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A DATABASE FOR BUFFALO MEAT TRACEABILITY IN INDIA

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ABSTRACT

Farm-to-fork traceability has emerged as benchmark for meat quality assurance in the International meat market. India is the largest exporter of buffalo (*Bubalus bubalis*) meat in the world; nevertheless, need for indigenous traceability system based quality assurance protocols to enable exports to the developed countries has been increasingly emphasized. To address this gap, a complete protocol for achieving traceability was conceptualized and a traceability database (www.livestocktraceindia.in) was developed to support the Indian buffalo meat sector. Traceability model and the database established was field tested. This article provides brief information of the traceability framework and the mode of its operation. The traceability database encompasses enrolment of animals, farms and abattoirs. Animal identification was achieved using ear tags with Internationally accepted identification numbers. Premises including farms and abattoirs were identified using unique pin code based system. Provision was given to end user to retrieve information and trace back the origin of meat using the database's retrieval system. Database and traceability protocols developed can help promote livestock sector, meat traceability and meat export in India. The database can act as model for establishment of traceability system in other countries producing and exporting the buffalo meat.

Keywords: *Bubalus bubalis*, buffaloes, traceability, meat, India, database

INTRODUCTION

Traceability is defined as the ability to trace and follow a food, feed, food producing animal or ingredients, through all stages of production and distribution (European Commission, 2000). Meat traceability indicates the ability to trace back the origin of meat up to the level of farm and animal of origin. Complete meat traceability system must enable both forward (tracing the product forward from gate to plate) and backward (tracing back the product to its source *i.e.* from plate to gate) traceability. Traceability intends to reduce risk and minimize the impact of food borne diseases. Livestock diseases such as Foot and Mouth Disease

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(FMD), Hemorrhagic Septicemia (HS) have direct impact on buffalo meat trade. This requires a framework in food traceability to ensure their control, gain consumer confidence in food safety and comply with laws and regulations of both producing and importing country (Zhao *et al*., 2013; Bai *et al*., 2017). The Sanitary and Phytosanitary Measures (SPS) of the World Trade Organization (WTO) promote traceability of animal products (WTO, 2015). The exporting countries must build traceability system for animals and animal products to sustain the competitive international trade and overcome trade barriers (Wilson and Beers, 2001). Being largest exporter of buffalo meat in the world, India must work to implement livestock traceability system in the country. Countries which adopted livestock and meat traceability include Brazil, Australia, United States of America, New Zealand, Canada, Argentina, Uruguay, Japan, European Union, Mexico and South Korea (Schroeder and Tonsor, 2012). The ISO: 22005 is a benchmark certification exclusively for traceability of feed and food chain and intend to boost image of exporters in the international market.

According to the 20th livestock census of government of India, there are 109.85 million heads of buffaloes in India (Department of Animal Husbandry, Dairying and Fisheries, 2019). India exported 1.24 million tons of buffalo meat worth 3,608 million USD in the year 2018 to 2019 (APEDA, 2019) mostly to Vietnam, Malaysia, Philippines, Egypt, Kuwait and Saudi Arabia. In order to expand acceptability of buffalo meat in the global market, especially in the high income developed countries, India needs to implement stringent quality control system backed by livestock traceability network.

Recent introduction of Food Safety and Standards (Food Recall Procedure) Regulations, 2017 by the Food Safety and Standards Authority of India (FSSAI, 2017) has mandated food recall (action to remove food items from chain, including that possessed by consumers). Under this regulation, the Food Business Operator (FBO) must establish procedures and arrangements to retrieve food and food products from food chain and must do so if demanded. Traceability system aids immediate implementation of such guidelines. Nevertheless, comprehensive meat traceability database is non-existent in India. To address this gap, a traceability system suitable to India was conceptualized and buffalo meat traceability database was developed for the use of stakeholders. Database enables registration of animals, farms and abattoirs; provides platform for retrieval of information; hosts herd management system to help performance recording of buffaloes and support scientific farm management. The system can be a good model for developed countries interested in implementation of traceability system for buffalo meat.

