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Indian perspective in Food Traceability: A review

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Abstract:

India is the second largest producer of fruit and vegetables in the world. Fruit production in India has increased 89 % in the last decade. In the present paper It is exposed the necessity for a proper traceability in the Indian food industry, because the sector is demanding an adequate system due to the precarious nature of existing supply chain, and to reduce the numerous cases of food safety incidents and fraudulence. This work also presents the existing traceability techniques in India which include RFID, Holograms, Barcode, Nuclear techniques and other tracking media to monitor production process. Furthermore it is revealed the initiatives implementation from APEDA and its association with GS1 India in the form of Anarnet, Peanut.net, Meat.net, and Grapenet for the Indian farming products, as well as several ICTs initiatives that are actively working in many states of India.

However the development of an effective food traceability system is affected by a numbers of factors like restrictive government marketing standardization, insecure policies and unstable actions for food safety, underdeveloped and unorganized infrastructure in market area and the supply chains, from the farmers to non-existent cold chain facilities and small local stores, and inadequate agricultural practices with large number of small and medium industries and famers. Therefore an effective food traceability system is not only an important tool to manage food quality and safety risks, but also to promote the development of effective supply chain management in India.

Keywords: Food traceability, food waste, traceability systems, India, food distribution

1. Introduction

A complete definition of traceability is given by Olsen and Borit (2013), they define traceability as "The ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications".

The terms "tracing" and "tracking" are generally discussed in the traceability. According to Petersen and Green (2005), tracing is backward process where origin is identified by history or records in supply chain and tracking is the forward process where end users and trading partners are identified by location in supply chain, while both term provides the visibility to the supply chain (Van Dorp, 2002). Stefansson and Tilanus (2001) point out that tracking and tracing system must be connected with physical transportation system and information system.

Current traceability systems are characterized by the inability to link food chains records, inaccuracy and errors in records, and delays in obtaining essential data, which are fundamental in case of food outbreak disease (Badia-Melis et al., 2015). These systems should address the recall and withdraw of non-consumable products, however up to date there are still recent reports covering the implementation of food assurance systems that do not mention the traceability question although they are highly related to food traceability, e.g. implementation of Good Manufacturing Practices in a mozzarella cheese processing plant (Dias et al., 2012), the assessment of costs for implementation of food safety systems in a small dairy plant (Cusato et al., 2014) or implementation of a food safety system in a dairy processing plant (Cusato et al., 2013).

Foras et al. (2015) present a positive evolution in the traceability system in a developed country (Norway) between 2008 and 2013. They successfully simulate recall methods to determine the pathway through the supply chain from retailer back to the origin. The conclusion is that wholesalers are well prepared to conduct trace backs and withdrawals.

Also traceability has driven many issues related to food crisis management, traceability of bulk products, quality and identity preservation concerns, fraud prevention, anti-counterfeiting (Dabbene, et al., 2014), and minimize food adulteration (Spink et al., 2016).

Over the past few years several countries have gone through mandatory regulation for food traceability systems (Riviere and Buckley, 2012), as well as set up the specific regulations or policies on the national level for domestic products, excluding the India (Schroeder et al., 2012). To export to those countries, where traceability system is mandatory, India must walk along with them, as well as need to follow their defined criteria. Although several conceptual frameworks have been proposed in an effort to explain the dynamics of traceability system, however few of them have focused on the existing food traceability system across the globe, which include the European Union (EU) countries, such as Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Sweden, and the United Kingdom, where all are under the mandatory regulation of EU Legislation 178/2002, whereas other European countries, such as Norway and Switzerland, both have developed the “identitas” for cattle (Charlebois et al., 2014).

Moreover, New Zealand also has mandatory traceability for cattle (NZMPI, 2013). Brazil implemented a mandatory traceability and identification system for livestock under the Brazilian System of Identification and Certification of Origin for Bovine and Buffalo (SISBOV) (Dalvit et al., 2007). In addition, Australia has mandatory requirements for tagging and identification of cattle, sheep, and goats, whereas focus over IRA (Import Risk Analysis) in order to identify and classify potential quarantine risks while importing (IRA Handbook, 2011). Canada also strictly follows mandatory traceability for all animals with tagging for livestock identification (CFIA, 2012). Nevertheless United States (US) does not have mandatory food traceability system, but also require an entire report of traceability of products and enforcement for registration (Charlebois et al., 2014). Russia also requires complete information about the pesticide usage and prohibited to genetically modified organisms (GMO) (New eastern outlook, 2015). Japan implemented a rice traceability regulation in July 2011 (USDA/ERS, 2014). Still China is at basic level of the food traceability, however it

requires pig, cattle, and sheep to be identified with an ear tag system with a 2-dimensional (2D) barcode (Luo et al., 2010).

Indian market is occupied by number of small and medium industries, and up to now, there are certain question marks about the implementation of the traceability system in small enterprises, taking into account the intrinsic difficult of these factors. When the implementation of quality assurance systems in small food enterprises is evaluated, one of the main external factors that influence the adoption of the food traceability. Also this adoption depends on the type of enterprise, the products it produces (e.g., perishable, bulk, seasonal), and the market where its products are sold. The most important factors for enterprises that deal with agricultural products are needed better customer satisfaction, product traceability, and information about quality and sales (Karipidis et al., 2009).

