incidence the authorized officer can enter the information by opening the 'disease incidence reporting' page and entering the required information.

Reports related to premises*:* The primary aim of premises registration is to enable rapid tracing of the premises where particular types of animals are maintained. For example, if in a village a few cases of FMD have been detected and the team has to get in touch with all the farmers rearing large animals, say around 5 km perimeter of the hot spot, the database would be able to generate such a list with contact details. An alert message then can be sent to these farmers and in a planned way the outbreak investigations and preventive measures can be implemented. The reports however can be generated only by designated officers of the Department.

4.9 Retrieval

4.9.1 Online Retrieval

Information pertaining to contact details and addresses of the abattoirs and farms can be retrieved using the traceability code of farm and abattoirs in the retrieval link shown in the home page of the database (www.livestocktraceindia.com).

Similarly, details of the origin of meat, place of its processing, antemortem, and post-mortem information be retrieved using the traceability code or batch code on the meat package.

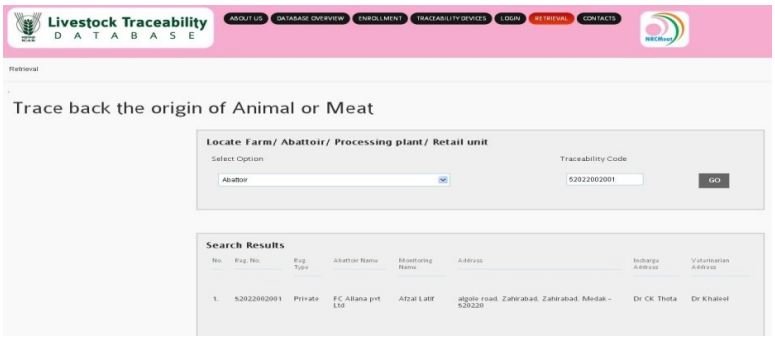

Figure 9: Internet based tracing back of origin of meat

4.9.2 Retrieval using Short Message Service (SMS)

Purchasers or consumers can retrieve the information of abattoir, farm, and origin details of the meat using mobile based Short Message Service (SMS). Traceability code can be messaged to 09645221221 in the following format: LS Traceability code (e.g. LS 625252222). Normal SMS charges will be applicable for retrieval.

4.10 Herd Management

Upon logging in using the farm/ premise username and password, 'Herdman management' link will be visible on the main menu. Click it to open Herdman application.

Daily Action

The action menu displays overall options in the software for scientific management of the herd.

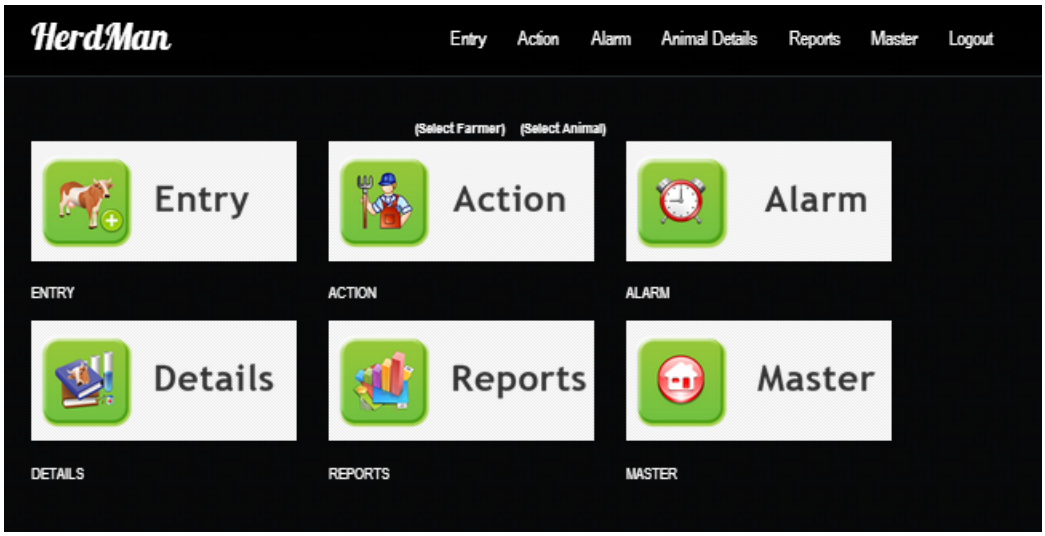

Figure 10: Herdman action menu

The action list includes:

Parameter

- Check for first heat after calving
- Check for subsequent heat
- Check for PD
- Animal expected to Calving.
- Animal expected to dry off

The action list generated can be generated, in case the manager/workers are to be handed over the list.

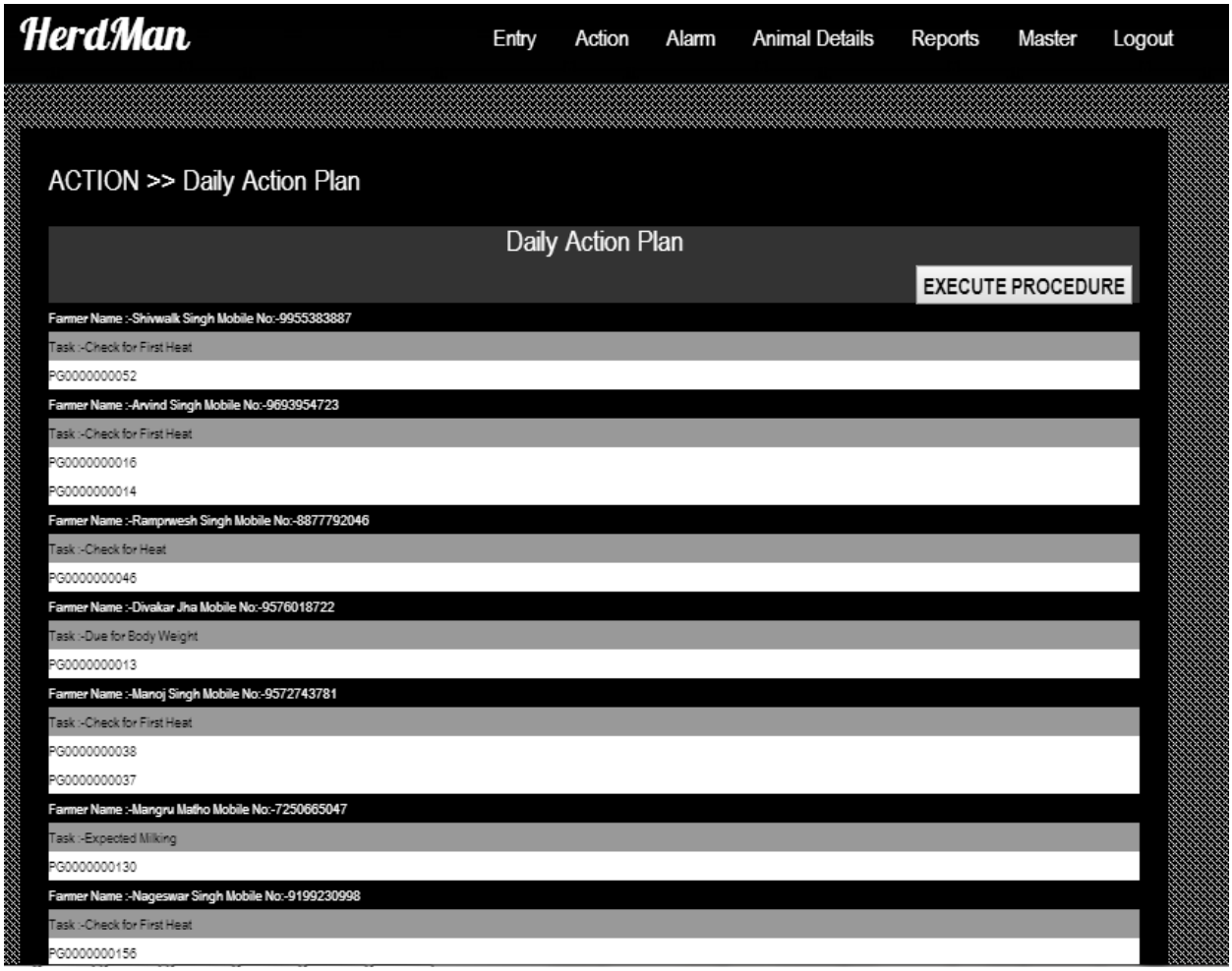

Figure 11: A daily action plan for the management of livestock farm

Action list generated farm-wise for the following tasks

Check for first and subsequent heat: Since the default value for the parameters 'First Heat After Calving' and the 'Subsequent Heat' are different, the action list of eligible animals for these two activities are distinct. Although, the subsequent action that is insemination data entry format is similar to both. Clicking the arrow against the 'Check Heat' column would generate the heat entry form, whereas, clicking 'Preview' would generate a printable report. For the first heat after calving the list would be generated as per the default parameter defined for 'Action List'. For example, if it is defined as 30 days then all the animals after 30 days of calving that have not shown first heat would be displayed.

Check for Non-Return: These are the animals that have shown heat and have been inseminated earlier and have missed at least one heat. Such animals are regarded as unconfirmed pregnant and

their list will be generated as ‘Non-return’. Such animals are to be just checked once again for heat so that one is sure about their potential pregnancy status. In case the animal is not showing heat no action needs to be taken.

Pregnancy Check: It generates a list of all the animals that are due for a pregnancy check. For printing, the report click on PD. This report also serves as the PD entry form. The ID numbers of the animal also carry ‘*’ or ‘**’ which means that the animal is due for PD1 or PD2, respectively. For printing, the information click on ‘Preview’ and then click on the print option. The PD checklist will be generated as per the defined parameters. Once the animal is confirmed pregnant, and the information is entered in “Herdman”, all the subsequent physiological events will be automatically calculated.

Expected for calving: To make necessary provisions for calving as well as to facilitate ‘steaming up’, it is necessary to identify animals 20-25 days ahead of the date of calving. This enlists pregnant animals close to the expected date of calving. The time required for steaming up can be decided by defining an alarm parameter.

Due for Milk Recording: These are the animals that are due for milk recording. The interval would depend on the parameter defined earlier. For example, if it is defined this value as ’10 days’ then every 10th day the animals that are to be recorded for milk is generated. Clicking at the column would generate the milk entry format similar to the one described earlier.

Expected to dry off: Herdman calculates the ‘expected drying’ off date based on the PD-II entry. The Action List generates the ID numbers of all the animals that are due for drying off on that date. To generate a report, click the ‘expected drying’ button. The report gives all the relevant information about the animals to be dried off.

Entry

Go to the main menu and click the "Entry” menu.

After clicking on the ‘Entry’ button, the screen will display options as shown in fig. 6.5

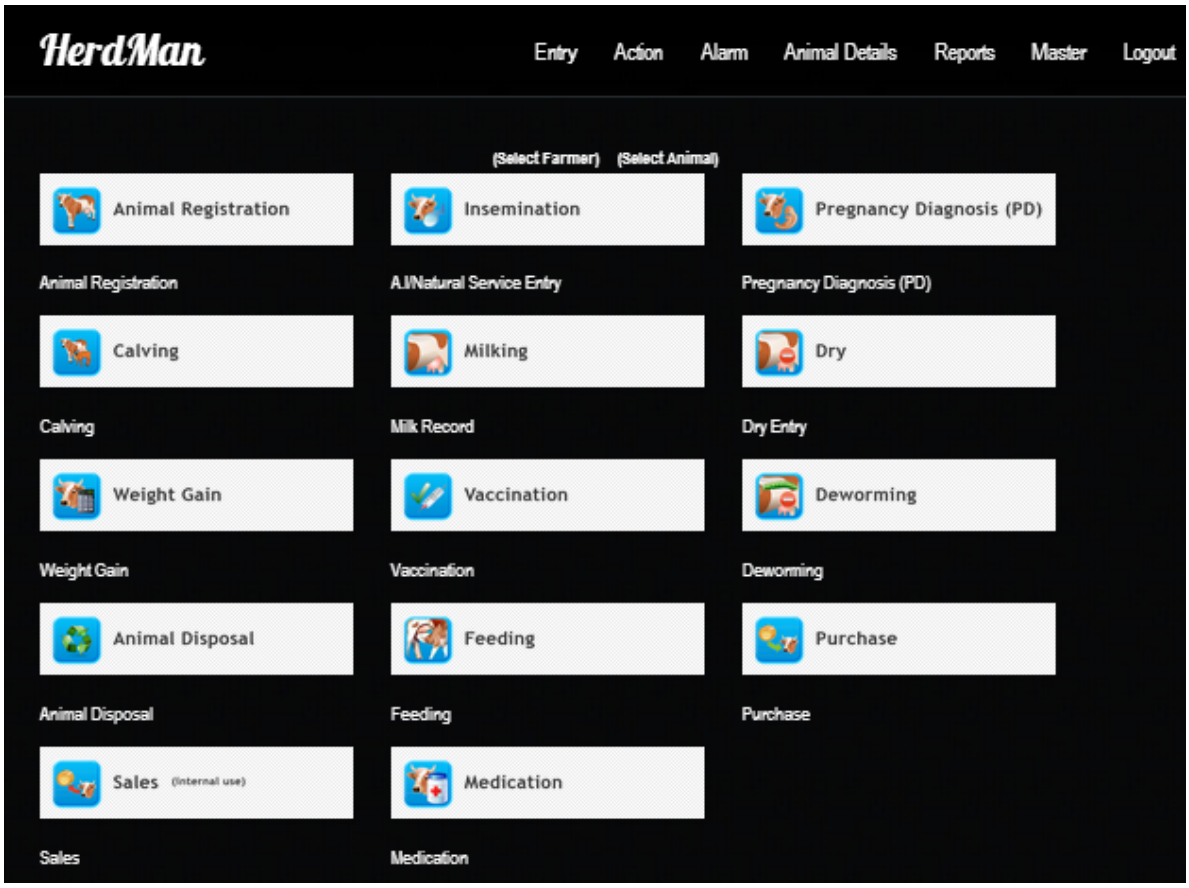

Figure 12: Different entry options in the Herdman software system.

