ICTs in Food Consumption Aspects and Activities Allied to Agriculture in India

ICT India Working Paper #59

Abhishek Beriya

October 2021

Center for Sustainable Development

EARTH INSTITUTE | COLUMBIA UNIVERSITY

Acknowledgements

Abstract

The share of activities allied to Agriculture have seen significant increase in the total Agriculture sector gross value added in India over the past few years. In this paper, we review the trajectory of ICTs and digital technologies in the food consumption aspects in India and activities allied to agriculture, particularly livestock and dairying. We also briefly cover the concept of food traceability. Indian startups are rapidly progressing in the food delivery space and a number of startups are covering almost every aspect in the dairying sector. Many startups are also facilitating online cattle trade. All these startups are contributing to the Indian economy. Traceability and other technology led processes have also led to increase in farmer incomes. However, cost affordability and customization for Indian smallholder livestock farmers emerge as the prerequisites for greater digital technology penetration. Telemedicine for livestock health management emerges as an area with a lot of potential to benefit livestock farmers especially in remote and hilly areas with accessibility concerns. Governments can play a proactive role to take these technologies to larger number of farmers by comprehensive digitisation efforts in execution of publicly funded initiatives and also by encouraging startups.

1.0 Introduction:

Agriculture is one sector which emerged relatively unscathed from economic perils owing to disruptions caused due to the Covid-19 pandemic around the world. In India, Agriculture and allied activities were generally exempted from the lockdown measures and exhibited resilience owing to a confluence of factors working in conjunction, viz., a bountiful monsoon, adequate soil moisture, replenished reservoir levels, improved labour availability during the covid-19 pandemic and favourable terms of trade for agricultural products and thus it was the only sector which remained in expansion zone in 2020-21(Reserve Bank of India, 2021).

Share of Agriculture and Allied Sectors in Total GVA at current prices:

Items	Year					
	2014-15	2015-16	2016-17*	2017-18#	2018-19@	2019-20**
Share of GVA of Agriculture & Allied Sector in GVA of Total Economy (per cent)	18.2	17.7	18.0	18.0	17.1	17.8
Share of Crops	11.2	10.6	10.6	10.4	9.4	NA
Share of Livestock	4.4	4.6	4.8	5.1	5.1	NA
Share of Forestry & logging	1.5	1.5	1.5	1.4	1.3	NA
Share of Fishing & aquaculture	1.0	1.1	1.1	1.2	1.2	NA

Source: Department of Agriculture, Cooperation & Farmers Welfare (DAC&FW).
Note:**As per the Provisional Estimates of Annual National Income 2019-20 released by CSO on 29th May 2020.
@As per the First Revised Estimates of National Income, Consumption Expenditure, Saving and capital Formation for 2018-19 released on 31st January, 2020. # Second Revised Estimate. * Third Revised Estimate.
NA- Data not available.

Table Source: Economic Survey 2020-21, Government of India

It is pertinent to note from the above that within the agriculture sector, the share of crops has fallen from 11.2 per cent in 2014-15 to 9.4 per cent in 2018-19. The decline in the share of crops has been made up by an increase in the share of livestock and fisheries sectors.

Thus, it is evident that increasingly, allied activities are playing a significant role in the agriculture sector in India. Hence this paper focuses on the allied activities in the Indian agricultural sector. More specifically, we review the potential of Information and Communication Technologies (ICTs) in the food safety, consumption and livestock (especially dairy) operations in India.

The Indian dairy industry comprises 300 million herds of cattle spread across 75 million dairy farmers. A vast majority (approx. 70%) of these dairy farmers are smallholders and a large quantum of dairy production remains unorganized. These smallholder dairy farmers lack veterinary support, advice on cattle nutrition, access to optimal nutrition and animal health

products, transparent markets for trading cattle and, in some cases, market access for their milk. At the same time, private dairies and dairy cooperatives struggle with sourcing milk, managing farmer payments, building traceable supply chains, and ensuring quality. (Mathur N., 2020). Moreover hygiene and traceability of food have become vital in a post-covid era.

