Dairy Scoping Study in India

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

CGIAR

Kingdom of the Netherlands

Citation: Swamikannu Nedumaran., Moses Shyam Davala., Kumaracharyulu Deevi., Jyosthnaa Padmanabhan., Shefali Srivastava., Judy Thomas., Victor Afari-Sefa., 2025. Dairy Scoping Study in India, International Crop Research Institute for the Semi-Arid Tropics, India. 107 pp.

Dairy Scoping Study in India

Submitted to

Consulate General of the Kingdom of Netherlands, Bangalore, India

Submitted by

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT),
Patancheru, Hyderabad, Telangana

Contents

List of Figures

List of Tables

Acronyms

Acronym	Abbreviation
AHIDF	Animal Husbandry Infrastructure Development Fund
AI	Artificial Insemination
APPI	Animal Pandemic Preparedness Initiative
ARIMA	Auto Regressive Moving Average model
ASI	Annual Survey of Industries
BVD	Bovine Viral Diarrahoea
CM	Clinical Mastitis
CMIE	Centre for Monitoring Indian Economy
CMP	Clean Milk Production
DAHD	Department of Animal Husbandry and Dairying
DGFT	Director General of Foreign Trade
DIDF	Dairy Processing and Development Fund
DTCE	Dairy Training Center for Excellence
EBITDA	Earnings before Interest, Taxes, Depreciation, and Amortization
ET	Embryo Transfer
FAO	Food and Agriculture Organization
FMD	Food and Mouth Disease
FSSAI	Food Safety and Standards Authority of India
GCMMF	Gujarat Co-operative Milk Marketing Federation Ltd.
GCMS	Gas Chromatography Mass Spectrometry
HBF	Hans Blankert Fund
IBT	Ice Building Tank
ICPMS	Inductively Coupled Plasma Mass Spectrometry
IVF	In-vitro Fertilization
JMF	Jharkhand Milk Federation

KMF	Karnataka Cooperative Milk Producers Federation Ltd.
KVK	Krishi Vigyan Kendra
LCMS	Liquid Chromatography Mass Spectrometry
LSD	Lumpy Skin Disease
MN MT	Million Metric Ton
NABARD	National Bank for Agriculture and Rural Development
NAIP	Nationwide Artificial Insemination Program
NCDF	National Cooperative Dairy Federation of India
NPDD	National Program Dairy Development
OECD	Organization for Economic Cooperation and Development
OGL	Open General License
PE	Poly Ethylene
PGA	Partner Government Agencies
PP	Poly Propylene
PPR	Peste des Petits Ruminants
RGM	Rashtriya Gokul Mission
SCM	Sub Clinical Mastitis
SOP	Standard Operating Procedures
STEC	Shiga toxin-producing Escherichia coli
TBD	Tick-Borne Diseases
TCMPF	Tamil Nadu Cooperative Milk Producers Federation Ltd.
UHT	Ultra-High-Temperature processing
USDA	United States Department of Agriculture
VHC	Veterinary Health Certificate

Message

The Netherlands is globally renowned for its dairy industry, with a rich tradition of producing milk, butter, and cheese. The iconic landscape of meadows, cows, and windmills is closely tied to the country's image. Beneath this lies a modern sector focused on people, animals, and the environment, making it a large and significant contributor to the Dutch economy.

The transformation of the Dutch dairy sector since the second half of the 20th century is fascinating, particularly in how technology and innovation have driven production and productivity despite a reduction in the number of farms. After the European Union introduced the milk quota system in the 1980s, the focus of the Dutch dairy sector shifted from expanding production to reducing costs. Investments in milking machines and cooling systems encouraged farmers to specialize in production rather than diversify into other forms of farming, while EU subsidies for Cubicle Sheds and Milk Cooling Tanks further supported production. Key innovations like the use of milking machines, artificial insemination, improved farming practices (fertilizers, silage, maize, and feed additives), and advances in breeding practices were key game changers, significantly increasing milk yield per cow. The average productivity of a Dutch cow increased from 4,205 kg/year in 1960 to 9,309 kg/year in 2023, reflecting a 219% growth. Simultaneously, the average size of a dairy farm grew from 9 cows per farm to 110 cows per farm, a staggering 1,222% increase!

While productivity growth has been key in the Dutch dairy industry, sustainably increasing production is even more crucial. Climate measures, particularly those targeting greenhouse gas reduction and energy policies, will increasingly impact dairy companies. For instance, the nitrogen policy and the phasing out of derogation aim to gradually reduce manure spreading in the Netherlands. By January 1, 2026, Dutch dairy farmers will only be allowed to spread a maximum of 170 kg of nitrogen from animal manure per hectare per year (down from 230 to 250 kg).

India's dairy sector is diverse, with regions at varying stages of development. It includes well-organized cooperatives and both foreign and domestic companies, each employing different approaches to supply chains and product lines. India has firmly established itself as the world’s largest producer of milk since 1998, contributing an impressive 25% of global milk production and still growing. The dairy industry plays a crucial role in the country’s economy and rural development, providing livelihoods to over 84 million rural households.

The success of India's dairy sector is largely attributed to the *White Revolution*, which transformed the country from a milk-deficient nation to one that is self-sufficient and surplus-producing. In collaboration with the Ministry of Animal Husbandry and Dairying, organizations like the National Dairy Development Board (NDDB) and cooperatives such as Amul and private sector players like Hatsun have played a key role in achieving this growth.

In view of the above, there is a growing interest on both the Indian and Netherlands side to cooperate in the dairy sector. This study is a result of a collaborative effort between the Agriculture Department of the Embassy of the Kingdom of the Netherlands, New Delhi, and the International

Crop Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad, focusing on the recent advancements in India's dairy sector.

I would like to extend my heartfelt congratulations to ICRISAT for their dedicated efforts in producing this valuable volume, which has been instrumental in shaping this study. We are confident that this work will be an invaluable resource for policy analysts, policymakers, and the wider research and development community. Additionally, this study will play a crucial role in fostering commercial success through collaboration on mutually identified development projects, furthering the bilateral goals of both India and the Netherlands.

Mr. Michiel van Erkel,
Agriculture Counsellor for India and Sri Lanka,
Embassy of the Kingdom of the Netherlands in New Delhi

MESSAGE

ICRISAT is dedicated to transforming dryland agriculture and is actively shaping agriculture agri-food systems to benefit producers, farmers, and consumers alike. In dryland regions, integrated crop livestock systems are vital for sustainability. The dairy industry plays a crucial role in ensuring nutrition security, particularly in the semi-arid tropics.

ICRISAT's mandate crops show significant potential for use as forage, and the organization has been focusing on developing dual-purpose crops that can enhance crop-livestock integration in Asia, Africa and beyond. In Africa, ICRISAT has been piloting innovative technologies for livestock farmers, such as mobile calls and calling systems, to improve the soil fertility and support sustainable agricultural practices.

This report provides a comprehensive overview of the current state of India's dairy industry, analyzing key trends in production, market dynamics, policy reforms, and emerging innovations. It also underscores the growing imperative to address climate change through sustainable practices, recognizing that the future resilience of the sector depends on reducing its environmental impacts.

As we look ahead, sustainable agri-food industry in India will require concerted efforts and collaboration among all stakeholders — from farmers, cooperatives, and processors to policymakers, researchers, and consumers. By aligning strategies and resources, we can foster a sector that is not only efficient and productive but also environmentally sustainable and equitable.

We thank the Government of Netherlands for their support and hope this report serves as a valuable resource for decision-makers, industry participants and stakeholders, and contribute to create a more resilient inclusive and equitable future for India's dairy industry.

Dr Stanford Blade
Interim Director General, ICRISAT

An Overview on Indo-Dutch Collaboration

The Netherlands is geographically small but popularly known worldwide as a dairy country. The Netherlands is the eighteenth-largest economy in the world and fourth largest in the European Monetary Union. Dairy is one of the biggest industries in the Netherlands where gross milk production stands at €7.14bn in 2024. The dairy sector makes an important contribution to the Dutch economy. With a projected annual growth rate of 3.60% between 2024-2029, the gross production value is expected to reach €8.52bn in 2029. The dairy cow population of the country is 1.6 million, producing 14.7 billion Kg of milk. Cheese is the main product from processed milk occupying 59% of the dairy products of the country. The Dutch dairy sector is a major player in the global market, has accounted for around 8% of the Dutch trade surplus and for 45,000 direct full-time jobs. The Dutch dairy sector has a strong market position in Europe and in the world. The Dutch Dairy Association and its members are part of a larger dairy landscape.

Traditionally, Dutch dairy companies have worked closely together with other companies and organizations across the dairy chain across the world, some key associations with the Indian dairy sector is listed below:

- PUM, a Dutch consortium tied up with Mango Dairies, in Pilibhit of Uttar Pradesh, India. PUM's Hans Blankert Fund (HBF) funded Mango Dairies to use cattle slurry as fertilizer for their crop fields.
- Kanpur-based dairy company Tasty Dairy Specialities Limited has collaborated with PUM to set up an Indo-Dutch Centre of Excellence in Dairying in Kanpur.
- HollandDoor, a Netherland-based organization dedicated to bridging the gap between the demand and supply of knowledge, skills and networks organized four K2K (knowledge to knowledge) training program on dairy farming in four different states in India.
- The Dutch Government, together with the Department of Animal Husbandry and Dairying is planning to establish a Dairy Training Centre of Excellence (DTCE) in Karnataka to help dairy farmers adopt Dutch technology and improve the quality and quantity of milk, managing dairy farms, and getting insights into marketing.
- Provimi Animal Nutrition India founded in 1927 at Rotterdam, Netherlands joined with the Cargill family of businesses in 2011. The company operates in 40 countries including India.
- Nutreco, a global animal nutrition and aquaculture company based in the Netherlands has invested in India's leading dairy-tech startup Stellapps to enable farmers to increase productivity and efficiency. through the award- winning Smart Moo technology.
- Trouw Nutrition India, the animal nutrition division of Nutreco, is a leader in innovative feed specialties, feed additives and premixes, operating from Telangana, India.
- DSM, which is the acronym for Dutch State Mines, merged with the Swiss company. Firmenich to form a new entity named DSM- Firmenich. DSM Nutritional Products produces essential nutrients such as synthetic vitamins, nutritional lipids and novel cattle feed additive (Bovaer) to reduce methane production from dairy production. It works across 3 states in India, Maharashtra, Telangana and Tamil Nadu.

- De Heus, the second largest private player in animal feed in the Netherlands, is operating in 20 countries including India (Punjab) with 80 plant locations.
- CRV genetics which originated in the Netherlands and Flanders, is a leading international company providing extensive range of top bulls and options with sexed semen (SiryX). It has collaborations with Khushal Honey and Dairy Producers Association, operating from Punjab.
- Van Hall Larenstein, University of Applied Sciences is working since 2011 with Krishi Vigyan Kendra (KVK) of Agricultural Development Trust, Baramati, Pune, Maharashtra. Van Hall Larenstein and Saxion Universities of Applied Sciences and several Dutch companies collaborate under the project: *Integrated Solutions For The Expanding Dairy Farms in the State Of Maharashtra, Pune District In India.* With this project Krishi Vigyan Kendra (KVK) aims to help family farmers to scale up from 10-40 cows to 80-100 cows, with a higher production and quality.

Executive Summary

Dairy is one of the biggest agri-businesses in India and a significant contributor to the Indian economy. India is the highest milk producer and ranks first position in the world contributing about 25% of global milk production in the year 2023. Dairy is the largest single agricultural commodity with a ~4% share in the economy. The milk production of India has registered a 39% increase during the last 10 years and stands at 239.30 million tons in 2023. Accordingly, the per capita availability of milk is 471 grams per day in India, as against the world average per capita consumption of about 329 grams per day.

India aims to achieve a massive share of 30 % of world milk production by 2030. The country has managed to attain a top position in milk production globally owing to its huge bovine population, however, the full potential of the Indian milch herd remains unattained.

This executive summary outlines the key findings and recommendations regarding the Indo-Dutch collaboration in the dairy sector. This section sets the stage for a detailed exploration of India's dairy industry within a global context, highlighting its significance and potential for growth.

In the introduction, the report provides a background on the Indian dairy sector and an in-depth analysis of the upstream market, where the 5Ps of Indian dairy—population, production, productivity, per capita availability, and herd size are examined in a state-wise spectrum. This analysis is essential for understanding the foundational elements of the dairy industry, including cattle health, feed resources, and the impacts of climate change and greenhouse gas emissions.

The downstream market section shifts focus to the dynamics of dairy cooperatives and private enterprises, illustrating their contributions to the overall market. Key statistics on the share of organizations in gross sales, market size by product, and product-wise margins provide a comprehensive view of the industry's economic landscape. Future projections for various dairy products, such as butter, cheese, and yoghurt, further underscore the growth potential of this sector.

Following this, the report addresses critical food safety issues and other challenges faced in production, marketing, and consumption. This analysis is vital for identifying gaps in the current practices and ensuring the sustainability of the dairy supply chain.

The chapter on current technologies and potential advancements for value addition explores existing methods and identifies technology needs for improving efficiency in the industry. This is complemented by a discussion on the export and import potential of dairy products, detailing the nature of both markets and highlighting trade relationships, particularly with the Netherlands.

Regulatory frameworks governing the import and export of milk and dairy products are also examined, with attention given to recent legislative changes. This provides a context for understanding the compliance landscape that impacts market operations.

Policies for dairy development are discussed next, showcasing various government initiatives aimed at enhancing the industry. These policies, such as the National Program for Dairy Development and the Rashtriya Gokul Mission, reflect a structured approach to fostering growth and innovation in the dairy sector.

The final chapters focus on training needs and the expertise available from the Netherlands, detailing various training programs and initiatives designed to build capacity within the Indian dairy sector. This section highlights collaborative efforts that can enhance skills and knowledge transfer, paving the way for more effective practices in dairy management.

The report concludes with a roadmap for dairy sector development, synthesizing the insights gathered throughout the chapters into actionable recommendations for stakeholders aiming to improve and expand the dairy industry in India.

Key Trends and Opportunities Identified

Milk Productivity

- **Regional Variability:** The eastern part of India predominantly features low milk productivity, with indigenous cattle averaging 2.9 kg/day and buffaloes at 1.8 kg/day. In contrast, the northern region shows higher productivity with indigenous buffaloes yielding an average of 7.3 kg/day. The southern region, particularly Karnataka and Tamil Nadu, predominantly utilizes cross-bred cattle, averaging 6.8 kg/day.

Cattle Feed

- **Market Potential:** The cattle feed market constitutes 33% of the total animal feed market, with a demand of 67 million tons, while current production is only 8 million tons. This significant gap indicates substantial growth opportunities. Cooperatives are the primary producers, accounting for 42% of total production, followed by private companies and homemakers.

Genetic Improvement

- **Biodiversity:** India possesses a rich biodiversity with 50 defined cattle breeds and 17 buffalo breeds. However, some populations are declining due to reduced productivity, which poses an economic challenge. Genetic improvement is essential to enhance milk production.

Sex Sorted Semen

- **Increasing Adoption:** There is a growing trend among Indian farmers to adopt sex-sorted semen, with high demand for breeds such as Holstein-Friesian and Jersey, as well as various indigenous breeds.

Cattle Health

- **Economic Impact of Diseases:** Mastitis accounts for nearly 70% of milk loss, resulting in economic losses estimated at approximately €879 million. Foot-and-mouth disease (FMD) and brucellosis also impose significant economic burdens, underscoring the need for enhanced health management strategies.

Climate Change and GHG Emissions

- **Challenges:** The dairy sector faces challenges related to heat stress, enteric emissions, and manure management. Cost-effective solutions, including cooling units and feed additives, are necessary for effective management.

Industry Overview

- **Market Share:** Cooperatives hold a substantial 58% share of the dairy market, with the Gujarat Co-operative Milk Marketing Federation Ltd. commanding 47% of this segment. Although major private players have a minimal market share, there is potential for growth as milk production continues to rise.

Product Segmentation

- **Processed Milk Dominance:** The processed milk segment accounts for 76% of market volume and 64% of value. Healthy EBITDA margins for products like yoghurt and cheese indicate promising opportunities for investment.

Future Projections

- **Market Growth:** The market value for milk and cream in India is projected to reach €18.31 billion by 2025 and €28.07 billion by 2035, with Gujarat identified as the largest consumer base.

Export Opportunities

- **Limited Market Access:** India currently accesses only 30-40% of the global dairy market. Focused efforts on value-added products such as cheese and curd, especially in the Middle East, could enhance export potential.

Quality Control and Regulatory Compliance

- **Challenges:** Ensuring consistent quality of dairy products is a significant challenge due to their perishable nature. Additionally, navigating complex food safety regulations poses hurdles for startups in the sector.

Competition and Branding

- **Market Dynamics:** The Indian dairy sector is highly competitive, necessitating that startups differentiate themselves through innovation and branding to secure market share, which requires considerable time and investment.

Farmer Engagement

- **Modern Practices:** Engaging small-scale farmers to adopt modern practices remains a challenge due to limited resources and knowledge access.

Sustainability Concerns

- **Environmental Impact:** The dairy industry faces increasing scrutiny regarding its environmental practices, emphasizing the need for sustainable methods to attract environmentally conscious consumers.

Skill Development

- **Training Needs:** Collaboration between dairy companies and Sector Skill Councils is vital to address the shortage of skilled labour, particularly in areas like genetic improvement and food safety compliance.

Import and Export Landscape

- **Trade Regulations:** India's contribution to global dairy imports is below 1%, with major imports coming from Europe. Strict regulations govern the trade of livestock germplasm, highlighting the need for compliance and quality assurance.

