

# A Study of Technological Advancement & Transformation of Indian dairy Sector

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## Abstract

The Indian dairy sector plays a vital role in the country's economy and has emerged as one of the largest milk producers globally. With a substantial increase in population and rising demand for dairy products, the need for technological advancements in this sector has become evident. This research paper aims to analyze the recent developments and technological interventions in the Indian dairy industry, including dairy farming, milk processing, and distribution. It also explores the impact of these advancements on productivity, quality, and sustainability. Additionally, the paper discusses the challenges faced by the industry in adopting and implementing these technologies, along with potential future prospects for further growth.

*Keywords- AI, Socio-economic Development, Feeding Facilities*

## Introduction-

Artificial intelligence (AI) considered as a set of technologies that performs perception, learning, reasoning, and decision-making, aimed at endowing machines with intelligence that can be used to solve complex and challenging problems. It has now reached to a level where available abundant data with well reached computing technology have collectively resulted in to well programmed algorithms that are bringing huge advancement in various fields. AI and its applications have made life easier and better. It has brought human convenience to a greater height.

Until 2019, India had been gradually increasing its dairy product exports. The major dairy products exported by India include skimmed milk powder (SMP), whole milk powder (WMP), butter, ghee (clarified butter), and various other dairy products.

According to the data available up to 2019, India's dairy exports were primarily to countries in the Middle East, Southeast Asia, and neighboring countries. Some of the key importing countries for Indian dairy products included Bangladesh, UAE, Nepal, Pakistan, and Vietnam.

However, India's dairy product exports were not as significant compared to its domestic consumption and production. The country remained a net importer of dairy products as it also imported significant quantities of dairy commodities, especially during periods of domestic shortages.

## Importance of the dairy sector in India's overall economic schema:

The dairy sector not only provides employment to the rural workforce, but is also a significant contributor to the national economy. While the share of agriculture and allied (A&A) sector in the gross value added (GVA) has consistently declined from 18.2 per cent in 2014 to 17.2 per cent in 2017, the share of livestock to GVA has increased from 4.4 per cent to 4.9 per cent during the same period. Importantly, within the A&A sector, among the key livestock products, milk and milk products have the highest share, at around 67.2 per cent in 2017. The dairy sector plays a pivotal role in aiding the reduction of rural poverty and inequity, in addition to *ensuring the food security of millions* of rural households.

## India and US: Dairy Sector trade:

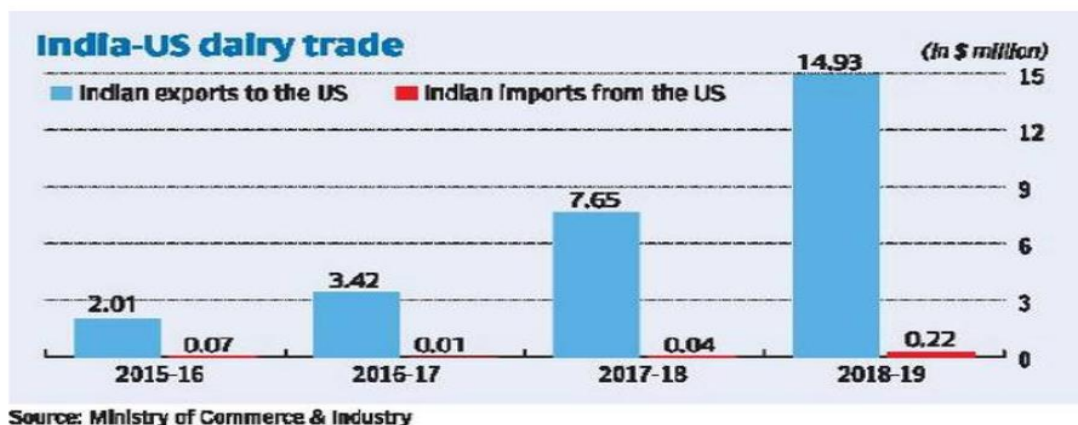
Coming to the dynamics of the dairy trade with focus on the US and India, the data shows that the US is a net exporter in dairy trading, with its share in global exports standing at 4.9 per cent as opposed to an import share of around 2.8 per cent in 2018.