Insemination Entry: In case the AI worker wants to enter AI for individual animals, it can be done by clicking on 'Insemination' and filling Insemination form. Depending upon the nature of

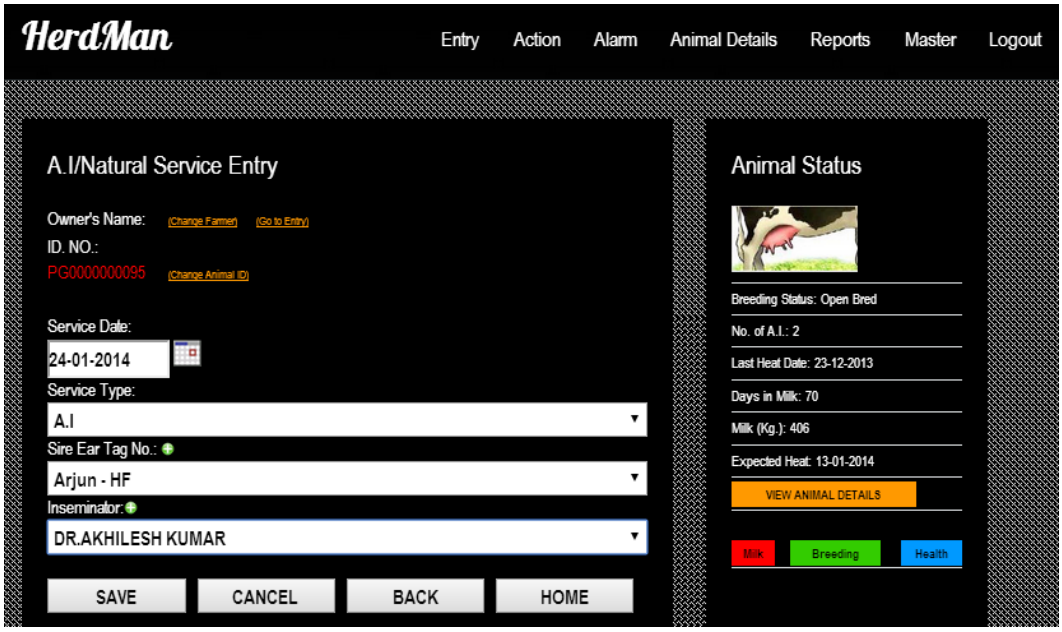

Figure 13: Artificial insemination entry format

heat (first or subsequent) select the id number from a combo box.

The form will show other details of the animals such as breeding status, heat sequence, last heat date & expected date of heat. Now enter the actual heat date. Select service type by clicking in the box to display options, 'AI', 'natural', and 'skip'. Then select sire (in case of AI such bulls name will be displayed whereas if natural is selected then accordingly farm bull will be displayed). Select the desired one. Now click in the inseminator box to generate the default list of inseminators (only when AI is selected as an option). Likewise, enter all the insemination details. Now click 'Save' to save all the entries.

Pregnancy Diagnosis (PD) entry: The PD entry of the individual animal can be done by entering the results of PDI or PDII examination in the appropriate cells. PD results cannot be entered unless the animal has been entered for heat or AI/service

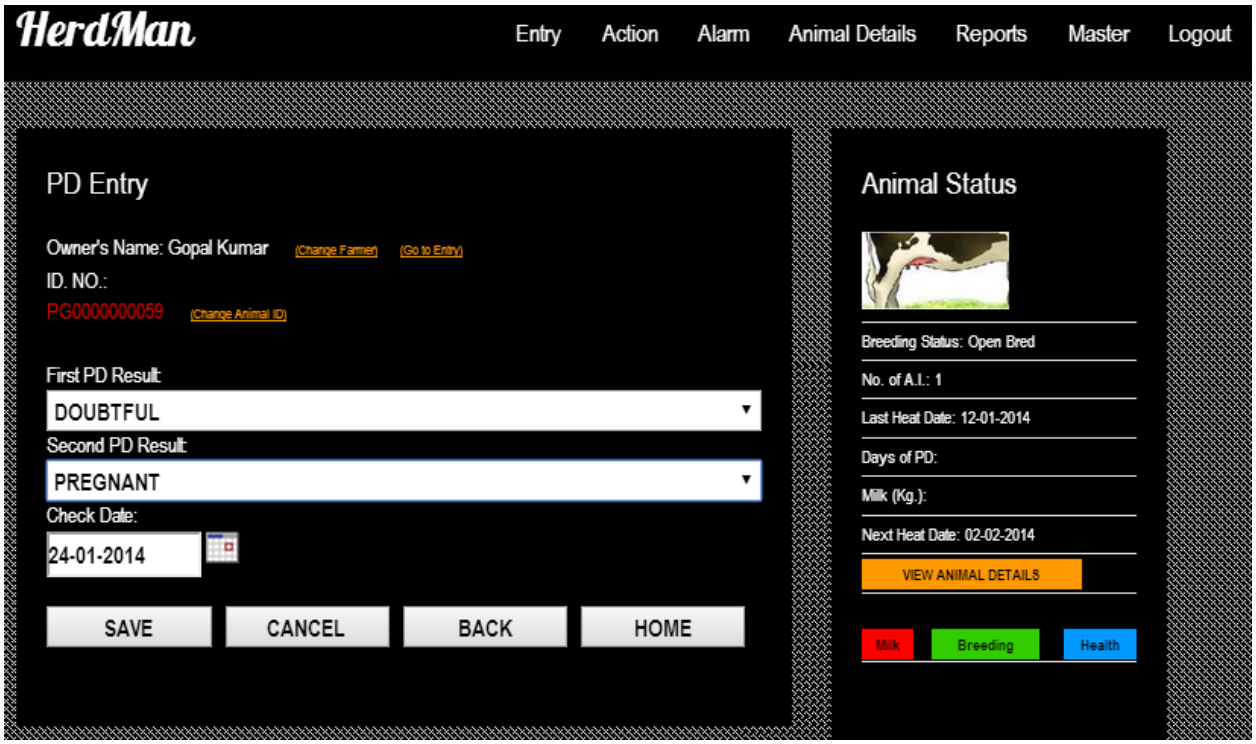

Figure 14: Pregnancy diagnosis entry format

Calving Entry: For recording day-to-day calving, go to the main menu and click on the 'breeding and milk' and 'calving' submenu. This will display an entry form. The entry form with the I.D.

number of all the animals that have been confirmed pregnant will be displayed. Record all the relevant details and click 'Save' to update the record. Click 'BACK to return to the main menu.

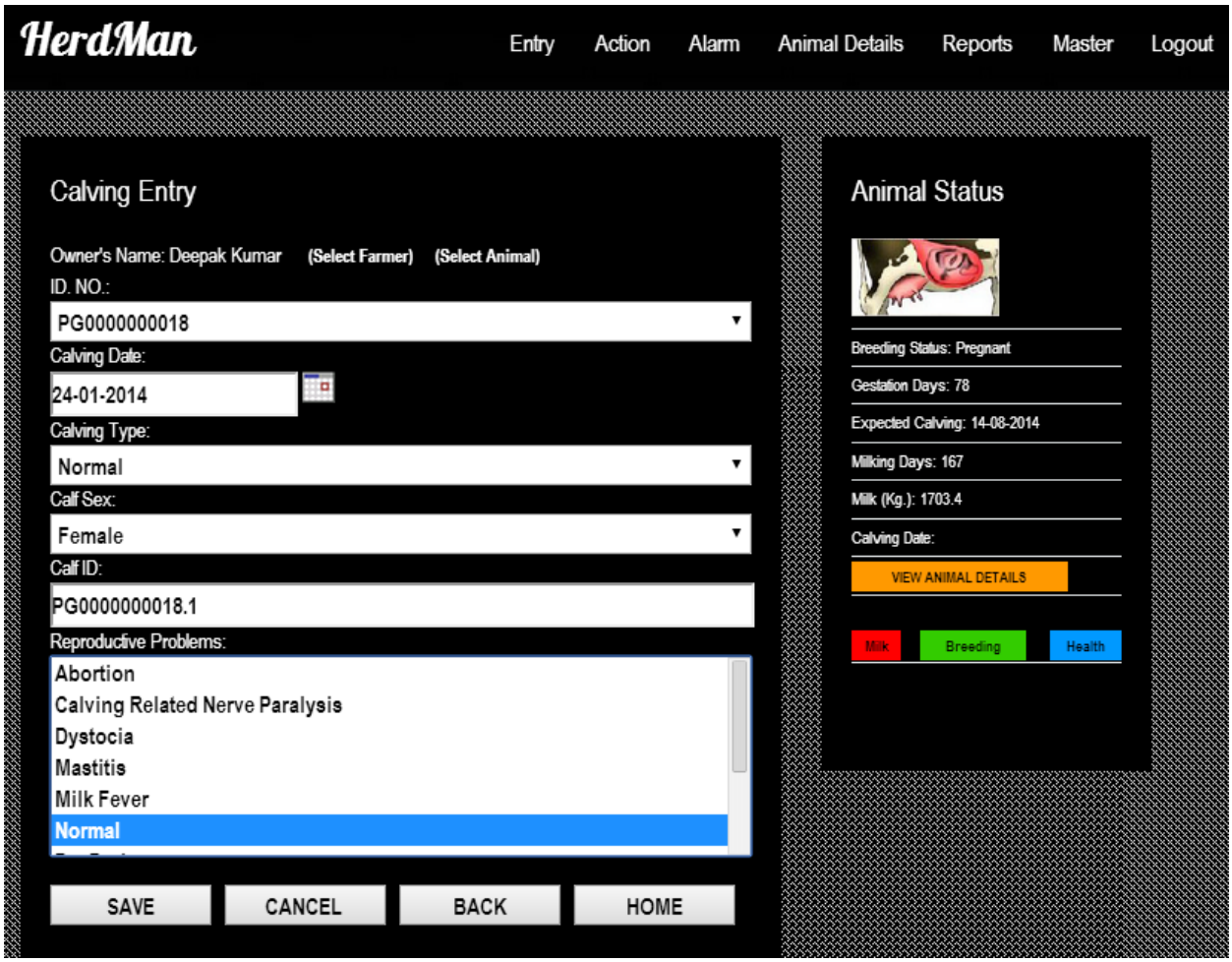

Figure 15: Calving entry format

Now enter the date of calving, select if the calving was normal or abnormal, and select the 'calving problems'. Other details can be entered by typing in the box provided below the 'Calving Note'. This could be any surgical procedure, 'fetatomy' procedure, etc. Such information will be stored in the individual animal folder. Click 'Save' to save the information. After saving the information the calf will also be registered for which you need to give the new ID number. When the new calf file is created the parent details are automatically taken from the database of the dam. It is recommended that for calves you must have a separate 'lot' so that data management is easy.

Milk Entry: The entry form for individual animal milk data entry can also be opened from the 'Milk Entry' main menu.

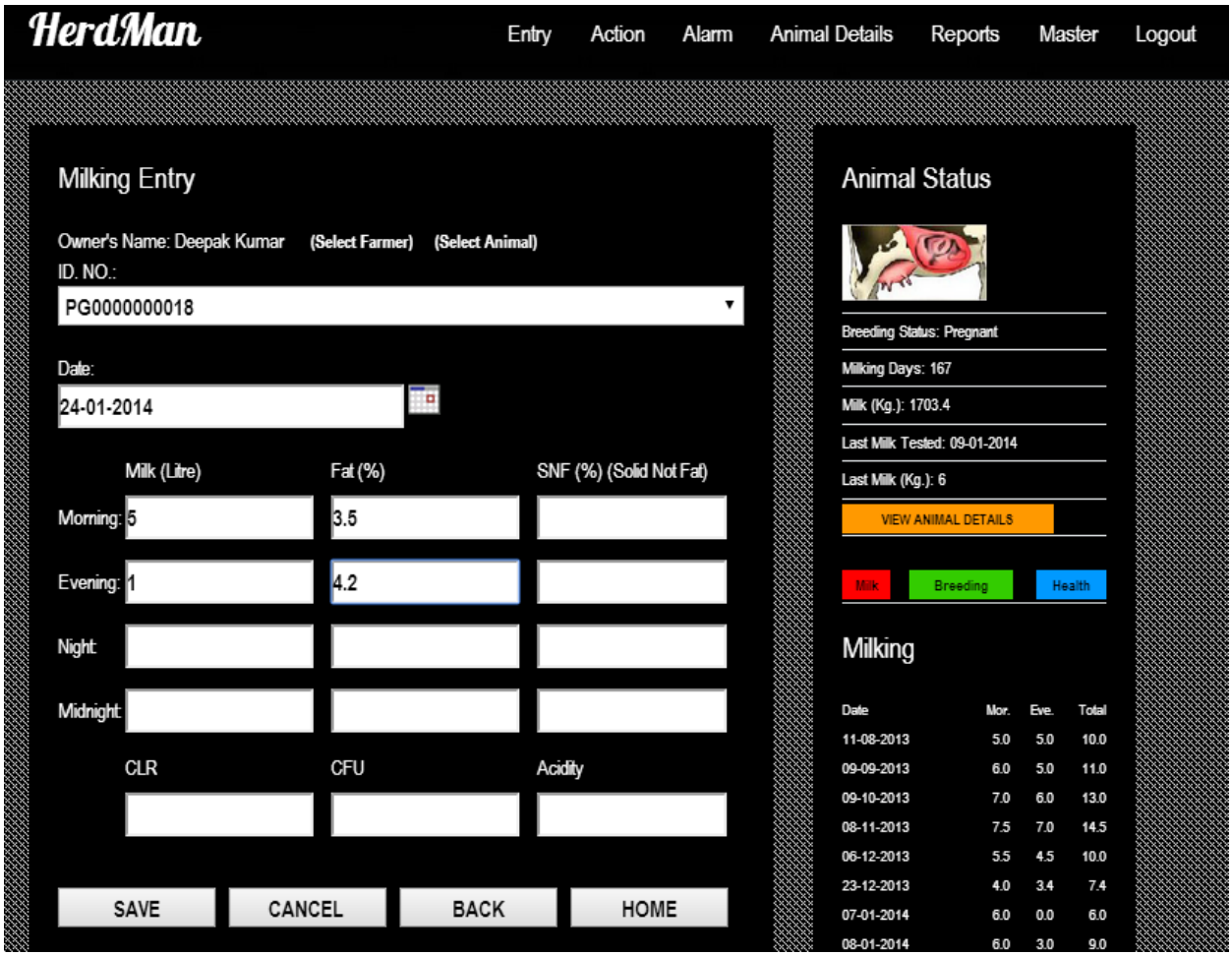

Figure 16: Milking entry format

Select the ID number of the animal either by selecting from the list generated after clicking the box against the ID number or you can also type the ID. This will generate the data grid of entries entered up till now. Enter the date, and milk weight for the morning, evening, or a total of the day. Enter the composition in terms of fat, SNF, and protein as % and save. The information will be saved in the 'Milk Production Details' as kg of each composition produced.

Body weight entry: Through this form, the weight of the animals, directly taken as Kg can be entered. Select the 'Bodyweight Entry' submenu from select the animal's combo box.