In UK, small and medium-sized enterprises present a positive attitude towards traceability in term of recognition of its importance but an unwillingness to invest in traceability systems' enhancement due to the uncertainty of whether traceability systems can reduce the probability of recalls or not (Mattevi et al., 2016).

According to the Saxena and Gandhi (2015) in the Indian Horticulture Database from 2014, India is the second largest producer of fruit and vegetables in the world after China. Agriculture remains a very imperative sector of the Indian economy both in terms of contribution to source of employment to the millions across the country and gross domestic product (GDP), which was 13.9 % during 2013-14 (Saxena et al., 2015).

Food production in India has increased in last decade 2001-02 to 2012-1. In particular, fruit production has raised 89 %, from 43,000 Million Tonnes (MT) to 81,285 MT, and vegetable augmented 83 %, from 88,622 MT to 162,187 MT. These increases are a result of an increase in the number of farms and diversification in the cultivation methods (Saxena and Gandhi, 2015).

Food retail sector in India

In recent years Indian retail sectors are growing up very rapidly and leading to the revolution of retail sectors in domestic market. Despite progressing in food sector,

however some of them such as small food sectors and grocery sections, both are highly unorganized, and segmented. As of 2012, India's retail sector was dominated by more than 12-15 million Kirana stores, which are typically family-owned outlets found on almost every street corner (USDA, 2014). At current situation there are maximum numbers of stores of several famous national and international retailers like 550 stores from Reliance Fresh (Reliance Industries), and followed by the Future group with 530 stores (GSCG, 2015).

Nevertheless, thousands of shopping malls are jumping into market at every day, but still Indian public prefers to go at a nearby weekly bazaar or market or Kirana stores, which is the easiest gateway and affordable to every middleman who resides in India.

Foreign entities are attracting and investing towards Indian retail sector including Germany's Metro (Kulkarni, 2015), Wal-Mart, is joint venture with Bharti (Patnaik, 2015), and UK's Tesco (Malviya, 2015).

Indian corporate houses such as Reliance Fresh, Imperial Tobacco Company (ITC) - Choupal Fresh, Aditya Birla Group, Godrej-Nature's Basket, Namdhari-Namdhari's fresh, National Dairy Development Board through SAFAL (which is the largest organised retail network of fruits and vegetables in India), and business groups such as Adani-Fresh, also entered into retailing and putting up more focus on fresh fruits and vegetables (GSCG, 2015).

Food wastage in India

There are several reasons in the present whole food supply chain system, from farmers to consumers that account for an enormous amount of food wastage in India, such as lack of storage space, improper care, wastage by consumers, improper post-harvest management, lack of infrastructural facilities, poor transportation facilities, inadequate packaging, lack of refrigerated transport, lack of awareness, stock management inefficiencies, inefficient distribution, corruption, and natural calamities, etc. (Artiuch and Kornstein, 2012).

According to UN's Food and Agriculture Organization (UNFAO, 2013), every year nearly 40% of the total food produced in India is being wasted by grower or consumer or its

144 spoiled before reaching to consumers, where wheat is also enlisted in this wasting list
145 which is about 21 million tons of wheat per annum, due to inadequate storage and
146 poor management by government run Food Corporation of India (FCI) and
147 unfortunately the wheat is eaten or rotten by insects or rat, instead of reaching to the
148 needy person. In 2012, Gulati et al. (2012), estimated that the food grain leakage for
149 the year 2011-12 increased up to 46.72 %. As stated by Mr. Sharad Pawar, the former
150 agriculture minister, the country needs to reduce as well as control over the food
151 wastage which worth $8.3 billion annually (Chauhan, 2013).

152 A recent study conducted by Emerson (2013), annually India is wasting out a large
153 amount of fruits and vegetables that worth USD 2.45 billion, and in order to improve
154 this situation in future, India must solve the recent problem of the country's lack of
155 adequate cold storage facilities and refrigerated transport system (Bhosale, 2013).
156 Whereas, the cold storage capacity must be increased up to 61 million metric tons for
157 covering an entire commodity. Currently cold storage capacity, which is only 30.11
158 million metric tons that manages by 6300 cold storage houses across the country, but
159 it also requires more than USD 10.15 billion to build up the smart cold storage capacity
160 for all food products (NCCD, 2012).

161 Major food wastage is occurred in weddings ceremony, canteens, hotels, social and
162 family functions, as well as households etc., moreover the amount of food wastage
163 and losses are increasing day by day (Phukan, 2014). According to the Global Hunger
164 Index (IFPRI, 2013), India ranks 63rd, out of the 78 hungriest countries, where
165 traceability and associated quality control could help to improve food distribution
166 processes and reduce food wastage (IFPRI, 2013).

167 As per recent survey by Indian Institute of Management (IIM) Calcutta, only 10%
168 perishable foods are able to preserve under the cold storage facility in India and
169 remained 370 million tons of foods at risk (Kazmin, 2014). Basavaraja et al. (2007) also
170 conducted study on post-harvest food losses (PHL) of cereals in the state of Karnataka
171 (India), in which found that most of the PHLs occur at farm level than market level.

Indian agriculture sector ought to establish and integrate food traceability systems with risk management systems in order to improve food safety in the entire food chain (Sugahara, 2012; Aung and Chang, 2014).