This paper is for a project 'Towards a New Indian Model of ICT led Growth and Development' jointly undertaken by TERI and the Centre for Sustainable Development at Columbia University. In this paper, we do a brief literature review of the potential and use cases of ICTs in Veterinary and Dairy Technology Solutions. Then traceability and food safety aspects are discussed. The next section lists relevant Indian startups in food delivery and dairy technology solutions. Then cattle trading startups and applications are discussed before the conclusion.

2.0 Review of Literature around Veterinary and Dairy Technology Solutions:

Reddy V., (2018) notes that India being the world's largest milk producer, it is essential to apply Information and Communications Technology platforms (ICTs) to the dairy industry on a large scale. Current trends like Business Intelligence (BI), Business Analytics (BA) and Data Science are not being applied presently in the Indian dairy sector and this aggravates the turbulence noticed in the sector. From producers of milk consisting of large farms and the small and marginal farmers to retailers selling milk and various milk products, the Indian dairy value chain has a large number of actors and the data is not well collated. Reasons that could be attributed to the insignificant application of ICTs in Indian Dairy industry are size of the industry, scale of operations, and number of stakeholders and the fact that it is capital intensive. According to Reddy's study, Baroda Dairy has implemented the software "Enterprise-wide Digitization" on Oracle platform and about 2,000 various reports being generated to make the system successfully implement and facilitate latest technology. Mother Dairy in Delhi has integrated operation technologies into IT and further is exploring the option of the IoT-based devices to get to a real-time data management and create dash boards that could help in minimising on the losses due to process failures / product failures.

Wangde G. (2019) comprehensively lists latest dairy technologies and use cases as reproduced below:
1. Health Tracking Devices for Cattle: These are wearable animal gadgets (these can be implanted in the cattle's ears, tail, legs, neck or any part of the body)similar to human fitness trackers allowing the dairy farmers to monitor, track and manage their cattle's health aspects like nutrition, pregnancy status, milking frequency and milk production etc., that too real time.
2. Robotic Milking Machines: Latest robotic milking machines come with sensors attached, which serve multiple purposes. These sensors can detect whether the cow or which of its teat

is ready for milking or not and once milking begins, impurities, colour and quality of milk can also be determined. Poor quality milk can also be diverted to another container. Further, the machines can automatically clean and sanitize the cattle teats after milking.

3. Cattle Monitoring Drones: Basically these drones keep track of the cattle in fields and barns. Some drones are equipped with thermal sensing technology, which helps to track the cattle from the heat of their bodies. Drones can capture the pictures of pasture areas and also relay information as to whether these are suitable for cattle grazing.

4. Product Traceability for Customers through Blockchain: The Kerala government in India is leveraging blockchain technology to streamline purchase and distribution of milk, fish and vegetable in the state

5. Milk Freshness: Technological efforts are undergoing to detect the freshness of milk and store it for a longer period of time. Australia-based food technology company Naturo has developed a technology that can keep natural milk fresh in the refrigerator for at least 60 days without using any additives or preservatives. US scientists have pioneered a new pasteurization technique, which increases shelf life of fresh milk from 13 days to 40 days without changing its taste or nutritional value. In India, IIT Guwahati scientists have developed a smartphone-app aided paper sensor kit that can test the freshness of milk and inform how well it has been pasteurized.

6. Automated Cattle Traffic Management: These are computer-controlled gates that can open and close electronically and also sort the livestock on the basis of their readiness to milk.

7. Feed Management: Digital feed monitoring solutions are also being developed; these can help farmers with feed inventory, quality and quantity and even make it possible to customize feed for each animal based on individual animal parameter like body weight, milk yield and quality etc.

8. Ecommerce Marketplaces: Like in almost every other commodity, e-commerce is also making its foray into dairy products.