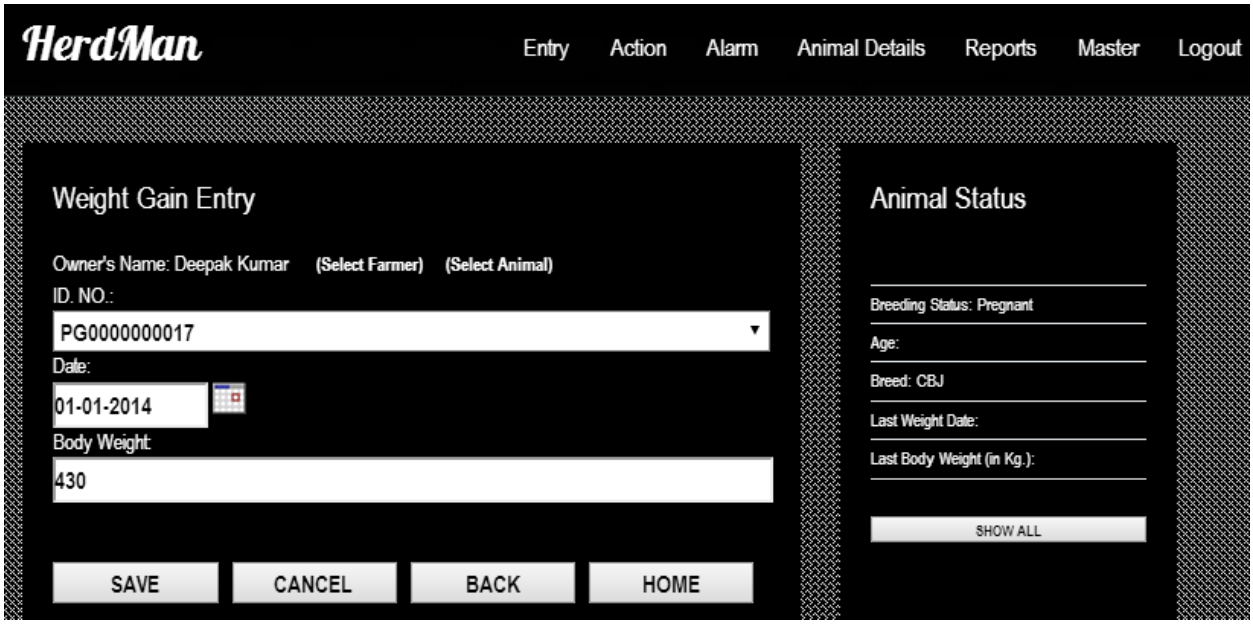

Figure 17: Weight gain entry format

The form also shows the age of the animal, the previous date on which weight was taken and the last weight recorded. Now enter the date of the weight on the right top-side of the form and then enter the weights taken in Kg. In case the previous weight is available the program will calculate the weight gain in grams per day. Click on 'Save' to save the information.

Vaccination Entry: Through this entry form all the vaccination records of the animals can be built up. Normally, all the animals in the herd or lot are vaccinated on the same day; hence the vaccination records can be built up accordingly.

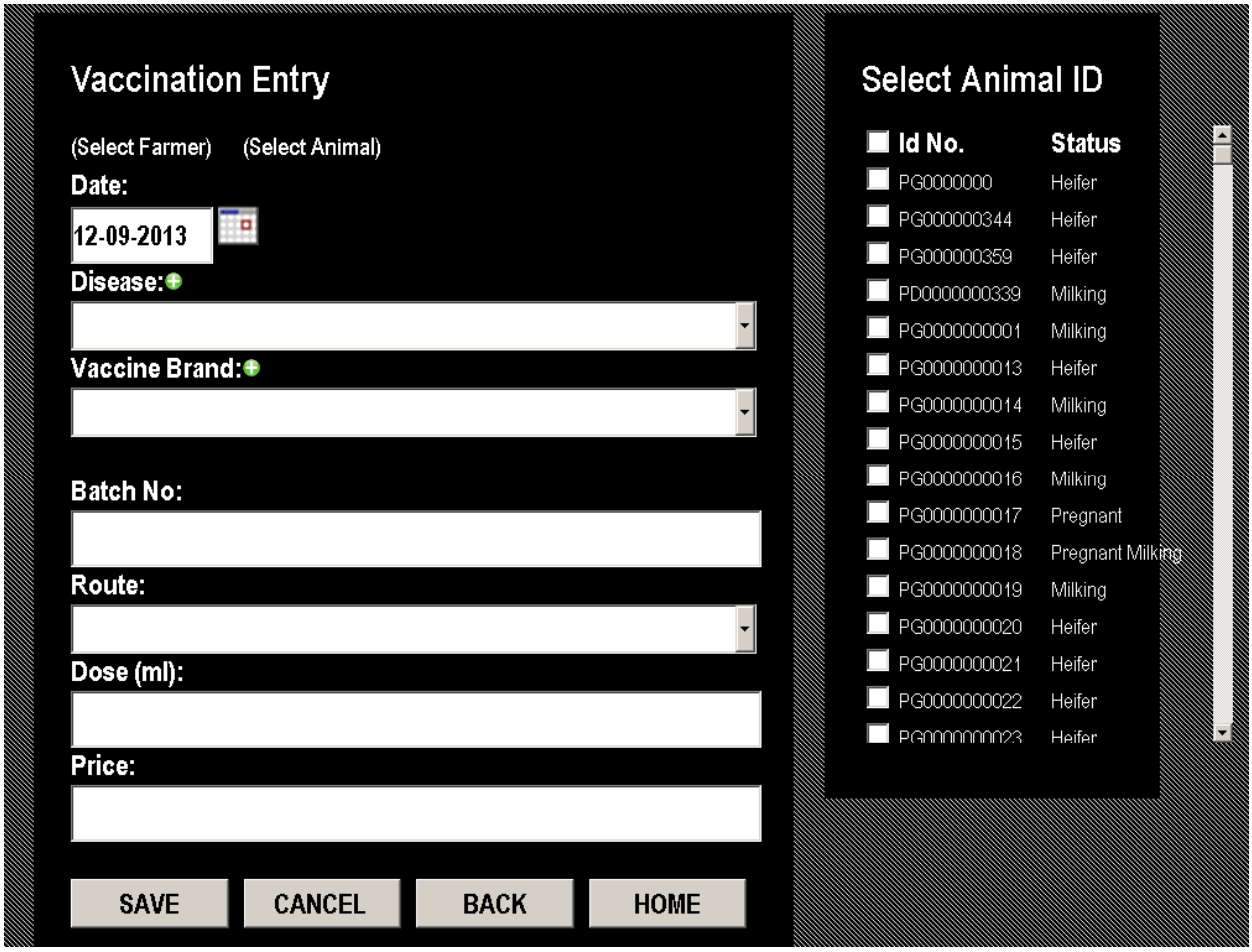

Figure 18: Vaccination entry format

In case you wish to enter for all the animals in the herd then click on the box 'Select All'. In case you have vaccinated all the animals at the same time select 'Check All' by clicking on the box on the right. In case you have not vaccinated a few animals they can be de-checked by again clicking on the box against the animal. Once you have selected the animals then you can enter the vaccine details on the left-hand side of the form. Select the date of vaccination, the disease, the vaccine type, source batch number, rate, and route of administration. Recheck the entries and if correct, click 'Save' to save the entries. Likewise, you can enter all the previous vaccination details of the farm.

Deworming Entry: The entry form of the Deworming is similar to vaccination. Deworming format can be opened up by clicking on the 'deworming' menu of 'entry'. If you are deworming all the animals in the herd/lot then click on the 'Check All' button on the right side. In case some animals are to be removed from the entry you can click on the box against the ID number of the

animal. This will de-check the ID from the entry. Now enter the details of the Deworming drug, source dose, etc., and save the entries by clicking on the 'Save' button'.

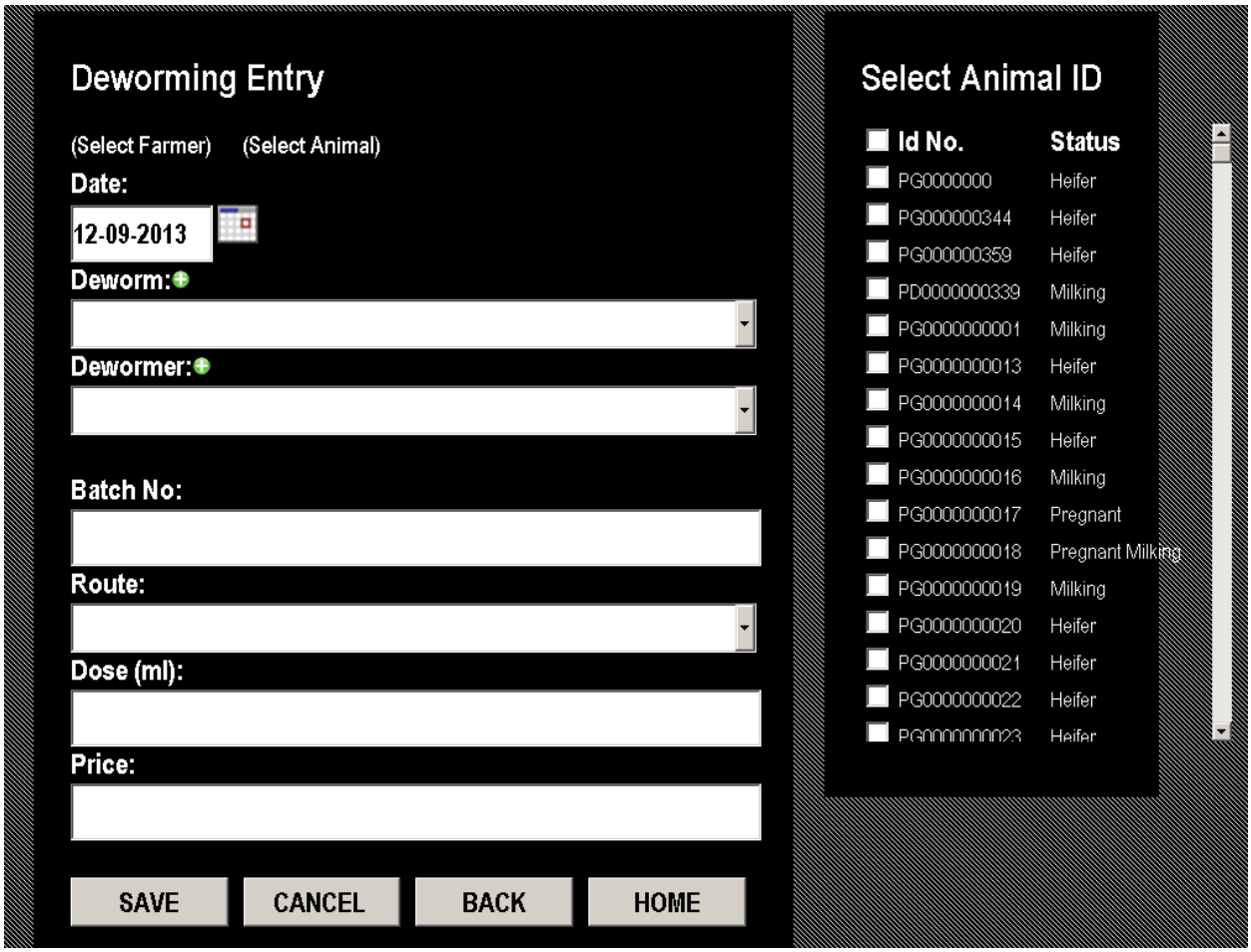

Figure 19: Deworming entry format

The animals in the dairy farm are always dynamic in that due to several reasons the animals from the farm are disposed off. This could be due to the sale of excess of animals or culling of animals that have become non-productive and hence uneconomical for the farm operations. Normally also there would be some amount of mortality on the farm. Such animals are to be removed from the active database. Using the 'Disposal Entry' menu can perform this entry function.

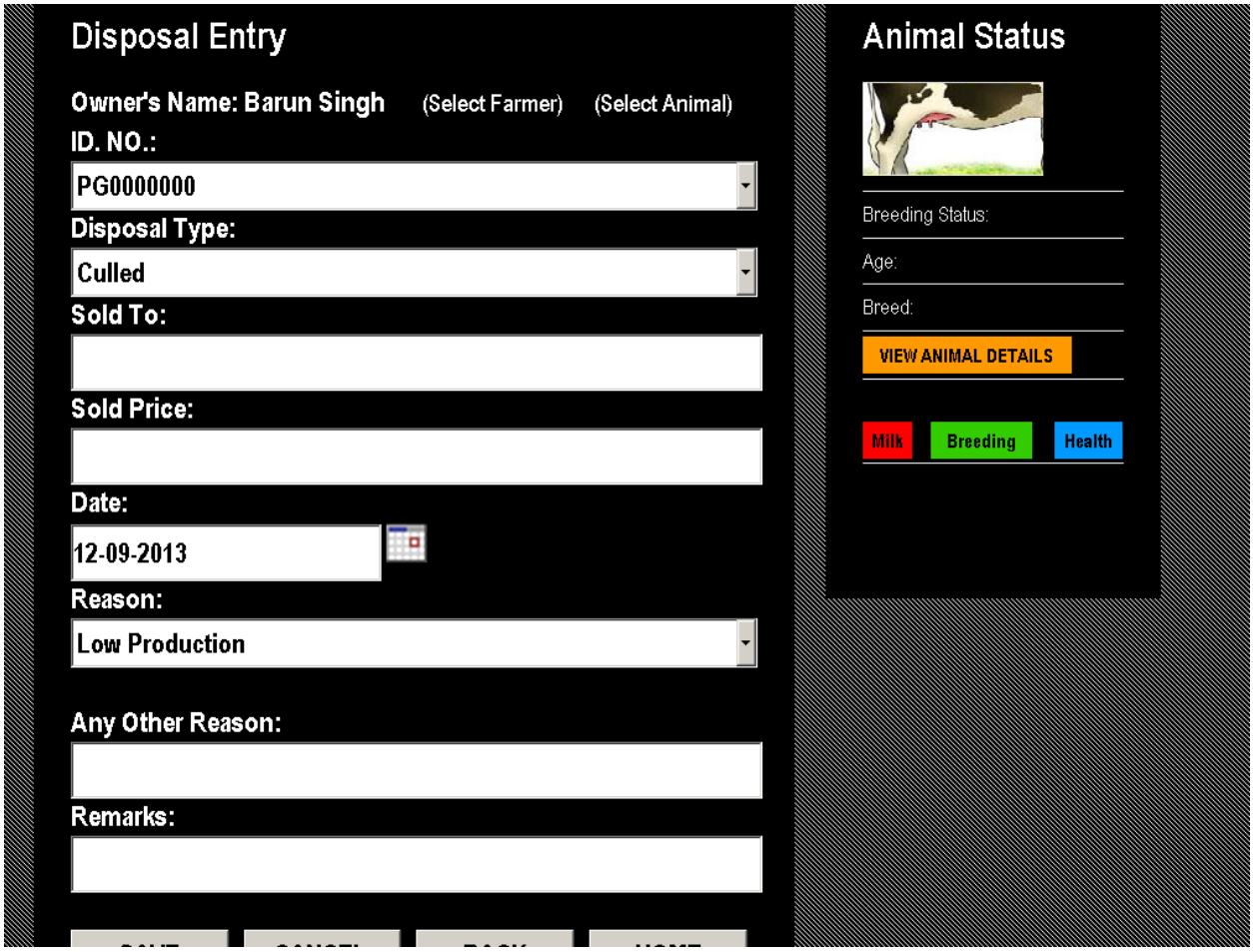

Figure 20: Disposal entry format

Disposal Entry

Go to the Disposal Entry menu on the main menu and click to open the “disposal entry" form (Fig. 6.13). Disposal of animals is due to three main reasons: (a) died, (b) culled, and (c) sold. Out of these except the death of the animal, the others are voluntary. The form for died and culled are similar but for sold the form is different.