MATERIALS AND METHODS

Identification of buffaloes

Identification of individual buffaloes was undertaken using ear tags encrypted with 15-digit traceability code (*e.g.* 900220000000278) allotted by International Committee for Animal Identification and Recording (ICAR) based on Radio frequency identification device (RFID) ear tags (M/s. Identis Tech Solutions Pvt. Ltd, Hyderabad). However, after national program on tagging and animal identification system of animals was implemented by the Department of Animal Husbandry, Dairying and Fisheries, Government of India in the year 2017, a 12-digit

visible *cum* bar-coded ear tags obtained from Livestock Development Agency, Government of Telangana, Hyderabad, India were used for animal identification (Figure 1).

Identification code for animal farm, abattoir and meat product processing plant

Identification of premises is essential for enabling trace back of the product. Premises include farm/ abattoir/ processing plant. A Postal Index Number (PIN) based method for identification of premises was designed keeping in view the ease of identification and convenience of allotment. Code consisted basically of three different components;

Component 1: First 6-numbers of PIN of the premise location

Component 2: Subsequent 2-numbers indicate the type of operation e.g. 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 and products retail unit.

Component 3: Last 3-numbers are serial numbers of the farm/ firm allotted upon registration e.g. First buffalo farm enrolled in Chengicherla, Hyderabad with PIN 500092 will have the code: 50009201001. Using this system code of first abattoir of Chengicherla, Hyderabad, India = 50009202001.

Traceability labelling of meat packages

Meat packages must have identification code of farm of origin, abattoir where slaughtered and ear tag of the animal/ batch number. At the abattoir, if meat of individual animal is packaged, ear tag number of the animal can be printed. If group of animals are slaughtered then for pooled meat batch number can be created. Batch number will contain list of animals slaughtered and pooled into batch. Traceability codes can be placed over meat packages using bar coding. Using details mentioned on the package, retailer and consumer can trace back origin of the meat using internet database. Type of bar-code label used was water proof and low temperature resistant enabling label retention during processing and storage conditions of meat.

Designing of livestock traceability database

Flow of information in the database was finalized based on inputs collected from stakeholders and information elicited during the survey undertaken. Online database (www.livestocktraceindia.in) was custom designed (M/s. Infovet Pvt. Ltd., Pune) in Asp.net language using SQL Server 2012.

RESULTS AND DISCUSSION

The farm-to-fork livestock traceability system was developed for the first time in India; the database can be accessed at www.livestocktraceindia.in; its components (Figure 2).

Framework of web based meat traceability system

Survey was undertaken to understand buffalo farming and marketing channels in dairy farms located at Telangana State (Hyderabad and Warangal), Punjab (Ludhiana) and Maharashtra (Nagpur and Solapur) States. Survey was focused on operational steps undertaken at buffalo farms, management methods, marketing channels, etc. Five abattoirs were visited to understand steps involved in slaughtering, packaging and despatch of export consignments. Based on the information gathered during survey and discussions made with

stakeholders, the information flow in traceability database was finalized and web based meat traceability database was designed with url http://www.livestocktraceindia.in and central data server was hired for hosting the database. Software platform for performance recording of herd and scientific management of farm was linked to the web-based database. Traceability database was Copyright protected (Registration No. SW-12499/2019 dated 12th June 2019) with Copyright office of Govt of India. Access was provided for the retrieval of information by consumer. Information of animal and premises can be obtained using animal identification number and premises identification number, respectively.

Identification and coding of animals and premises

Identification of animals and premises like buffalo farm, abattoir and processing plants were the basic requirements for achieving traceability. Method followed for identification of buffaloes and coding of premises is given below

Identification of buffaloes

Animal identification is the core requirement for implementation of livestock traceability system and most common method of animal identification is ear tagging. Radio Frequency Identification (RFID) based ear tags with 15-digit identification number allotted by International Committee for Animal Recording (ICAR, Rome) was used for buffalo identification. National animal identification scheme of Government of India using laser printed visible *cum* bar-coded tags having 12-digit identification numbers were also used for animal identification. Prices of RFID tags are higher than bar-coded ear tags and it also require specialized reader for reading encoded number. On the other hand, bar-coded tags being cheaper can be easily read using smart phones by downloading the reader application software. However, RFID tags are more suited for electronic applications in the farm and automation applications.