9. Supply Chain Technology: Cooling technologies that are energy-efficient and cost-effective, cold chain warehouses and cold boxes, Phase Changing Material (PCM) pads, temperature-controlled cold chain packing, refrigerated vehicles, cold chain pallet shippers are being increasingly deployed to make the dairy supply chain more efficient.

10. Farm Management Technology: Farm management softwares can help automate and digitize production and operations activities in an end-end manner.

11. Biotechnology: The potential of dairy biotechnology is in the areas like artificial insemination and embryo transmit technology, increasing disease resistance in livestock, scientific feeding of cows, development of new vaccines, prevention and disease management of animals, and food-grade bio-preservatives, etc.

However, most importantly, most of these dairy technologies face adoption barriers in India because of the preponderance of small-scale and unorganised players in the Indian dairy industry who lack financial means, accessibility and expertise to deploy the technology. Of

late though, it can be said that dairy technological revolution has begun in India, and over time, these technologies can be expected to become common.

The global nonprofit HealthforAnimals defines Veterinary Telemedicine as: 'Telemedicine' is the term used for digital interactions between the veterinarian and client. This can refer to the use of text messaging, photo messaging, email and video calls, right through to the use of apps and wearable devices (although right now, devices are mainly used to monitor livestock rather than pets). (healthforanimals.org)

The IoT For All portal lists some use cases for IoT-Enabled Livestock Management. Using a wearable collar or tag, battery-powered sensors can monitor the location, temperature, blood pressure and heart rate of animals and wirelessly send the data in near-real-time to farmers' devices so that farmers can check in on the health and location of each individual animal in their herd from anywhere as well as receive alerts if something falls outside of the normal range. Besides tracking health, livestock monitoring solutions can use GPS tracking to gather and store historical data on preferred grazing spots or use temperature tracking to determine the peak of mating season. (iotforall.com)

Francisco Maroto-Molina et al (2019) developed a low-cost solution to enable the monitoring (they call it 'monitorization') of a whole herd. An IoT-based system, which requires some animals of the herd being fitted with GPS collars connected to a 'Sigfox' network (Sigfox' - it is a low power wide area (LPWA) network operator) and the rest with low-cost Bluetooth tags, has been developed by them. They demonstrate their solution (based on the LPWA and short-range (BLE) sensor networks) to be effective in monitoring the location of each animal in a herd at a much lower cost than existing solutions. Their cost per animal (for sheep) is 36–54 Euros and considering a device lifespan of five years, it works to 18–21 Euros per sheep per year service cost including battery change and connectivity charges. For beef cattle, this cost would be higher. As per the authors, these solutions have capability of being used beyond location monitoring also like to study animal affiliations within a herd and as indicators of heat, calving and other reproductive and health events of interest for farmers.

Teller L.M. and Moberly H.K (2020) have conducted a literature review on veterinary telemedicine that supports the use of veterinary telemedicine for teleconsultations, and using wearable and mobile health (mHealth) devices for monitoring animal health. They find that there is robust data to support virtual care for veterinary consults, like those on radiology, pathology, cytology, behaviour, and cardiology. Data also supports teleconsulting to improve animal care in areas where resources may be limited, including rural areas, developing countries, and other remote locations. Teleconsulting and mHealth have been shown to be effective across many species, including companion animals, exotics, equids, and food animals. It is thus time to move forward with veterinary telemedicine using keeping in mind the benefits and concerns that surround any tool integrated into veterinary practice.

Akhigbe, B.I et al (2021) highlight the fact that the Internet of Things (IoTs) will play a key management role in Livestock Management (LsM). Three primary factors that will accelerate this are: IoT's retrofitting capability, its data-savvy nature, and ability to work in synergy with Disruptive Technologies (e.g., cloud computing, blockchain technology, AI, etc.). This will happen by deploying its primary feature of identification by sensing and observation, etc., through monitoring and control to manage the strict regimentations in LsM. The health and wellbeing of livestock have been highlighted as important factors in determining the quality of animals as products in the market. Technology often thrives innovatively when data are available. Thus, the authors found that data will be its main contributor and traditional approaches of reactive data processing will give way to the proactive approach of augmented analytics to provide insights about animal processes. This will undoubtedly free LsM from the drudgery of repetitive tasks with opportunities for improved productivity.