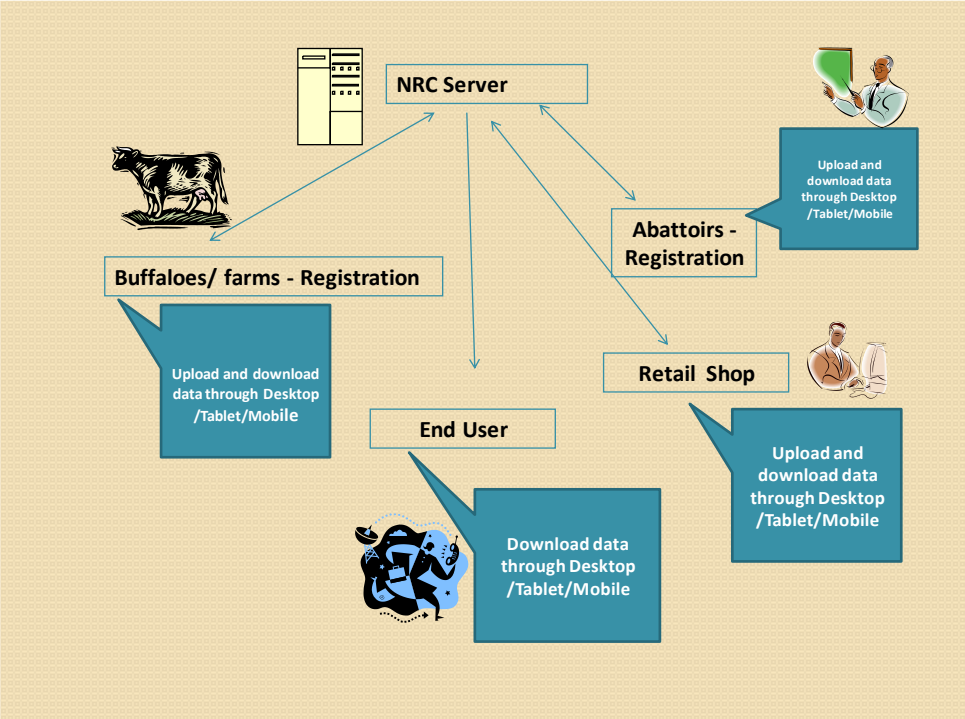

Figure 21: Overview of the web-based traceability system

Table 1: Different provisions provided in the herd-management system of the database

Major Heading	Minor Heading	Content
Entry	Insemination	Date of heat, servicing, method of service (natural or artificial insemination), details of sire, and name of Veterinarian performing insemination.
	Pregnancy Diagnosis (PD)	Date and result of pregnancy diagnosis. This will help the farmers to retrieve the animals that are not conceived or empty or pregnant
	Calving	Date of calving, sex of calf, and problems, if any with calving can be recorded.
	Weight Gain	Animal-wise body weights can be recorded on different dates.
	Milking	Quantum of milk during different periods of the day. Composition and quality of milk in terms of fat, SNF, CLR & CFU.
	Dry	Date and reason for drying of the animal.
	Vaccination	Date, a disease for which vaccinated, brand, quantity, and route.
	Deworming	Date of deworming. Details of dewormer used, its dose, and price.

	Feeding	Type and quantum of feed used.
	Purchase	Details of purchase of animals and other materials.
	Sales	Details of sales of animals and other materials.
	Medication	Details of medication, period, reason, and date.
Action	Daily action plan	Based on the inputs given in the entry, a daily action plan is generated based on different assumptions
Details	-	Based on the entries made details of individual animals can be generated.
Reports	-	Based on the entries made reports are generated as per the farmers' requirements.

Chapter 5
ANIMAL IDENTIFICATION FOR PERFORMANCE RECORDING - EXPERIENCE WITH MAIRA

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5.1 Introduction

Animal identification for traceability and productivity improvement is the core requirement but is largely neglected in developing and under-developed countries. In order to implement such a program and to institutionalize it, the Department of Animal Husbandry, Government of Maharashtra accepted my proposal to establish the Maharashtra Animal Identification Authority, under the control of the Maharashtra Livestock Development Board. Due to active support of an initiative of the then Secretary, Department of AH, the project funds were sanctioned and the necessary software platform was developed and implemented. With the sudden transfer of the Secretary, the program lost its steam. In the meantime, the Commissioner AH also was transferred and a new Commissioner joined. He derailed the program and demanded changes to accommodate the current program, without emphasis on performance recording. In the meantime, the Government of India sanctioned a budget for ear tagging and cattle registration, hence the objectives of MAIRA were forgotten. The lesson from the project are (a) the program should be conceived and regarded as important by the field staff; (b) the program should have a larger-long term objective actively involving all the stakeholders; (c) global experience is that at the field level identification and data recording should be left to the private players whereas the government agencies should insist on acquiring data of public-health and national/provincial concern.

5.2 Importance of Animal Identification and Traceability: With the current scenario of several pathogens jumping and causing diseases in humans, the need for animal traceability has come to the fore and many countries are now trying to develop such a system. Animal identification, linked to performance recording should be the core activity of the animal husbandry department since unless productivity, health, and fertility data are available, sound planning of productivity improvement is not possible. Most western countries focus on this aspect through 'dairy herd improvement programs' run by the farmers' cooperatives. Animal identification was linked to

transport, payment of subsidies, and milk/animal procurement, hence the farmers were forced to get actively involved. As a result, animal productivity increased substantially since data helped in genomic selection and the health data facilitated identifying the infection focus areas, enabling the drawing of preventive programs. In India however, due to the involvement of the government in the animal health and breeding sector, the focus was on establishing more hospitals and polyclinics and strengthening the treatment facilities, without any emphasis on diagnosis and record keeping.

5.3 Tryst with Animal Data Recording: I was exposed to animal identification and data recording system during my Ph.D. program at the Ontario Veterinary College, Guelph, Canada, and felt its importance for India. After my return, I joined Bombay Veterinary College, and the city provided me an opportunity to conceive the idea of developing software for small-hold dairy operations. Luckily somewhere in June 1998, I met in the Delhi flight one Gentleman, who owned a software development company in Mumbai. I requested him to help me out with software since I wanted to use it in my dairy practice. He was kind enough and agreed to depute three software developers who developed Herdman software, and validation of the software was given as M.V.Sc. project. Initially, the system was on Visual Basic but since VB.Net offered advantages, his team helped in changing the platform. I tried the system on two dairy farms, but it was not successful, mostly because of hardware-related problems. The system was of not any use to small-hold and I realized that unless the system caters to small farmers it won't make any business sense. The team also developed software for semen banking since the idea was to develop independent software for all the dairy-animal-related activities with a common database to share, something like Microsoft Office.

5.4 MAIRA as an Institute: Mr. Rajesh Agrawal, an I.A.S. officer took over as Secretary of the Department of AH in Maharashtra. He was M. Tech holder in IT from IIT. During meetings, he realized that although there were numbers in the technical reports, but there was no traceability of the cows, calves born, or the farmers who were benefitted. He came to know of my interest and experience in large data capturing and analysis and invited me for interaction. He was emphatic that there should be animal traceability and data recording for proper planning and evaluation of various schemes. At that time, although, the NDDB was recognized as the National Animal Identification Centre for purpose of representing in the International Committee on Animal Recording (IntCAR), its function was not institutionalized. There were no guidelines on types of

data to be recorded, who will record it, how the series would be maintained, and guidelines for the tag manufacturer. The NDDB was restricted to only dairy cows, whereas there were no guidelines for sheep, goats, canines, and other animals. I had two apprehensions, (a) the activity should be institutionalized, and (b) the need should be perceived by the technical staff of the Department. On my suggestion, three groups were formed for larger consultations with all the stakeholders, and one of these was on traceability and the introduction of IT in the Department management. This team included a cross-section of the stakeholders including the Stockman cadre, and members from the NGO (JK Trust and BAIF). We were supposed to go around and talk to technical staff, but the BAIF and JK Trust did not cooperate, for the obvious reason that the system would bring transparency. With the assistance of two members of the AH department, I prepared a report and presented it to the Secretary at the MLDB Board meeting. I floated the idea of forming the Maharashtra Animal Identification and Recording Authority (MAIRA), which the Secretary and Boar liked, and immediate steps were taken to issue a government resolution. Traceability means, transparency and accountability, hence I was getting signals from the AH top brass that the idea was not attractive, but they could not do much as the Secretary was for it.

Three activities were proposed: (a) the breeding services provided by the NGOs to be streamlined with online digital reporting, with each animal to be identified by tagging; (b) registration and testing of bulls used in natural service and (c) e-management of semen bull centres. The GR also mentioned that for receiving any benefit, especially the purchase of animals for distribution, the one tagged and registered would be preferred. Several benefits were envisaged for AI Technicians registering in the program for breeding data updates. It was to be voluntary for six months to be made mandatory, later on, by promulgating a state law. That was the end of MAIRA activities. A program to launch MAIRA was planned with the hands of the Chief Minister. Unfortunately, due to political upheaval, the Chief Minister had to resign hence the launch was dropped.

5.6 Sunrise and Sunset of animal tagging and Semen Banking Digitalization: In the Board, it was decided by resolution that Herdman will be used in MAIRA and Semen Perfect will be deployed in two Semen stations. The software applications were ready and only minor additions were to be done. The system was deployed. At that point of time, the Commissioner AH was also given charge of Vice-Chancellor of the University so the Secretary AH asked me to entrust the purchase and deployment work through the University, since purchase procedures could be straight

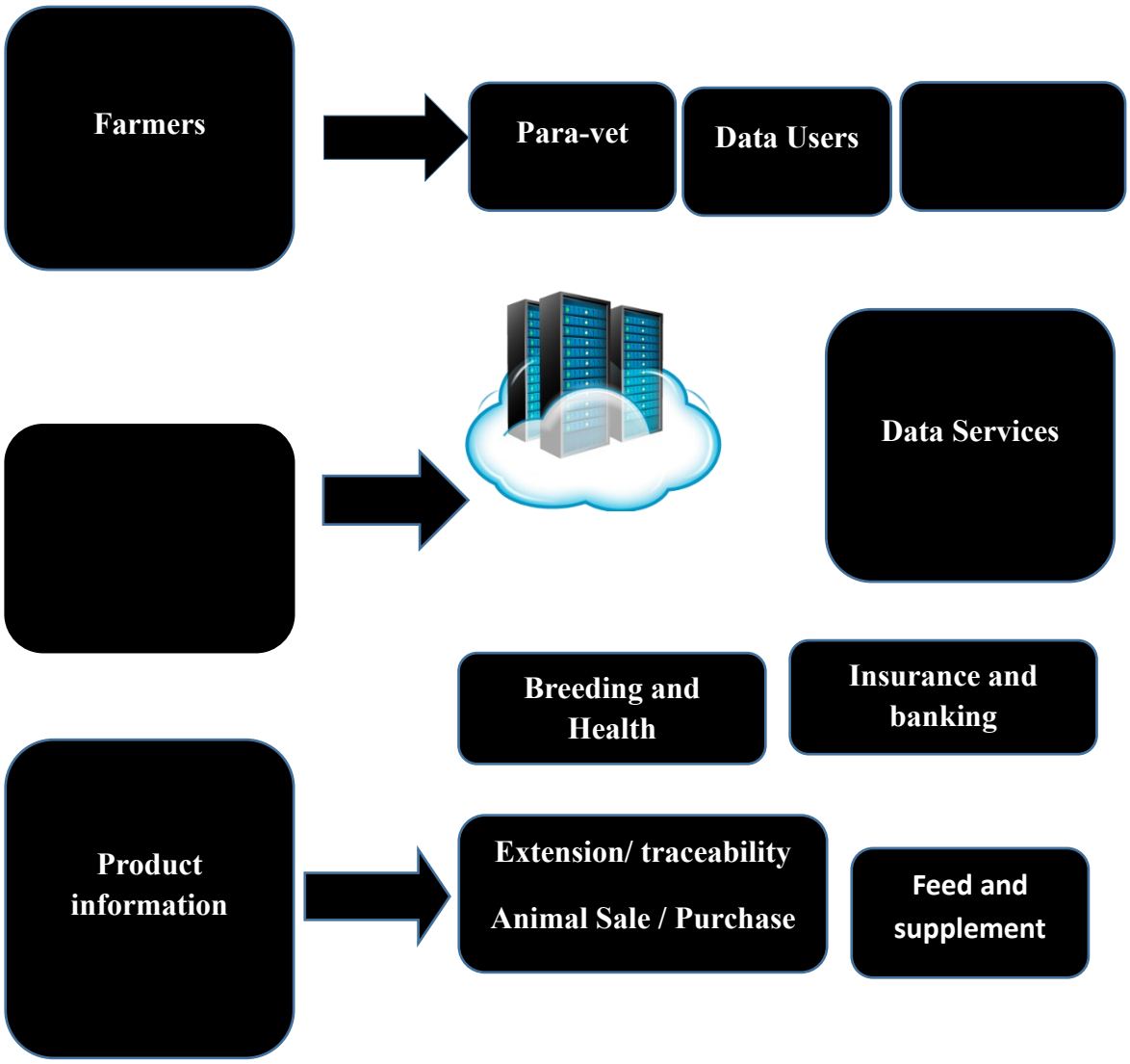
as the University was undertaking allocated work for the Government of Maharashtra, with specific instructions on the software to be used. There was of course resistance from the staff of the Department to use the system, the major grouse, who will enter the data. The staff of the Semen Banks refused to enter any data and wanted the MLDB to provide them, a data operator. On request budgetary provision of appointment of contractual staff for the two semen banks was sanctioned. I did not go by the advice of the in charge of the Semen station to appoint his relative, so, indirectly the data operator was harassed and they did not cooperate, hence the person left in desperation. In the meantime, the new Chief Minister wanted Mr. Rajesh Agarwal in the Finance Department so he left, and with that MAIRA became orphaned.