Designing and allotment of premise numbers

At present, no national or internationally accepted guidelines exist for identification codes of premises like farms, abattoirs and processing plants. Identification of premises helps in tracing back and implementing focussed disease control measures. Postal Index Number (PIN) based code designed for identification of farms, abattoirs and processors comprised of 11-digit number (first 6- numbers reflect PIN of the area). Stakeholders are generally well acquainted with PIN number hence it will be easy to decipher the premise in the region. Next 2-digits indicate type of operations undertaken in the premises (01 Buffalo farm; 02 Abattoir; 03 Meat product processing plant; 04 Abattoir with processing, etc). Last 3-digits indicate serial number of the premise. Common identification number for farm, abattoir, processing plant and retail units would enable easy allotment of numbers upon registration.

Registrations and enrolments

Registration of animals and premise was undertaken as follows (Table 1).

Animal registration

Individual animal is the basic unit of data recording. Unique identification of animal is paramount for registering into the database. The traceability code mentioned over the ear tag and its maintenance throughout value chain would enable tracing back of origin of meat source. Farm

animal details can be entered in the database by logging in to the farm profile. Information collected during the process of registration are: animal identification number, sex, species, breed, parity/lactation Number, identification number of dam, identification number of sire and date of last calving.

Premises registration

Premises that can be enrolled in to the database include buffalo farms, abattoirs and meat processing plants. Farm in the context of traceability is the place where animals are reared; such farms can be registered in the database. Basic information about the farm is entered for registration for enrolling; generating login profile of the farm. Upon approval from the administrator, farmer will get an e-mail confirmation message; following which, farm manager can login to the site and enrol animals and also use herd management software. Subsequently, all premise related activity records can be updated and maintained using the login ID generated. Similarly, abattoirs and meat processing plants can also be registered and login profile can be obtained for further information updating.

Administrator module

All new registrations require to be approved by the administrator. Administrator can also create species and breed information in the formats. Only authorized persons have access as administrator to manage the information. Information is monitored and assembled in appropriate form using administrator module. Administrator of the livestock traceability database (www.livestocktraceindia.in) is managed by ICAR - National Research Centre on Meat, Hyderabad, India. Administrator team monitors overall activities of the traceability database and addresses problems arising thereof by the stakeholders while using the database.

Buffalo performance recording using 'Herdman' software

Animal identification, performance recording and analysis of collected data helps in systematic planning of the farm activities, scientific farm management, monitoring breeding and creating reports; this would help in developing strategies to enhance productivity of farm.

Vaccination details of registered animals can be entered and updated periodically in the database by the authorized farm manager. Common vaccinations such as FMD, HS and Brucella have been provided in the vaccination section; further, farmer can add additional diseases using the master link of the Herdman software. Daily action menu displays overall options in the software for the scientific herd management. Action list includes parameters such as detection of first heat after calving, subsequent heat, check for pregnancy diagnosis, animal expected to calve and animal expecting drying off. Action list can be generated to handover list by manager/ workers.

Abattoir data recording

In the abattoir, information entered into the database include animal identification number, batch number of meat package, date of arrival, name of supplier, species, breed, sex, ante-mortem and post-mortem inspection reports. Meat can be packaged with individual animal or batch number. If batch number has to be mentioned on meat package, ear tag number of every animal and part of the batch is mentioned. End user will be able to trace back details either by using animal identification number or batch number. Batch

number displays meat of all animals packaged.

Trace back provision in database

Transparency is achieved by keeping information open regarding origin of meat starting from point of rearing to place of slaughter, packaging till end user. Meat traceability database contains information about contact details and address of abattoirs and farms; information can be retrieved using traceability code of the origin (farm and abattoirs) in the retrieval link available in the database home page (www.livestocktraceindia.in).