Singh R. (2021) lists certain barriers to promotion of telemedicine in developing countries. Increased broadband connectivity is a prerequisite to facilitate access to many bandwidth intensive telemedicine applications, particularly to rural and remote communities which is yet to be fully realised in India. Another barrier is knowledgeable staff that can support and manage the technical specifications. Another issue is that the responsibility of error that may occur at any point during a health /application using telemedicine, should be made clear as multiple parties play a role in the transmission and execution of telemedicine. State level licensure laws meant for regulating interstate telemedicine practice are not uniform from state to state hence these should be taken care off. Then author mentions about self-confidence and psychological barriers which may be taken care of through proper trainings and education efforts. The same study also cites some relevant statistics in India; there are approximately 9527 veterinary hospitals/polyclinics, 20,897 veterinary dispensaries, 24482 veterinary aid centres and 67,048 artificial insemination centres offering veterinary services. At the same time the requirement of 67,000 veterinarians is fulfilled only by the available 34,500 veterinarians. Shortage of work force and inadequacy of veterinary infrastructure demonstrates the need of telemedicine as future of animal health care services in India.

3.0 Food Safety and Traceability:

The ISO defines traceability as the "ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution" (iso.org).

International Trade Centre (ITC), 2015 describes traceability as "it is the ability to identify the origin of food and feed ingredients and food sources, particularly when products are found to be faulty. A traceability system allows an organization to document and / or to locate a product through the stages and operations involved in the manufacture, processing, distribution and handling of feed and food, from primary production to consumption." They also opine that traceability, therefore, facilitates the identification of the cause of

nonconformity of a product, and improve the ability to withdraw or recall such product if necessary and prevent unsafe products from reaching the customers

More generally, Traceability, in food and agriculture industry, basically tells us where a particular food item came from. In other words, it allows us to trace the origin of a food product back to its source. Traceability can answer some or all of the following questions about a food item (SourceTrace Traceability Guide, 2021):

- Is the food safe and free of contamination
- The farmer who produced the food and where and how it was grown
- When was it harvested and where it was post-harvest
- Is it organic or if it is laced with pesticides
- Ecological footprint of the food
- Ethical concerns like whether forced labour was used in production or deforestation done to produce the food

Traceability is thus relevant for the end-consumer, growers, traders and other value chain players in the supply chain as well as regulators. Traceability can help in differentiating food quality, branding, global compliances, to provide proof of sustainable practices and pricing.

Technologies supporting traceability and Global standards in traceability (CII-FACE, GS1, 2017-18, SourceTrace Guide, 2021):
- Alphanumeric codes
- Barcodes
- RFID
- Product Markers
- QR codes to track the packages
- QR code printer
- Biometrics/GPS
- Smartphones to capture data and read QR codes
- Web interface to see reports etc.
- Bluetooth weighing machines to automatically capture weight
- IoT sensors to capture soil and warehouse data
- AI enabled quality testing solution
- Blockchain for advanced data security

Among the above mentioned technologies, the most cost effective technology is barcodes. It needs to be used with global standards to enable all trading partners in the supply chain to communicate seamlessly with each other.