A new Commissioner joined, who thought the idea of data recording etc., was useless. He was not interested in the digitization of semen banks and online semen straw distribution and LN_2 inventory management. Even though the software system was fully ready and operational, he wanted radical changes to convert it into a department website. I had to yield to his demands and new modules in the system were added. He was however a taskmaster, who made sure that the system deployed was put to use by the staff. He did not pay any heed to resistance. But the system had become aimless, more like transforming the data written on paper to computer, mainly for easing reporting to the Government. The data analysis to understand problems and impact analysis was forgotten.

I was holding the charge of Dean, Faculty at the University at Nagpur, and one fine morning someone from the Department informed me that since there is an Assembly session in Nagpur, the Minister wanted some activity to be flashed in the newspaper as an achievement of the Department. Although the project was taking its last breaths, an inaugural function was organized in the University Hall. The Department staff were eloquent and self-patting in showing the Minister how the Department was entering the digital world. The activity ended there, and MAIRA was put on the back burner forever. Recently I happened to be present in a presentation where the top officials of the Department mentioned about MAIRA being merged with INAPH of NDDB, but all the screens he showed were of Herdman and none from INAPH.

5.7 Corporate Efforts to Popularize Performance Recording: Out of my interest, however, I continued to work on animal identification and wanted to use a novel technology relevant to our needs. I was looking for an identification device that should enable not only animal identification but should also be a data carrier, so that details of the animals can be accessed from anywhere, anytime. While on a visit to Canada in early 2012, I chanced upon seeing in a magazine a QR code printed on an advertisement asking the reader to scan to know more details. This code used the technology of linking the scan code to a URL link deployed on the server. I thought if the system could be used for even update, in addition to downloading, it would serve the purpose. After my return, the team got to work in just two months we developed an encrypted QR code printed plastic ear tag that after scanning by our scanner in the App, downloaded the animal's file and also enabled update of the new data with time-stamping. We found the system to be robust, as it solved the problem of fraudulent data updates since unless the code was scanned animals' files could not be accessed. The aim was to provide animal historical data to the service providers who could update the data in real-time from the animal side. We filed a patent for this technology. In 2013, post-retirement from the University, I got full-time engagement in this project since I was convinced that, like in other countries, animal data recording could be done efficiently only when it is industry-driven and in private hands. We planned a comprehensive software to support the dairy enterprise, wherein not only there is traceability of farmers and animals, but the services, payments, insurance, and sale purchase of animals could be digitized on a single program.

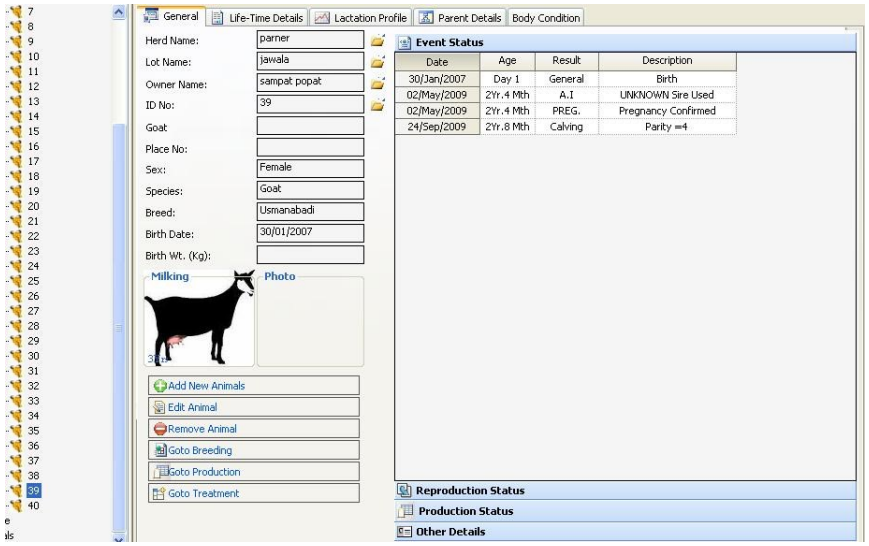
5.8 Herdman Enterprise Software: While interacting with industry and dairy herd improvement organizations (DHIP) in USA and Canada, I realized that the animal service industry was not happy with the data system, since it was in a silo, not pooled and shared with the industry. The farmer's data remained with the farm, and only some data was shared with the DHIP. Since the farmers were not being helped with data analysis in real time they were also not happy and the data update lagged considerably. So we decided on a system where data ownership will be of the owner, the data management organization would be the custodian and there will be an arrangement wherein the farmers would agree to share pooled data with the industry, if it would benefit them directly, such as animal feed industry, semen suppliers and breeding companies.



It was a chance meeting with Dr. John Henry who at that time was heading the AH activities in Hatsun Agro Products, Chennai. Luckily, he was also an alumnus of the University of Guelph but from Animal Science Department. He understood the importance of data and decided to use Herdman to register all the animals and the farmers from whom Hatsun was collecting milk. It was decided that within two years, one million animals will be registered and total veterinary and breeding services will be digitized.

The animal performance recording program was expanded to include digital payments, deductions, semen supplies, inventory management, and medicine inventory management. He saw to it that all hurdles were removed. Within two years, the milk process planning and organization of veterinary services were digitized, leading to the saving of crores of rupees every year. Currently,

the Herdman platform manages day-to-day data of 1.2 million cows and buffaloes, with paperless data collection and analysis. The system recently has been further upgraded to web-based and the menu-driven in the dashboard. The system provides data penetration to the highest officer in the organization up to the animal level. It is also attached to maps, so one can generate map-based reports. Genomic-related data capture has also been added and it is hoped that soon many 'milk Unions' in Gujarat will join the Herdman bandwagon. It is also planned to launch 'tele-veterinary services' with the help of gadgets such as tele-stethoscope, tele-microscope, and tele-laboratory.



Seeing the success in the dairy, it was decided to develop similar enterprise software for sheep and goats to enable meat traceability. The idea was to develop software to link animal data recording to services, marketability, and consumer access to quality and safety. The goat software by the name Caprovi is also ready to launch to provide meat traceability.

Chapter 6
TRACEABILITY IN EXPORT MEAT SECTOR

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6.1 Understanding traceability

Traceability is the ability and the mechanism designed for tracing an animal product along all steps in the production chain back to the holding origin of the live animal from which the product was derived. Traceability or product tracing is defined by the Codex Alimentarius Commission as "the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution". Traceability means that movements can be traced one step backward and one step forward at any point in the supply chain. Traceability allows microbial contamination and other situations to be pinpointed and bring under control quickly. It also allows companies to establish the bona fides of a variety of quality claims. The traceability facilitates the meat industry to establish reassurance on product/process traceability and production techniques that may help to promote confidence in the integrity and origin of their products.

6.2 Need for Traceability

Consumers are making dietary shifts towards sustainable and reliable products due to disease outbreaks and food contamination. Traceability solutions with technology integration deliver a digital footprint of the product and assure compliance with quality standards. It is necessary to develop new technologies and realistic approaches to provide automatic animal identification. Traceability refers to a simple traceback system that may provide consumers with quality assurances throughout the supply chains, intending to reduce the risks of foodborne diseases. In meat supply chains, transparency is necessary to guarantee the safety, quality, and trust of consumers in meat products

6.3 World Meat Trade at a Glance

As the world's population increases, global meat consumption is expected to grow steadily in the coming years. Between 2016 and 2020, the volume of meat production worldwide has increased from 317 million metric tons to 328 million metric tons, according to a 2021 report by *Statista.* According to *Statista,* the market value of the meat industry is expected to increase from

US$ 838 billion in 2020 to more than US$1 trillion in 2025. Various activities fall within the meat industry, including the slaughter, processing, packaging, and distribution of poultry, cattle, pigs, sheep, and game. According to *FAO*, it is estimated that a total of 335 million tons of carcass weight was produced worldwide in 2019. The Food and Agriculture Organization of the United Nations (FAO) has estimated that by 2050 there will be a 73% increase in meat and egg consumption and a 58% increase in dairy consumption over 2011 levels worldwide.

6.4 Meat Trade – India

India is the world's top exporter of buffalo, sheep, and goat meat. These animals produce approximately 53% of India's milk and 26% of its meat. Its livestock sector accounts for 4.5% of India's GDP, with two-thirds of this being pastoral production. In addition, poultry farming is one of the main sectors contributing to the country's economic development. Between 2000 and 2016, the country's agricultural production surged from US$101 billion to about US$367 billion, driven mainly by high-value segments such as horticulture, dairy, poultry, and inland aquaculture. During this period, meat, fish, and processed products exports grew between three to five times. To achieve its full export potential, India's Ministry of Commerce and Industry emphasizes, in its Agricultural Export Policy 2018, the need to build around agricultural infrastructure and the digitization of supply chain processes and has pointed to livestock traceability as a critical enabler to ensure the efficiency and compliance with global quality standards to integrate livestock products into the global value chain.

Fig 1. Meat traceability map

6.5 Generic principles for a meat traceability system

Meat traceability usually starts with the birth of the animal, followed by maturing, slaughtering, butchering, processing, distributing, and consumption. The challenge with the implementation of supply chain traceability is the exchange of information in a standardized format between various links in the chain. Globalization has led to an increase in the significance of efficient systems for information exchange between food businesses. Sector-specific guidelines must be developed which are product specific and includes:

(1) Creating a standardized parameter list for the given product throughout the value chain.

(2) Identifying data to be recorded at each link in the value chain.

(3) Creating a data management and information exchange model for both internal and chain traceability in the value chain.

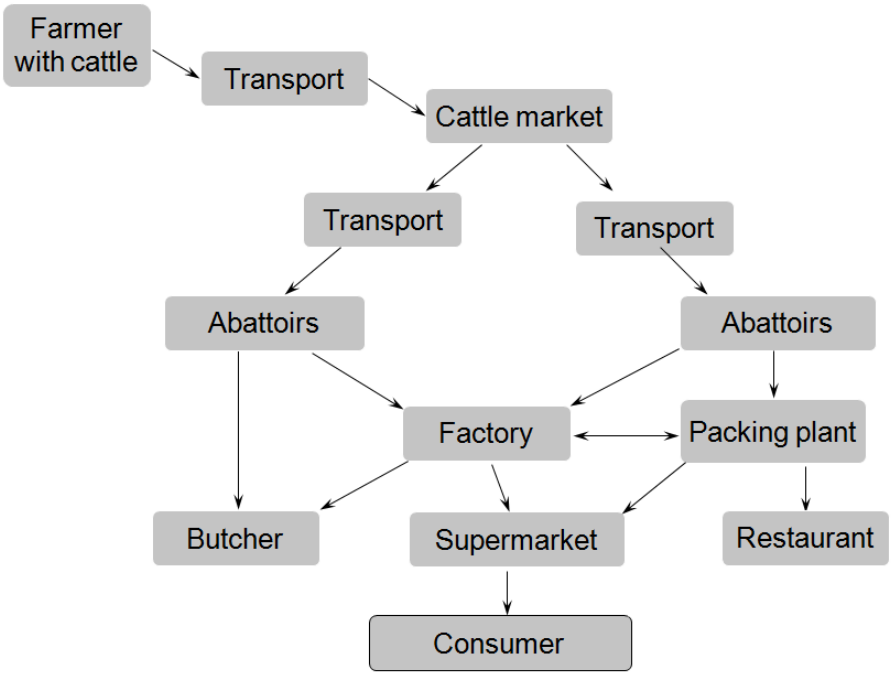

Fig 2. Traceability web

6.6 Pillars of Traceability

A fully functional traceability system for the livestock industry should be based on three pillars:

- **Animal identification** – Associating a unique identification number to an animal (i.e., attaching a marker to an animal).

- **Premises identification** – Assigning a unique tracking number to a specific land location (i.e., description or geo-referenced coordinates) by a territorial premises registry.
- **Animal Movement** – Recording the change of location of a uniquely identified animal at a given time/date.

6.7 Traceability - Animal Identification:

Plastic ear tags are the most widely used identifications of animals in many countries, due to its low cost. RFID utilizes wireless electromagnetic fields for transferring data. RFID technology has the characteristics of mobile item identification and non-contact identification. The use of RFID technology to monitor the entire process of food production and distribution, to achieve the safety of agricultural products from farm to table, can guarantee the quality of agricultural products, and maintain public health. DNA fingerprint identification utilizes DNA, an innate barcode within animals, to identify a particular animal farm throughout to table.

6.8 Traceability – Products Identification

The methods of products identification include :

(a) One-dimensional barcodes such as the EAN/UPC barcode family as the longest established and widely used GS1 barcodes in retail and especially the GS1-128 and ITF-14 barcodes.

(b) Two-dimensional barcodes, are a square, including many tiny individual dots. The Quick Response (QR) Code is commonly used in traceable labels that contain traceability information about the product. QR code is a new means of recording traceability information and is advantageous because it can be quickly read, has a large data capacity, and occupies a small space.

(c) Multi-dimensional barcodes that store information on the x-axis, y-axis, and colors. Obviously, this provides considerably more information than a two-dimensional code.

6.9 Consumer Expectations at the Retail End

Consumers have many things to consider when buying food, such as:

- Price;
- Quantity;
- Quality;
- Diet and health issues;
- Marketing e.g. product brands, and campaigns.

- Consumers want to know that the food they buy is safe to eat and, for some, that source of the meat, animal welfare, and the environment have been taken into account

6.10 Packaging Information

The information shared by the manufacturer is vital for the consumer to know about his expectations on the product information as well as to know about the product traceability. The labeling requirements are always governed by the statutory food laws of the country of manufacturing. In India labeling requirements on meat foods are governed by FSSAI Act. Hence the labeling requirement plays a vital role in the process of traceability. In addition to these labeling requirements, the meat importing country shall specify any additional labeling information as per their food safety standards.

6.11 What is required on meat packaging by law?

Food Safety and Standards Authority of India (FSSAIP) labeling Requirements for food products are as follows:

1) The Name of Food
2) List of Ingredients
3) Nutritional information
4) Declaration regarding Veg or Nonveg
5) Declaration regarding Food Additives
6) Declaration of name and complete address - manufacturer, marketer, packer, or bottler, as the case may be.
7) FSSAI logo and license number
8) Net quantity, Retail Sale Price, and Consumer Care details
9) Lot/Code/Batch identification.
10) Date Marking
11) Labeling of Imported Foods
12) Country of Origin for Imported Foods
13) Instructions for use
14) Declaration regarding Food allergen
15) Declaration of food material sold in retail but not meant for human consumption

6.12 Traceability – Present Status

In India, traceability is mandatory for all export-oriented plants as they are compulsorily certified for Food Safety Management System Standards like ISO 22000: 2018. Once the animal is slaughtered, the carcass is tagged. The tag includes details of the animal's ear tag number from which we can pinpoint the source of the food animal. The batch/unique reference number, which can be found on the food package that corresponds to the carcass tag, is used throughout the production process to follow the movements of a product at each point of the supply chain. This information is recorded electronically making it easily accessible at any time when the information is needed.