Validation of the database

Pilot testing of the meat traceability database was performed with consent at M/s. J.S. International Export Abattoir, Unnao, Uttar Pradesh. After the pilot testing, abattoir management shown interested for the implementation of the traceability system in the abattoir. About 10,000 animals have been registered to promote exports from the abattoir. Six organized dairy farms located at Karnataka, Andhra Pradesh and Telangana state have also enrolled into the traceability database. Privacy of the farm is not compromised in the database and the data of one farm cannot be accessed by other farmer as it is login protected.

RESULT AND DISCUSSION

Information Network for Animal Productivity and Health (INAPH) is a traceability database managed by National Dairy Development Board (NDDB), Gujarat, India (INAPH, 2019). The INAPH provides platform for registration of bovines and recording of performance; however, it doesn't contain abattoir module to enable meat traceability. The 'Meat.Net' database designed and managed by Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India (APEDA, 2019) is an online system that offers services to registered processing units; health certificate is issued to export consignment of meat products. The Meat.Net is for export abattoirs and online quality reports are generated by veterinarians. Nevertheless, Meat. Net database doesn't contain module for backward traceability (farm-fork traceability) as the system focuses only on post-slaughter traceability. In comparison to INAPH and Meat.Net, the new traceability database (www.livestocktraceindia.in) developed by ICAR - National Research Centre on Meat, Hyderabad, India reported here has platform for both performance recording of meat animals and meat traceability. The database enables farm-to-fork traceability for buffalo meat and the system can be easily adopted by farmers and meat processors in India.

Government of India has initiated program for the identification of cattle and buffaloes by tagging with bar-coded ear tags and issuing of 'Nakul Swastya Patra' (animal identification cards) across the country. Aim of this identification program is performance recording and productivity enhancement; however, abattoir component is missing in this program. Since meat traceability module must be an ongoing national program; buffalo traceability data base aims to fill this gap, ensures meat traceability and usher to take Indian meat industry to higher altitudes of the International market.

According to the European Commission (2000), system intended for identification and registration of bovines shall comprise of four elements - (a) ear tags to identify animals individually, (b) computerised databases, (c) animal passports, and (d) individual registers on

each holding. Animal identification and recording systems were historically developed by breed associations to maintain pedigree details of animals, by breeding organizations to implement genetic improvement programs that required performance recording as a prerequisite; livestock improvement organizations used for assisting farmers for the management herds; veterinary health institutions and organizations used for distinguishing health/ vaccination status of herds/ individuals animals. Farm enterprises can improve their production using smart monitoring and control. Smart monitoring, planning and control of production processes are part of smart farming supported by broad spectrum of technologies, ICT components, hardware and software systems (Kruize *et al*., 2016). Animal identification elements make use of body marks, ear tags, Radio-Frequency Identification (RFID) tags, retina image recognition, or DNA fingerprinting; product identification refers to barcodes (EAN UCC, PLU, and GS1), 2D barcodes (QR, VC, and DM) and RFID or Electronic Product Code (EPC) (Bai *et al*., 2017).

'Herdman' module has been incorporated in to traceability database to provide farmers the benefit of smart farming. This module has provisions of farm entries such as artificial insemination, pregnancy diagnosis, milking, feeding, vaccination, deworming, medication, etc anticipated for smart animal farming.

The Ireland uses Calf Birth Registration System database at the national level. Irish database enables registering of information into the database of calf ear tag number, sex, breed, date of birth, herd of origin and ear tag number of dam (Shanahan *et al*., 2009). Information collected in the buffalo traceability database encompasses entries of this Irish system. Although animal registration is on time process, nevertheless information pertaining to the animal can be updated time to time in the database.

Transparency in meat supply chains is necessary to guarantee its safety, quality and gain trust of consumers in meat products (Kassahun *et al*., 2014). The buffalo traceability system has comprehensive retrieval mechanisms; source of origin is ascertained and third parties such as quality monitoring agencies can get needy information from establishments/ farms.