Overall Training Needs

- **Broad Focus:** There is a pressing requirement for training across the dairy supply chain, especially in genetic improvement and adherence to food safety standards. The Government of the Netherlands may consider fostering partnerships that can facilitate this knowledge transfer.

CHAPTER I: Introduction

India has held the top position in global milk production since 1998. From a milk deficit in 1947 to becoming the largest dairy nation in the world, the growth of the Indian dairy sector is noteworthy. Globally, India is now at the cusp of becoming "Dairy to the world" by contributing around 24.64% to the total milk production. India aims to achieve a massive share of 30 % of world milk production by 2030.

Over the span of 70 years (1950-23), milk production in the country has surged from 17 million metric tons (Mn MT) to 239.30 Mn MT (Fig. 1), with an annual growth rate of 4 %. During the first 10 years after independence, the annual compound growth rate in milk production was 1.64%, which later declined to 1.15% during the 1960s. In 1950-51, per capita milk consumption was just 124 grams per day. This number fell to 107 grams by 1970. Despite having the largest cattle population globally, India's dairy industry struggled with an annual milk production of less than 21 million tons.

With the launch of *Operation Flood*, milk production took a steep rise from 51.4 Mn MT in the 1990s to 239.30 Mn MT by 2023. Presently, milk production is growing at the rate of 2.08 % globally, while in India the growth rate is around 4.3 %. The per capita availability of milk in India is much higher than the world average.

The dairy industry holds immense importance for India due to various reasons. It provides livelihoods for over 80 million rural households, primarily small and marginal farmers as well as landless individuals. Though India is the leading producer of milk, the country has not yet fully realized its potential in this area, making it a significant player on the global stage.

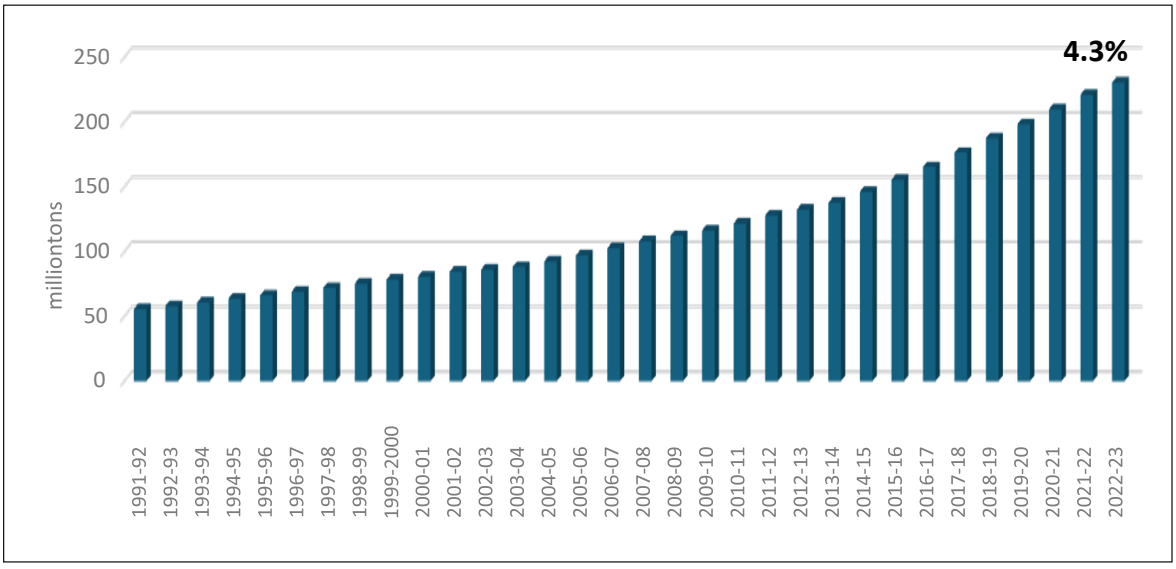


FIG 1: TRENDS IN MILK PRODUCTION SOURCE: DAHD 2023

CHAPTER II: India's Dairy sector in the Global Context

The chapter focuses on India's context in the global dairy scenario in terms of population production and productivity to enhance their productive and economic efficiencies as well as their qualitative standards to improve the process and business through benchmarking.

2.1 POPULATION

India accounts for the largest inventory of bovine population globally (Fig. 2). The population of bovine animals in India consists of Indian dairy cattle, Asian domestic water buffaloes and others. Livestock estimates in 2023, show that the Indian cattle herd of 307.5 million head is composed of some194.2 million head of dairy cattle and 113.3 million water buffaloes.

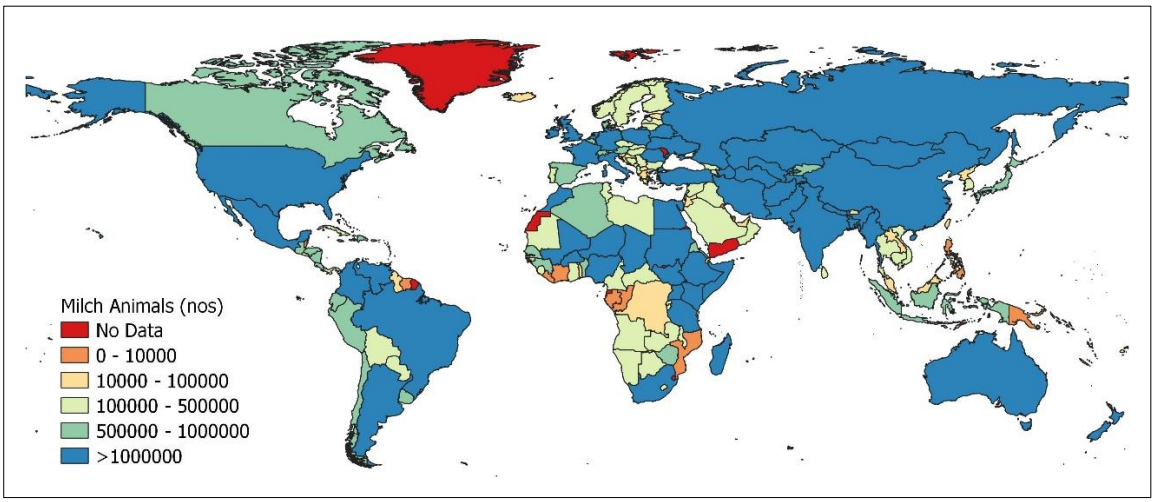


FIGURE 2: GLOBAL MILCH POPULATION SOURCE: FAOSTAT 2023

2.2 PRODUCTION

The top milk-producing countries in the world (Table 1) are India (207 Mn MT), followed by the European Union (149 Mn MT), United States (102 Mn MT), and China (43 Mn MT). Dairy is one of the biggest agri-businesses in India and a significant contributor to the Indian economy. India is the highest milk producer and ranks first position in the world contributing 31 of the global milk production in the year 2023. Dairy is the largest single agricultural commodity with a ~4% share in the economy.

Table1: TOP MILK PRODUCING COUNTRIES OF WORLD (Mn MT) SOURCE: USDA 2023

Country	Production (Mn MT)	Country	Production (Mn MT)
India	207	Brazil	28
European Union	149	New Zealand	21
United States	102	United Kingdom	15
China	43	Mexico	13
Russia	33	Türkiye	20

2.3 PRODUCTIVITY

The milk yield of Indian cattle stands at 987 kg/ year, which is substantially lower than that of other countries (Fig. 3), such as Israel (11,000 kg/ year), Netherlands (9,200 kg/year), USA (7,038 kg/ year), and Denmark (6,273 kg/year).

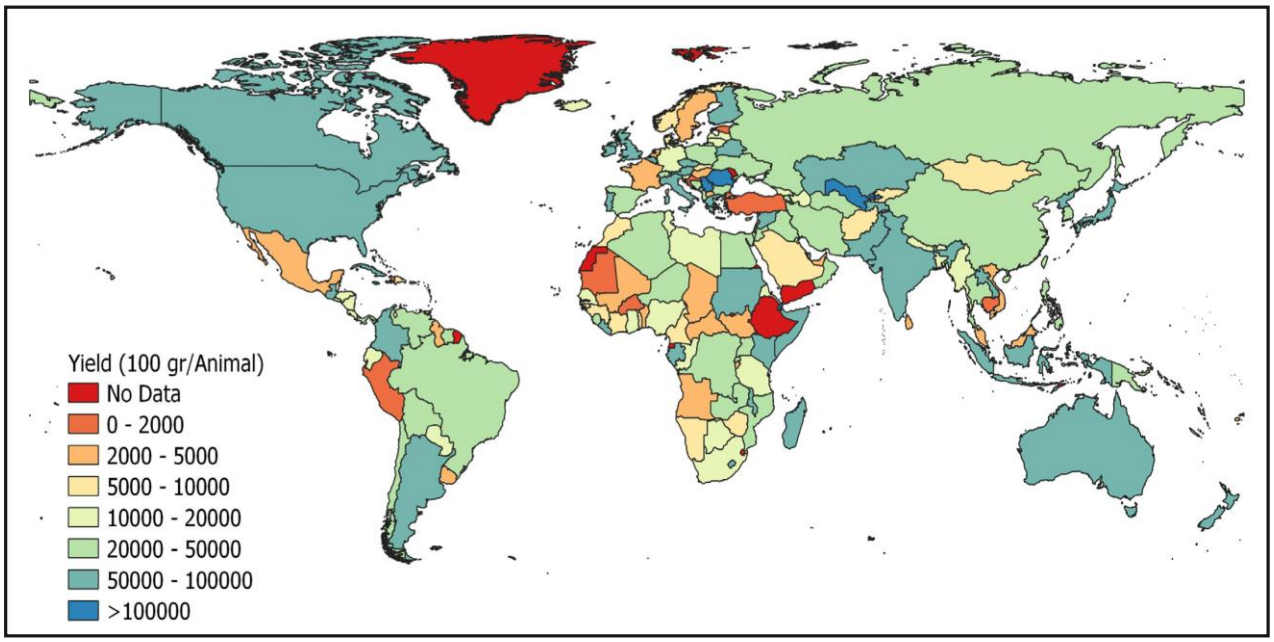


FIG 3: GLOBAL MILK PRODUCTIVITY *SOURCE: FAOSTAT 2023*

A growing world population and changes in consumption habits continue to boost dairy demand The Government of India predicts that these changes will drive the milk production to 300 Mn MT by 2030. Market research companies project that the household expenditure on milk and milk products will be 45% of the food budget by 2050. Although India is the largest producer and consumer of dairy, its per capita consumption remains low. With the population expected to grow to 1.66 billion by 2050, the industry holds substantial opportunities to tap into its full potential.

The reasons for low milk productivity can be attributed to:

- **Poor nutrition:** Cattle need a balanced diet of proteins, carbohydrates, fats, vitamins, and water. Empirical studies show that improving the quality and quantity of feed and fodder has a greater impact on increasing milk productivity than breed improvement.
- **Disease outbreaks:** Diseases like Lumpy Skin Disease (LSD) can cause a marked decrease in milk production and in some cases death of the infected cattle. Mastitis is another common disease that reduces both the productivity of the cow and the quality of the milk.
- **Reproductive efficiency:** Poor fertility of dairy bovine continues to be a major factor limiting the profitability of dairying.

The factors contributing to low productivity in India's dairy sector create significant opportunities for research, technology exchange, and capacity building through Indo-Dutch collaboration.

CHAPTER III: Upstream Market

Dairy products' quality depends on upstream factors, starting from the quality of milk (includes breed, feed, health, etc.) to supply variability, cold-chain management, and shelf life. Sound upstream supply management entails everything from procuring quality milk to instituting rigorous quality controls and training programs. The Government of India (GoI) foresees investment opportunities to the scale of € 1.72-2.71 Billion in this value chain segment.

Hence, this chapter focuses on key aspects of the cattle and buffalo sector, including population dynamics, production levels, productivity, per capita availability, and consumption patterns (the 5Ps). It also examines herd size and the availability of feed and fodder at both the state and national levels. Additionally, the chapter addresses the status of genetic improvement, identifies target bulls for enhancement, and assesses the overall health status of cattle in India.

3.1 5P'S OF INDIAN DAIRY -STATE-WISE SPECTRUM

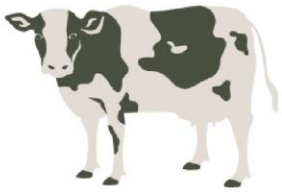
3.1.1 POPULATION- IN-MILK CATTLE AND BUFFALO

In India, the combined population of in-milk cattle exceeds that of buffalo by 12%. The breeds and numbers vary across different states. Uttar Pradesh, a major milk-producing state, has a higher buffalo population than cattle (Fig. 4).

- In India, the exotic population constitutes only 1% of the total in-milk population and cross-bred 21% Exotic population is high in Uttar Pradesh and Punjab owing to large cattle farms and high returns from dairy. Favourable and breed-suitable temperature is also one of the reasons for high number of populations in the states of Uttar Pradesh and Punjab.
- Jersey cross-bred cattle is the breed of choice in the plains of Tamil Nadu and government breeding policies in both states are the drivers of the high cross-bred population in both Tamil Nadu and Karnataka
- Growth in exotic cattle breeds is observed across all major milk-producing states, suggesting a shift towards higher milk-yielding breeds. The rapid growth of exotic breeds compared to indigenous breeds over the past seven years suggests that the population of exotic breeds may soon surpass that of indigenous breeds. This trend is driven by the higher productivity and faster maturity rates of exotic breeds.
- Despite the growth in exotic breeds, states like Madhya Pradesh and Rajasthan maintain a higher population of indigenous cattle for milk production, indicating the continued relevance of indigenous breeds.

Number of In-milk Animals (2022-23)

Cow - 56% of in-milk animals

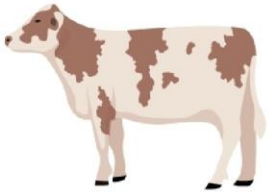


Exotic
10,270,000 Nos.
(1%)

Top States	No. of animals (0000s)
Uttar Pradesh	206
Punjab	197
Bihar	145
Maharashtra	119
Madhya Pradesh	82

Indigenous
162,350,000 Nos.
(15%)

Top States	No. of animals (0000s)
Bihar	3477
Uttar Pradesh	3337
Rajasthan	2154
West Bengal	1288
Gujarat	1184



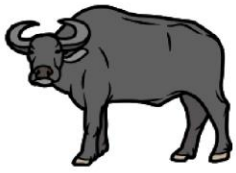
Crossbred
223,810,000 Nos.
(21%)

Top States	No. of animals (0000s)
Tamil Nadu	3559
Karnataka	2311
Maharashtra	2065
Rajasthan	1902
Gujarat	1661

Non-descriptive
209,190,000 Nos.
(20%)

Top States	No. of animals (0000s)
Madhya Pradesh	4789
West Bengal	2256
Rajasthan	2118
Uttar Pradesh	1649
Maharashtra	1466

Buffalo – 44% of in-milk animals



Indigenous
298,270,000 Nos.
(15%)

Top States	No. of animals (0000s)
Uttar Pradesh	8704
Rajasthan	3307
Gujarat	2915
Bihar	2523
Andhra Pradesh	2241

Non-descriptive
209,190,000 Nos.
(20%)

Top States	No. of animals (0000s)
Madhya Pradesh	3642
Uttar Pradesh	3254
Rajasthan	2906
Maharashtra	1411
Gujarat	1185

FIG 4: TOP FIVE STATES WITH HIGH CATTLE AND BUFFALO POPULATION SOURCE: DAHD 2023

In the last seven years in India, exotic cattle breeds are experiencing growth at a rate of 7 % while indigenous ones are growing at 2% (Table 2). The exotic cattle numbers are growing significantly in all main milk-producing states, while Madhya Pradesh and Rajasthan still have more indigenous cattle for milk production.

To focus on states like Rajasthan, Gujarat, and Karnataka, for breeding and milk production activity as the governments heavily supports crossbreeding programs.

TABLE 2: CAGR OF CATTLE AND BUFFALO POPULATION (2016-2022)

States	Indigenous Cattle	Exotic Cattle	Buffalo
Andhra Pradesh	-3%	4%	3%
Gujarat	-1%	13%	2%
Karnataka	-1%	11%	1%
Madhya Pradesh	2%	8%	6%
Maharashtra	1%	6%	2%
Rajasthan	3%	15%	4%
Uttar Pradesh	0%	7%	2%
India	2%	7%	2%

SOURCE: DAHD 2023

3.1.2 PRODUCTION - BY STATES

India's milk production is spread across the country, with the largest production volume (Fig. 5) coming from Uttar Pradesh (15%), Rajasthan (15%), Madhya Pradesh (8%), Gujarat (7.5%), Andhra Pradesh (7%), Maharashtra (6.5 %), Karnataka (6 %) and Punjab (6%). Those states with higher numbers of crossbreed and exotic animals tend to exhibit higher milk yields irrespective of the size of the bovine population.

The variation in milk output across leading states over the past seven years, from 2016 to 2022, reveals that Uttar Pradesh has consistently maintained its position as the top producer. In close pursuit is Rajasthan, experiencing a substantial growth rate of 12.45%. All other states have shown significant growth, with Karnataka a 13% increase (Fig. 6). These findings imply continued expansion in India's milk production in the upcoming years.