6.13 IT Enablers in Traceability

The meat industry is seeking to establish reassurance on traceability and production techniques that may help to promote confidence in the integrity and origin of their products. In meat supply chains, transparency is necessary to guarantee the safety, quality, and trust of consumers in meat products. Block chain-based traceability solutions deliver a digital footprint of the product and assure compliance with quality standards. Block chain-based livestock traceability enables livestock producers and meat processors to comply with the strictest legislation and helps them demonstrate full traceability in their supply chain. Today's world food platform demands increasingly stringent standards. Thanks to the advent of blockchain-based traceability, livestock supply chain management is revamping, and the entire sector is leaning into an era of completely transparent and safe supply chains. According to research firm Gartner, 20% of the world's top supermarkets will be using blockchain by 2025.

6.14 Conclusion

Agriculture and animal protein production will increase substantially to meet the demand of the world's growing population but must do so in the context of sustainability. Livestock traceability is the roadmap for identifying opportunities for human capital and business development while encouraging sustainability practices that will arguably be the most crucial value-add for livestock products. The consumer is more interested and involved in the origin of the meat, and the process up to the sale of the product. To keep all matters concerning the processing of the meat clear and transparent, there must be continuous information available

regarding traceability, product specifications, and quality. Livestock traceability solutions drive sustainability and ensure a safe future. As a spillover effect, traceability enabled improved collection of data about production processes which are helping improved production management decisions, and secondly, it led to improved supply chain coordination for purposes such as pricing, ordering, and aligning supply and demand.

Chapter 7
MEATTRACE – AN AVANT-GARDE BLOCK CHAIN BASED BUFFALO MEAT TRACEABILITY SYSTEM

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7.1 Introduction

The meat which is consumed by the consumer traverses a long distance before it comes to their plates. Traceability, at the very essence, helps us to track the journey of the product at these various points down to the last detail till its provenance so that we can be assured of its sourcing, transportation, and quality. India is the world's largest exporter of buffalo meat globally. In 2018-19, it exported 70% of its buffalo meat production accounting for 1.24 Million Tonnes of deboned buffalo meat equivalent to 2.0 Million Tonnes of dressed buffalo carcasses valued at INR 25,168 Million (US$ 3.61 billion) [1]. Over the years, there have been various issues in the supply chain of meat and poultry products which has strengthened the case for ensuring traceability across the different products. The capability to track each product as intimately as possible is highly significant for establishing its wholesomeness, in terms of both safety and quality. Traceability allows issues such as microbial contamination, storage decays, transportation malaises, etc. to be pinpointed accurately and brought under control quickly. Finally, as a meat processor or a farmer as well, it is not just about increasing trust in their brands but also commanding premiums for their products that provide that transparency and, at the end of the day, instill trust.

Chainflux, on a contract research partnership with ICAR-NRC on Meat, has successfully developed a blockchain-based buffalo meat traceability system, **MeatTrace**. This platform is built atop Chainflux's blockchain platform, **Shine** and the platform is developed in such a manner that it gave a traceability ledger fit for the needs of the buffalo meat value chain. We are currently validating this system across different abattoirs and farms across the country to gauge its effectiveness and improve data hygiene and traceability.

7.2 Advantages of a blockchain-based traceability system

A blockchain is a distributed ledger which is a type of database, or system of records, that is shared, replicated, and synchronized among the members of a network. It is one statement of truth shared across all participants in the supply chain. Blockchain combines all the following points:

a. Once data is entered, it cannot be tampered with

b. All data is fully traceable on the ledger.

In a centralized system, users will have to trust the operators of that system. Blockchain technology can be used to ensure the storage of all information related to the food products in a shared, immutable, visible, and transparent system for all the parties along the supply chain. One of the more famous ones among several use cases includes the Nestle case study with the IBM blockchain in tracking the provenance of food products, including meat [2]. Others include the Beefledger project in China to track the history and provenance of Beef and Carabeef on the blockchain. [3]

7.3 Decentralized - Creating trust amongst participants: When multiple parties are sharing sensitive data, Blockchain is the best means for all parties to build trust in the system.

Security: Blockchain provides verifiable security, meaning that users can verify that their data is shared in an encrypted form through the blockchain.

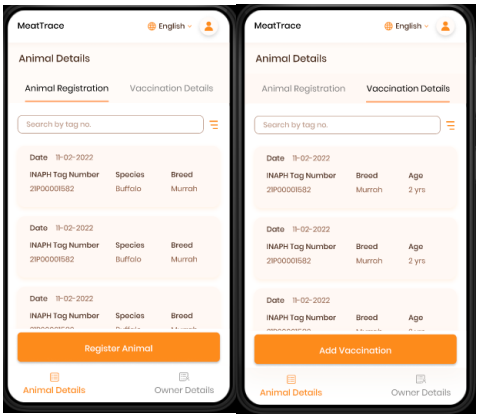
Immutable: Data once entered into the blockchain cannot be tampered with. If one wishes to append changes, it has to be done through consensus. There will be an audit trail that shows what exactly happened. This makes blockchain more secure when it comes to data tampering.

7.4 MeatTrace - The end-to-end model of traceability

We have established a chain of traceability as per the current data sets across the various points of the buffalo meat value chain on the Shine blockchain platform. We have also identified the data which will be mandatorily required to ensure the data chain is unbroken and also to plug the information gaps across these levels to the extent possible. To establish a matrix of traceability from the farm level, we require the data backing of INAPH and NDDB tagged buffaloes, and with the current availability of the data, we will ensure that our model will provide traceability from the abattoir level till the finished product is sent for exports.

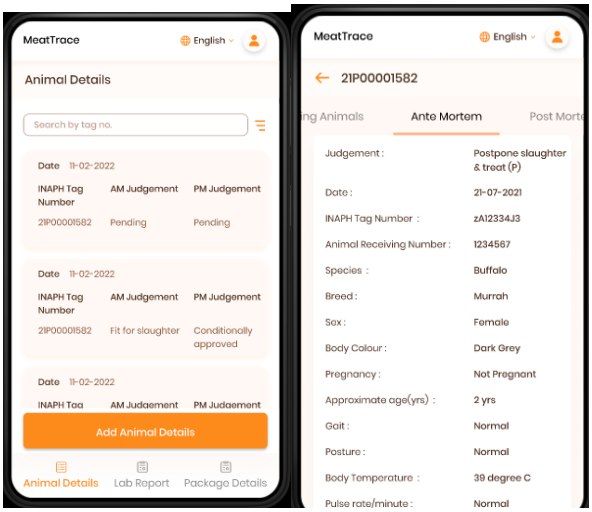
We are currently in discussions with INAPH to ensure the integration of the INAPH database with our MeatTrace platform

At the Farm



Right from the source, where the cattle and all breeds of livestock are reared, the data collection and storage will start. Data such as the farm ID, name of the farm, cattle tags (if available), vaccination history, and feed history should be intensively recorded which will then be stored on the blockchain for posterity.

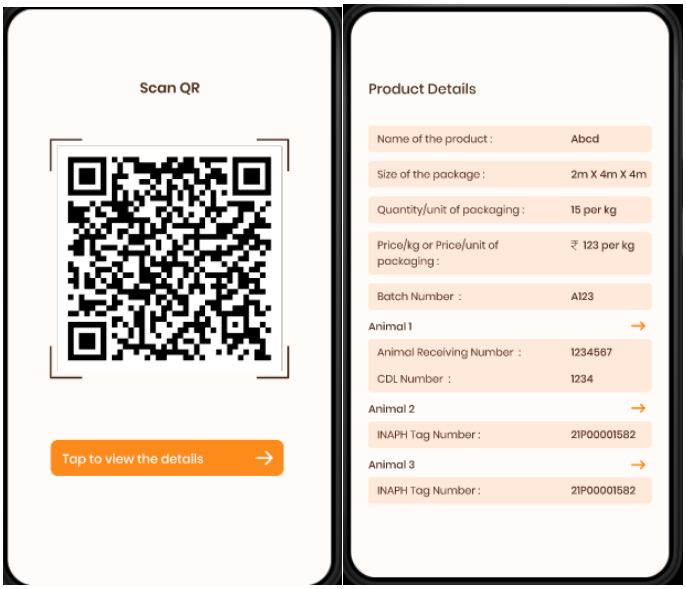
Municipal Abattoirs/Slaughterhouses



At the point where the cattle are being deposited for slaughter, we have tests being done on the cattle, carcass weight measured, and sifted into batches as per processing required and products

required. All the data points which need to be collected as part of the ante and post-mortem process are also added here. All this data will be recorded and can be added on online/offline modes as well.

Packaging / Processing Centres



Once the packaging is done, and the details are entered as per the provisions given, it should be able to showcase the same at the scan of the QR code which will be affixed on the packaging material of the respective product. The products can vary as per the export and retail requirements, but the scan of the QR code should give the details right from the batch of the animal, its receiving number at the abattoir to the INAPH tag number tagged to the particular receiving number.

MeatTrace – The next steps

Chainflux, along with ICAR-NRC on Meat, is doing a beta test of our platform across different abattoirs and buffalo farms across the country. We are testing the platform's compliance with the rigorous measures required as per HACCP and BIS standards in terms of ensuring that there is provision for the data needed for a chain of traceability is complete. With more inputs and feedback coming from our on-ground validations, we are also making the final modifications as per the stakeholder's requirements on the field as well before deploying it across different clients.

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Chapter 8
BIOMETRIC BOVINE IDENTIFICATION THROUGH A MOBILE PHONE

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8.1 Introduction

Traceability is the ability to verify the history, location, or application of an item by means of documented identification. As global incomes grow, food traceability is becoming a major concern for global consumers. Today's consumer is not only highly concerned about the origin of his food but also the logistics pathway employed to ensure that the food reaches him at his place of consumption. Specialized foodstuff like high-end organic produce have evolved highly digitalized and transparent traceability systems to ensure their appeal to their customers. Similarly, the meat sector in many advanced countries too has developed a robust traceability system from the slaughterhouse to the consumer, that has enabled it to recall particular batches of product upon the detection of pathogens or during outbreaks, etc. Few countries like Japan have a highly developed traceability system for high-end meats like wagyu that trace every packet of meat to its particular animal of origin.

Giving every animal its own unique identification number and linking all the data about that particular animal to it would form the basis of effective animal identification and traceability system. This kind of system will help in developing ownership ascertainment, scientific farm management, developing effective breeding strategy, achieving farm-to-fork traceability, and in implementing effective disease control programs, livestock insurance, and subsidy schemes. The most common method of animal identification practiced globally is ear tagging. Different types of tags are in use like visual tags, radio frequency identification devices (RFID) tags, bar-coded ear tags and quick response (QR) coded tags, etc. Though highly popular due to its low cost and relative ease of application and ease of use, problems with tag retention over a long period, especially during different handling, rearing, and weather conditions compromise the effectiveness of such tag-based identification. Also, intentional tampering with the ear tags could easily compromise a tag-based traceability system.

In order to surmount such problems, systems that can validate the identity of each of the individual animals are required. The most commonly used methods for traceability verification are based on molecular techniques like Microsatellite genotyping and/or SNP genotyping. Though extremely accurate, such techniques are time-consuming and costly. Also, their field applicability in an Indian scenario wherein farms are spread over broad geographical areas often in remote villages is very challenging.

An easy-to-use, simple and accurate animal identity verification system that uses a ubiquitously available instrument is the need of the hour. To fulfill such a requirement, we at Clonoid, have developed 'GoMukh' an Artificial Intelligence (AI) based software program that can identify individual bovines through the analysis of bovine muzzle images captured through a mobile camera.

The 'GoMukh' bovine recognition software uses Clonoid's proprietary facial recognition algorithms based on deep convolutional neural networks. In order to identify a particular individual, a general facial recognition software uses biometrics to map the facial features of that individual from a photograph or video. We have applied a similar concept to bovine facial recognition. The proprietary algorithm maps the key factors of muzzle or nose print and creates a unique facial signature for that particular muzzle. Next time when the same muzzle image is added to the system for matching, the facial signature - a mathematical formula that compares the new information with a database of registered cattle muzzle images to find a match. The recognition process starts with the algorithm locating the muzzle in the image and marking it within a bounding box. This is followed by aligning all the factors of that muzzle like geometry and photometrics in such a way that they are consistent with the database. Then the features of that muzzle that can be used for the recognition process are mined. These features are finally used to perform the matching against the known muzzle patterns in the database.

The algorithm was developed using a large training dataset to train a very deep convolutional neural network-based model for bovine muzzle recognition, which has resulted in a highly accurate recognition software. A mobile app 'GoMukh' was also designed to facilitate easy collection and analysis of muzzle images, which will also act as a user interface while enabling easy and quick image processing, analysis, and assignment. Cross-browser compatibility was also provided to the animal identification application to enable clean access across all major browser

platforms including but not limited to Internet Explorer, Mozilla Firefox, and Google Chrome. The system was built with open-source technologies available in the market to realize the benefits of easy code maintenance, short delivery timelines, and easy modifications and/or enhancements that may arise in the future. We used PHP, Java, HTML, CSS, JavaScript, and Apache servers running in a Linux environment. 'GoMukh' was implemented with different types of PHP frameworks for different modules as needed and also used Java Server side modules for security purposes, while MySQL is used for database purposes. All the images are stored in the file system and the links are stored inside the MySQL Database. The mobile App was designed using Android packages under Java Framework.

The 'GoMukh' App functionality requires many approvals which it takes while installing the application. The app takes care of blurriness and lighting of images, it rejects the images if they are found to be not as per the needs of the system. This mechanism saves the resources and bandwidth for the total system thus improving the performance of the system in total. Images of the muzzle needed for identification can be captured using a mobile camera with a minimum of 5 Megapixel resolution. This mobile camera-centered muzzle-based animal identification method applies to only bovines above the age of 2 years.

The brief procedure for collection of the muzzle images from bovines is as follows: Clean the muzzle of the animal with a clean cloth. Take photographs of the tag for identification. Restrain the head of the animal preferably by tying it to a pole. Shaking of the face or head will blur the image hence animal must be restrained properly. Put up a chin-up pose for imaging. Hold the camera around 1 foot from the muzzle. Ensure that the muzzle is in the middle of the screen with the nostrils as the side edges. Clearly visible beads and ridges without any blurring indicate a good quality image. The camera must be focused on the inter nostril region. Nostrils should be close to the edge of the photograph with little margins. Ensure good lighting on the face especially on the muzzle with no shadows or harsh light. The image should not be captured under direct sunlight. In the case of outdoor photography use an umbrella to block the excess light. After capturing, images must be uploaded onto the app along with the corresponding identification number of the animal.