Global standards in traceability (CII-FACE, GS1, 2017-18):
- Interoperable and scalable

- Technology agnostic
- Unique identification
- Sector and product neutral
- Cross-functional

Reasons for increasing propensity of consumer to buy and pay for traceable food (Mathur H., 2021):

- Traceable food is also safe food as it not only establishes origin but also the condition in which the food was stored, transported and processed
- Traceability establishes trust in the supply chain between different actors which is of high importance especially in products which are commoditised or unbranded items like fruits, vegetable, staples
- A section of consuming class is the 'fair-trade' consumer who cares about the price that producer is getting. Traceability solutions can enhance farmer's share in the price paid by consumer

4.0 Startups in the food delivery and dairy technology space in India:

Some startups active in India in traceability and those that are harnessing technology in the food (cooked as well as raw/fresh) delivery space as well as working towards digitizing the dairy supply chain, improving milk quality and production are listed below:

SourceTrace: SourceTrace is a global company providing digital solutions to agriculture and food businesses. They provide SAAS (software as a service) solutions and agri-value chain management software that can enable full visibility into the agricultural and food value chain, with touchpoints across every stage – from farm to retail. It can thus enhance farmers' incomes; build trust and better engagement with stakeholders and enables organizations to implement data-driven agriculture. It features a complete food traceability system through a single platform, that is customizable for different commodities, allows monitoring of different stages (procurement, storage, logistics to retail) and allows in-depth analysis while being asset light at the same time. It is providing its services in 37 countries and has a very active presence in India. (sourcetrace.com)

Zomato: Zomato is a technology platform that was launched in 2010 to connect customers, and restaurants via delivery agents. Customers can use the platform to search and discover restaurants and order food from them, they can also read and write reviews and upload photos and book table reservations. Restaurants get a large prospective client base to engage and acquire customers to grow their business. This model utilizes the services of delivery executives who are generally called partners; they are not employees of the company but receive payments on a per transaction (delivery) basis. This constitutes the new model of engagement in the economy which has come to be known as the gig-economy. (Oxford

dictionary defines gig economy as 'a labour market characterized by the prevalence of short-term contracts or freelance work as opposed to permanent jobs'). In fact, Zomato is now a publicly listed company on the Indian stock exchanges On July 23, 2021, Zomato listed on the Indian stock exchanges at the culmination of a hugely successful initial public offer.

Swiggy: Swiggy is another online food ordering and delivery platform, founded in July 2014. Swiggy is based in Bangalore, India, and as of August 2021, was operating in around 500 Indian cities. It competes with Zomato in the food delivery space in India.

Licious: It's a meat, fish and seafood delivery startup serving in the major cities of India. For meat to stay fresh and retain its natural juices, it needs to be stored at a. They maintain the meat temperature between 0° and 5°C from the time of procurement of the product to cleaning, cutting and storing it, until it leaves for delivery and also keep it chilled while delivering. Since its inception, Licious claims to have successfully delivered to more than two million unique customers till date with over 90% repeat consumption across markets and 20,000 orders a day with current annual revenue projection at around 1000 crores. It has grown at a CAGR of 300% year on year, delivering 300+ SKUs to customers in 90-120 minutes. An average Licious customer buys products two-three times a month and spends close to INR 22,000 on a monthly basis. To ensure minimal wastage, they leverage tech tools and in-house algorithms to forecast and track customers' behaviour online and adopt strategies accordingly. For instance, they decided that a customer should be able to place an order even if the product was not available at the moment, and the person would be informed about the delay in delivery. Therefore, a customer may get a message like this one: Three selected items will be delivered in the next 90 minutes, and the fourth product will be delivered after four hours or the next day. (inc42.com, livemint.com, timesofindia.com)

Freshtohome: It's a similar company to Licious delivering fresh fish, meat and seafood and competes with Licious and serves major Indian cities. (freshtohome.com)

Mr Milkman: It offers a cloud-based 'SaaS platform' with automated processes which enables dairy farms to track subscriptions, revenue, sales growth, payments and customer consumption patterns. It tracks real-time analytics of operations, from farm to consumer by tracking orders, delivery and inventory management and also helps avoid wastage by providing precise data on daily variable operations (Singh R. 2019; milkmanapps.com)