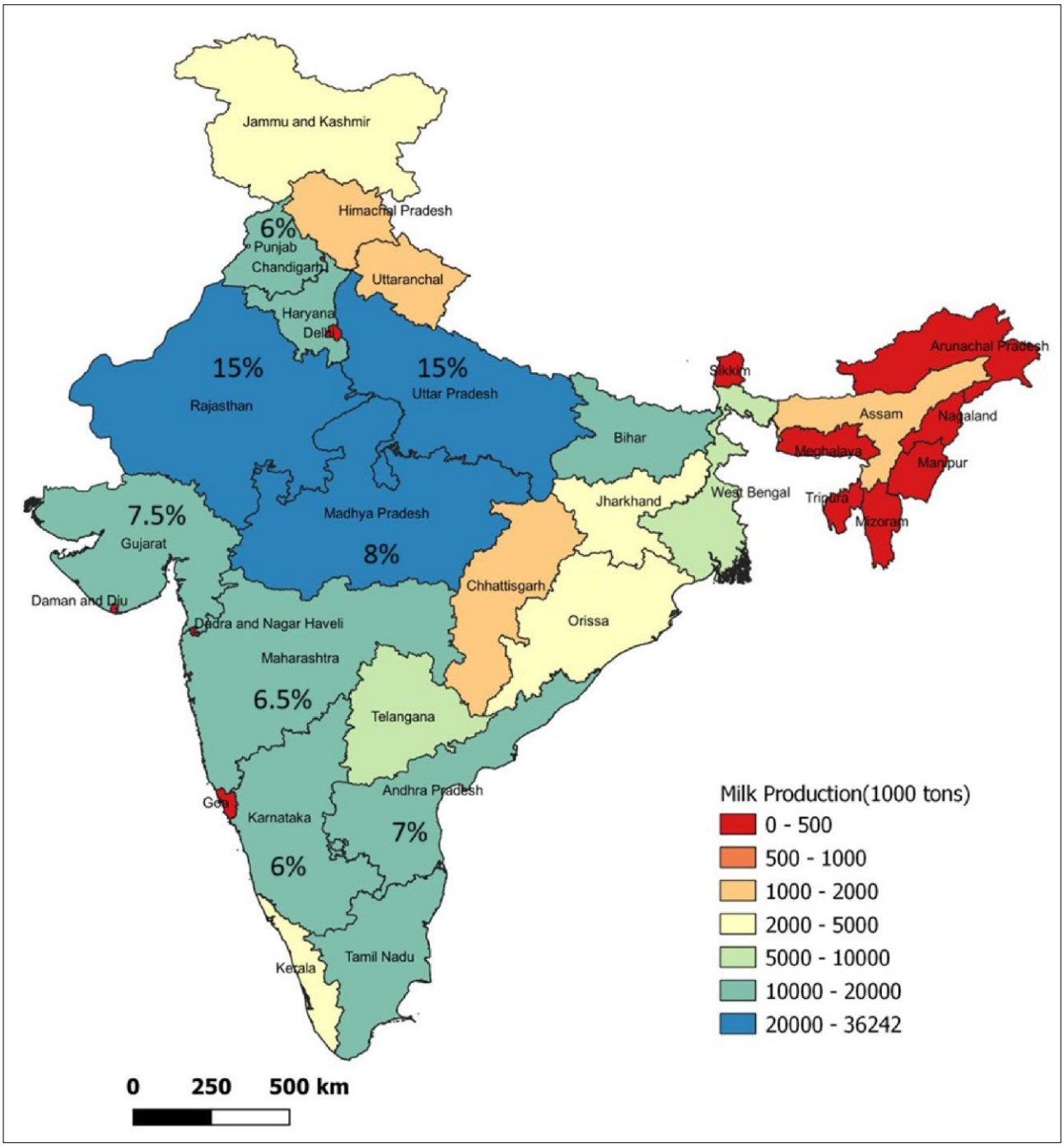


FIG 5: SPATIAL MAP OF SHARE IN MILK PRODUCTION IN INDIA *SOURCE: DAHD 2023*

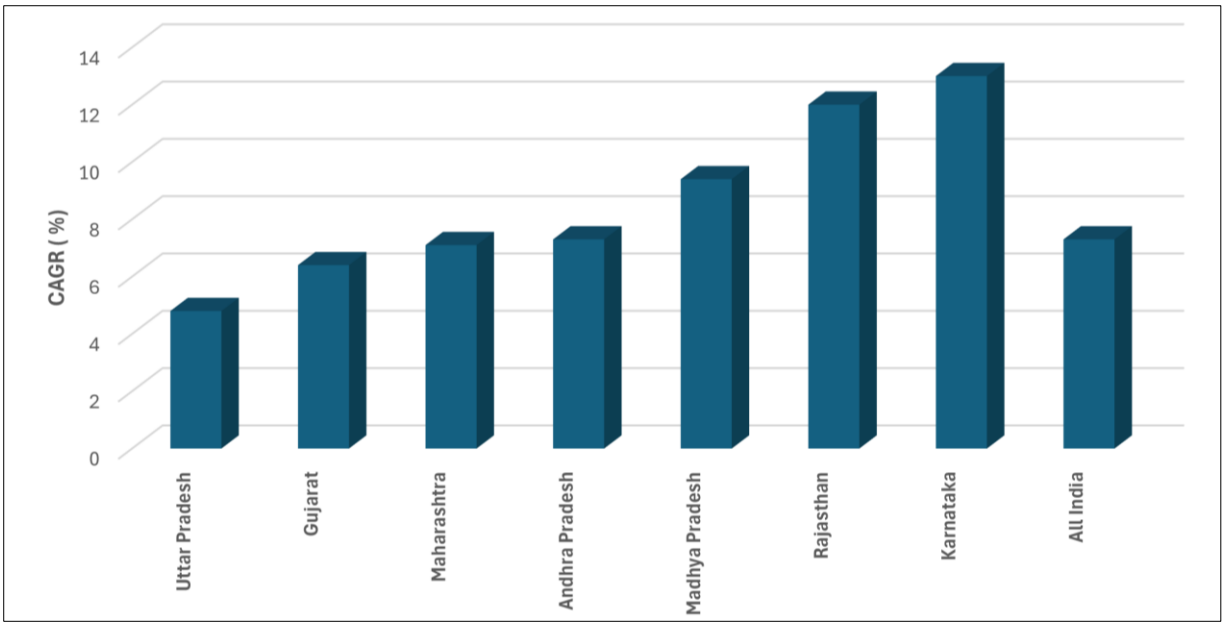


FIG 6: CAGR OF MILK PRODUCTION IN MAJOR STATES *SOURCE: DAHD (2023) AND AUTHORS CALCULATIONS*

The positive growth trajectories observed across all major milk-producing states, particularly in Karnataka, signify a promising outlook for the expansion of India's dairy sector. These trends can be attributed to various factors, including government initiatives to promote dairy farming, improvements in animal husbandry practices, and increasing demand for dairy products in domestic and international markets.

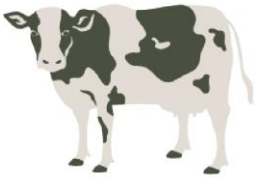
3.1.3 PRODUCTIVITY PER ANIMAL

Punjab has the highest per-day productivity for cattle (Fig. 7) because of its commercial milk production and effective feed and forage management practices.

Haryana is strong in buffalo productivity due to the high presence of Murrah buffalo. The sorghum wheat and rice-wheat cropping systems prevalent in Haryana blend well with the Murrah buffalo farming system. Mechanized farming, along with support from the Department of Animal Husbandry for high-quality semen for artificial insemination aimed at breed improvement, has expanded the potential for high-tech dairy farming in Haryana. Additionally, the availability of a ready market for milk further enhances this scope.

A lack of pure genetic resources and poor management of feed and fodder were the primary causes of the low output, suggesting room for improvement.

Cow

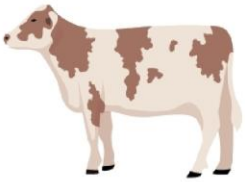


Exotic
Average - 11 kg/day

Top States	Average Productivity (kg/day/animal)
Punjab	16.4
Andhra Pradesh	15
Telangana	12.5
Maharashtra	12.4
Haryana	12.3

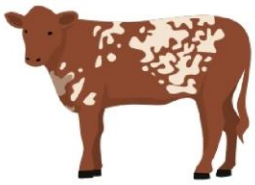
Indigenous
Average - 4.17 kg/day

Top States	Average Productivity (kg/day/animal)
Punjab	9.15
Chandigarh	7.47
Haryana	7.07
Rajasthan	6.3
Telangana	5.81



Crossbred
Average - 8.41 kg/day

Top States	Average Productivity (kg/day/animal)
Punjab	12.83
Kerala	10.77
Haryana	10.3
Maharashtra	10.26
Karnataka	9.8



Non-descriptive
Average - 2.87 kg/day

Top States	Average Productivity (kg/day/animal)
Punjab	6.44
Haryana	6.14
Delhi	6.08
Rajasthan	5.5
Gujarat	4.22

Buffalo

Indigenous
Average - 6.76 kg/day

Top States	Average Productivity (kg/day/animal)
Haryana	10.82
Punjab	9.92
Andhra Pradesh	9.62
Delhi	9.59
Telangana	8.52

Non-descriptive
Average - 4.82 kg/day

Top States	Average Productivity (kg/day/animal)
Haryana	9.18
Rajasthan	6.64
Punjab	6.57
Sikkim	5.78
Kerala	5.3

FIG 7: AVERAGE PRODUCTIVITY OF ANIMAL BREED (2022-23) *SOURCE: DAHD 2023*

3.1.4 Per Capita Availability of Milk in India

The per capita availability of milk is 459 grams per day in India during 2022-23 as against the world average of 322 grams per day and is highest (>1000 g/day) in the states, of Rajasthan, Punjab and Haryana (Fig. 8).

Northeastern states have the lowest per capita availability among Indian states mainly due to the low production potential of the animal. Inadequate availability of feeds and fodder and lack of organized setup for milk procurement and sale impede milk production in Northeast India. It also presents ample scope for increasing productivity through the control of animal disease, scientific management and up-gradation of genetic resources, development of processing and marketing facilities in this region.

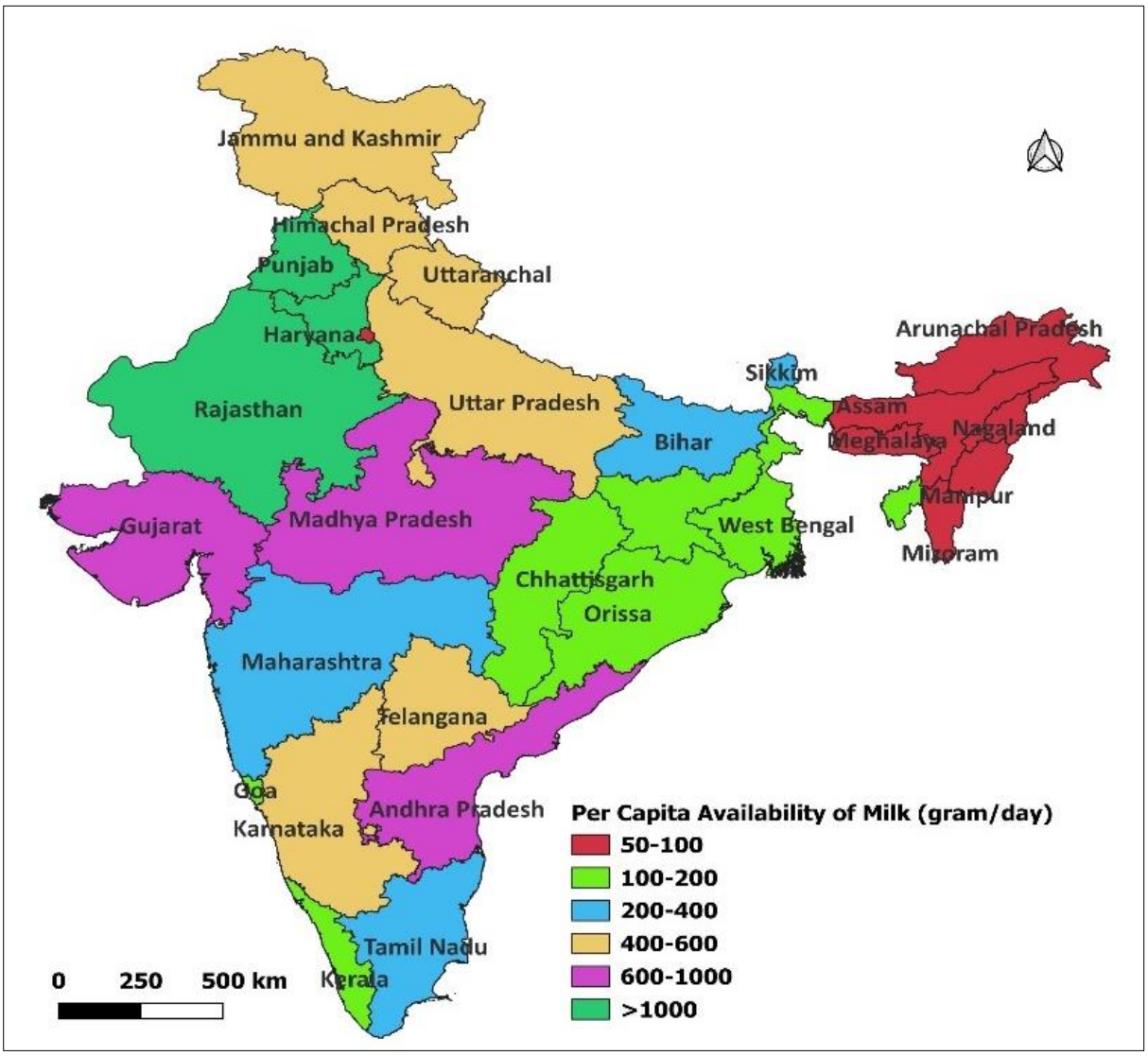


FIG 8: PER CAPITA AVAILABILITY OF MILK ACROSS STATES SOURCE: DAHD 2023

3.1.5 Per Capita Consumption of Milk and Curd (Yoghurt)

Punjab and Haryana may be called the land of milk and curd, but when it comes to consumption, they fall behind the consumers from southern states like Andhra Pradesh, Telangana, Tamil Nadu, and Karnataka. According to the National Dairy Development Board, Punjab, and Haryana have the highest per capita availability of milk.

The National Family Health Survey (NFHS-5) shows that on average the southern women (>70%), consume more milk and curd than the northern states (Fig. 9). In India, on average, 48.8% of men and women consume milk and curd daily (NHFS-5- Survey).

FIG 9: CONSUMPTION PATTERN OF CURD BY STATE **SOURCE: NFHS 2023**

Milk accounts for a significant portion of total consumption in India, contributing approximately 37% of dairy products. Dairy products such as yoghurt, sweets, cheese, ice cream, infant formula, milk powder, cream, and chocolate together make up around 20% of overall consumption.

According to NDDB Report (2019), the households consume mostly loose milk comprised of milk from their own milch animal (72%). Another 25% of households consume branded milk (pouches/ bottles/cartons).

The market size for fresh packaged dairy products in India was 10.65 billion euros in 2020 and is expected to increase to 18 billion euros by 2025. The packaged fresh milk category is projected to grow at a 3.4% CAGR from 2021 to 2026. Rajasthan, Himachal Pradesh, and Uttar Pradesh have the highest dependency on household milk from their own milch animals.

The study also observed that product share in total household consumption is milk 37%, curd (yoghurt) 13%, tea and coffee 10%, ghee 8%, buttermilk 4%, butter 3%, lassi (Sweet Butter Milk) 2%, paneer 3%, other milk products 20%.

Dietary preferences and the hot climate are primary factors driving the high consumption of yoghurt in the southern states. This trend in milk and curd consumption suggests a significant opportunity for introducing yoghurt variants in the southern region of India

3.2 HERD SIZE

India holds the distinction of being the leading global milk producer and having the largest bovine population. The primary milk producers in India are predominantly small and marginal farmers, with 97 % of them maintaining an average herd size of two (Table 3). According to the Organization for Economic Cooperation and Development- Food and Agriculture Organization (OECD-FAO) data 2021, there are over 75.4 million farms in India, and the bulk of them (97%) have two animals per household. Large farmers with over fifty cows make up just 1% of the population.

In large-scale farmers, few can achieve higher productivity through feed management and animal management, economies of scale, and investment capabilities leaving a scope for investment and training for higher returns.

Targeted efforts towards training and capacity building and organizing farmers through cooperatives and FPOs can maximize the impact for this segment.

Table 3. AVERAGE HERD SIZE OF DAIRY FARM FARMS IN INDIA

Herd size (cows per Farm)	% of farms	Number of farms (Mn)	Number of cattle (Mn)	Average cow milk yield (Lt/ Year)
2	97	73	146	700
8	2.6	2	16	1100
18	0.4	0.3	5	1500
50	0.07	0.05	3	2500
100	0.03	0.05	2	4000
Total	100	75	172	2365

Source: OECD-FAO 2021

3.3 FEED, ADDITIVES AND FODDER

3.3.1 FEED

The Indian animal feed market was valued at € 11.11 billion in 2023. The IMARC Group expects the market to reach € 21.08 billion by 2032, with a compound annual growth rate (CAGR) of 7.2% from 2024 to 2032. The cattle feed market accounts for 33% of the total animal feed market (Fig. 10) and is growing at a CAGR of 4.0% (Future Market Insights, 2024).