In contrast, the share of India is minuscule at 0.3 per cent and 0.06 per cent in global dairy exports and imports, respectively, in 2018.

However, bilateral trade in dairy products between the US and India reveals a very variant picture.

While the dairy exports to US have *increased by almost seven times* from \$2.1 million in 2015-16 to \$14.9 million in 2018-19, the pace of imports from the US has shown a moderate uptick (see Chart).

This translates into a sharp jump in trade surplus for India from \$1.94 million to \$14.41 million during the comparable time period against the US.



The increasing volume of India's dairy sector requires an inclusion of technology in to its operations.

## Literature Review-

Traditional method of farming is not sufficient to meet growing demand of farming products so they have to use automated process to bring efficiency and effectiveness. Application of IoT, Machine Learning, Deep learning and AI brings better result in farming system (Kirtan jha et al, 2019). Day by day, the applications of AI are becoming very crucial due to its ability to bring transparency, food protection and hygiene.

How much milk will an animal will produce will depend of the health and food input to the animal (Tarapdar, 2011 :Tanwar et al, 2013). There are other factors also which are so important in reducing efficiency of the dairy sector in india that includes our diagnosis, clinic and medical support to animal. Despite of government private efforts to improve animal husbandry health, the morbidity and mortality is still a big concern of worry (Bangar et al 2013). Reducing morbidity and mortality of the animals should the greatest priority of government, health department and Agriprenuership will also induce the productive reproductive parameters of the animals (Prasad et al 2004)

Haryana is leading state in India in term of milk production which produces around 74.42 MT milk every year. Dairy farming is a major source of employment in rural part of Haryana which counts around 83% people are either directly or indirectly associated with animal husbandry. The dairy sector is an important source of livelihood for landless, small & Marginal farmers (Iqbal 2010). Rural portion of Haryana faces many challenges in improving the health of animals and cattle these challenges include-proper housing facilities, conventional fees deficit and medical facility ( Sen et al 2014). NDRI has set up a network of Dairy Vikas Kendras (DVKs) in the selected villages of Haryana.

The marketing efficiency of cooperative society mild dairy is found much better in comparison to their private diary counterparts (Dhaka&Rangasami 2008). The primary factor behind determining the price of milk and milk product was primarily cost of milk production (Saravankumara &Jainb 2009).

The indicators had shown a positive & strong association between employment generated by the cooperative society members to their income level where as the association was not that strong among non-members (Srikant 2007). Most of the dairy initiatives were found profitable .the study was to understand profitability and its measurement with respect to investment made by the agripreneurs (HimaBindu& Subrahmanyam2012).

The author build a case study on “Gokul Cooperatives” union which was understood with help of strengths, weaknesses , opportunities and threats faced by Gokul cooperatives. The authors finds that the cooperative has to work hard to improve upon the total efficiency of the organization in terms output and profitability (Rathod 2011)

Besides digitalization, emerging technologies like Internet of Things (IOT), Machine Leaning (ML) and Artificial Intelligence (AI) can also be used for an improved Dairy Farming Management. There are various technology companies which are working to provide a sustainable solution to the problem

How Technology is Transformation Indian Dairy Industry

### 3.1 AI in Cattle Identity

| Sr No | Company         | AI based Solution in Dairy Farming   |
|-------|-----------------|--|
| 1     | <i>Canthus</i>  | Canthus uses AI to evaluate health and ability of reproduction   |
| 2     | <i>Mood -ID</i> | MOO-ID is a tech based platform that works for cattle identification<br>Stellapps- Tech based solution that optimize the supply chain of the milk production                   |
| 3     | <i>MoooFarm</i> | MooFarm is a milktech startup that toils with Microsoft that help Indian dairy farmers to solve the problem of cattle identity by developing a machine learning (ML) solution. |