According to Golan et al (2004), for fortifying firms the government policies must be focused, and should be invested in the traceability system and need to develop a controlling or monitoring system that can be watched over the unsafe and falsely advertised foods which comes in market, it must be taken some appropriate action that may help to remove that food as soon as possible from the system.

2. Necessity of traceability in the Indian food industry

2.1. Functional role of the traceability system within Indian food supply chain

In the last half decade 2009-2013, the exports of India has risen at annual rate of 6.6 % (OEC, 2015), so far India has been exported many farming products such as mango, banana, onion, ladyfinger, pomegranate, and more to many parts of world under the guideline of Agricultural & Processed Food Products Export Development Authority (APEDA), and Agriculture Marketing (AGMARK) (APEDA, 2013a).

Food Safety and Standards Authority of India (FSSAI, 2011a), aims to give a comprehensive views to food business operators in terms of behavior of food recall portal, as well as how they should be carried out a food recall portal in order to develop an efficient rapid identification system, removal of unsafe food, and preventing customers from potentially hazardous food in market. This is to take traceability as an integral part of food logistics (Bosona and Gebresenbet, 2013).

Although India does not have any obligatory traceability system (Schroeder et al, 2012), but nevertheless in recent years Indian government has been started to work with private entities, state and central governments, which include FSSAI, APEDA, GS1 India, NABARD (National Bank for Agriculture and Rural Development), FPO (Fruit Products Order), ITC's eChaupal, and Reliance industry etc. for developing the traceability system within the Indian food industry and food supply chain, moreover

paying attention towards trade and distribution of the agriculture products in cost effective ways to compete with global market (Jacques and Zuurbier, 2008).

Traceability reduces public costs like medical, and private costs like product recalling (Abbot, 1991; Hobbs et al., 2005), helps to obtain the rich profit by reducing the labor cost of reading code, reduce goods in stock, and reduce the occurrence of larceny (Biederman, 2006), reduce distribution costs (Michael and McCathie, 2005), reduce operating and storage costs (Yong-Dong, S et al., 2009), ensure the quality of production and products (Wall, 1994), increasing food safety and security (Anica-Popa, 2011), ensure consistent quality of food products and prevent food safety problems (Li et al., 2006), gives accurate, timely, complete, and consistent information about products (Regattieri et al., 2007), reduces labor productivity losses (Veronneau, and Roy, 2009), save time and money (Moe, 1998), reduce human error (Frederiksen et al., 2002).

Fundamentally, India requires more development in current national food laws, as well as need to adopt an effective traceability system in order to improve and change within current food industry and food supply chain. As suggested by researchers the following factors are essential to control the food outbreaks and fraud, in order to establish the new food traceability legislation in Indian food industries.

2.2. Food Safety Incidents and hazard identification in India

In India, the main principle cause behind increasing food safety concern is the inconsistency and arbitrariness in food safety monitoring system, for example the problem of antibiotic in honey (Narain, 2010), growing the use of milk adulterants and tainted meat (Biswas et al, 2015).

Small dairies and household dairy stores, utilizes nearly 22% of total 35 % processed milk for preparing traditional Indian dairy products (IAI, 2011; IBEF, 2012), and these products are highly perishable and being packed without using any aseptic packing conditions (Dabbene et al., 2014), whereas, difficult to trace the source of milk from which the products have been made and fail to meet international safety, packaging

and transparency standards due to lack of investments, equipment and technology (Gupta, 2007; IAI, 2011).

European Union temporarily banned on export of Indian food items, which include alphonso mangoes, eggplant, the taro plant, bitter gourd and snake gourd due to fruit flies, antibiotic residues, cadmium and vibrio (Sonwalkar, 2014).

As reported by Food Standards Australia New Zealand (FSANZ), Australian based Indya Foods Pty Ltd has recalled Indian based company Haldiram's food product such as Tasty nuts from Indian and South Australia supermarkets, because of contamination with aflatoxin, a highly toxic compound (FSANZ, 2013; Chandra, 2014). Food and Drug Administration (FDA) also renounced the food products from Haldiram because of high levels of pesticides, mold and bacteria (Newsdesk, 2015).

In 2012 FDA recalled the frozen tuna fish of Moon Fishery from India, due to the presence of Salmonella in sampling strips (Rothschild, 2012). Whereas, in 2010, Russia banned on export of Indian bovine meat as well as enforced many limitations on exporting products from Indian origin (Radyuhin, 2010).

Major problems are associated with street vendor food; firstly Mahale et al (2008) studied over sugarcane juice, lime juice and carrot juice found with high load of coliforms, fecal coliforms, vibrio, and staphylococcal counts. Whereas secondly, Das et al (2010) studied over Indian chat-food, which is very famous street food and found loads of bacterial pathogens such as S. faecalis, E. coli, S. aureus, Bacillus spp., Klebsiella spp., and Pseudomonas spp.