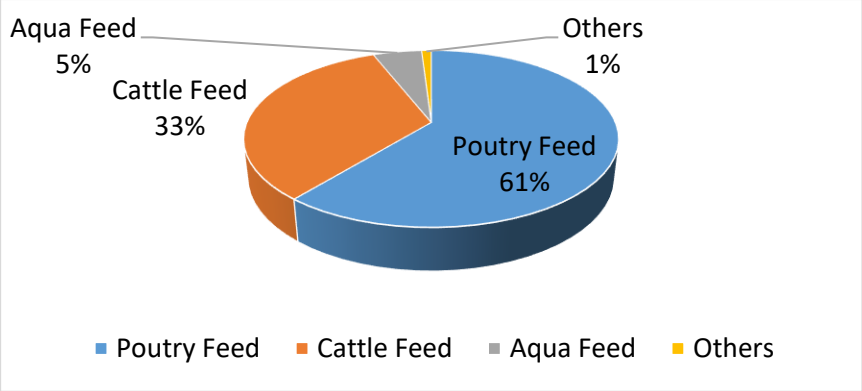


FIG 10: FEED SHARE BY SPECIES SOURCE: FMI REPORT 2024

According to the FMI Report, the concentrate feed segment is expected to account for a market share of 43.5% in 2024. Based on form, the pelleted cattle feed segment is expected to have a share of 33.9%. The concentrate Foods Segment will account for a high market share. The concentrate foods feed segment emerged as the dominant force in the cattle feed market, commanding 43.5% of the total market share in 2024.

The main cattle feed produced by the dairy cooperatives are BIS type-I, BIS type-II bypass protein feed, buffalo feed, calf starter pregnancy feed. Out of total cattle feed, BIS type-II feed occupies 82% of total production (Table 4). The cattle feed mainly comprises grains (such as sorghum and millet), groundnut, mustard, cotton oil cakes, de-oiled rice and soybean. Crude protein forms the main composition (~20%) of the feed followed by fiber (10-15%). The proportion of fat ranges from 2-4%.

Table 4. SPECIFICATIONS FOR COMPOUND FEEDS ON DRY MATTER BASIS SOURCE: NDDB

Characteristic	**Requirement**		
	Type 1	**Type 2**	**Type 3**
Crude protein (%), Min.	22	20	18
Crude fat (%), Min.	4	2.5	2
Crude fiber (%), Max.	10	12	15
Sand silica (%), Max.	3	4	5
Vitamin A (I.U./kg), Min.	7000	7000	7000
Vitamin D3 (I.U./kg), Min.	1200	1200	1200
Vitamin E (I.U./kg), Min.	30	30	30
Common salt (%), Max.	1	1	1
Calcium (%), Min.	0.8	0.8	0.8
Phosphorus (%), Min	0.5	0.5	0.5
Avl phosphorus (%), Min.	0.25	0.25	0.25
Aflatoxin B1 (ppb), Max.	50	50	50

3.3.2 ADDITIVES

According to Mordor Intelligence, the India Feed Additives Market size is estimated at 1.03 billion Euros in 2024 and is expected to reach 1.31 billion Euros (Fig. 11) by 2029, growing at a CAGR of

5.22% during the forecast period (2024-2029). Poultry is the largest animal segment due to the rising consumption demand for poultry products and the increasing poultry population by 27% during 2017-2022. Among the additives, the demand for antioxidants (CAGR 6.07%) is growing at the fastest rate due to the increasing consumption of meat and milk products and the shelf life of animal feed. In 2022, the Indian livestock feed industry witnessed strong demand for feed additives such as amino acids, binders, minerals, probiotics, and prebiotics and feed additives comprise 60.5% of the market's total value. Lysine and methionine emerged as the leading amino acids in the country, accounting for 72% of the total feed amino acids market in 2022.

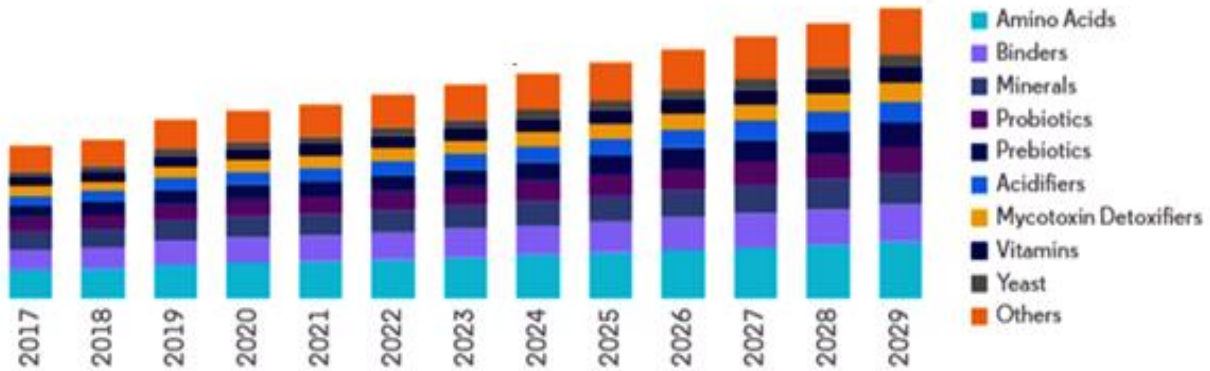


FIG 11. MAJOR FEED ADDITIVES SOURCE: MORDOR INTELLIGENCE

Synthetic binders dominate the market and account for 69.9% of the total binders' market in 2022. These binders have become an essential component in animal feed as they enhance digestion and nutrition intake, besides being used in pellet feed and illness prevention.

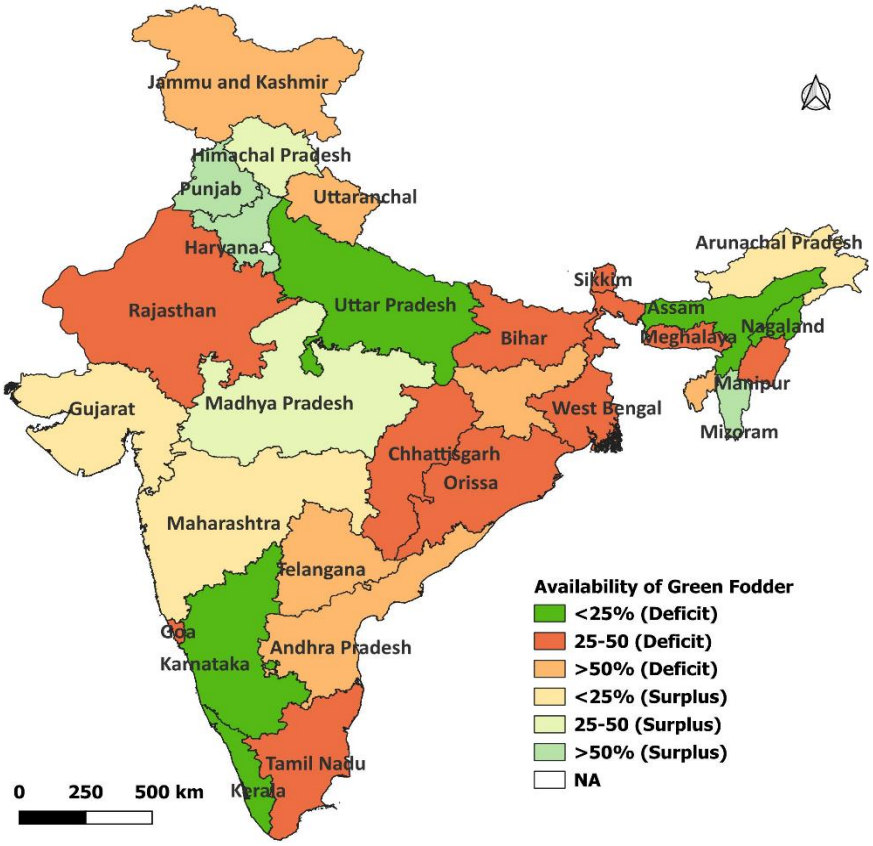
Antioxidants are projected to be the fastest growing segment in the Indian feed additives market, with a CAGR of 6.1% during the forecast period of 2023-2029. They are increasingly used to extend the life of animal feeds. Antibiotics, such as citric acid, are essential in minimizing pathogen colonization, lowering the formation of harmful metabolites, and enhancing the availability of protein, Ca, P, Mg, and Zn.

3.3.3 FODDER

Scientists and industry experts opine that breed purity and feeding systems determine milk production, body weight, fertility performance, hormone parameters, ovarian function, and survival. Green and dry fodder constitute a major source of feed for animals as they are cheap and affordable. However, there was a shortage (>50%) of green fodder in 6 states and dry fodder in 7 states (Fig. 12). And among the major states, Andhra Pradesh stands out as a major state where the shortage of green and dry fodder is acute. Hence there is a scope for forage crop expansion and productivity increment in Andhra Pradesh.

Developing a forage seed distribution network in selected states where dairy/animal husbandry is a major economic activity. The promotion of green, fruity silage is one of the best solutions as the dry matter content is up to 25-35%. Crops rich in soluble sugars/CHO are most suitable for ensiling

(maize, sorghum, pearl millet). Cultivated and natural grasses can be ensiled with the addition of 3-3.5% molasses. Machinery for threshing and baling of rainy season paddy has great market potential in India.



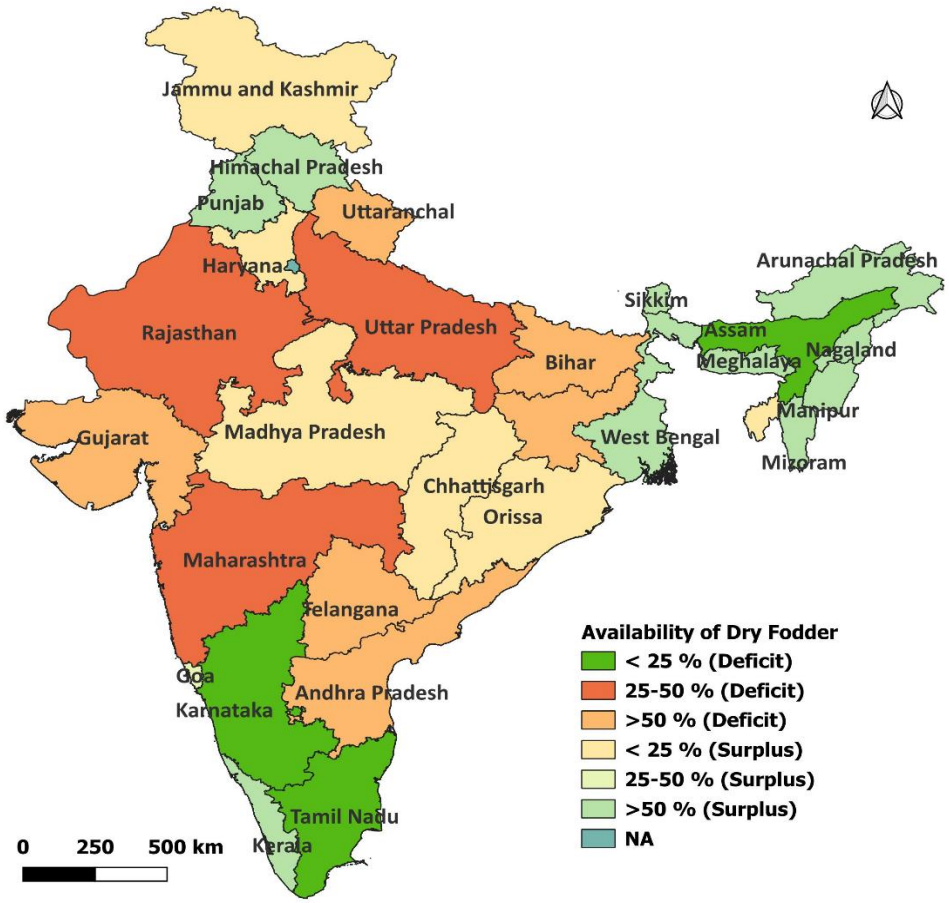


FIG 12: FODDER (GREEN AND DRY) AVAILABILITY BY STATE SOURCE: DAHD 2023

3.4 Genetic Improvement

According to NDDB to make dairying profitable, productivity (milk production per animal) needs to be increased. The productivity of dairy animals can be increased by:

- Improving genetic potential for milk production by using animals with high genetic potential for milk production as parents
- Better feeding and management of the existing animals.

Currently, there are three key methods for cross- breeding in India, namely, In-vitro Fertilization (IVF), Embryo Transfer (ET) systems, and Artificial Insemination (AI). Out of the three mentioned procedures, AI and IVF are the most prevalent.

India is the 2nd largest importer of bulls in the world and imports most of its bulls from the United States. Under National Dairy Plan Phase-I, high genetic merit bulls were imported from Germany and Denmark and were allotted to different semen stations nationally. About 28 semen stations were strengthened to produce disease-free semen doses.

India imports most of its frozen semen from France, United States and Canada. Recently in

January 2024, the National Dairy Development Board (NDDB), imported 40,000 doses of bull semen from Brazil to boost milk production via artificial insemination of Indian native breeds such as Gir, and Kankrej.

Nationwide Artificial Insemination Programme (NAIP) Phase-IV has been initiated from 1st August 2022 covering 33 million animals through Artificial Insemination (AI) in 604 districts with less than 50% Al coverage. AI coverage of bovines in the country is about 30 % ranging from 71 % to even less than 1 % for different states. That means 65 % of animals are still bred through natural services either because the services are not available at farmers' doorstep, or they are not convinced with the efficacy of the existing services. About 80 million inseminations are carried out in the country annually with an estimated overall conception rate of 35 % as against 60 % plus AI success rate in dairy-developed countries. This indicates that the benefits of AI can be doubled by improving the quality of AI services.

The major challenges in AI services area include:

- Limited availability of bulls with high genetic merit and high fertility
- Poor conception rates with AI
- AI is being carried out by untrained manpower
- Semen quality control tests

Sex Sorted Semen

According to the Grand View Report on India AI Market Size Share and Trends, the India bovine artificial insemination market size is estimated to be € 408.97 million in 2023 and is projected to grow at a CAGR of 8.94% from 2024 to 2030.

It is estimated that in 2023-2024, the government semen stations have produced over 4.95 million semen doses, and other channels like dairy cooperatives, NGOs, and private semen stations have produced over 4.97 million semen doses.

The semen segment is anticipated to grow at the fastest CAGR of 9.59% over the forecast period due to several factors. This segment consists of normal and sexed semen. The main driving factor for this segment is the rising use of sex-sorted semen in the country. The adoption of sex-sorted semen in the country was largely dependent on its import from other countries like Brazil. However, in recent years, the government, as well as private players, have taken the initiative to produce sex-sorted semen indigenously, with records from DAHD putting the total production by the government as well as private players in 2023-2024 at more than 8 million doses.

The productivity enhancement through breeding activity can be implemented in Punjab and UP for exotic breeds, Tamil Nadu, Karnataka, and Maharashtra for crossbreeds, and Uttar Pradesh (UP), Rajasthan, Bihar, Punjab for descriptive cattle.

Some of the common challenges in this sector include:

- Commercial availability of the sorting technology
- Lower sorting speed and efficiency
- Standardization in Indian conditions
- Low number of elite bulls-Progeny Testing
- Lack of skilled staff

Straws for frozen semen. At present the frozen semen doses are available in French Mini (0.25 ml) straws

Superior Breeds of Indigenous cattle and buffalo in India

The Government of India with the twin objectives of development and conservation is implementing

programs for genetic improvement of select indigenous dairy breeds (see table below). The future holds promise for improvement in the productivity of Indigenous breeds of cattle and buffaloes through AI, sex sorted semen, progeny testing and pedigree selection.

Some breeds are highly popular and can be seen in almost 19 states, while some are confined to a few states (Table 5). For e.g., Sahiwal:19 states, Gir -15 states, Harian - 14 states, Red Sindhi - 12 states, and Tharparkar- 10 states. Uttar Pradesh reported the highest diversity, with a total of 12 breeds. Rajasthan, Maharashtra, and Kerala each recorded 10 breeds, while Odisha and Punjab reported 9. Additionally, the census for Andhra Pradesh and Madhya Pradesh indicated the presence of 8 breeds in each state.

The presence of a large population of milch and dual-purpose breeds like Gir, Sahiwal, Hariana and Kankrej in many of the states revealed their importance for milk production. This provides an opportunity to preserve the genetic resources of indigenous breeds by identifying the superior bulls through breeding techniques like Pedigree Selection and Progeny Testing and for non-descriptive Indian breeds with crossbreeding methods.

Table 5. GENETICALLY SUPERIOR INDIGENOUS BREEDS OF INDIA Source: NDDB and DAHD

Cattle			Buffalo	
Breeding Tract	Breed	Main Uses	Breed	Main Uses
Andhra Pradesh	Ongole, Punganur	Milk and Draught		
Asam	Lakhimi	Milk and Draught	Luit (Swamp)	Milk and Draught
Assam	Red Sindhi	Milk		
Bihar	Purnea	Milk and Draught		
Bihar	Red Sindhi	Milk		
Bihar	Gangatiri	Milk and Draught		
Chattisgarh.			Chhattisgarhi	Milk and Meat
Gujarat	Gir	Milk	Mehsana, Banni	Milk
Gujarat	Kankrej, Tharparkar, Nari	Milk and Draught	Jaffarabadi, Surti	Milk and Draught
Haryana	Hariana,Belahi	Milk and Draught	Murrah	Milk
Himachal Pradesh	Himachali Pahari	Milk and Draught	Gojri	Milk and Draught
Karnataka	Deoni	Milk and Draught		
Kerala	Red Sindhi	Milk		
Kerala	Vechur	Milk and Manure		
Madhya Pradesh			Bhadawari	Milk and Draught
Maharashtra	Deoni	Milk and Draught	Marathwadi, Nagpuri	Milk and Draught
Maharashtra			Pandharpuri	Milk
Odisha	Binjharpuri	Milk and Draught	Kalahandi, Chilika	Milk and Draught
Odisha	Red Sindhi	Milk		
Punjab	Sahiwal	Milk	Gojri	Milk and Draught
Punjab			Nili Ravi	Milk
Rajasthan	Kankrej, Nari	Milk and Draught		
Rajasthan	Sahiwal, Rathi	Milk		
Rajasthan	Tharparkar	Milk and Draught		
Tamilnadu	Red Sindhi	Milk	Bargur	Milk and Manure
Telangana	Poda Thirupu	Milk and Draught		

The National bull-stations house bulls of exotic cattle breeds (Holstein-Friesian and Jersey), cross-bred (Holstein Friesian and Jersey crosses), Indigenous breeds (Ongole, Amritmahal, Hallikar, Sahiwal, Gir, Dangi, Khillar, Tharparkar, Krishna Valley, Gangatiri, Red Kandhari, Nimari, Red Sindhi etc.) and buffalo breeds (Murrah, Surti, Jaffarabadi, Bhadavari, Banni, Pandharpuri, Nagpuri,

Mehsana etc.). These are the breeds to target for Pedigree selection, Progeny Testing and AI program in India. For Indigenous buffalo such as Murrah, states like UP, Bihar, Haryana are ideal.