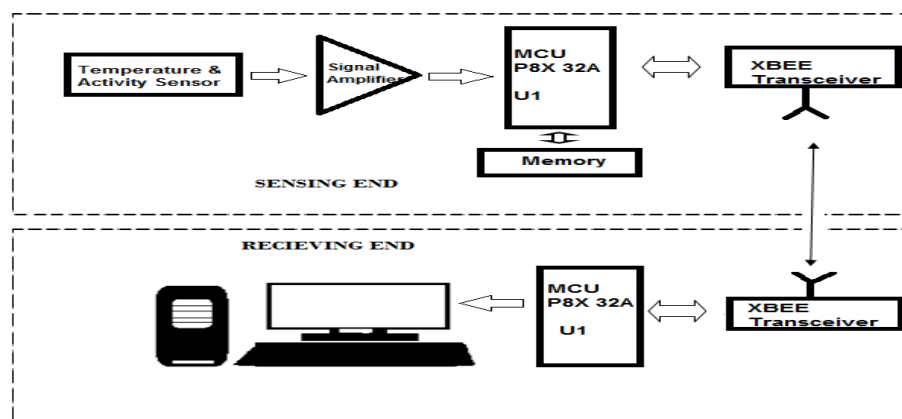
### 3.2 Health Tracking Instruments-



Indian Farmers have been facing huge loss every year due to illness and other disorders of their cattle. Today Technology has been so instrumental in addressing this problem. Shown fig reflects GPS enabled digital chip that empowers a farmer to track the status of their cattle. The device will also alert for any misuse of cattle for slaughter and any health condition. These devices are akin to human health tracking devices like smart watches etc.

#### 3.2.2 Sensor Design

The System is designed to identify and monitor the temperature and communicate through Wireless Sensor Network (WSN). The device provides real time data to the farmer. The Micro Controller is the key that monitors the sensors and calculating the sensor feedback, It then stores it in package unless the cattle is approach of station thereafter it transmit the data to base station. Below diagram (Fig-) shows the functioning model of cattle Health Monitoring and Disease Detector (CHMDD)



**Fig-2 Functioning Model of Cattle Health Monitoring and Disease Detection**

#### 3.2.3 Robotic/Automatic Milking Machines

Cow's milking was done manually which used to require an increased cost, manpower and hygiene issue was also involved in it. Sensor enabled robotic system is a great solution which is attached to cow's teat.

The system has arms and/or cups that extract milk from cow with more efficiency and effectiveness. Robotic milking machines have following advantages over traditional methods of milking-

- It reduces time and monetary and physical cost
- Maintains and provide better milk quality
- Improvements in animal health and welfare are also the key outcomes of the adoption of AMS

Evidence suggests that cows are profoundly affected by stress in their environments. Loud noise, yelling, and whistling are very stressful to cows. Besides, cows are creatures with strong social interaction

Unlike humans, machines are not affected by the time of day, seasons, or mood swings.

The evidence suggests AMS reduces physiological stress and discomfort compared with non-automated milking to a certain extent, and AMS is also able to monitor and detect cattle health and behavior.

### 3.2.4 Cattle Monitoring Drones



**Fig-3 Cow Monitoring drones**

Cattle graze in the fields for extended periods of time so it is often difficult for farmers to regularly check their health. Drones offer a method to autonomously check and monitor the herds health and general disposition, allowing any safety or health issues to be addressed much sooner.