2.3. Food fraudulence in India

In India, recently the milk scam was disclosed in which powder and saturated fatty oil were mixed with milk for increasing the sale of milk (Paul, 2016), whereas Indian authorities discovered in their study that most milk manufacturers were diluted or contained by unappetizing agents such as hydrogen peroxide, detergent and urea (Banerji, 2012).As per the prevention of food adulteration Act, 1954, which comes under FSSAI (2011b), usage of toxic chemical in food is prohibited, however some retailer mix the yellow colored rice bran or lead chromate with turmeric powder to

increase its quantity, as well as another oil is argemone which is mixed with mustard oil. Pulses also adulterate with Keshari dal (Mishra, 2010), however most common food frauds involve is to change the essential ingredients with something of lesser value, wherein effective traceability, regular audit and reconciliation measures can assist in preventing fraud and theft of food items.

3. Effective traceability techniques in India

In India, existing product identification technologies are alphanumerical codes, Hologram, Barcode, Radio Frequency Identification (RFID) tags, and the geographical indication (GI) tag. In the near future, recent food traceability techniques, such as Bio tracing, Nano sensor, global positioning system (GPS) and geographic information system (GIS) would be utilized by India. Nevertheless, in order to understand the principle of operation of traceability system, a deep knowledge of the interaction of harmonized traceability techniques with transparency is required.

Definitely the new and efficient traceability systems can control the human error as well as creating more awareness of food quality standards, and result in savings at some level of the supply chain (Furness et al, 2003; Larsen and Lees, 2003). In India, The food traceability market is being increased with the growing understanding for food safety among the consumers and government authorities.

In the last year, Cargill announced that its going to build a 100 % traceable and sustainable supply chain of the palm oil in India by 2020 (Cargill, 2014), whereas recently started the food safety awareness program across the country under the Surakshit Khadya Abhiyan (Cargill, 2015).

In recent year Tea Board of India introduced, Trustea and Rain Forest Alliance (RFA) certifications, which are mandatory for all tea manufacturers in order to set up the transparency, reliable supplier of tea and traceability in both domestic as well as overseas market, but nevertheless only one tea factory has obtained all certifications, which is Harrisons Malayalam Ltd (HML) (Kumar, 2015).

McDonald restaurants recently introduced the food traceability for potatoes to keep a track of the product sources from 40 different suppliers across the country in order to provide food safety and quality (McDonald, 2015).

Numerous farm products like grape, mango, banana, onion, potato, soybean and poultry are able to increase the economy of small holder farmers as well as those could change the face of Indian farming sector, whereas few of them are certified by APEDA, so which can be easily traceable and identified in Indian market (APEDA, 2013a).

Following modern traceability systems are currently being used across Indian food industry and other sectors:

Alphanumerical codes in India

Traditional food deliverymen has paced into forward and using a system of alphanumeric codes printed on reusable containers for easily identifying and supplying fast service to their customer (Narayan, 2016). According to Regattieri et al. (2007) alphanumerical codes are a combination of the alphabetic and numeric characters of different sizes, which is generally found on products label, whereas it is very lucid, and non-mechanized process (Abad et al., 2009).

Hologram in India

As reported by Agrawal Arun (ASPA, 2015), general secretary, Authentication Solution Providers' Association (ASPA), in Rajasthan State (India) where few departments and brand owners are being employed the authentication solutions, wherein Rajasthan State Food & Civil Supplies Corporation are also focusing on food safety and notified to use a security hologram on daily household food items like tea, salt, pulses, Spices, and atta (wheat flour) etc. (ASPA, 2015). According to Barger et al (2000) a precise definition of hologram is a physical structure that diffracts light into an image, while it refers for both the encoded material and the resulting image. In addition, it is an effective product authentic solution which empowers to consumer, brand owners and government authorities to easily identify genuine products against to fake.

Barcode in India

Major food processing companies including the Dabur food, Godrej beverages & foods, Amul, Hindustan Unilever, ITC, Kohinoor food, Mother dairies and Venkys India (Shah ,2011) are using the barcode and 2-D quick response (QR) code techniques in order to develop an effective authentic product solutions, while assisting to build up a confidence in customers. In addition, the growing retail sector is also responsible for emerging this segment, whereas continuously asking for distributors, manufacturers to adopt the barcode system for their products.

Recently APEDA adopted the GS1 standards, while most of the more visible and useful applications have been achieved through the usage of GS1's product identifiers in barcoding for Grapenet, Anarnet, and Tracenet. Additionally APEDA, it is an agro trade promotional body of the government of India, and has already been providing traceability services to improve the confidence of importing countries in Indian agricultural products (GS1 India, 2012). According to Zare Mehrjerdi (2010), barcode is an openly machine-readable data which is printed over the objects, whereas by means of electronics barcode readers can be easily encode, store and recall information.

Radio frequency identification (RFID) in India

Currently in India, RFID technique is being utilized by several dairy industries, including Amul dairy, which uses RFID tagging for milk yielding animal on their Anand farm in Gujarat state, Chitale dairy, which uses RFID tagging for tracking and storing information relating to health issue, and Govardhan dairy, which uses RFID tagging for identifying their cattle by numbers, both from Pune, Maharashtra state (Swedberg, 2010; Rohatgi, 2014).

In their study, Agarwal et al (2014) suggested that a new developed smart ration card using Radio Frequency Identification (RFID) would help to prevent from fabrication in the distribution of ration, which is fixed allowance of provisions or foods like sugar, oil etc. from the ration shops with ration card. At present days, in India both domestic and foreign retailing players like Wal-Mart, Metro, Reliance, Food bazaar, Tata sons, Future groups, and Bharti, have already taken steps towards RFID technology with suppliers to go in for RFID (Srivastava, 2004; Kelepouris et al., 2007).