3.5 CATTLE HEALTH

Cattle are a valuable resource for the agricultural industry, but they are exposed to a variety of diseases that can affect their health and productivity. India's bovine dairy cattle and water buffalo herds remain exposed to various animal diseases. Animal diseases pose a significant threat to the livestock sector throughout the world, both from the standpoint of the economic impacts of diseases themselves and the measures taken to mitigate the risk of disease introduction or spread. Major Disease in India are,

- Mastitis is an inflammation of the udder that reduces milk production and can affect food hygiene. Mastitis is responsible for nearly 70% of milk loss. Economic losses due to mastitis in India were estimated to be around € 879.74million. In one of the other studies conducted in India, in buffaloes, there was 32.9% prevalence of subclinical mastitis. The prevalence estimates for Subclinical Mastitis (SCM) and Clinical Mastitis (CM) were 45% and 18% in India.

- Foot and Mouth Disease: Foot-and-mouth disease (FMD) is one of the most important transboundary animal diseases affecting livestock and wildlife species worldwide. The crossbred and highly productive animals were more severely infected than local breeds and the sex-wise and age-wise comparison revealed higher incidence in females and adult animals. The prevalence of FMD is estimated to be 21% and the projected farm level economic loss € 2,860 million.

- Brucellosis: Bovine brucellosis is widespread all over the Indian subcontinent. The prevalence of brucellosis is estimated to be 17% and the economic losses ranged between, € 205 Mn Euros, to € 340.20 Mn Euros.

The other diseases that affect the cattle and buffalo population are

- Bluetongue (28% prevalence)
- Botulism
- Bovine Viral Diarrhoea (BVD)
- Epizootic haemorrhagic disease
- Tuberculosis
- Lumpy skin disease
- Broadly, species of arthropods infesting livestock are grouped into flies (biting and non-biting), fleas, lice (biting and sucking), ticks (soft and hard), and mites (burrowing, non-burrowing, and follicular). Among five major groups of ectoparasites, biting and non-biting flies and ticks are the potent vectors for many bacterial, viral, rickettsial, and protozoan diseases.

- The cumulative milk loss and treatment cost for tick infestation was calculated as € 497.98 million while loss due to Tick-Borne Diseases (TBDs) amounted to €160.36 million

The data provided baseline information for the industries and government to develop strategies to minimize economic losses. The government of India also focuses a lot on immunizing large animals-cattle, buffalo, sheep, and goat. In the coming years, the national immunization program for Brucella, PPR (Peste des Petits Ruminants) and FMD (The foot-and-mouth disease) offer a huge potential for vaccines.

3.6 Climate Change and GHG Emissions

3.6.1 Climate change

Indigenous animals are sturdy, and are endowed with the quality of heat tolerance, resistance to diseases, and ability to thrive under extreme climatic conditions. The anticipated rise in temperature between 2.3 and 4.8 °C over the entire country together with increased precipitation resulting from climate change is likely to aggravate the heat stress in dairy animals, particularly in hybrid animals, adversely affecting their productive and reproductive performance.

In 2022, a Lancet Report[1] estimated that increasing temperatures could reduce milk production in India's arid and semi-arid regions by 25% by 2085. The decrease in conception rates during summer seasons can range between 20 and 30%, as per the study. The major losses due to heat stress are decreased feed intake, quality of milk, and reproduction rate (Fig. 13).

[1] *Thornton, Philip et al. 2022, Impacts of heat stress on global cattle production during the 21st century: a modelling study, The Lancet Planetary Health, Volume 6, Issue 3, e192 - e201*

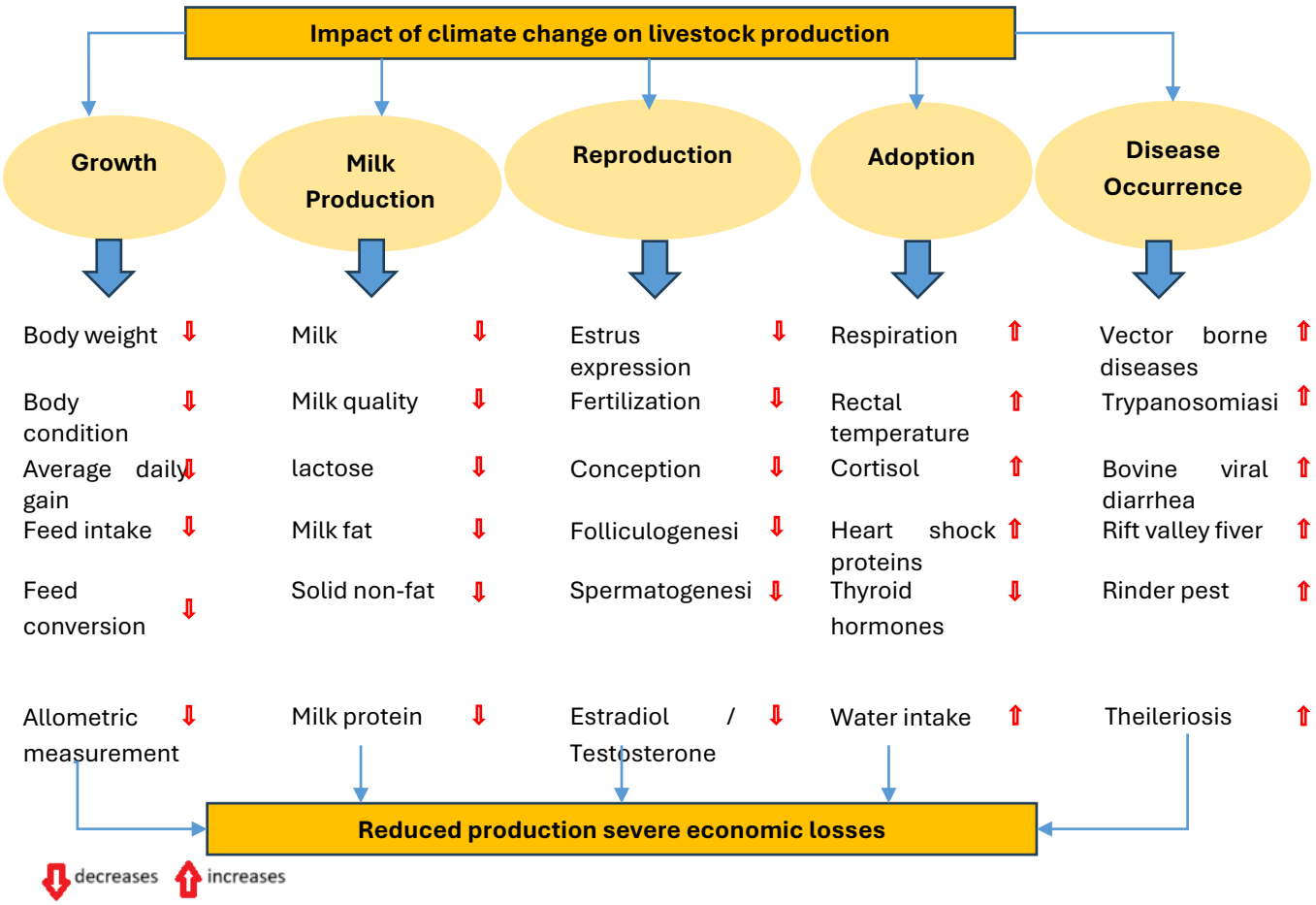


FIG 13: IMPACT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION SOURCE: SABURT, IUBAT, 2024

3.6.2 GHG EMISSIONS

Cattle produce 14.5 %of global greenhouse gas emissions. The majority of that is in the form of methane, a potent greenhouse gas that is a natural byproduct of how some livestock process food. Cattle are the No. 1 agricultural source of greenhouse gases worldwide. Each year, a single cow will belch about 99.8 kg of methane.

The cattle population comprises of cross-bred cattle, Indigenous cattle and buffaloes. The figure 14 shows emissions from these three categories of the cattle population. The emissions estimated between the years 1992 and 2018 showed that indigenous cattle and buffaloes were the main drivers of methane emissions from the livestock sub-sector.

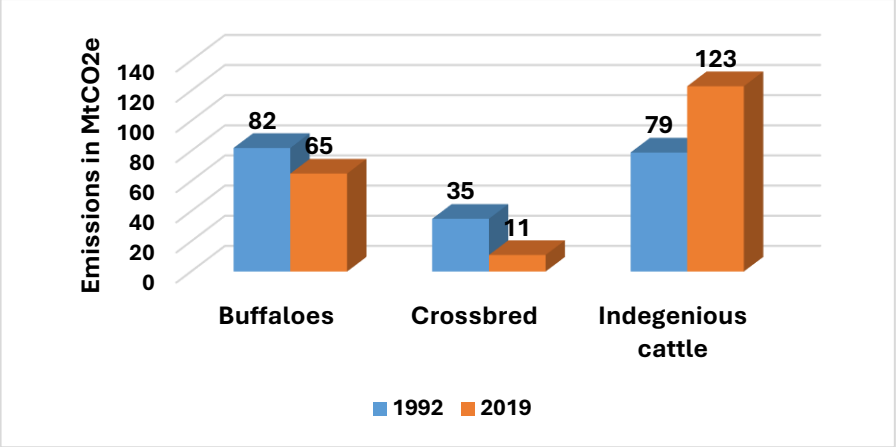


FIG 14. ESTIMATED EMISSIONS FROM CATTLE AND BUFFLOES SOURCE: VASUDHA FOUNDATION

GHG emissions from the livestock sub-sector include emissions due to enteric fermentation in herbivores and manure management practices. The top five highest emitting states (Fig. 15)[1] due to both enteric and manure activities are Uttar Pradesh (2550.92 Gg yr–1) followed by Rajasthan (1342.44 Gg yr–1), Madhya Pradesh (1187.84 Gg yr–1), Bihar (998.63 Gg yr–1), Maharashtra (861.38 Gg yr–1), Gujarat 797.42 (Gg yr–1), and West Bengal (707.25 Gg yr–1). India's NDC target is to reduce its GHG emissions intensity by 45% by 2030. The livestock sub-sector contributes to a significant amount of emissions. Technical and financial support can help farmers and pastoralists take advantage of the environmental and economic benefits of livestock rearing

1 Anuja Samal et al 2024 Assessment and Quantification of Methane Emission from Indian Livestock and Manure Management

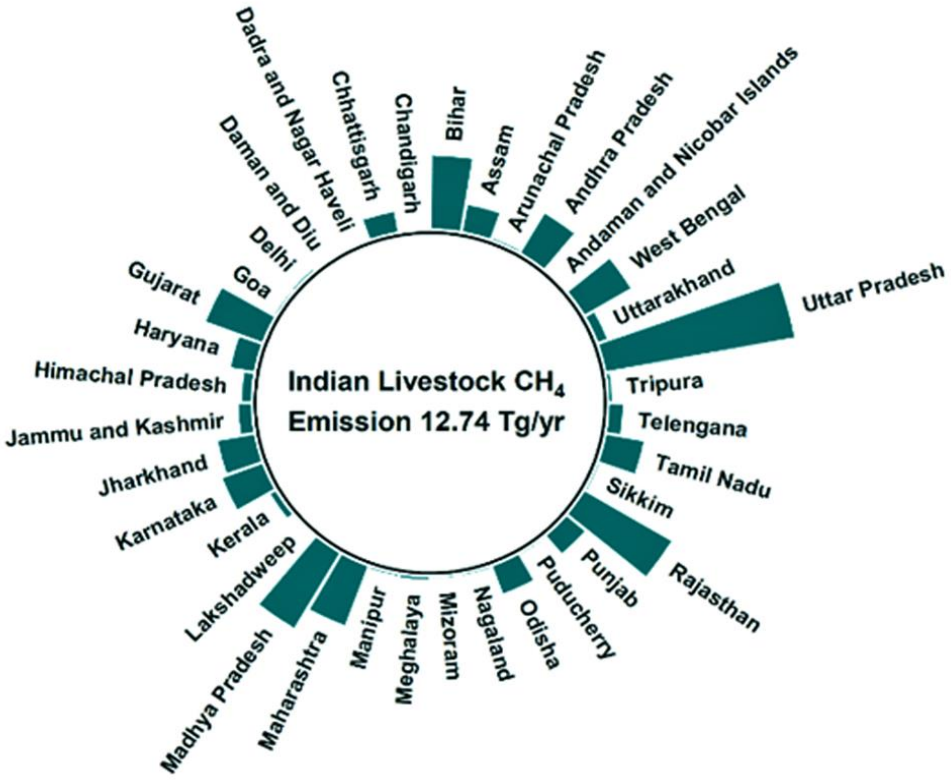


FIG 15. STATE-WISE METHANE EMISSIONS FROM LIVESTOCK SECTOR SOURCE: SAMAL ANUJA 2024

Potentially suitable strategies for the Indian context include

Feeding balanced rations to animals can also reduce enteric methane emissions (Table 6). Assuming that in pursuit of all these strategies, even if 25% of emissions reduction is achieved, India could reduce 55.44 million tons of CO2 emissions of methane in 2030

- Tannins – adding plants containing condensed tannins has been shown to effectively reduce methane emissions from cattle by 13-16%
- Fats and oils – including fats and oils in diet can reduce methane yields by up to 40% depending on the dosage
- Chemical inhibitors – can help improve energy efficiency in cattle and can potentially reduce GHG emissions by up to 91%
- Ionophores – including ionophores in the diet improves energy efficiency and lowers the risk of rumen bloat while reducing GHG emissions between 5 to 30 %

Table 6. POTENTIAL METHANE REDUCTION STRATEGIES FROM LIVESTOCK

Feed additive	**Mode of action**
3-nitrooxypropanol (3-NOP).	Methane Inhibitor
Red Seaweed	Methane Inhibitor
Ionophores	Rumen Fermentation modifiers
Tannins	Rumen Fermentation modifiers
Essential oils	Rumen Fermentation modifiers

Source: Alison P Pfau

KEY INSIGHTS

- India is the world's number one in cattle and buffalo population and production but ranks low in productivity compared to many developing countries
- Feed production is 7.33 Mn MT and requirement is 67 Mn MT projecting huge investment opportunities
- Six states are under severe (>50%) green fodder shortage and 7 states are facing dry fodder shortage indicating the need for alternative approaches

Genetic Improvement

- Improving genetic potential for milk production in future generations of animals by using animals with high genetic potential for milk production as parents
- 65 % of cattle and buffalo are still bred through natural services. The targeted 70% coverage by artificial insemination by GoI requires the production of around 200 million frozen semen doses. This requires the establishment of new frozen semen stations and also an enhancement in the production potential of existing semen stations
- The use of sex-sorted semen will be a game changer not only for enhancing milk production but also for limiting the stray cattle population (a major issue in UP, MP, and Bihar). Indian organizations were able to produce 2 million frozen semen against the target of 3 million indicating the gap and need

To make dairying profitable, milk production per animal needs to be increased. The productivity of dairy animals can be increased by better feeding and management of the existing animals. However, by this, milk production cannot be increased beyond the animal's genetic potential. So, pedigree selection and progeny testing has huge potential in India.

Animal Health

- Prevalence of various livestock diseases in India are foot-and-mouth disease (21%), bluetongue (28%), brucellosis (17%) in cattle and buffalo
- Mastitis is responsible for nearly 70% of milk loss. Economic losses due to mastitis in India were estimated to be around € 879.74million. The prevalence estimates for SCM and CM were 45% and 18% in India
- The projected farm-level economic loss due to FMD in cattle and buffaloes in India was € 2,860 million
- Brucellosis: Bovine brucellosis is widespread all over the Indian subcontinent. The economic losses in due to Brucellosis range between € 205 Mn Euros to € 340.20 Mn Euros.
- The revenue losses due to various health hazards indicate the emergency steps for proper health management in cattle and buffalo.

Climate Change and GHG Emissions

- In the context of climate change, heat stress and nutritional stress are the main factors that negatively impact dairy cattle's ability to reproduce. To help their calves avoid heat stress, Indian dairy farmers typically use fans, cooling devices, and sprinklers. Any cutting-edge technology in the Indian market has enormous potential.
- GHG emissions are directly proportional to population size. The states like UP, Rajasthan and MP are the major contributors of GHG emissions from cattle population in the country. The emissions can be reduced by proper feed management and feed additives.