### 3.2.5 Product Traceability for Customers through Blockchain

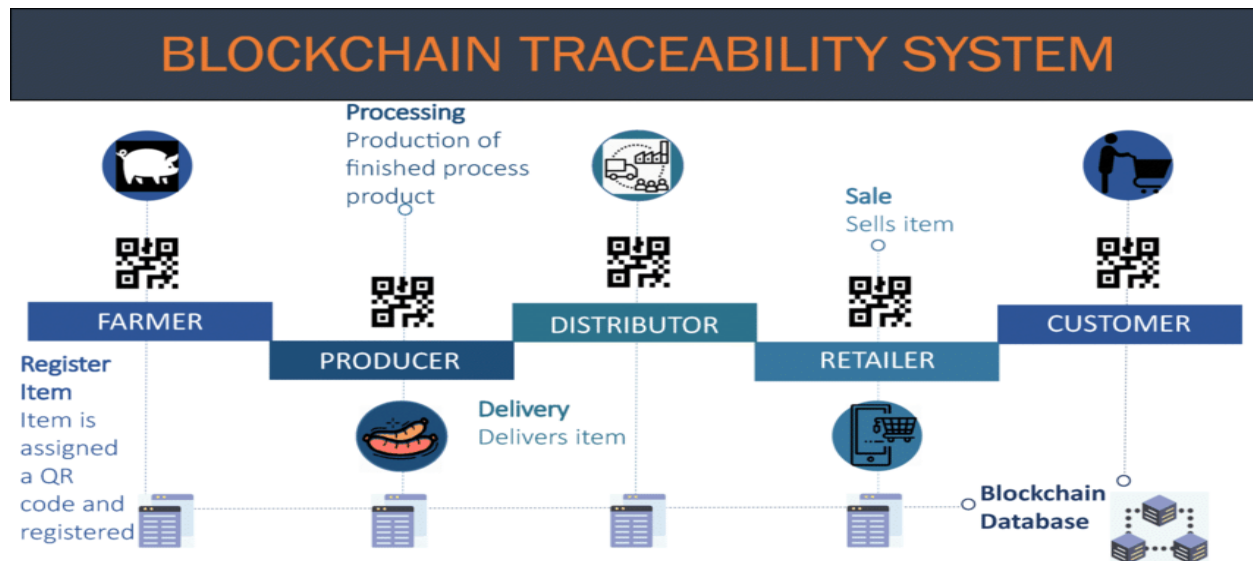


Fig-4 Product Traceability system using blockchain

Blockchain enhances the ability to quickly pinpoint potential sources of contamination to efficiently prevent, contain or rectify outbreaks. Transparency in terms of blockchain food traceability can validate and authenticate food origin and improve brand credibility.

The combination of immutability, enhanced visibility, transparency and data integrity provides numerous benefits that improve trust in extended food supply chains (FSCs). Blockchain can enhance traceability, enable more efficient recall and aids in risk reduction of counterfeits and other forms of illicit trade.

### 3.3 Indian Dairy Response to changing Trends

Meanwhile, it's important to note that unlike in the West, India's dairy industry is highly unorganized. Which means that about 60 per cent surplus milk is handled by the unorganized sector (milkmen), while the remaining 40 per cent is procured by the organized sector comprising of dairy co-operatives and private companies? In developed countries, about 90 per cent surplus milk is handled through the organized sector.



## Industry's Response to Changing Trends in India



### Changing Trends

Growing acceptance of the work-from-home concept

Increasing consumer awareness of quality, safety, and hygiene

Consumers adapting to new channels (e.g. online grocery/foodservice)

Increasing concerns about sustainability

### Industry's Response

Shifting product mix toward more convenient ready-to-drink/eat product categories (e.g. dairy beverages)

Focus on nutritious, high quality, and safe products (e.g. probiotics)

Adopting and/or partnering with technology to reach consumers (investing or collaborating with third-party partners for online platforms)

Direct engagement with farmers, providing access to inputs and services to improve farmers' income, and exploring sustainable solutions (e.g. renewable energy)