The 'GoMukh' app uses a simple protocol for identifying individual animals. The app has a complex algorithm that compares the current image with the available images in the database by

checking the patterns of ridges and beads in the muzzle, (Fig. 1) and uses the pattern to confirm the identity of the animals. This app helps to confirm the identification of a particular animal or it verifies the correctness of the identification number of the said animal. In other words, the app will assist in confirming that the animal identification tags/ numbers are not tampered with. For this purpose, the muzzle image of the animal must be captured immediately after tagging the animal. All the images collected from the animals have to be uploaded onto the app along with the identification number of the animal. To verify the identification number of the particular animal, the image of the animal has to be captured and uploaded to the app along with the probable identification number. If the muzzle image of the animal in question matches the database images then the app will confirm the identity. In case, there is any mismatch, it indicates that the animal identification muzzle image is not matching with the identification number. If the collected image is blurred, the app will not consider the image for uploading.

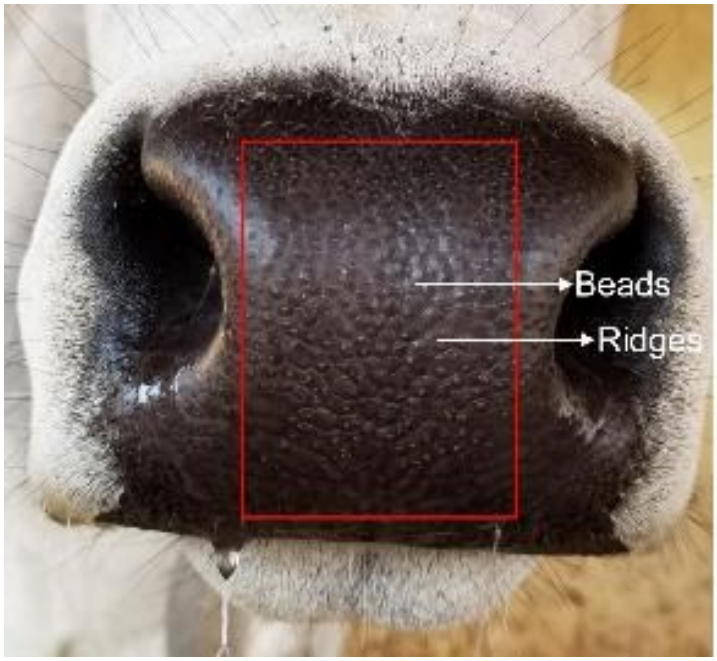

Fig. 1. Beads and ridges on the muzzle based on which GoMukh software identifies an individual.

Girish *et al.* 2020, the paper on which this article is based, shows that in order to validate the 'GoMukh' software muzzle images of 198 bovines were collected. Details of the images taken and results obtained are given in Table 1 (Girish *et al.* 2020). Out of the 5,652 readable images about 5,540 images were accurately assigned to a specific individual by ear tag number. They did

not cross-match with any other imaged animals, which gives the accuracy of above 98.02% correct assignment of the animals using the GoMukh app.

Image details	Result
Total no. of animals imaged	198
Total no. of images	6119
Average no. of images per animal	31 (~30.90)
Total no of blur images (which were not accepted by the app)	467
Average no. of blur images per animal	2(~2.358)
Percentage of blur images	7.63
Total no. of app readable images	5,652
Percentage of total readable images	92.36
Percentage of readable images assigned correctly to an individual	5,540
Percentages of images assigned correctly	98.02
Total no of readable images which could not be assigned to any individual (among readable images	112
Percentage of images not assigned to any individual (among the readable images)	1.98
No. of images assigned wrongly to another individual	0

(Girish et al. 2020)

About 2% of the readable images (112) were not correctly assigned to the specific individual animal, this may be because of improper imaging due to extreme angles of the photo due to animal movement, water drops on the muzzle, improper lighting/focus and shaking of Camera/ Phone handling. But most importantly, none of the images were wrongly assigned to another individual. That means there was no cross identification or wrong identification. of the image by the software, which makes the GoMukh app highly consistent.

Conclusion

The science of muzzle-based identification of bovines is not new, in fact, the first scientific study of bovine muzzle-based identification was published exactly a century ago by Petersen in the year 1922. Subsequently, this method was used in different countries like the US and Japan for individual animal identification. However, as the muzzle patterns are recorded by inked muzzle

print collection, collecting, and cataloguing the muzzle ink imprint-based physical repository was inconvenient to do on a large scale as it lacks quality, and the process is very laborious.

In the last few years, many people have suggested the use of AI to make this process more practical and user-friendly. The 'GoMukh' software is a big step in that direction, the app is easy to use and highly reliable. The system can be easily integrated into different ongoing traceability programs like animal identification drive done by the Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Government of India, Maharashtra Animal Identification and Recording Authority (MAIRA), Information Network for Animal Productivity and Health (INAPH) of National Dairy Development Board, meat traceability (www.livestocktraceindia.in) system established by ICAR–National Research Centre on Meat, Hyderabad, traceability program of Agricultural and Processed Food Products Export Development Authority, New Delhi (Meat.Net) and different livestock insurance programs.

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Chapter 9

MOLECULAR MEAT TRACEABILITY

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Consumers increasingly insist on a comprehensive and integrated food safety policy (the so-called 'farm to table' policy), which has consequences both for producers and for control authorities. Traceability is widely recognized to be the basis of any modern food safety control system integrating both animal health and food hygiene components. Hence, traceability of animals and animal products has become a priority for governments, due to consumer safety demands. Animal identification and registration is the basis for different traceability and traceback systems.

Traceability is defined as the ability to trace the history, application, or location of an entity by means of recorded identifications. Traceback systems have been implemented for the purposes of animal health, as a part of surveillance, to provide the information required to prevent the uncontrolled spreading of disease. The primary goal of an animal traceback system is to provide information on the source of infection or prohibited additives so that preventive and control measures can be applied to avoid the introduction of the contaminant. These systems should allow the identification of sources of infection and prevent the uncontrolled spreading of infections in the animal production chain.

Food traceability has received unprecedented attention in many countries (Badia-Melis et al., 2015, Dabbene et al., 2014). European Union (EU) established regulations (1760/2000/EC, 1825/2000/EC) to enforce all Member States to identify food-producing animals, including flocks and individuals (Mezes et al., 2013). Traceability was also introduced in the United States through the Food and Drug Administration (FDA) (Dabbene et al., 2014). Japan, Canada, Australia, and other countries have built their meat traceability management systems in succession (Wilson et al., 2001).

Individual traceability allows the identification of the animal from which a product has been obtained. DNA purified from food is analyzed using microsatellites or SNP molecular markers. Microsatellite analysis enables the production of a unique genetic profile for each animal, called DNA fingerprinting. Simple sequence repeats (SSR) and single nucleotide polymorphisms (SNP) are the main DNA marker types used (Shan et al., 2005). An SSR with numerous alleles

has a higher mean polymorphic information content, which is beneficial to distinguish individuals with a smaller number of markers. Most SNPs only have two alleles, and the polymorphisms are relatively lower, but the genotyping of SNP is relatively simple and low cost, which makes it the preferred marker in many situations (Allen et al., 2010). Traceability studies based on SSR and SNP markers have been extensively conducted in recent years.

Dalvit et al. (2008) tested a set of 12 SSR markers for assessment of a genetic traceability system of six cattle breeds of Italy when genotyping the five most polymorphic loci and found out that the probability of finding two identical animals was five in one million. Zhao et al. (2017) used 16 SSRs to conduct individual identification and meat traceability for six common breeds of beef cattle in China. The results showed that when a combination of six highly polymorphic loci are used, the match probability value is about seven in one million. In the process of individual identification, different SSR markers usually exhibit different polymorphisms in the same population, while the identical markers may also show different polymorphisms in different genetic background populations. Under this circumstance, the selection of polymorphic markers is very important in genetic traceability practices (Zhao et al. 2017). Thus, the SNP marker shows great potential in individual identification and meat traceability practice.

Cheong et al. (2013) used 90 SNP loci to differentiate 1602 cattle individuals from native Korean breed Hanwoo and other breeds such as Holstein. The results showed that the accuracy was 100% (Cheong et al. 2013). Zhao et al. (2018) selected 36 SNPs with minor allele frequencies, more than 30% from the 59 SNP markers belonging to 29 autosomes of the bovine genome. Using the SNPs panel, the probability that one individual is incorrectly assigned ranges from 1.12 out of 10 (×15) to 3.38 out of 10 (×12), depending on the different breeds. At the same time, the selected twelve most polymorphic SNPs were successfully used for meat traceability of Halal beef through meat and reserved blood sample comparison, which had the potential to further guarantee the safety of Halal beef in the Chinese market (Zhao et al. 2018). Wu et al. (2017) employed seven polymorphic SNPs to verify the origins of lamb in Northwest and East of China, and the results showed that the probability for two random individuals to have the same genotype was only 0.185% (Wu et al. 2017).

Besides individual identification, SSR and SNP markers can also be used for breed information confirmation. Rogberg-Munoz et al. (2014) utilized 22 SSRs to discriminate the Chinese yellow cattle breed from seven foreign breeds. The result showed that all foreign breeds could be differentiated from the Chinese yellow cattle, although some individuals of Chinese

yellow cattle were wrongly allocated as Limousin or Holstein, which may have been the result of the introduction of these breeds into China in recent years (Rogberg-Munoz et al. 2014). Mateus et al. (2015) employed SSRs to determine the cattle breeds origin of beef products present in the Portuguese market with the Protected Designation of Origin (PDO) mark. When the population origin information was unknown, the matching probability of 90 representative samples with their correct populations was 96%; when the population origin information was known, the probability reached 98% (Mateus et al. 2015). Dimauro et al. (2015) used 110 SNPs and 108 SNPs with high PIC values to successfully differentiate 21 sheep populations in five different geographic areas. With advancements in DNA-related detection technologies, the use of DNA fingerprinting for individual identification and breed differentiation will have more extensive applications.

DNA traceability technology is the most reliable genetic marking technique followed by morphological labeling, cytological labeling, and biochemical marking (Ludith et al., 2014). DNA polymorphisms directly reflect differences in the genetic makeup of the individual. Each animal possesses a unique DNA code, which is permanent and remains intact throughout life (Vazqez et al., 2004). In addition, DNA fingerprinting does not need any external product labeling system. DNA can be taken at any point in the production chain, and it can be matched with the history of the animal, thus providing the information for the individual traceability (Loftus 2005). However, one limitation of DNA fingerprinting is that it is a multi-step process that requires DNA extraction, designing specific amplification primers, PCR amplification, and identification of the corresponding PCR fragment, which need high technical requirements (De et al., 2004). Meanwhile, some factors may also affect the accuracy and reproducibility of DNA fingerprint authentication like DNA degradation and PCR inhibitors. Furthermore, due to genetic differences between populations, the same DNA marker has varied polymorphism, raising the need to screen more specific genetic markers. Finally, the cost of the DNA fingerprinting technique is higher, which is one of the reasons for limiting its application in a wide range. If the above limitations could be addressed, the promotion and application of molecular meat traceability will become imminent.

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Chapter 10
INTERNATIONAL ORGANIZATIONS GUIDING LIVESTOCK TRACEABILITY AROUND THE WORLD

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10.1 International Committee for Animal Recording, Rome

International Committee for Animal Recording (ICAR) is the organization for the standardization of animal performance recording and productivity evaluation. ICAR was established in March 1951 in Rome, Italy as a small regionally bound organization. However, due to its consistent activities, ICAR has evolved into International status. It is a registered non-profit International Non-Governmental Organization (INGO). The objective of ICAR is to promote the development and improvement of performance recording and evaluation of farm animals. Objectives of ICAR are achieved through establishing definitions and standards for measuring animal characteristics having economic importance. ICAR develops and establishes standards to define criteria to be applied consistently in the provision of recording and evaluation services, in the manufacture and supply of animal identification, performance recording, and analytical devices, and in the testing of such and analysis of animal products and performance for recording and evaluation purposes. ICAR rules define basic principles of animal identification, registration of parentage, performance recording, and genetic evaluation which are followed across the world. Based on sound scientific evidence, the ICAR guidelines recommend procedures and methods of animal identification, registration of parentage, performance recording, and genetic evaluation.

Mission of ICAR

ICAR's mission is to provide information and services which help member organizations to develop, operate and manage their business. It provides information and services which promote the benefits of recording and evaluation, thereby increasing the demand for the services provided by member organizations. It also helps in developing guidelines and standards which facilitate the provision of services and the exchange of information by member organizations both nationally and internationally and it acts as a body through which member organizations can work together to achieve shared objectives.

Aims and main objectives of the Committee

a) To promote the development and amelioration of performance recording for farm animals and their evaluation, such objective is to be achieved through establishing definitions and standards for measuring characteristics having economic importance.
b) ICAR establishes rules and standards and specific guidelines for the purpose of identifying animals, the registration of their parentage, recording their performance and their evaluation, and publish the findings.
c) It provides incentives for concentration and collaboration in all activities having to do with animal performance recording and evaluation within and among international organizations, public authorities, and industry;
d) It encourages the use of the findings of performance recording to assess the value of animals and establish specific codes of conduct, given that both aspects have a bearing on the profitability of animal production.
e) It facilitates the interpretation of findings at the practical level by publishing reports showing the results obtained through the application of methods of performance recording and evaluation.
f) The association has also as its aim the drafting of articles, publication, and distribution of journals and books, the organization of seminars and workshops, and granting of scholarships to selected researchers or students.
g) Within the scope of its activities, the association can enter into any transaction having to do with movable or immovable property where such transactions are in pursuit of its aims.

The numbering system followed for the identification of animals has to be approved by ICAR for International acceptability and is followed across the world. National Dairy Development Board, Anand represents India in ICAR. NDDB distributes ICAR-approved codes for individual identification of animals to interested organizations in India. Several private agencies have also been authorized to supply ICAR-approved ear tags for the identification of animals.

10.2 Global Food Traceability Centre

Challenges in implementing a system-wide food traceability system are many. To support and advise agencies interested in implementing traceability Global Food Traceability Centre (GFTC) was established by the Institute of Food Technologists, Washington, United States of

America. The Centre is a long-term, collaborative, public-private partnership created to address the issue of food traceability. The primary purpose of GFTC is to strengthen the performance of the agriculture and food industry. It will do this by raising understanding of the value and importance of tracking and tracing of food, and by fostering collaborative research and communications that provide traceability tools to raise the capabilities of agri-food businesses. It will also act as a focal point to articulate the importance of being proactive and foresighted concerning food traceability and safety. The vision of the GFTC is t*o become the global resource and authoritative voice on food traceability.* The goal of GFTC is to improve the product tracing capabilities of industry and government with regard to food-borne outbreaks and emergency management as well as to build and expand services and solutions that will increase the benefits of traceability and collaboration amongst participants in the food system (farm to fork). GFTC works with businesses, industry, academia, and government agencies to more proactively address food traceability.