CHAPTER IV: Indian Dairy Processing & Downstream Market

4.1 COOPERATIVES AND PRIVATE COMPANIES IN THE DAIRY SECTOR

Currently, India's dairy industry is highly unorganized, unlike the developed economies where 40% of marketed fluid milk is handled through the organized sector. Even within the organized sector in India, about 60% of surplus milk is handled by the co-operatives (Fig. 16), while the private sector procures the remaining 40%. The milk cooperatives and milk producer companies (MPCs) are government, producer-owned institutions.

Presently, there are 228 dairy cooperative milk unions in India covering nearly 17.26 million farmers collectively comprising 196,000 village level dairy corporative societies. During the year 2022-23, dairy cooperatives procured an average of 58.9 million Kg of milk per day and marketed an average of 42.7 million Litres per day (LLPD) (NDDB, 2023; DAHD, 2023).

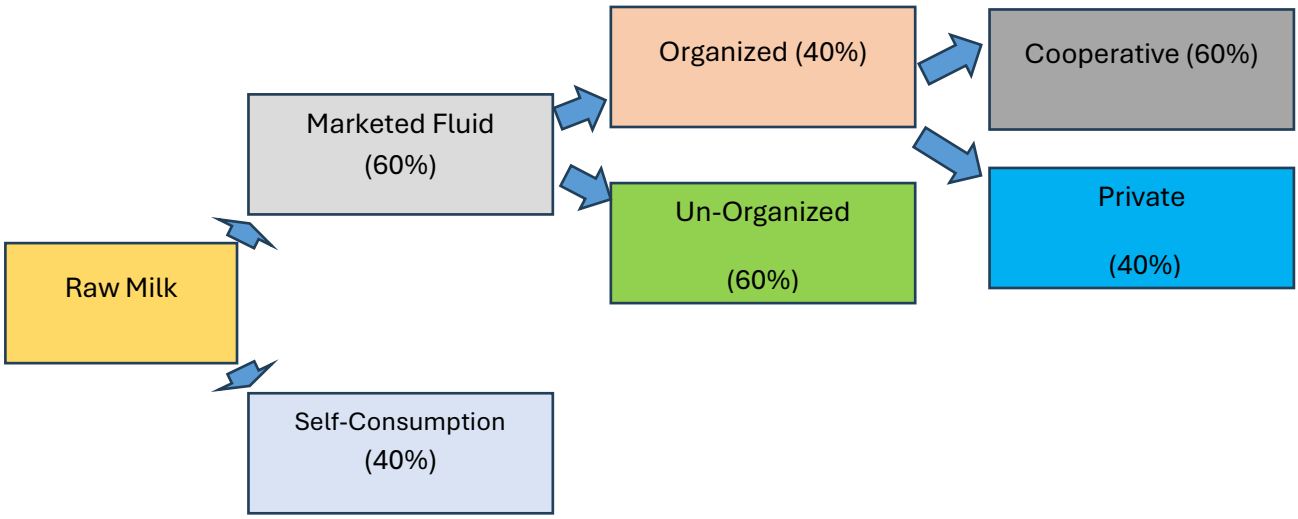


FIG 16: SHARE OF ORGANIZATIONS IN GROSS SALE VALUE OF DAIRY PRODUCTS IN 2022 SOURCE: NDDB

As per the Annual Survey of Industries (ASI, 2022), cooperative societies (58 %) had the major share in the gross sale value of dairy products in India (Fig. 17) followed by non-government companies private (26 percent), non-government companies-public (12%), partnership (3 percent) and individual proprietorship (1 percent). The lowest shares in the gross sale value were of individual proprietorship (0.58%), limited liability partnerships (0.14 percent), government companies– public (0.13%), government companies– private (~0%), and others (0.16 percent).

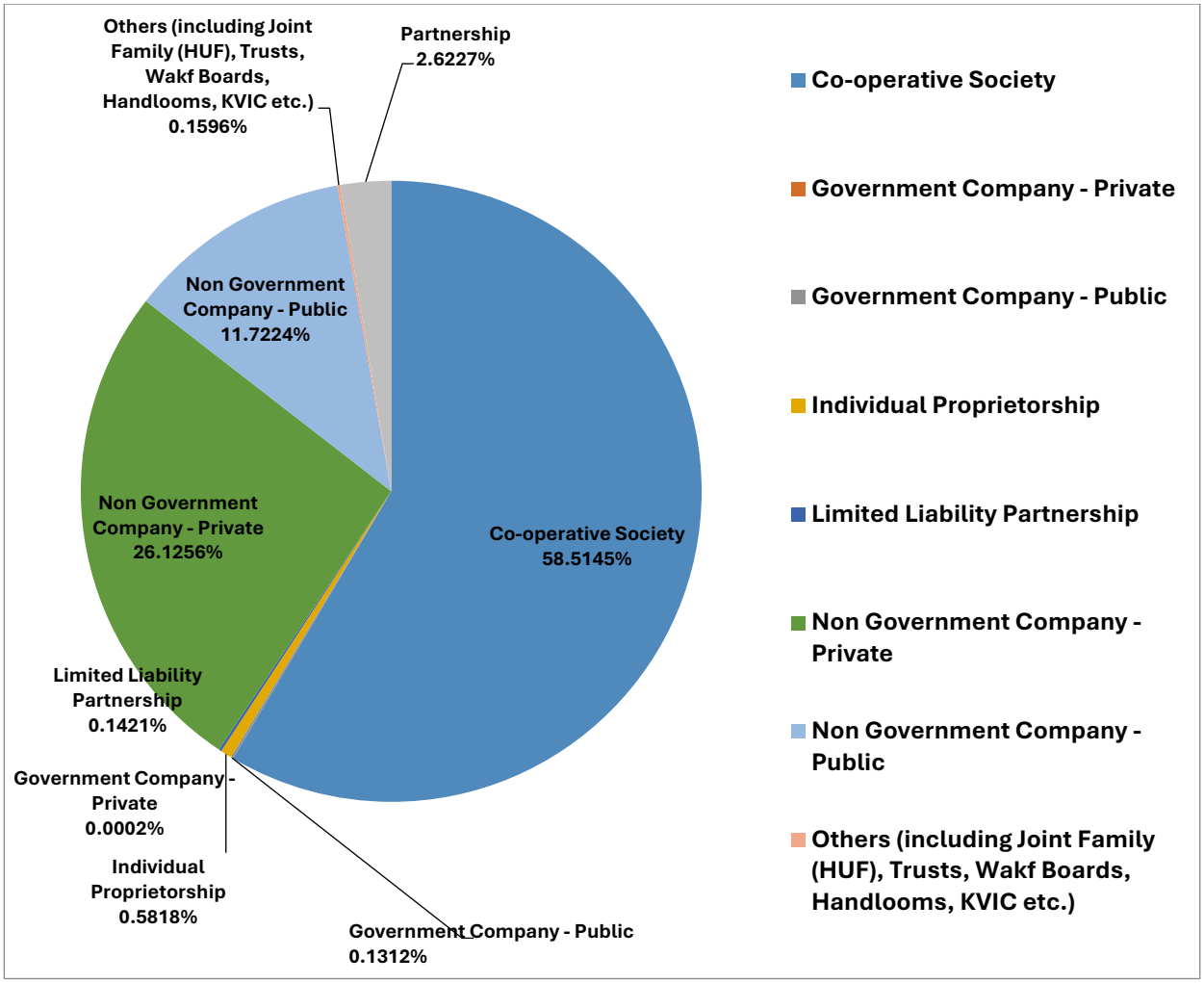


FIG 17: MARKET SHARE OF DAIRY BY SEGMENT SOURCE: ASI 2022

The key players in the Indian dairy market in 2023 were Gujarat Co-operative Milk Marketing Federation Ltd. (GCMMF), Karnataka Cooperative Milk Producers Federation Ltd. (KMF), National Dairy Development Board (NDDB) and Tamil Nadu Cooperative Milk Producers Federation Ltd (TCMPF) with the shares of 19 %, 8 %, 4 % and 4 % respectively (Fig. 18). The major private players in the market were Hatsun Agro Products Ltd. (2 %), Nestle SA (2 %), Lactalis Groupe (2 %) and Heritage Foods Ltd. (1 %). To focus on the companies with <=10% share in the market for technology transfer and training which helps them to compete in the market and improve market share.

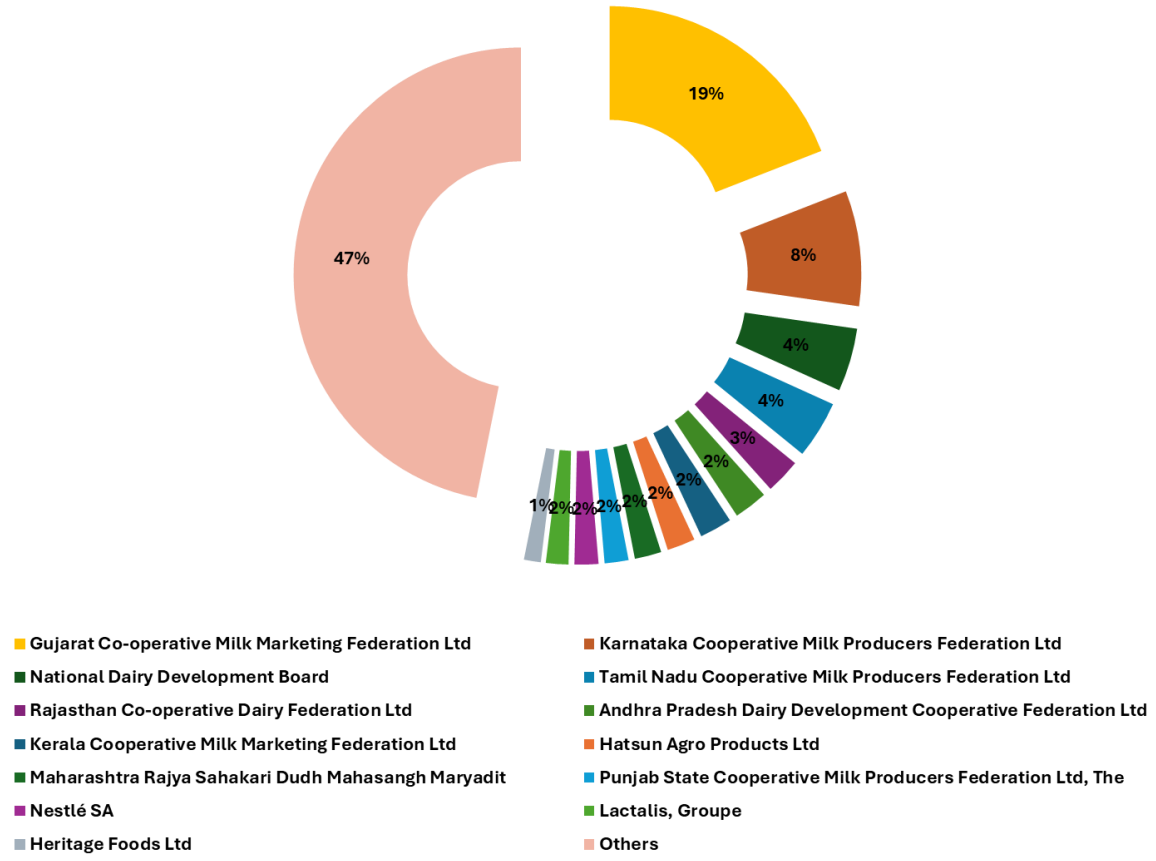


FIG 18: MARKET SHARE OF DAIRY BY PUBLIC AND PRIVATE PLAYERS SOURCE: ASI 2022

4.2 MARKET SIZE OF THE INDUSTRY BY PRODUCT – QUANTITY

There is a stark difference between the volume and variety of processed products produced from milk in developing and developed countries. According to the Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization's report (FAO), in developed countries, most of the milk production is processed into butter, cheese, skimmed milk powder and whole milk products. It is forecasted that the global production shares of developed countries for butter and whole milk products will decrease slightly in 2026. In terms of milk solid basis, developed countries will increase milk production by 10% - of which 37% of that increase will go to cheese production, around 23% to skimmed milk powder, 20% to butter, 10.5% to whole milk products and 8.5% to fresh dairy products. In developing countries, of the 33% increase in milk production in 2026, 85% will go to the production of fresh dairy products, 7% to butter, 4% to whole milk products, 3% to cheese and 0.6% to skimmed milk powder.

In 2022, the product with the highest ex-factory value manufactured (Fig. 19) was processed liquid milk (€ 2496 Mn Euro). The other products with high ex-factory value included milk (€ 2,496 Mn Euro), toned milk (€ 2,347 Mn euros) and full cream milk (€ 1,417 Mn Euros).

Product	Unit	Quality	Ex-factory value in Million Euros
Milk	Tonne	4.92	2496
Toned milk	K Litres	4.68	2347
Full cream milk	K Litres	2.5	1417
Skim milk and whey powder	Tonne	0.43	1228
Fat free/low-fat(skimmed)milk	K Litres	1.68	848
Milk and cream	Tonne	0.08	142
Condensed milk	Kg	51.18	58
Cream	Tonne	0.01	19
Cream, fresh	Kg	0.81	8
Evaporated milk	Kg	2.83	2
Raw milk of buffalo	Kg	0.02	0.1
Other processed liquid milk	K Litres	7.98	4006

FIG 19: MARKET VALUE OF MILK PRODUCTS SOURCE: CMIE 2022

Ghee produced from buffalo milk highest market size (0.26 Tonne) compared to other fats in Indian market

FIG 20: MARKET VALUE OF MILK FATS IN INDIA SOURCE CMIE 2022

Product	Quantity (Tonne)	Ex-factory value in Million Euros
Ghee (clarified butter) of buffalo milk	0.26	1188
Ghee of cow milk	0.12	567
Butter of buffalo milk	0.1	330
Cheese from milk of cattle, fresh of processed	0.1	315
Butter and other fats and oils derived from other milk	0.09	298
Butter of cow milk	0.08	282
Cheese, fresh or processed	0.03	154
Cheese from milk of buffalo, fresh of processed	0.04	100
Other fats derived from cow milk	0.01	10
Other fats derived from buffalo milk	0.00	4

4.4 Product-wise margins

4.4.1 Processed Milk

Milk is sold in two formats – pouch and tetrapak. With a procurement price of €0.27, pouch milk retails at € 0.44 a litre and tetra pack at €0.64 per litre. Trade margins, including promotions, range between 15% and 20% for pouch milk and over 20-25% for tetra pack milk. Packaging material is higher in tetrapak milk, at ~€0.09 per litre and in pouch milk, it is likely €0.016 per litre. EBITDA (Earnings before Interest, Taxes, Depreciation, and Amortization) margin of~5.8% for pouch milk and ~9.4% for liquid milk. Return ratios are similar, at ~20%.

4.4.2 Curd

Cup curd is sold at 2.5 times the price of pouch curd on a per-litre basis. The input-output ratio is 1:1, i.e. 1 kg of milk is required for 1 kg of curd. Pouch curd, however, retails at €0.64 vs. pouch milk at €0.43. Cup curd, on the other hand, retails at €1.33 (€0.27 for 200 grams). The packaging material cost for pouch curd would be like that for pouch milk, at €0.016.

4.4.3 Yoghurt

With a more premium positioning, flavoured yoghurt commands a higher price (vs. Mishti Doi), at € 0.21 for 80 grams. Trade margins are higher due to the product being relatively new to consumers, and raw material costs are also higher due to the presence of fruit concentrate.

However, margins are more than offset by the higher MRP, resulting in 20% EBITDA margin and ~40% ROIC (Return on Invested Capital).

4.4.3 Cheese

Most cheese in India has a fat content of ~260 grams and a protein content of ~220 grams per kg. Given that cow's milk has a fat content of ~35 grams per kg of milk, 7.4 litres of milk would yield 260 grams of fat, which is needed to produce one kg of cheese. Similarly, a kg of cow's milk has ~32 grams of protein and, hence, 8.6 litres of milk would yield ~270 grams of protein, of which ~80% or 220 grams is casein, which goes into a kg of cheese (the remaining 20%, which is whey protein, is not an ingredient of cheese in any material quantity).EBITDA margins in cheese can be healthy, in the mid-to-high 20% range for the B2C segment. If working capital is kept reasonable (150 days) and capacity is fully utilized (3.5x asset turnover for cheese + whey), then return ratios in this range are possible.

KEY INSIGHTS

There is a growing demand for safe, nutritious, health-promoting milk products calling for value addition, product diversification, and complete quality assurance. Several products, especially cheese, yoghurt, and flavoured Ultra-High Temperature processing (UHT)milk are growing faster than other products.

Industry experts opine that there is a growing demand for ghee, and Italian cheese in the Indian market due to changing food habits. Cheese also has export demand in Middle Eastern countries.

- The products that have immense potential in the dairy market are lactose-free milk and drinks, recombined/fortified milk, concentrated and condensed milk, high- quality A2 milk, skimmed milk powder, whey proteins, baby foods, and maternity foods.
- Efficient whey recovery during cheese processing is also a need of the industry.
- Marketing initiatives highlighting the nutritional benefits, convenience, and versatility of dairy products can stimulate consumer interest and drive demand.

4.5 FUTURE PROJECTIONS

The projections for different product segments in the dairy sector of India until mid of the next decade (2035) is addressed in this section. The projections were made using the historical unitlevel data published by the Annual Survey of India (ASI, India). Using Unit-level data from ASI between 2010 and 2019, projections have been made till 2035. Due to differences in the scale of measurements of the various product segments, projections for the value of the sales, which is a proxy of the market value, were made.