*Fig-5 Dairy Sector response to change*

### Strategies and Way forward

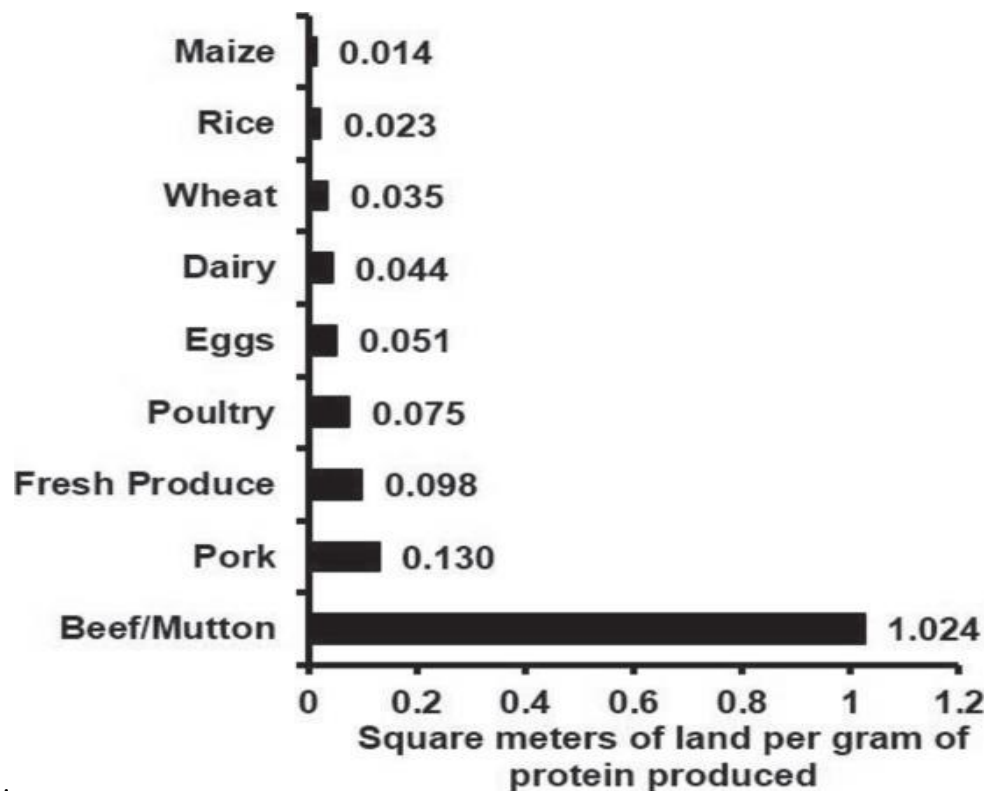
In the present situation, the potential of precision agriculture in general and precision dairying in particular is limited by lack of appropriate measurement and analysis techniques for various important factors (National Research Council 1997). The limitation in data quality/availability has also become a major obstacle in the demonstration and adoption of the precision technologies. In this context, an effort has been made to propose strategies for adoption and operationalization of precision dairy farming in India and developing countries where the similar scenario exists.

- Creation of multidisciplinary teams involving scientists in various fields, like dairying, engineers, manufacturers and economists to study the overall scope of precision farming.
- Since the tools are costly, formation of farmers' cooperatives, self help groups or community organizations would be one of the solutions in developing countries like India.
- Pilot study should be conducted on farmer's field to show the results of precision farming implementation.
- Creating awareness through right extension approaches and advisory services amongst farmers about effective application of the technologies. This is possible by understanding the impact of PDF for the farming communities under different socioeconomic and ecological conditions.
- Additional effort needs to be directed towards implementation of management practices needed to fully utilize the information provided by these technologies. Controlled university research on precision dairy farming simultaneously with field on farm adoption should be practiced.
- Promote the technology for progressive farmers who have sufficient risk bearing capacity since the technology requires capital investment.
- Provide complete technical backup support to the farmers to develop pilots or models, which can be replicated on a larger scale.
- PDF applications need to address a clear problem associated with clear actions or standard operating procedures (SOP). By using the information collected by PDF systems, the production performance of the cattle can be improved, making these systems more cost-efficient.
- The management systems must use the data to provide useful information to 'time poor' farmers or herd managers in a clear and efficient manner which align with potentially diverse farmer needs and resource management.
- New legislative and policy issues and additional market compliance demands also need to be considered by the concerned agency. Further, protection of the farmer's privacy and data ownership also need to be ensured.
- Before investing in a new technology, a formal investment analysis should be conducted to ensure the suitability of technology in catering the farm needs.
- Effective coordination among the public, private sectors and growers is, therefore, essential for implementing new strategies to achieve fruitful success.
- Advances in technologies fuelled by consumers of information and application open a window of opportunity to create cost-effective systems for large scale precision dairy production.
- The technologies need to be flexible enough to be relevant to a range of farmer perspectives and farm business structures.
- The research and extension professionals need to improve their skills and performance to offer decision support to PDF farmers by user-centric and design oriented approaches.
- The role of extension professionals and advisors is to act as a sense maker in the smart farming innovation system, rather than a mere promoter or barrier to technology uptake

## Conclusion



The advantage of dairy- and egg-based diets over vegan-based diets is attributable to the essential amino acids and micronutrients from dairy- and egg-based diets that are missing in appropriate ratios in typical plant-based foods.