Document-Based (Paper/Electronic Documents) traceability system in India

Majorly smaller industries and producers are focused over simple pen and paper for reporting, stock information and communicate data with partners in supply chains. Besides manual process which is time consuming, as well as provide inappropriate information or error with respect to the accurate source, location, or doubtful product, and it is unable to transfer information among partners in the food supply chain because of unavailability of electronic recording and reporting system, hence in such case the product information like product lot number, harvest date, product receipt/shipping date, quantity, or ingredients, which is written by manually in the handbook (Karippacheril et al., 2012).

Nowadays, Indian software companies like Infosys, Logisoft, Tata consultancy services (TCS), and Tech Mahindra, which are being assisted toward using the traceability in the form of Enterprise Resource Planning (ERP) systems, that can be used for storing data and inventory control, warehouse management, accounting, and asset management. ERP systems can read standardized data from barcodes and RFIDs, including global trade item numbers (GTIN) and global location numbers (GLN) (Karippacheril et al., 2012).

Nano Technology in India

According to Pradhan et al. (2015), India is being progressed in the field of nanotechnology, but nevertheless very difficult to estimate the actual situation because of unavailability of data and reports from leading Indian food companies and laboratories, which include the Adnano Technologies, NanoBio Chemicals, NanoShel, NanoXpert Technologies, Sisco Research Laboratories, Quantum Corporations, DaburPharma, Meda Biotech, and Velbionanotech.

Nuclear Technique in India

The basic features of the nuclear technique is to determine of food provenance (IAEA, 2011; Simon, 2015), the nuclear techniques like genomic technique and isotopic, both are at ground level in India but consistently going ahead. As reported by Rohit (2016), in short time Indian basmati rice is to be acquired GI tag, which is used to identify the

origin, quality and other characteristics of the products, basmati rice cultivated in the region of northern India.

Information and Communication Technology (ICT)

Several publications have appeared in recent years documenting the emerging information and communication technology (ICT) in India, where ICTs become very popular and providing easy solution to the farmer, trader, suppliers and even manufacturers too, along with ICTs give fast, reliable, efficient service and real time information in term of the quality and quantity of the agricultural products marketing (Lashgarara et al., 2013). Parwez (2014) also described the benefits of ICTs and informed that farmer can easily forward and sharing the information with other person or system and able to solve information based problem in short period, whereas Indian agriculture sector is being progressed rapidly and many private as well as public sector with ICTs enabled initiatives.

In a recent study by Pant et al. (2015) discussed how to use the effective GPS/ GIS traceability in order to enhance the efficiency of high quality milk, as well as proposed the lead role of traceability system in monitoring movement of milk distribution vehicle and handling of raw milk as well.

Following ICTs initiatives have been started their outstanding work in many states of India (Table 1).

4. Initiatives of traceability systems in India

4.1. Introduction to the GS1 India and data interpretation for product identification

The simplest way of representing the traceability system is GS1 India, which is an autonomous body under Ministry of Commerce & Industry, Government of India and founder members including Ministry of commerce, Confederation of Indian Industry (CII), Federation of Indian chambers of commerce and Industry (FICCI) , Associated

chambers of commerce and Industry of India (ASSOCHAM), federation of Indian export organisation (FIEO), Spices Board, bureau of Indian Standards(BIS), Indian Merchants Chambers(IMC), Indian Institute of packaging (IIP), APEDA and Its affiliated to GS1, Brussels, Belgium along with 114 GS1 Organisation worldwide (GS1 India, 2012; MSME, 2007).

The generic packaged items having fixed weights are identified by produce electronic identification board universal product codes (PEIB UPC) but at this stage the buyer cannot track and trace the product, mostly the trader or grower uses prefix 033383. While the generic loose items or non-packaged items, which are sold in large quantity and identified by means of Produce Electronic Identification Board price look up codes (PEIB PLU), but it does not include any reference number as well as don't know who supplied the product (GS1 US, 2007).

At trade level (trader), where the company uses the GTIN as company prefix and product features. The trader or grower uses generic prefix "033383" with a generic 5-digit item reference number assigned by produce marketing association (PMA), for example "033383000016" (GS1 US, 2007).

GS1 India also guides to company to register their saleable / stock keeping (SKU), in order to get unique identification number, global company prefix (GCP), as well as item reference number or global trade identification number (GTIN-standardized in 14 digits) (GS1 India, 2012).

As shown in above figure 1, the underlined digits 890 represents the India as country of origin in which including of GS1 Company prefix (9 digit), Item reference number (3 digit) and Check digit (1 digit) (GS1 India, 2012).

4.2. Traceability systems for Indian Farming produce through GS1 India Standards and APEDA

In recent years APEDA has been initiated the new electronics traceability system for agro-food safety, and emphasized on the application of the information technology in the traceability system for various farming produces, which include grape, banana, pomegranate, ladyfinger and peanut, as well as all farming produces have their

independent traceable methods. But a key limitation is that currently it is not mandatory for all farmers or produces except the export point of view as required by particular counties, then certain produce takes to electronic and IT enable traceability system with the regulation, compliance and monitoring though various processes like sanitary and phytosanitary (SPS) measures and AGMARK certifications. For example, Grapenet traceability system for grape, Okra farms for ladyfinger, Anarnet for pomegranate, Peanut.net for peanut or groundnut and Tracenet for organic products, whereas APEDA provides laboratory testing and certification for export and help to tracking and tracing information through its internet based traceability software system (APEDA, 2013a).