Projections were made using econometric models for time series. The projections were made using two alternate time series models namely Auto Regressive Moving Average model (ARIMA) and simple time series linear models. These are widely used models for making forecasts. The projections from the model of best fit were selected based on standard metrics of model selection between the two models for each of the states. To ensure ease of comprehension the exhaustive list of items available at the unit level was aggregated into broad categories (Table 7) the details of which are furnished in the table below:

Table 7. DETAILS OF AGGREGATION OF DAIRY PRODUCTS BASED ON PRODUCT SEGMENTS

Category	**Items**
Milk and cream products	Milk cream concentrated, sweeteners, cream fresh, milk cream in solid form, processed liquid milk
Butter &Cheese	Butter and other fat oils, cheese fresh or processed
Ice cream	Ice cream & other edible ice cream
Yoghurt	Yoghurt and other fermented acidified, casein
Whey	Whey products
Others	Dairy products n.e.c

4.5.1 MILK AND CREAM

The below heat map depicts the projected value of sales of milk and cream products in the different states of India. It reveals that the total market value of milk and cream in India is projected to be 1,831 million € by 2025 and reach 28,069 million € by 2035. Projections suggest that among the states, Gujarat is the largest consumer base for milk and cream in the country followed by Maharashtra, Tamil Nadu, Uttar Pradesh, and Karnataka. Milk could possibly be the major source of protein consumption from dairy products as the consumption of other protein sources from dairy products (eggs and meat) is reported to be low in these states. Besides, the per capita consumption of milk in these states has been historically higher relative to the national average.

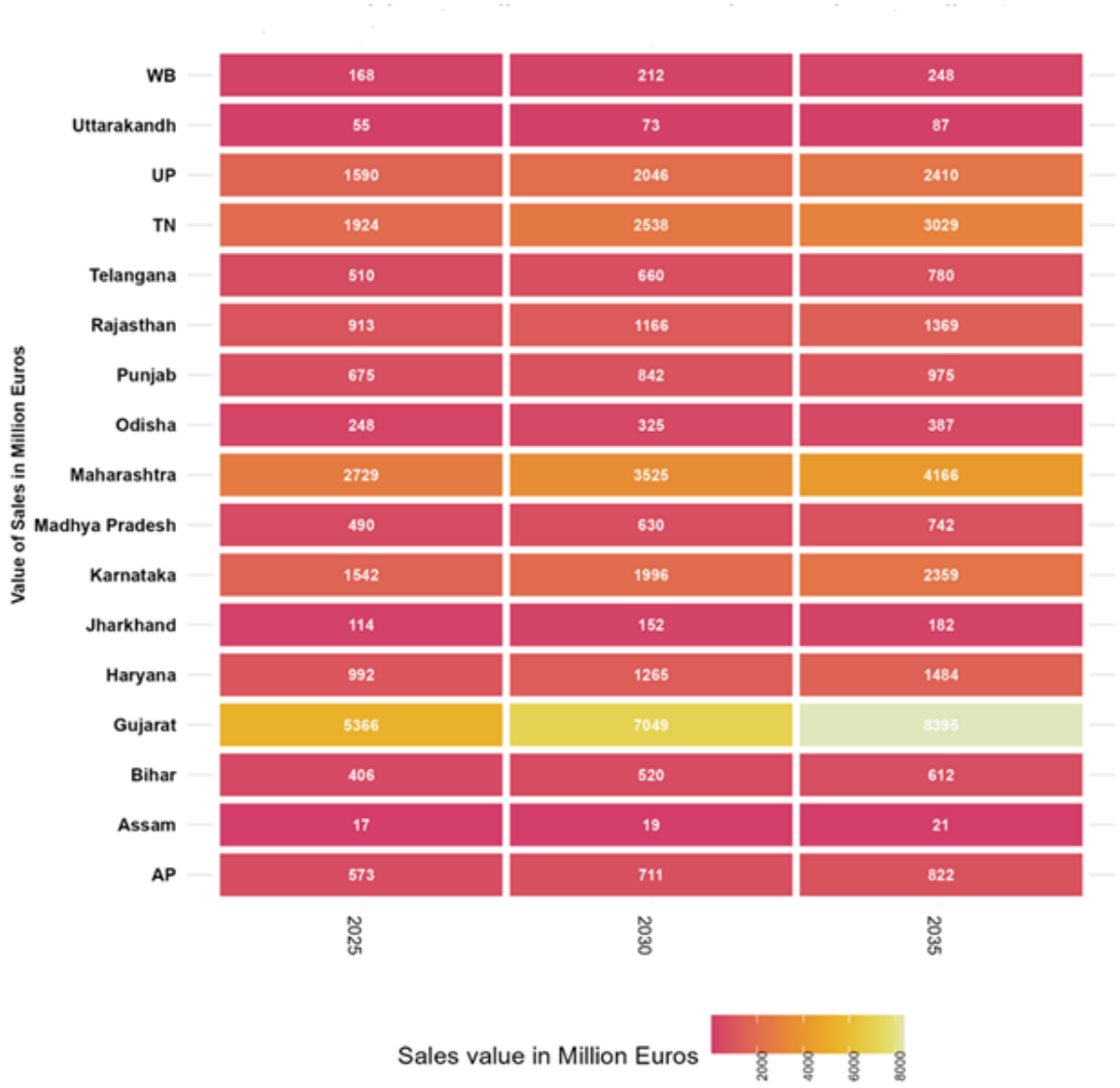


FIG 21: PROJECTED VALUE OF MILK AND CREAM IN INDIA SOURCE: ASI AND AUTHORS CALCULATION

4.5.2 BUTTER AND CHEESE

The below heat map depicts the projected value of sales of butter and cheese in the different states of India. It reveals that the total market value of butter and cheese in India is projected to be 4,115 million € by 2025 and reach approximately 6,327 million € by 2035. Projections suggest that among the states, Gujarat is the largest consumer base for butter and cheese in the country followed by Uttar Pradesh, Maharashtra, Tamil Nadu, and Punjab.

FIG 22: PROJECTED VALUE OF BUTTER IN INDIA SOURCE: ASI AND AUTHORS CALCULATION

4.5.3 ICE CREAM

The below heat map depicts the projected value of sales of ice cream and related products in the different states of India. It can be inferred that the total market value of ice cream in India is projected to be 1,335 million € by 2025 and reach approximately 1,776 million € by 2035. Projections suggest that among the states, Maharashtra has the largest consumer base for ice cream in the country followed by Karnataka, Madhya Pradesh, West Bengal, and Uttar Pradesh.

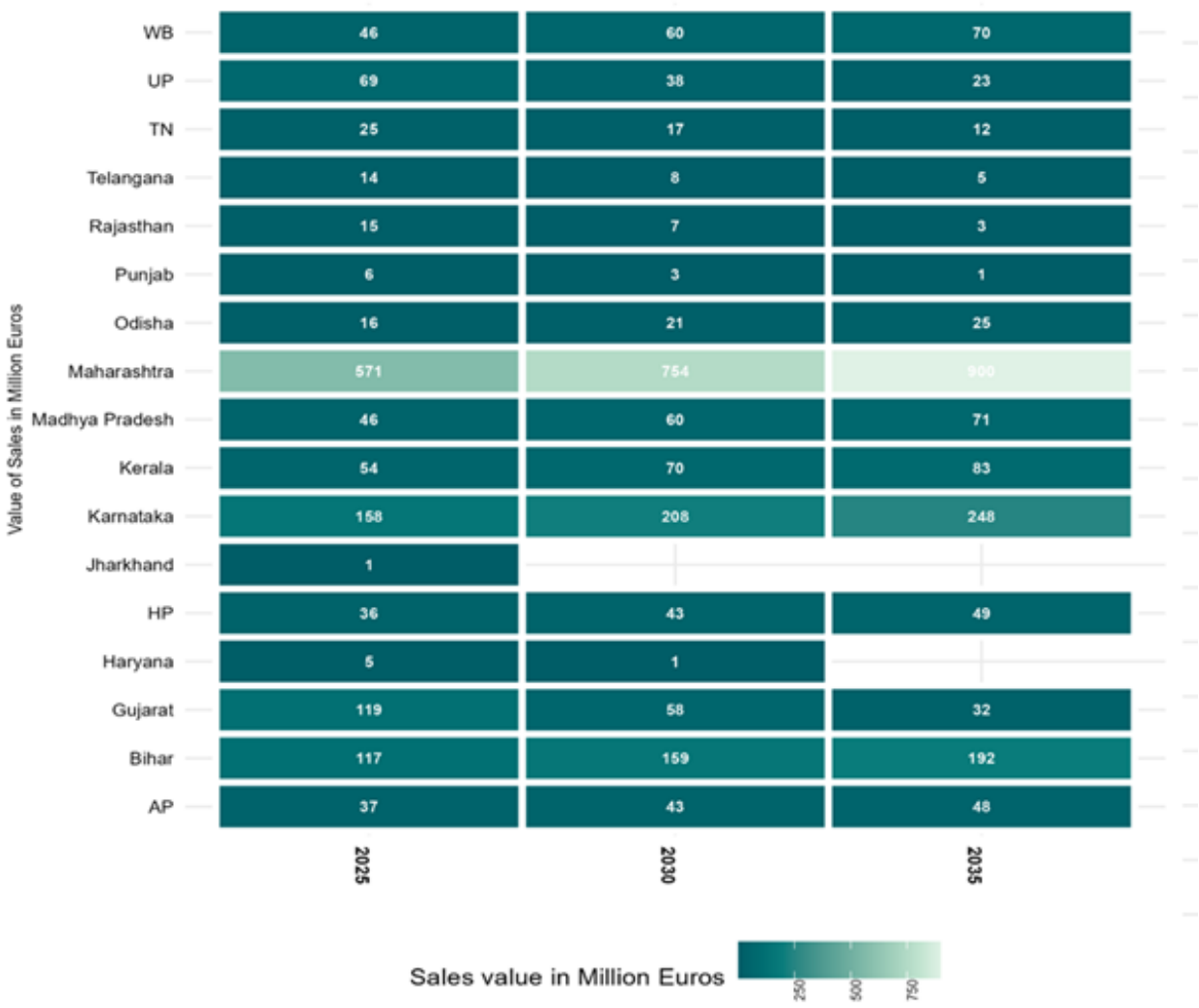


FIG 23: PROJECTED VALUE OF ICE CREAM IN INDIA SOURCE: ASI AND AUTHORS CALCULATION

4.5.4 YOGHURT

The below heat map depicts the projected value of sales of yoghurt in the different states of India. It shows that the total market value of yoghurt in India is projected to be 1,263 million € by 2025 and reach 2,121 million € by 2035. Projections suggest that among the states, Gujarat the largest consumer base for yoghurt in the country followed by Andhra Pradesh, Tamil Nadu, West Bengal, and Uttar Pradesh.

FIG 24: PROJECTED VALUE OF YOGHURT IN INDIA SOURCE: ASI AND AUTHORS CALCULATION

4.5.5 WHEY

Whey and associated high-energy products have made headways in the Indian market recently and therefore the market for this product segment is still in its very nascent stages and is limited to a few Indian states. Based on historical data Uttar Pradesh so far has the largest customer base for Whey products.

4.5.5 DAIRY SALES PROJECTION BY STATE

The projected values of sales in states of India was given in Table 8. By 2035 the dairy sales will be highest in Gujarat (11997 mill Euros) followed by Maharashtra, Uttar Pradesh, Tamil Nadu and Karnataka. Overall all India dairy sales will reach 41344 mill Euros by 2035

Table 8. PROJECTED VALUE OF SALES OF DAIRY PRODUCTS IN INDIAN STATES IN (MILL EUROS)

State	Year		
	2025	2030	2035
Gujarat	7520	10007	11997
Maharashtra	3769	4932	5863
Uttar Pradesh	2686	3496	4143
Tamil Nadu	2474	3288	3940
Karnataka	2057	2699	3213
Haryana	1605	2090	2478
Rajasthan	1207	1562	1846
Punjab	1066	1377	1626
Andhra Pradesh	871	118	1316
Madhya Pradesh	779	1013	1199
Telangana	744	995	1196
Kerala	634	839	1003
Odisha	300	399	478
Uttarakhand	226	307	372
West Bengal	243	312	368
Jharkhand	145	193	231
Himachal Pradesh	38	46	51
Bihar	19	22	25
India	26383	34695	41344

KEY INSIGHTS

The forecast is in line with the historical trends in the consumption of dairy products across Indian states. Besides, developing the market for different products is contingent on several other economic factors and ease of investment in the states for the national and international dairy companies to invest. Several cultural practices influence consumption patterns and preferences. The forecasts also align well with estimated income and demand elasticities for the diverse dairy products in India (NDDB, 2019). The database of the processing infrastructure of the private sector players in the dairy sector doesn't exist in India. Such a database is required to promote better public-private partnerships in the country and to attract additional foreign investments into the industry.

Overall, projections suggest the expanding market for dairy products in the country is driven by the expanding upper and higher income strata of the country for specialized and high protein dairy products (Whey, Fortified Milk, Flavoured Yoghurts, including baby product formulations) by the lower income strata as an alternate source of an affordable source of protein.

- The major private players in the market were Hatsun Agro Products Ltd. (2 %), Nestle SA (2%), Lactalis Groupe (2 %), and Heritage Foods Ltd. (1 %). Overall, the market share of private companies in the processed milk segment is less than 2%.

- The processed milk segment holds 76% of the market in quantity terms and 64% in value terms, providing greater scope for private investors in the non-milk sector.

- EBITDA margin of ~5.8% for pouch milk and~9.4% for liquid milk. EBITDA margins for curd/yoghurt range from 9% to 20% depending on the format and return ratios range from 25% to 40%, For Yoghurt, EBITDA margin is 20%. EBITDA margins in cheese can be healthy, in the mid-to-high 20% range for the B2C segment. As the EBITDA for Yoghurt and Cheese is showing healthy margins, these are the potential products for investment.

- The total market value of milk and cream in India is projected to be €1831 million by 2025 and reach € 28069 million by 2035.

  Projections suggest that among the states, Gujarat is the largest consumer base for milk and cream in the country followed by Maharashtra, Tamil Nadu, Uttar Pradesh, and Karnataka.

CHAPTER V: Food safety issues and other challenges in product production, marketing and consumption

The dairy industry has many stakeholders, including small farmers, dairy companies, distributors, and retailers. This makes supply chain visibility a challenge. Raw fresh milk has a perishable characteristic, so it needs appropriate handling from milking to processing, otherwise, fresh milk will be contaminated by bacteria so that the shelf life becomes shorter, and it loses quality. Milk contamination and milk adulteration negatively affects the quality of milk. Milk contamination mostly occurs due to environmental contamination and bad handling practices. Contamination also occurs due to poor animal health, utensils, unhygienic milking and milk handling practices, extraneous matter, feed, medicines, fertilizers, environment etc. Unlike contamination, adulteration is deliberate. Often performed to intentionally degrade the quality (and increase the quantity) of milk to make profit illegally.

Common adulterants are water, melamine, starch, urea, oxytocin, formalin, hydrogen peroxide, and detergents. Prevalence of microplastics is observed in samples and microplastics in milk and pouches are primarily Polyethylene (PE) and Polypropylene (PP). The administration of antibiotics/veterinary drugs in affected animals.

Table 9. IMPORTANT RISK FACTORS IN MILK SUPPLY CHAIN

Step in Dairy Chain	**Important Risk Factors**	**Implications for Milk Safety**
Primary production	Diseases (mastitis) Housing, bedding and husbandry Feed and water quality Waste management	Increased shedding of pathogens directly into milk from diseased animals (including asymptomatic carriers). Poor housing and husbandry practices increase the risk of udder contamination due to high stocking, concentration of waste, stress, and soiled bedding, leading to contamination of the milking environment and raw milk. Poor quality water for stock drinking, teat washing, and cleaning can increase the risk of milk contamination Contaminated or poorly prepared feed may increase fecal shedding of pathogens into milk and milking environment.
Milk collection	Milking practices Equipment cleaning Personnel hygiene	Poor milking practices, including dirty, chapped or cracked teats, insufficient cleaning and maintenance of milking equipment, and poor personnel hygiene can lead to direct contamination of raw milk with pathogens.

Raw milk storage	Availability and efficiency of cold storage facilities	Inappropriate temperature control of raw milk, coupled with the usually high temperature in the region and erratic power supply, can lead to accelerated growth of pathogens in milk during storage.
Packaging	Packaging Equipment and material	Poor packaging, inappropriate packaging materials, and poor hygiene can contribute to cross-contamination of milk or open up milk to contamination from the environment.
Transportation and distribution	Transportation mode Road network between milk collection centers and market centers Maintenance of cold chain	Transporting raw milk between farms and market centers by foot, bicycles, motorbikes, or other means without a proper cold chain enables the growth of pathogens. Poor road network systems increase the time for transportation and distribution of raw milk, and coupled with poor cold chain facilities, allow the rapid growth of pathogens in raw milk.
Traditional milk processing	Pasteurization/thermal treatment Fermentation practices Personnel hygiene and sanitation of the processing environment.	Inadequate pasteurization temperatures may not be able to eliminate pathogens in already contaminated milk and may even encourage the faster growth of pathogens. Spontaneous fermentations (without properly defined starter cultures), coupled with poor time/temperature controls can expose fermented products to pathogenic microorganisms. Poor sanitation of processing environments and personal hygiene by milk processors can lead to direct contamination of processed milk products with pathogenic microorganisms.
Consumer practices	Storage temperature at home storage Adherence to handling instructions and good personal hygiene	Poor refrigeration during home storage of both raw and processed milk can accelerate the proliferation of pathogenic microorganisms. Lack of proper hygiene and non-adherence to handling instructions can lead to contamination and proliferation of pathogenic microorganisms.