Akshayakalpa: The entire milk production process at Akshayakalpa is automated. The cows are milked using machines that imitate the sucking of a calf. After milking, the milk goes to Bulk Milk Coolers through attached pipelines. The milking machines and the BMCs are run on electricity generated from Methane gas that comes from Cow dung. After chilling, the milk is moved to the plant in tankers designed to maintain the freshness of the milk. At the plant, the packaging process is also automated so that there is no human contact with the milk

at any stage. They also carry out testing at farm level to detect any trace of antibiotics in the milk. The test results are then uploaded to the cloud so that results are closely monitored on a regular basis. All their products are certified organic and they presently operate in Bengaluru and Chennai. (akshayakalpa.org)

Mooofarm: Mooofarm uses an Uber-like model and allows farmers to connect virtually and schedule physical visits with veterinarians and artificial insemination technicians. Its mobile application also provides services such as agricultural extension, farm management tools and an online community to support with enhancing milk yields and rationalizing costs. They are working with thousands of farmers in Punjab. (indianweb2.com)

StellaApps: It is a Chennai-based company that has developed innovative applications and tools leveraging Internet of Things (IoT), Big Data, Cloud, Mobility, and Data Analytics to improve agri-supply chain parameters, including milk production, milk procurement, cold chain, animal insurance and farmer payments which is supported by the dairy company that is procuring milk from these farmers. (livemint.com)

Country Delight: Gurugram-based Country Delight promises natural, fresh and unadulterated milk directly to the doorstep of the consumer. Consumer ordering and servicing happens through a mobile application that helps manage one's milk requirements. It delivers milk and dairy products directly from the farmer to the customer. Country Delight has an integrated cold chain to deliver perishables like milk, curd and other dairy products fresh. They deliver approx. 3 million orders a month across Delhi, Mumbai, Pune and Bengaluru, and have grown 50 times in the last three years. They claim that the milk is delivered within 36 hours of milking. They use technology to monitor the cycle of the milk real time, its nutritional value, temperature of the milk, and milk tankers and hence are able to supply milk without adding anything to the milk or recombining with any preservative, adulterant or milk powder. (countrydelight.in/)

Milkbasket: Milkbasket delivers milk, bread, eggs, butter, juices and other daily need items every morning, right at the consumers' doorsteps, free of charge across Gurugram, Noida, Delhi, Ghaziabad, and Bengaluru and is planning to expand further. It offers over 9,000 products across fruits and vegetables, dairy, bakery and other FMCG categories and also claims to have achieved positive unit economics.
Similar startups are **Supr Daily**, with operations in Mumbai, Delhi-NCR, Pune, Bangalore, Hyderabad and Chennai and **BBDaily** serving in Bangalore, Hyderabad, Chennai, Mumbai, Pune, Delhi, Gurgaon, Noida, Kolkata, Ahmedabad, Lucknow, Kanpur, Visakhapatnam, Vijayawada, Guntur, Chandigarh, Patna, Indore, and Kochi.

5.0 Cattle trade apps and online portals:

In India, several cattle trading apps such as **Animall, Pashushala, PashuLok, Pashu Mall, Pashu Mela, Pashu Vyapar**, among others, have been trying to make their mark felt in the arena of online cattle sale and purchase. For instance, Animall has been downloaded more than 4 million times in Haryana, Uttar Pradesh and Rajasthan since its launch in November 2019. Another cattle trading app, Pashushala, got 15,000 calls from farmers during the Covid pandemic as they wanted to know how they could sell or buy cattle online. Founded in 2018, Pashushala's services are available in Punjab, Haryana, Rajasthan, Uttar Pradesh, Bihar and Madhya Pradesh. The app has so far facilitated "fully assisted" sale and purchase of around 650 cows and around 350 buffaloes. Apart from private players, the central government also launched its own portal for cattle trade — E-pashuhaat — in 2016. This is a growing area of interest of startups.

6.0 Conclusion:

Technology driven food delivery startups are contributing immensely to the growth of the Indian gig economy. Further, food delivery startups promise quick turnaround times from source to consumer and better quality with traceability/standards that can be monitored. Better traceability also helps the exports economy. All of this has been a welcome development as it has led to better production processes and higher income for farmers/producers, more efficient supply chains and fresher and safer foods as well as convenience for consumers.