**Fig-06: Square meter of land per gram of protein produced**

Square meters of land required to produce 1 g of edible protein from various crops or production systems. Data from [Clark and Tillman \(2017\)](#) and graph modified from [Roser and Ritchie \(2017\)](#) under a Creative Commons CC BY-SA 2.0 license (<https://creativecommons.org/licenses/by-sa/2.0/>)

Robotics has the potential to become next frontier in the dairy and food industries. Looking to the future, manual handling of foods is not going to end soon. But still the acceptance of automation and robotics in the industry is increasing. Even though robots bring with them so many advantages like safety, consistency and efficiency, the challenges that lies before food robotics are the high costs involved and the requirement of skilled engineers. Hence there is immense potential of research in robotics for those specialized in automation, while educational institutions have an equally important role in imparting the advanced knowledge to keep the food industry at par with other more advanced sectors.

Additional research needs to be undertaken to examine the adoption process for not only successful adoption of technology but also to solve the issues associated with the technology adoption. Further, right extension approaches and advisory services for the farmers interested in PDF needs to be undertaken for its effective application under different socio-economic and ecological conditions

## 5.1 Milk Production – Overview

India is the leading milk-producing country worldwide, accounting for one-fifth of the global milk production. Over the last decade, production has increased at 5.5% annually, with 187.7 million tones of milk being produced in FY 2018-19.

### **5.1.1 The Problem**

Unlike the West, India's dairy industry is highly unorganized. About 60% surplus milk is handled by the unorganized sector (milkmen), while the remaining 40% is procured by the organized sector comprising dairy co-operatives and private companies. In developed countries, about 90% surplus milk is handled through the organized sector.

As the dairy industry is unorganized, technology advancements in the sector have been minimal. Lack of technology in this sector has resulted in high wastage and inconsistent quality & quantity of milk for many small farmers. According to research conducted by the Chambers of Commerce and Industry of India (Assocham) and MRSS estimates, about 3% of the milk produced gets wasted annually.

The volume of wastage, coupled with increased demand for dairy products, may hamper India's plan to produce about 300 million tones of milk by 2024. In addition, average milk yield of cows in India is lower than US counterparts—1,248 kgs of milk per cow in a year compared with ~10,000 kgs of milk per year. Indian dairy farmers must increase produce and focus on reducing wastage to meet the target.

### **5.1.2 The Solution**

Adopting technology solutions can help in increasing production efficiency and reducing wastage in the supply chain. Digitalization will play a crucial role in making the transformation possible. Digitalization will have a profound impact on the 'Milk Production' segment in the value chain. In India, dairy farming is unorganized, so technology penetration is relatively less; however, in the last five years, a few start-ups have mushroomed in this space. These firms aim to increase farmer productivity and reduce wastage.

Cattle management is one of the key areas where digitalization can have a significant impact. By leveraging the Internet of Things and advanced analytics, farmers can track the feeding pattern of cattle and monitor their health. This is likely to improve cattle productivity and increase milk yield. However, cattle monitoring through AI-based solutions is still at a nascent stage in India and only a few companies are offering this solution.

One such company offering cattle management solution is Prompt Equipments. The company tied up with the Indian Institute of Technology, Mumbai, to offer a wearable belt 'BovSmart'. The belt utilizes AI and the IoT to monitor cattle breeding and send timely alerts to farmers. Another company, Stellapps Technologies (Stellapps), provides a similar mooOn solution, which helps in maximizing cattle productivity and herd management through a wearable device for cattle and a mobile application, which provides recommendations to optimize herd performance. According to Stellapps, milk yield can be increased by 20% and cattle health expenses can be reduced up to 50% through this solution. About 4.5 lakh cattle are monitored through Stellapps solution.

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