Need of GFTC

Until now there has been no go-to resource and authoritative voice on food traceability. Industry, businesses, and governments all pursue their interests regarding food traceability with little collaboration. The result is a broad array of initiatives, programs, projects, and systems that may or may not directly improve the food industry's overall capabilities. GFTC was hence established to support various traceability initiatives being undertaken by different countries. Realizing the importance of GFTC several agencies including various private agencies, industries, universities, and government agencies are funding the initiative, etc. Current Founding Sponsors and Contributing Partners include: Cargill Inc., Eurofins Labs, FMI Foundation, Global Cold Chain Alliance, GS1 US, International Association for Food Protection, Intertek Group, Lyngsoe Systems, Mars Inc., National Centre for Food Protection and Defense, National Fisheries Institute's Seafood Industry Research Fund, PepsiCo, Produce Marketing Association, University of Guelph, Walmart, and Wegmans Food Markets.

Getting involved with GFTC

There are numerous ways for food system stakeholders to become involved in the GFTC. One simple step is to become a member of the Institute of Food Technologists. IFT is an international professional society with over 18,000 members worldwide in about 100

countries. As a member of IFT, people have access to IFT's entire array of food science research and information. Centre will assist companies to more reliably trace the paths of products through the supply chain, improve food safety and avoid devastating economic impacts. Any agency seeking information and guidance regarding the food traceability system can approach GFTC. Further information regarding GFTC can be obtained from www.globalfoodtraceability.org.

10.3 Codex Alimentarius Commission guidelines for food traceability

Codex Alimentarius Commission (CAC), an International standard developing body has devised, **'Principles for traceability/product tracing as a tool within a food inspection and certification system (CAC/GL 60 – 2006)'** as a guideline to the food industry. These guidelines act as a benchmark for the implementation of a food traceability system by the food industry. The content of the CAC guideline is given below:

Scope

1. Guideline elaborates a set of principles to assist competent authorities in utilizing traceability/product tracing as a tool within their food inspection and certification system.
2. Recognizing the dual mandate of the Codex Alimentarius, traceability/product tracing is a tool that may be applied, when and as appropriate, within a food inspection and certification system to contribute to the protection of consumers against food-borne hazards and deceptive marketing practices and the facilitation of trade based on the accurate product description.

Definitions

Inspection: is the examination of food or systems for control of food, raw materials, processing, and distribution, including in-process and finished product testing, to verify that they conform to requirements.

Certification: is the procedure by which official certification bodies and officially recognized bodies provide written or equivalent assurance that foods or food control systems conform to requirements. Certification of food may be, as appropriate, based on a range of inspection activities which may include continuous online inspection, auditing of quality assurance systems, and examination of finished products**.**

Equivalence: is the capability of different inspection and certification systems to meet the same objectives.

Traceability/product tracing: is the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution.

3. These principles cover the context, rationale, design, and application of traceability/product tracing as a tool for use by a competent authority within a food inspection and certification system.

Context

4. Traceability/product tracing, as defined above, is one of several tools that may be utilized by a competent authority within its food inspection and certification system.
5. An importing country should consider that a food inspection and certification system without a traceability/product tracing tool may meet the same objective and produce the same outcomes (e.g. regarding food safety, provide the same level of protection) as a food inspection and certification system with traceability/product tracing.
6. It should not be mandatory for an exporting country to replicate (i.e. establish the same) the traceability/product tracing tool as used by the importing country, when applicable.

Rationale

7. The application of a traceability/product tracing tool by a competent authority should improve the effectiveness and/or efficiency of the actions that may be necessary regarding its measures or requirements within its food inspection and certification system.
8. Traceability/product tracing is a tool that when applied in a food safety context does not in itself improve food safety outcomes unless it is combined with appropriate measures and requirements. It can contribute to the effectiveness and/or efficiency of associated food safety measures.
9. Traceability/product tracing is a tool that when applied in a food inspection and certification system can contribute to the protection of consumers against deceptive marketing practices and facilitation of trade on the basis of accurate product descriptions.
10. In every case a traceability/product tracing tool should be justified within the context of the food inspection and certification system and the purpose, objectives, and specifications of the traceability/product tracing tool clearly described. The scope and extent of the application of the tool should also be consistent with the described need.

Design

11. The traceability/product tracing tool may apply to all or specified stages of the food chain (from production to distribution), as appropriate to the objectives of the food inspection and certification system.
12. The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system.
13. The objectives, scope, and related procedures of a food inspection and certification system that includes a traceability/product tracing tool should be transparent and made available to competent authorities of the exporting country upon request.

Application

14. The application of traceability/product tracing should take into account the capabilities of developing countries.
15. If in the context of a traceability/product tracing tool an importing country has objectives or outcomes of their food inspection and certification system which cannot be met by an exporting country, the importing country should consider the provision of assistance to the exporting country, and especially in the case of a developing country. Assistance may include longer time frames for implementation, the flexibility of design, and technical assistance so that the objectives or outcomes of the food inspection and certification system of the importing country can be met.
16. A food inspection and certification system within which a traceability/product tracing tool is applied should not be more trade restrictive than necessary.
17. The application of the traceability/product tracing tool should be practical, technically feasible, and economically viable within a food inspection and certification system.
18. In deciding whether and how to apply the traceability/product tracing tool, in the context of a food inspection and certification system the competent authority should take account of the assessed food safety risks and/or the characteristics of the potential deceptive marketing practices being addressed.
19. Traceability/product tracing tool within the context of a food inspection and certification system should be implemented when and as appropriate on a case-by-case basis.

Chapter 11
IMPLEMENTATION OF LIVESTOCK TRACEABILITY – AN INDIAN PERSPECTIVE

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The unorganized livestock rearing system and educational backwardness of the farmers are considered to be the major challenges in implementing a livestock traceability system in the country. However, the awareness level of rural masses is constantly increasing. Penetration of internet and telecommunication facilities in nuke and corner of the country has raised the hope of making livestock traceability possible in near future. A country can learn from the experiences of other countries in its implementation. Consolidation of discrete efforts being put into livestock traceability in different states of India is the need of the hour to establish a national system. Policymakers need to make informed decisions on several aspects of traceability before chalking out a program and implementing it on a national scale. This chapter provides a brief note on questions that will come up before policymakers if a serious effort is to be made to the implementation of livestock traceability in the country.

1) Does India require a livestock traceability system?

The contribution of animal husbandry is extremely important for a nation's growth, development, and rural prosperity. The advent of the world trade organization has opened up vast opportunities for International trade and holding the highest number of livestock heads in the country, opportunities in the International market for livestock products can be exploited if traceability-based quality assurance is implemented in the right earnest. Europe and Japan realized the importance of traceability after the emergence of BSE which affected the marketability of their livestock products. Uruguay realized its importance after an outbreak of FMD which affected export competitiveness. Prevalence of diseases and poor-quality assurance methods in meat production are the major hurdles for promoting livestock products produced in India in the International market to address these issues traceability needs to be implemented. In addition, there are many associated benefits of livestock traceability like effective rolling out of government

schemes, promotion of e-marketing, food safety, scientific livestock management, enhancing knowledge level of farmers, etc. In the long run, livestock traceability can augment income to the producers by promoting marketability in both domestic and International markets.

India witnessed FMD outbreak of epidemic proportions especially in southern states in 2013. In Tamil Nadu, livestock numbering 64,260 were infected and 6,100 deaths were reported in 2013. In Karnataka, FMD claimed 2,060 cows and affected 16,573 animals in 1,304 villages in 19 districts of the State between September 1 and October 5, 2013. Karnataka government provided compensation of Rs 16,500 per bovine head. The country can avoid huge monetary losses occurring due to outbreaks of disease which lead to loss of animal lives, decrease in production, and consequent expenditure towards providing compensation to farmers. While evaluating traceability system based on the cost to be incurred for implementing traceability system, loss to the country due to non-implementation of traceability needs to be assessed. To make the Indian livestock sector competitive it is the need of the hour for policymakers and stakeholders to come together and devise a practical system for the implementation of livestock traceability in the country.

2) Whether to go for a mandatory or voluntary livestock traceability system?

Mandatory traceability will have legislative backing and identifying every animal, premises, and abattoir will be mandatory. In Europe, if any animal is found without a traceability tag and if the owner is unable to prove its ownership the animal will be destroyed. Voluntary systems are driven by market forces. If a producer wishes to export meat to the International market or domestic consumers prefer traceable meat, he will implement a comprehensive traceability system. However, if the target is only the domestic market and if consumer awareness is lacking producers may not follow the system. Although voluntary systems fail to provide a comprehensive quality assurance system at the national level, it will be a good idea to keep the traceability system voluntary, to begin with. Once the critical awareness regarding traceability and its benefits percolate among the stakeholders a mandatory system can be implemented over a period of time.

3) Up to what level does traceability needs to be implemented in the country?

Basically, there are three levels of implementation of livestock traceability which are:

i. **Traceable up to individual animal:** This system allows tracing back the origin of meat up to the individual level. In this case, a unique traceability code needs to be given to each meat

animal. EU follows traceability up to the individual level. Although this is the best system, it will be more complex, if not impossible, to implement especially in a country like India.

ii. **Traceable up to single herd:** Assuming that the health and feeding management of a particular herd is uniform to all animals and the ownership is also with one person traceability can be targeted up to a single herd. In that case, a unique traceability code to be allotted to the livestock owner/ farm/ premises and the same number will be put on all the animals as ear tags. Data corresponding in respect of the number of animals in the herd and their managemental details can be recorded against the farm code. This is used mostly for pig and poultry birds. However, it makes sense to initiate traceability targeting up to a single herd and update the information of a particular herd at regular intervals on to the database.

iii. **Traceable up to a group of herds:** If there are similarities in management practices of a particular group of herds, it can be taken as the basic unit for traceability. For example, in India traceability can be targeted to the village or inhabitation level. It is a very crude method of traceability but it enables easier implementation. India can initially target up to herd/ farm/ premises level as it will be easy to update the information on to the database. Once the traceability practices percolate to all stakeholders, the system can be intensified and traceability up to individual animals can be targeted.

4) Who will control and monitor the livestock traceability system?

At present, livestock traceability is being implemented in selected locations of Gujarat and Maharashtra. Export abattoirs do follow traceability in their own way. But all such efforts must be brought under one umbrella under unified authority at the national level. That will help in maintaining uniformity of the system across all states of the country. However, depending on the local needs, states can be given the freedom to modify the system without compromising the basic requirements. Hence, there is an urgent need to establish, 'National Livestock Traceability Authority of India' at the national level to initiate the process of conceptualizing and implementing the livestock traceability system.

5) What should be the basic unit for livestock traceability?

Traceability implementation requires an office wherein farmers can go communicate the status of the herd and collect the ear tags for tagging animals. Due to obvious reasons, farmers may not wish to move long distances for this work. Hence, it will be convenient for farmers if

livestock identification, information maintenance, and ear tag distribution offices are located in each village. India possesses about 6,38,000 villages spread across different states. Office of Registrar General and Census Commission of India, New Delhi provides unique code for each village and area of city (http://censusindia.gov.in/2011census/Listofvillagesandtowns.aspx). e.g. Code for Andhra Pradesh state: 28, Rangareddy district: 537; Ghatkeshwar Mandal: 04523; Chengicherla village: 574174. That code can be made used for devising and implementing livestock identification systems. Pin code-based farm/ abattoir identification method can also be used for numbering and recording information in a traceability system. Due to the vastness and huge number of villages, establishing an office in each of them will be a herculean task. Hence, it is suggested to identify related offices existing in villages as nodal centres for implementation. Some of the offices which can be identified as nodal centers are veterinary hospitals, primary milk cooperative societies, panchayat offices, etc. The service of educated youth of the villages can be utilized for undertaking the activities of the traceability centers.

6) Which species to be covered for traceability?

Many countries impose stringent traceability systems only for bovines due to their value in the International market and due to the BSE scare. In India, the export of beef is banned. Buffalo meat export is growing at a rapid pace and rearing buffaloes for export meat can be a good business model. However, as diseases like FMD occurs in both cattle and buffalo, traceability targeted only to buffaloes may not meet the disease control requirement. Poultry is a relatively organized system and it is possible to implement a batch-based traceability system. Due to the high fluctuation of the price of livestock products in the domestic market, there is an urgent need to take the poultry industry to the next stage by implementing a traceability system. In the sheep, goat, and pig sector, organized farms are very few. Export quantum is also lesser in these species as compared to that of buffalo meat. Hence, traceability can be implemented in cattle, buffalo, and chicken to begin with. After successful implementation in these species, it can be extended to other species with necessary modifications.

7) Is the traceability system to be implemented nationally or in the selected area only?

India is a country with huge diversity. Progress levels in terms of animal husbandry activities and veterinary services vary from state to state. An effort is being made by Animal

husbandry departments to establish disease-free zones. FMD control programs are also being implemented in different districts. It will be logical to tie up these efforts with a traceability system to demonstrate the utility of livestock traceability in disease control programs in the country. It will also be desirable, to begin with, in states where animal health and veterinary services are well developed and the awareness level of farmers is high. With a long-term focus on the implementation of livestock traceability at the national level, implementation in a selected area can be a practically feasible approach.

8) What kind of animal identification system is to be followed?

Varied types of animal identification systems are available. Of which RFID and simple plastic laser-printed visual ear tags are most commonly used. The electronic system requires specialized devices for its reading while visible tags enable reading from distance. Chances of tampering can be high in visible tags. RFID ear tags are three to four times costlier than that of visible ear tags. It must be noted that the European traceability system is mainly based on visual ear tags. In India, the Department of Animal Husbandry and Dairying, GoI is providing laser printed cum bar-coded ear tags to dairy animals since 2017. An effort is being made to extend this animal identification system to other species of meat animals also. Two sets of tags may be given to each animal for applying to both ears. This ensures that of falling of tags does not create any confusion in the identification of animals.

9) Do we need to rope-in abattoirs in the livestock traceability system?

Conditions of public abattoirs in the country are very poor. Even minimum facilities are lacking in such facilities. Combined with illegal slaughtering, traceability labeling on the meat for the domestic market is a challenging proposition. However, export abattoirs have state-of-the-art facilities and knowhow to follow meat traceability labeling. Export abattoirs do follow a traceability system by tagging the animal after it arrives at the abattoir. If the animals received at the abattoir are already tagged and traceable up to herd level, it will add up to their efforts and will boost the confidence of the importing countries also. Livestock traceability also requires the registration and coding of abattoirs. Once all the public and private abattoirs in the country are registered and codified it will be easy to plan up-gradation or modernization schemes to improve their conditions.

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