Whereas we have listed the benefits of IoT-Enabled Livestock Management, till its cost becomes much more affordable, direct application and use by small Indian farmers will be limited. Hence startups, bigger farms and co-operatives need to be the pioneers in this matter to steer further innovation and customize solutions for India.

Telemedicine is especially effective in areas where access to care is limited, whether because of geography, finances, or lack of resources. Thus it seems very suitable for rural India, specially remote and hilly areas. Telemedicine challenges include cost-effectiveness, robustness and accuracy of equipment, effectiveness in predicting health status, and information security. Hence proper internet connectivity, specialized trainings and equipment, policy support are needed to facilitate telemedicine. Cattle trading startups also need to overcome various limitation of online buying and actively work to improve their technical issues to make the online trade option convenient, attractive and secure for farmers.

The role of governments, both at the state and the federal level is also very important here to promote new technological solutions because Digitisation and ICTs should be comprehensively integrated in the execution and supervisory mechanism at all levels of

government work seamlessly. In this regard, governments can make effective use of digitisation as a tool for delegation as well as effective supervision and audits for publicly funded initiatives. They should collaborate with startups at all levels and encourage them to deliver better services. Government support would go a long way in increasing the penetration of the technologies to a larger farmer base across the country, which is very much required and desirable.

References:

- AgriTech Startup MoooFarm Raises €500K from Rockstart and Navus Ventures. November 04,2020. Available at https://www.indianweb2.com/2020/11/agritech-startup-moofarm-raises-500k.html

- Akhigbe, B.I.; Munir, K.; Akinade, O.; Akanbi, L.; Oyedele, L.O. IoT Technologies for Livestock Management: A Review of Present Status, Opportunities, and Future Trends. Big Data Cogn. Comput. 2021,5, 10. https://doi.org/10.3390/bdcc5010010

- Annual Report 2020-21 of the Reserve Bank of India. Available at https://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/0RBIAR202021_F49F9833694E84C16AAD01BE48F53F6A2.PDF

- Economic Survey 2020-21. Ministry of Finance, Government of India. Available at https://www.indiabudget.gov.in/economicsurvey/

- Food traceability in India A Study report by CII FACE and GS1 India 2017-18 Available at https://face-cii.in/sites/default/files/final_report-version_2.pdf

- Francisco Maroto-Molina et al. A Low-Cost IoT-Based System to Monitor the Location of a Whole Herd. Sensors 2019, 19, 2298; doi:10.3390/s19102298

- Hariharan S. Licious raises $192 million in Series F funding round. July 02, 2021. The Times of India. Available at https://timesofindia.indiatimes.com/business/india-business/licious-raises-192-million-in-series-f-funding-round/articleshow/84062340.cms

- https://akshayakalpa.org/

- https://countrydelight.in/

- https://dahd.nic.in/

- https://healthforanimals.org/resources-and-events/newsletter-repository/26-telemedicine.html?q=86

- https://languages.oup.com/google-dictionary-en/

- https://mooo.farm/aboutus/

- https://psiborg.in/livestock-monitoring-using-iot/

- https://www.animall.in/#

- https://www.dairyglobal.net/Smart-farming/Articles/2020/6/The-2-sides-of-Indias-dairy-sector-592553E/

- https://www.freshtohome.com/

- https://www.iotforall.com/use-case/livestock-management

- https://www.iso.org/obp/ui/#iso:std:iso:22005:ed-1:v1:en

- https://www.licious.in/about-us

- https://www.nddb.coop/information/stats/pop

- https://www.zomato.com

- Mathur H., 2021. Why we need 'traceability' in the food supply chain. Forbes India Magazine. Available online at https://www.forbesindia.com/blog/economy-policy/why-we-need-traceability-in-the-food-supply-chain/

- Mathur N. Indian startups are out to digitize dairy farming. 2020. Available at https://www.livemint.com/industry/agriculture/indian-startups-are-out-to-digitize-dairy-farming-11604550784072.html