4.2.1. Grapenet traceability system for grape in India

Currently, Grapenet is extensively monitored to fresh grapes, which are exported to the European Union, as well as which uses GS1 standards for farm identification and traceability of physical goods in the supply chain originating from the grower to the processor/ packer and onwards (GS1 India, 2012) and it facilitates the tracing of the products from retail shelves to the farm of the Indian grower, through the various stages of sampling, testing, certification and packaging in compliance with the standards identified by national research centre (NRC), Pune (APEDA, 2013a). So far 40,000 farmers and 115 exporters from different region has benefitted of this system and increased their income along with product cost hiked by 40%. On this great innovation the APEDA received the National Award for Grapenet implementation (APEDA, 2013a).

4.2.2. Tracenet traceability system for organic products in India

Tracenet which works under the APEDA, that collects, stores and reports of forward and backward traces, as well as maintaining authentic information and related data by the operators / producer groups and certification bodies within the organic supply chain in India. Whereas, tracenet system covers certification for all horticulture and agriculture crops including cotton / cotton products, processed foods and wild harvest. Recently on this great work, APEDA has won the e-ASIA award in the year 2011 (APEDA, 2013b).

As shown in figure 2, APEDA and GS1 India have together initiated a traceability system for horticulture produces, which include grapes, pomegranate, mango, ladyfinger etc. (APEDA, 2013a). Initially, under APEDA, registration of farms with any district agriculture or horticulture officer of state horticulture department, then farm is inspected by horticulture officers. Besides GS1 India also helps to get registration of farms for specific GLN which identifies a farm or Small Medium-sized Enterprises (SMEs) in any part of a food and agriculture value chain (GS1 India, 2012).

4.2.3. Initiatives of the meat products traceability under APEDA

Recently APEDA published to their webpage, as of 1 April 2015 the health certificate must require to every company for exporting of the meat through Meat.net and inform to entire exporter that the export consignment must be undergone through microbiological as well as other tests as required (APEDA, 2015).

4.3. Initiatives of traceability for livestock in India

Recently India has introduced cattle tagging using RFID for dairy farming, which include the organizations Amul dairy, Gowardhan dairy and Chitale dairy (Rohatgi, 2014).

In last few years ago, Chitale dairy tagged around 7000 cows and buffaloes in Maharashtra and Tamil Nadu states respectively (Mathis, 2010; Swedberg, 2010) and currently, as the number of tagging in this run increased up to 50.000 cows and buffaloes, as well as company has targets to capture all animals across the country because of increasing responding from farmers as well as dairy companies from last couple of years (Rohatgi, 2014; D'Monte, 2015). In addition, noticeable thing is that Chitale dairy uses combine passive RFID tag to track cows and buffaloes ,which is fitted on each ear of cattle and buffaloes (Rohatgi, 2014; D'Monte, 2015).

As stated by CSS Rao, managing director, Real ID Ltd, Mumbai (India), in future company is going to launch new way of tracking for livestock system in India as well as other countries. This unique system would provide the national livestock registry to government authorities and customers (Rao CSS, 2012).

4.4. Initiatives for seafood traceability in India

Recently Indian Society of Agribusiness Professionals (ISAP, 2015) published that, soon the Indian aqua farms for shrimps, and other species are going to be traceable. In addition, as reported by Rajkumar Gollapalli, National Fish & Seafood Aquaculture and Sustainability specialist, this aquaculture traceability brings an tremendous change, and solve the critical work in moment, as well as it is faster, easier, reliable, and efficient (Shawna, 2015).

5. Estimated cost for food traceability in India

In the last few years APEDA has been shown growing interest in electronic traceability system for farming products such as grape, banana, mango, pomegranate, and ladyfinger, simultaneously provide the guideline to the farmers about good agricultural practices as well as focusing over the food safety standards for improving better production and distribution (APEDA, 2013). Nowadays, building up traceability system in Indian firm has become easier with help of APEDA, AGMARK, and GS1 India. Traceability system can provide the maximum yield to the firm and beneficial investment.

According to Golan et al. (2004), eventually cost is the main matter in order to adopt advance and safety traceability system for the small, cottage industries and many producers, distributors and processors. Moreover the firm's traceability costs consist of equipment and technical costs, labor costs for food safety assurance, testing and traceability management like breadth, depth, and precision of the traceability system which is broadly connected with food and feed products from source to sale in food supply chain.

The following data collected through the discussions with technology providers and available traceability related products in market, because each firm faces a different set of costs depending on its circumstances and nature of products. While another factor appears that estimated costs have been categorized into fixed cost, where expenses that are not dependent on the activities of a firm as well as it is one time initial costs, and secondly, variable costs where expenses that change in proportion to

513 the activities of a firm like product volume and size of firm, also which is used to
514 achieve other purposes, such as labor, management, paper or faster delivery times and
515 computer system not to be included.