In the Europe, article 3 of FC/l 760/2000 states that "the system for identification and registration of bovine animals shall comprise of the following elements: ear tags to identify animals individually, computerised databases, animal passports, individual registers kept on each holding (European Commission, 2000). Many firms in the EU have implemented traceability schemes *viz*. Pingo Poultry (Nutreco), Danske Slagterier (Denmark), Beltrace (Belgium), etc. Meat traceability is required by EU law; Biotrack database (biometric identifiers for individual animals) makes use radio frequency identification (RFID) for the identification of cattle (GSI, Global Standards Agency); EPCg Global Network (electronic product codes, technology enabled automatic identification of items in the supply chain, anywhere in the world) exchange traceability data between stakeholders; uniform standard format for RFID tags as a global standard require to be introduced (Tomes *et al*., 2014).

It is important for Indian buffalo meat sector to embrace traceability system to gain access in more countries and stabilize exports. Kandanuri (2019) critically analyzed the Indian buffalo meat exports in last two decades and concluded that positive results for both growth and instability indicates that buffalo meat exports were not stable

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

Heading	Sub-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 those are not conceived or empty or pregnant
	Calving	Date of calving, sex of calf, 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 day. Composition and quality of milk in terms of total fat, Solid Not Fat (SNF), Corrected Lactometer Reading (CLR) & Colony Forming Unit (CFU).
	Drying	Date and reason for drying of animal.
	Vaccination	Date, 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 animal and other materials.
	Sales	Details of sales of animal and other materials.
	Medication	Details of medication, period, reason and date.
Action	Daily action plan	Based on the inputs given in the entry, daily action plan is generated based on different assumptions
Details		Based on the entries made details of individual animal can be generated.
Reports		Based on the entries made reports are generated as per the farmers' requirements.

Figure 1. Visible *cum* bar coded ear tags recommended by Department of Animal Husbandry, Government of India.

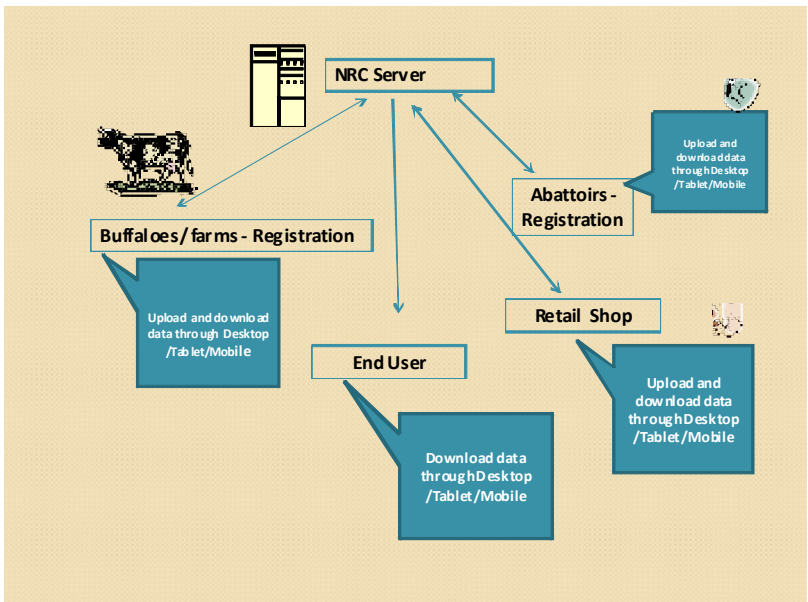

Figure 2. Overview of web-based traceability system.

though the growth rate was positive and high. To stabilize the exports and to achieve sustainable growth in buffalo meat exports, India needs to add value to its buffalo meat products and provide technological backstopping through traceability.