- Nandy M. Licious raises $192 mn from investors led by Temasek, Multiples PE.July 02,2021. Available at https://www.livemint.com/companies/start-ups/licious-raises-192-million-in-series-f-led-by-temasek-multiples-pe-11625208053611.html

- Press Trust of India. Milkbasket plans to launch Ipo next year. August 23, 2020 accessed from https://www.livemint.com/market/stock-market-news/milkbasket-plans-to-launch-ipo-next-year-11598600629786.html

- Reddy V. 2018. Use of information technology in Indian dairy sector. Available at: http://www.fnbnews.com/FB-Specials/use-of-information-technology-in-indian-dairy-sector-43152

- Shanthi S. From 100 Orders Per Day In 2015 To Over 20,000 In 2021: How Licious Cracked The Supply Chain. February 10, 2021. Inc42. Available at https://inc42.com/features/from-100-orders-per-day-in-2015-to-over-20000-in-2021-how-licious-cracked-the-supply-chain/

- Sharma S. How Zomato executed its IPO plan. July 26,2021. The Economic Times. Available at https://economictimes.indiatimes.com/tech/startups/how-zomato-executed-its-ipo-plan/articleshow/84732982.cms

- Singh R. Use of Veterinary Telemedicine, The Internet of Things (IoT) & Information and Communication Technologies (ICT) for Smart Livestock Farming in India. February 2021. Available at https://www.pashudhanpraharee.com/use-of-veterinary-telemedicinethe-internet-of-things-iot-information-and-communication-technologies-ict-for-smart-livestock-farming-in-india/

- Singh R. White Revolution 2.0: Dairy Tech Startups Rise On India's Cow-Friendly Policies. November 2019. Available at https://www.pashudhanpraharee.com/white-revolution-2-0-dairy-tech-startups-rise-on-indias-cow-friendly-policies/

- Supr Daily launches first brand campaign. February 07,2020. Best Media Info. Available at https://bestmediainfo.com/2020/02/supr-daily-launches-first-brand-campaign/

- Telemedicine Practice Guidelines of the Indian Medical Council. March 2020 Available at https://www.mohfw.gov.in/pdf/Telemedicine.pdf

- Teller L.M. and Moberly H.K. 2020. Veterinary Telemedicine: A literature review Veterinary Evidence ISSN: 2396-9776 Vol 5, Issue 4 DOI: 10.18849/VE.V5I4.349

- Traceability In Food And Agricultural Products. International Trade Centre and Trade Impact for Good. BULLETIN No 91/2015. Available at https://www.intracen.org/uploadedFiles/intracenorg/Content/Exporters/Exporting_Better/Quality_Management/Redesign/EQM%20Bulletin%2091-2015_Traceability_FINAL%2014Oct15_web.pdf

- Traceability: A Guide to Getting Started. 2021. SourceTrace. Available from https://www.sourcetrace.com/whitepapers/traceability-a-guide-to-getting-started/

- Velayanikal M. Machines are at the heart of next white revolution. June 14, 2020. Available at https://www.livemint.com/companies/start-ups/machines-are-at-the-heart-of-next-white-revolution-11592139473206.html

- Vyas B. Top four uses of livestock monitoring using IoT. August 20, 2019. Available at https://www.softwebsolutions.com/resources/livestock-monitoring-using-IoT.html

- Wangde G. 2019. 11 Ways Technology Is Transforming Indian Dairy Industry Forever trak.in Available at https://trak.in/tags/business/2019/09/02/11-ways-technology-is-transforming-indian-dairy-industry-forever-3-is-about-drones/#

- Yadav J. Apps now sell cows, but getting a farmer to buy one 'before milking it once' is a challenge. March 08, 2021. ThePrint. Available at https://theprint.in/india/apps-now-sell-cows-but-getting-a-farmer-to-buy-one-before-milking-it-once-is-a-challenge/615324/