516 Nevertheless, RFID tags are more costly than barcode, but completely depending upon
517 choice of firm whether passive or active tags (Ruiz-Garcia and Lunadei, 2011). Also
518 require the RFID-enabled label printers, readers, antennas, software, middleware, and
519 computers. Using barcode, it is simple as well as can be easily printed on regular
520 printer and save huge money. Furthermore annual and renewal fees both are cost per
521 year of owning and operating the system and it's required to pay for commencing year
522 after year service of the systems.

523 Table 2 indicates that calculated costs can be assisted to establish the partial
524 traceability system for Indian small and cottage food industries. In order to better
525 development and adopting barcode system for products, already the Indian
526 government has announced the financial assistance scheme for registered micro and
527 small manufacturing enterprises, where the eligible units to claim reimbursements of
528 75% of the one-time registration fee and 75% of the annual fee paid to GS1 India for
529 the first three years, against proof of payment (MSME, 2007; GS1 India, 2012).

530 6. Impediment for adoption and challenges of food traceability in India

531 Recently, considerable attention has been given to Indian farming sectors, which are
532 being progressed gradually, and many organized sectors are being grounded day by
533 day, but nevertheless the food safety and product recalling problems remain steady
534 because of some parameters such as structural, institutional, technical, cultural issues,
535 which affect to settle the food traceability in India, whether for the domestic market or
536 for export trade (Umali-Deininger and Sur, 2007). The main responsible factors that
537 affect food traceability in India are shown in the present section.

538 There are plenty of smallholder farmers and marginal farmers in India, near about 100
539 millions of small holder farmers have engaged in farm cultivating area with average
540 farm around 1 or 2 hectors either fertile or unproductive, while rate of literacy among
541 small holder farmers are low (FAO, 2005).

Mostly Indian agricultural markets are governed under the state Agricultural Produce Market Committee (APMC) acts, which handles more than 10000 regulated markets or Mandi, which is the main source of dealing commodities (Ramakrishna and Ajjappa, 2013), whereas nowadays regulated market is unable to protect and provide as much as facilities which requires to maintain the quality and traceability.

There is a deficiency of grades and standards for domestic market and loose enforcement. However, due to lack of financial budget, many small and cottage industries are unable to provide good quality products, and hence such companies must go through AGMARK certification for establishing food standards and grades for their products in domestic market, and proper development of food traceability in India (APEDA, 2013a).

There are inadequate good agricultural, manufacturing, and hygiene practices in India, which makes more difficult for the proper traceability; APEDA is being continuously worked on improving the food safety for domestic and export market, and emphasis on adoption of hazard analysis critical control point (HACCP) and international organization for standardization (ISO) certification among food manufacturers, as well as many agriculture universities are researching on good agriculture practices, fertilizers and post-harvest techniques (APEDA, 2013a).

The leading international players are entering and trying to set up their presence, and it shows the clear sign of growth of organised retailing sector. Nevertheless, increasing organised sectors are scaring of an unorganised sector like Kirana store, which offers products in lesser price and available on walking distance, hence food traceability is finding an obstacle (USDA, 2014). Still, India is at early stage and needs more struggle and investment to build up cold storage in order to provide facilities for all farm produces. Besides food wastage is also increased due to less available of cold storage, as well as most of the cold storages are manual or multilevel with having less storage capacity (Emerson, 2013).

There is a lack of SPS certification department, it is very important for exporting the farming produces to the foreign countries, which is issued under Ministry of

Agriculture, Government of India or district authorized plant protection officers (APEDA, 2013).

About 350 million people reside in rural India and most of them earn through the farming business, majority of farmers are sold out their high-value produce through wholesale markets, both regulated and unregulated. It is always complained by farmers about inadequate market facilities, high marketing fees, long distances to the market, and the dishonesty of traders (World Bank, 2008). Still the many manufacturers could not able to reach or catch the remote market or customer, it is just because of the country's poor infrastructure such as poor road system, unconvincing transport systems, power problems, water and major problems in connecting them with stations (World Bank, 2008). As per Agricultural Marketing surveyed by World Bank (2008), observed that Indian market is facing a lot of problems like small roads with less free space within market, limited warehouses and cold storages for farming produces, poor in waste management and pest controls in market, and rat problems as well. For reducing food safety risks can be only improved by investing more to upgrade the market infrastructure and services (World Bank, 2008).

Although India has progressed in information technology (IT) industries, rural areas lagged behind in world of ICT. However, the rate of literacy among rural people is very low with less understanding for the internet based information, which is available only in English language (Rao, 2009). In India, where 22 languages are officially recognized (Saxena, 2016), and more than 60 % of Indians speak Hindi language and nearly less than 12 % of population in India understand the English (Aula, 2014).

7. Conclusion

In this work, the existing food traceability systems in India as well as strength and weakness, challenges and practical problem of using such systems were studied. Still India is at early stage because of low consistency in the Indian market, which is occupied by number of small and medium industries, hence it is difficult to adopt this technology, and it might be impossible due to high installation costs of RFID tags, barcodes and readers, with low awareness. Nevertheless APEDA and GS1 India have

initiated a breakthrough food traceability system such as Anarnet, Tracenet, Peanut.net, Meat.net and Grapenet for the Indian farming products, as well as several ICTs initiatives that are being actively worked in many states of India, which include e-Chaupal, ColdStar Logistics, eFarm, TCS mKRISHI, Logistimo, Sohan Lal Commodity Management and more.