CONCLUSION

Safety, quality and traceability of meat are critical in gaining access into the international meat market. Farm-to-fork traceability has been globally accepted by quality assurance systems; its implementation would bring paradigm shift in meat animal sector in the country. Apart from export promotion, traceability will also help in ownership ascertainment, effective implementation of disease control programs, implementation of developmental schemes, food quality assurance, increasing productivity, livestock census, marketing of livestock products, opportunities, communicating essential information to stakeholders, food recall, etc. The livestock traceability database developed for buffalo for the first time has been designed to ensure meat traceability in the country to act as a model for developing countries intending to implement the traceability system in their countries. This is the first farm-to-fork livestock traceability system prototype in India which was developed under the auspices of Indian Council of Agricultural Research (ICAR) in India.

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REFERENCES

APEDA, 2019. *Analytical Trade Profile of Buffalo Meat*. Agricultural and Processed Food Products Export Development Authority, Ministry of Commerce and Industry, Government of India, New Delhi, India.

Bai, H., G. Zhou, Y. Hu, A. Sun, X. Xu, X. Liu and C. Lu. 2017. Traceability technologies for farm animals and their products in China. *Food Control*, **79**(2): 35-43. DOI: 10.1016/j.foodcont.2017.02.040

Department of Animal Husbandry, Dairying and Fisheries. 2019. *Provisional Key Results of 20th Livestock Census*, New Delhi, India

European Commission. 2000. Regulation (EC) No 1760/2000 of the European Parliament and of the Council of 17 July 2000 establishing a system for the identification and registration of bovine animals and regarding the labelling of beef and beef products and repealing Council Regulation (EC) No 820/97. *Official Journal of the European Communities*, Available on: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:204:0001:0010:EN:PDF

FSSAI. 2017. *Guidelines for Food Recall*. Food Safety and Standards Authority of India, New Delhi, India

INAPH. 2019. *Information Network for Animal Productivity and Health*. National Dairy Development Board, New Delhi, India

Kassahun, A., R.J. Hartog, T. Sadowski, H.

Scholten, T. Bartram, S. Wolfert and A.J. Beulens. 2014. Enabling chain-wide transparency in meat supply chains based on the EPCIS global standard and cloud-based services. *Comput. Electron. Agr.*, **109**: 179-190. Doi: 10.1016/j.compag.2014.10.002

Kruize, J.W., J. Wolfert, H. Scholten, C.N. Verdouw, A. Kassahun and A.J. Beulens. 2016. A reference architecture for farm software ecosystems. *Comput. Electron. Agr.*, **125**: 12-28. DOI: 10.1016/j.compag.2016.04.011

Schroeder, T.C. and G.T. Tonsor. 2012. International cattle ID and traceability: Competitive implications for the US. *Food Policy*, **37**(1): 31-40. DOI: 10.1016/j.foodpol.2011.10.005

Shanahan, C., B. Kernan, G. Ayalew, K. McDonnell, F. Butler and S. Ward. 2009. A framework for beef traceability from farm to slaughter using global standards: an Irish perspective. *Computers and Electronics in Agriculture*, **66**(1): 62-69. DOI: 10.1016/j.compag.2008.12.002

Kandanuri, V. 2019. Indian buffalo meat exports: Issues of growth, instability, concentration. *Buffalo bull.*, **38**(3): 505-520. Available on: https://kukrdb.lib.ku.ac.th/journal/BuffaloBulletin/search_detail/result/390949

Wilson, D. and P.T. Beers. 2001. Global trade requirements and compliance with World trade organization agreements: The role of tracing animals and animal products. *Rev. Sci. Tech. OIE*, **20**(2): 379-382. DOI: 10.20506/rst.20.2.1278

WTO. 2015. The World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). Available On: https://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm.

Zhang, X., J. Zhang, F. Liu, Z. Fu and W. Mu. 2010. Strengths and limitations on the operating mechanisms of traceability system in agro food, China. *Food Control*, **21**(6): 825-829. DOI: 10.1016/j.foodcont.2009.10.015

Zhao, Y., B. Zhang, G. Chen, A. Chen, S. Yang and Z. Ye. 2013. Tracing the geographic origin of beef in China on the basis of the combination of stable isotopes and multielement analysis. *J. Agr. Food Chem.*, **61**(29): 7055-7060. DOI: 10.1021/jf400947y