Second most important thing, is that food safety issue has become challenged to domestic and export markets, although India has improved the quality and safety of food products, it needs a proper implementation of the food standards by FSSAI (2011b), and it should be taken a strict enforcement of new standards by law enforcing agencies, whereas Indian government or renown private entities must be invested for building up new and advance international laboratories, infrastructure and facilities to regulated markets, which are currently managed by APMC.

Finally, currently major Indian retailers are facing the problem of lack of amenities, which include storage facilities, cold storage capacity, loading and weighing facilities, better constructed shop, superb road and linkage, and supply chain for food and grocery retailing. Those services play an essential role in developing the better marketing efficiency, whereas must establish traceability in unorganized sector like smaller and cottage industries under the action of the food safety standard laws.

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Table 1: Emerging solutions by private and government sector in India

Category	ICTs in India	Information	Source
Supply Chain Management	Logistimo	It uniquely suitable for rural markets, offers customers the ability to capture and share data in a simple, low-cost way.	www.logistimo.com
APEDA's Initiatives in Traceability	Hortinet	Recently APEDA has initiated the web-based traceability system for selected horticulture produces such as grape, pomegranate, banana, mango, ladyfingers along with their respective traceability system, wherein Grapenet for grapes, Anarnet for pomegranate, Peanut.Net for Peanut etc.	apeda.gov.in
	Meat.net	System integrates stakeholders like State Animal Husbandry Departments, Meat Plants/Exporters and Labs to have real time information/data on meat exports.	
Dairy Traceability	BG Chitale Dairy	Cattle Tagging in dairy farming. Number of Cow and Buffalo tagged 7000.	www.chitaledairy.com
Global Supply Chain	GS1 India	It registers to company and provides GCP and GTIN number	www.gs1india.org

	for systematic and transparent and easy food supply chain across country

Table 2: Estimated cost for Indian traceability system

Type of cost	Estimated cost (in dollar)	Comment
Fixed cost		
Farm registration	$1 per farm/plot	Under district agro / horticulture Officer
APEDA Registration	80	For Export under Hortinet, Anarnet, Grapenet etc.
CAG certificate	3	Under AGMARK
Certificate of Authorization (C.A.) for grading of fruits and vegetables	15	Under AGMARK
Warehouse Registration	250	Under APEDA , for all food produces except grapes.
GS1 India Registration for Company prefix(GCP) and GTIN number *Small (turnover upto $160000) *Medium (turnover upto $1600000) *Large (turnover upto $16000000)	 662 871 1093	GS1 India Registration costs depending upon the firm size and its annual turnover and it has 1 year validity or onwards And it includes registration fees, subscription fees, security deposit and service tax etc. Only 9 digits UPC prefix for 100 barcodes
GLN no. Registration (under GS1 India)	8	Under GS1 India
Variable cost		
Residue analysis	50- 150	Under NHRDF, depending upon type of fruits and vegetables. http://nhrdf.org/en-us/Services
2.GS1 India (Renewal fees) *Small (turnover upto $160000) *Medium (turnover upto $1600000) *Large (turnover upto $16000000)	 135 154 185	 Renewal fee for 1 year and Only 9 digits UPC prefix for 100 barcodes
RFID tag	Active: $5.0 per tag Passive: $0.16 per tag	Depend upon the choice of the firm to be required either active or passive tag
barcode label pre-printed or own printed on site	$0.005 per label	General data
Barcode scanner	40	Amazon online retailer
RFID tag Reader	50	Amazon online retailer
printer	50	Amazon online retailer

Figure 1: 13-digit GS1 India code

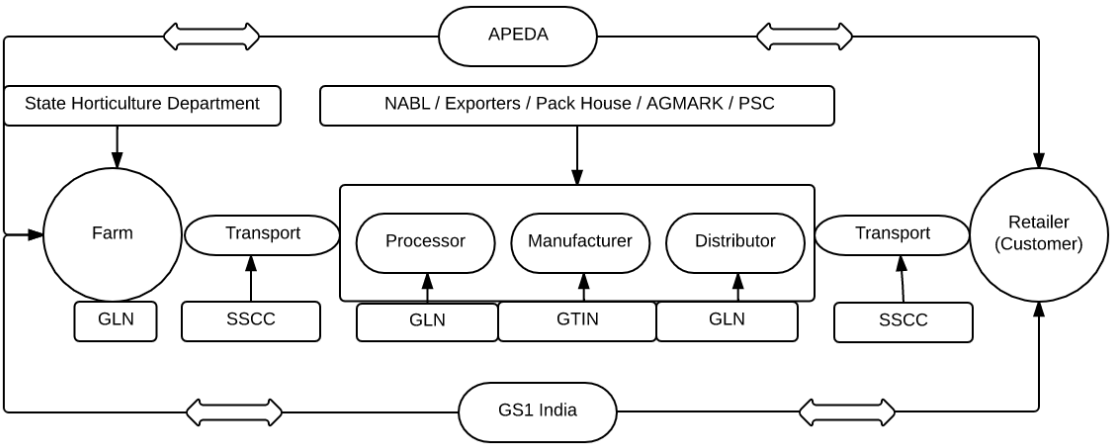

Figure 2: Traceability implementation in APEDA by using GS1 Standards