KEY INSIGHTS

- Major quality issues prevailing in the Indian dairy sector is related to the use of contaminated water, milk adulteration, use of veterinary drugs, heavy metals, mycotoxins, and pesticides.
- Quality of water (microbiological as well as chemical) used for cleaning utensils for milking, milking machines, bathing animals, cleaning udders, offered for drinking to animals is also an important source of contamination.
- Milk adulteration in certain pockets of India is very rampant and there is an inadequate mechanism for regular and continuous checks.
- Antibiotic residues in dairy are a perennial quality-related problem due to the use of unprescribed veterinary drugs.
- Mycotoxins including aflatoxins are detrimental to the health of milch animals if they are fed mouldy feed. Aflatoxin B1 is secreted in milk in the form of Aflatoxin M1.
- Contamination of milk and dairy products with pesticide residues is a matter of serious public health concern, since they are widely consumed by infants, children, and adults.
- One of the big challenges for exporting milk and milk products is the traceability issue, due to the lack of data related to animals (breed, genetics, lineage, milk production, diseases, vaccination, movements, etc.). The lack of systems to record these details is a major limitation in the industry.
- The Government of India, under the National Programme for Dairy Development (NPDD scheme), has approved the establishment of a State Central Laboratory for the Jharkhand Milk Federation (JMF). This laboratory is equipped with modern testing facilities, including Liquid Chromatography Mass Spectrometry (LCMS), Gas Chromatography
- Mass Spectrometry (GCMS), inductively Coupled Plasma Mass Spectrometry (ICPMS), Bac Somatic, MilkoScan-FT-1, etc. for analysis of milk and milk product contaminants such as pesticide residue, veterinary drugs, melamine, heavy metals, bacterial count, and somatic cell count. NDDB carried out a series of experiments (In-vitro and In-vivo) on the use of bentonite as a toxin binder for reducing Aflatoxin M1 contamination in milk.
- This necessitates the need for advanced techniques or instruments for rapid testing and identifying adulterant antibiotics in both pre-processed and post-processed milk and milk products.

CHAPTER VI: Current technologies and potential for advanced technologies for value addition

6.1 CURRENT TECHNOLOGIES FOR VALUE ADDITION

Aseptic Processing and Packaging:

This technique, understood as the most significant innovation in food technology over the past 50 years, involves creating shelf-stable products by separately sterilizing the product and the packaging material, then filling them in a sterile environment. This method has seen success in India with products like Frooti fruit juice drinks and Amul Taaza milk.

Developments in Packaging: Packaging technology has evolved beyond mere containment, now playing a crucial role in extending product life. Innovations include edible packaging, antimicrobial packaging, and smart or intelligent packaging, driven by consumer demand for shelf- stable and nutritious products. Biodegradable packaging materials are being developed to meet sustainability goals, though they currently face challenges in mechanical, barrier, and thermal properties compared to conventional plastics.

Biodegradable packaging is a promising trend in the dairy industry as it can break down more easily than traditional plastics. Some examples of biodegradable packaging for dairy products include:

- Plant-based plastics: These plastics are made from natural substances like corn starch and are biodegradable and compostable.
- Edible coatings: These coatings can be used to package dairy products and safely decompose without leaving behind harmful residues.
- Polylactic acid (PLA): This type of plastic is made from corn starch and is biodegradable and compostable.

Bioplastic containers: These containers are made from lactic acid from vegetable sugar and starch. They are free from synthetic plasticizers, 10 times cheaper than plastic, and 20 times lighter than glass.

6.1.1 Innovations in Packaging[1]

	Arta Industrial Group launched a new paperboard cup under the brand name FiberCup for dairy goods packaging. The company uses recyclable pulp fibers and recycled PET plastic resins as raw materials to produce these products.
	Brazil-based Agrindus adopted transparent PET bottles for the packaging of fermented milk brand Letti. Amcor Packaging supplies packaging materials for these products. These transparent PET bottles have thick walls to prevent deformation. It has excellent drop resistance and eliminates the need for the foil seal barrier.
	Constantia Flexibles, after five years of deep-research and testing, has recently introduced Eco Lam Plus packaging for meat, cheese, and dairy products. It comprises of layers of only PE lamination giving it a mono-material structure. This packaging reduces carbon footprint by almost 32% and ensures high degrees of moisture and oxygen barrier.
	Tetra Pak launched Tetra Classic Aseptic Cube in December 2018 for dairy, juice, and liquid food. It groups 6 packages to form a cube-saving 40% of transportation space. This one-of-a-kind structural innovation is cost-effective for manufacturers as well as environmentally sustainable.
	An Austrian company "Naku - Made of Natural Plastic" has launched a bioplastic container for dairy items. It comprises of lactic acid from vegetable sugar and starch. *The packaging is free from synthetic plasticizers, 20 times lighter than glass, and 10 times cheaper than plastic. It is completely biodegradable.*

Membrane Processing: This modern technology has overtaken conventional processes in the food industry due to its numerous advantages, particularly in dairy product manufacturing.

3D Printing: This technique manufactures various food products using additive manufacturing methods, allowing customization in shape, colour, texture, flavour, and nutrition. Its applications extend to space exploration and healthcare, offering innovative solutions in food production.

Developments in Preservation: Traditionally, both synthetic and natural preservative systems have been used in Indian dairy products. Although desiccation reduces the need for preservatives, adding synthetic additives or natural preservatives like bacteriocins (e.g., microgard, nisin, natamycin) can further extend shelf life, meeting growing consumer demand for natural ingredients.

[1] Source: Varun Juyal, Future of the Global Dairy Packaging Industry, 2024

Other Advanced Technologies:

- **Spinning Cone Column Technology (SCC):** Efficiently captures and preserves volatile flavour components from various liquids and slurries, benefiting products like dairy and beverages.
- **Bactofugation:** Utilizes high-speed centrifugation to remove bacteria from milk, capable of eliminating 70-80% of bacterial cells, enhancing product safety.
- **Super-Heated Water Spray Sterilizer:** A new sterilization method suitable for heat- sensitive products and delicate containers like plastic bottles, offering rapid heating and cooling for better product preservation.

6.2 TECHNOLOGY NEEDS FOR EFFICIENCY

- Energy Efficiency Technology in saving

  » Water: Most dairy plants in India consume 1 m3 of water per 0.3 L of milk production compared to the global average of 1 m3 of water per 1.1 L of milk indicating the scope for improvement.

  » Energy consumption in the dairy industry in India: The amount of electricity used to process different dairy products varies:

- Energy consumption per product

  » Liquid milk: 0.88 kWh/100 kg
  » Cream: 8.93 kWh/100 kg
  » Ghee: 2.77 kWh/100 kg
  » Cheddar cheese: 2.17 kWh/100 kg
  » Mozzarella cheese: 6.45 kWh/100 kg
  » Paneer: 1.45 kWh/100 kg
  » Ice cream: 4.77 kWh/100 lit

The proposed energy saving systems recommended for Indian Dairy Plants

  » Conversion of furnace oil fired boiler to fully automated biomass fired boiler
  » Installation of micro-turbine
  » Direct cooling method – Ice Building Tank (IBT)
  » Methane capture from dairy effluents
  » Solar rooftop system
  » Solar thermal system
  » Solar wind hybrid system

- Fully automatic milk processing units- Most processing units in India are semi- automatic.
- Filters/membranes for toxic screening- currently bio-polymer filters are commonly used and the efficiency levels are low.
- Gobber/Dung and slurry management and gas production for the energy needs of farmers.

- Unified Standard Operating Procedures (SOPs) for product development like sweets.
- Rapid test kits or advanced labs for detecting antibiotics, pesticide residue, heavy metals, adulteration and pathogens, etc.

The average time scale with current testing technology

» Adulterants (25 no) – 30 minutes
» Pesticides (85 no) - 12-24 hrs
» Antibiotics (93)
» Aflatoxin - (10 min)
» Heavy metals (10-12)
» Efficient Salmonellae, E, Coli, Listeria, and Campylobacter testing techniques

CHAPTER VII: Export and import potential of dairy products

India has a minimal presence in the global dairy export market, accounting for just 1 % of the total share. Major exporters of dairy products in the world are Germany (12.4%), New Zealand (12%), Netherlands (11.6%), France (8.3%) and USA (5.3%). India has not entered the global market and has remained mostly independent, despite being the world's largest consumer of dairy and dairy products. If the country were to increase its share in trade, it could substantially impact international markets.

Evolving dietary preferences and rising incomes of individuals have a significant impact on the global demand for dairy products. There is an increasing need for value-added dairy items that provide health benefits, such as infant formula, flavoured/ fortified milk, and cheese.

7.1 IMPORTS OF DAIRY PRODUCTS

7.1.1 NATURE AND POTENTIAL OF IMPORT MARKET FOR THE INDIAN DAIRY INDUSTRY

India's contribution to global dairy product imports is below 1%. The country primarily relies on importing Whey among all the various dairy products it brings in.

Major dairy products imported by India are whey, infant food, ice cream, and other edible ice and cheese (Fig. 25). Out of the total dairy imports, whey contributes a share of about 53 % followed by infant food and ice cream.

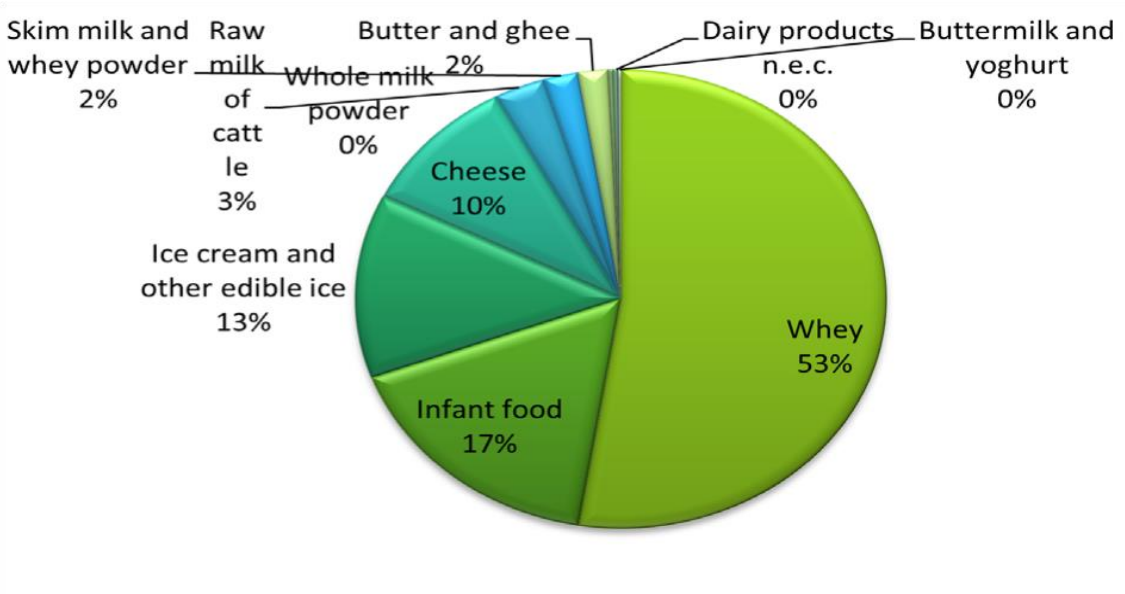


FIG 25: PRODUCT-WISE SHARE IN TOTAL DAIRY IMPORTS IN INDIA SOURCE: FAOSTAT

Examining the import value trend from 2016 to 2022 reveals a declining percentage share for whey as well as butter and ghee (Fig. 26). Conversely, there is an increasing trend for infant food, ice cream, and cheese imports. This indicates that these products hold significant potential for future imports into the Indian market or may be targeted as upcoming popular goods

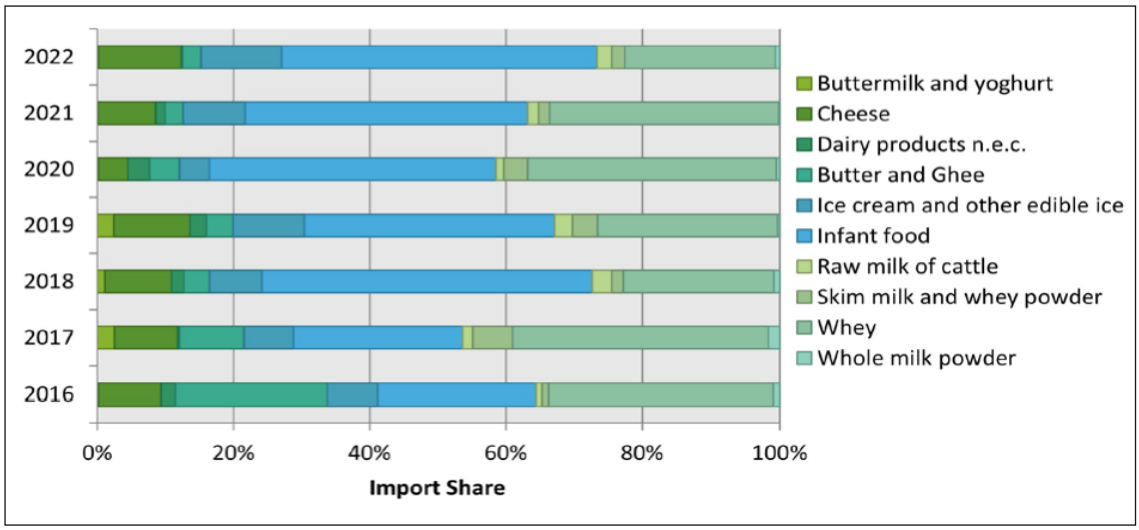


FIG 26. PRODUCT- WISE IMPORT VALUE – INDIAN MARKET SOURCE: FAOSTAT 2023

Trends:

- Whey constitutes a significant portion of dairy imports, with fluctuating trends indicating evolving demand.
- Increased imports of infant food, ice cream, and cheese reflect changing consumer preferences.
- Shift in import value shares towards high-value dairy products suggests market potential.

The top five importing countries for dairy products into India are France, Italy, the United Kingdom, Germany and Denmark (Fig. 27). Considering the total import value in terms of Euros, France has the highest share 35.30 % followed by Italy (7.49%).

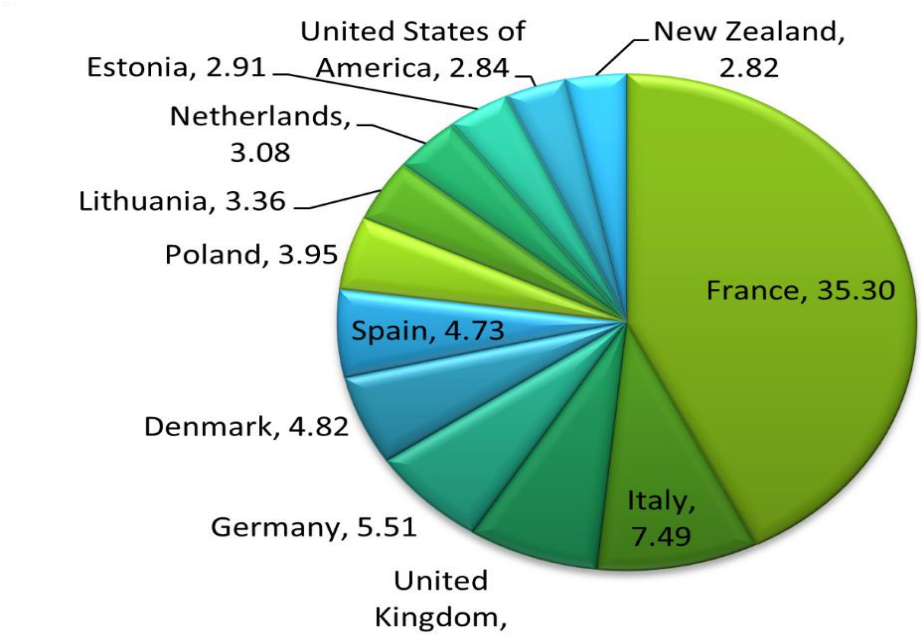


FIG 27. MAJOR COUNTRIES EXPORTING DAIRY PRODUCTS TO INDIA SOURCE: APEDA 2024

7.1.2 IMPORTS FROM NETHERLANDS

Cheese is the only milk product that is imported from the Netherlands. A total of 139 MT of cheese was imported which accounts for € 0.76 Mn in value terms (Table 10). Lactose is another product exported to India from the Netherlands.

Table 10. DAIRY IMPORTS FROM NETHERLAND Source: APEDA 2024

Product	**Qty MT**	**Euro € '000**	**% QTY**	**% Value**
Processed Cheese, Not Grated/Powdered	13.32	92	10	11
Mozzarella Cheese	2.69	16	2	2
Grated/Powdered Cheese, of All Kinds	0.3	3	0	0
Skimmed Milk In Powder, Granules And Other Sold Forms, of A Fat Content, By Weight Not Exceeding 1.5%	0.5	2	0	0
Other Cheese	122.39	741	88	87
Total	**139**	**854**	**100**	**100**

Product	**Qty MT**	**Euro € '000**	**% QTY**	**% Value**
Lactose And Lactose Syrup Containing 99% Or More Lactose Solid Form	6093.53	23092	38	34
Caseinate Other Casein Drvts &Casein Glues	1332.6	13721	8	20
Lactose And Lactose Syrup Containing 99% Or More Lactose Solid Form	3042.05	10617	19	16
Milk Albumin Incldng Concentrates Of Two Or More Whey Proteins	1285.07	8946	8	13
Other Chocolate and Food Preparation Filled	1886.52	6534	12	10
Chocolate And Chocolate Products	200.72	2644	1	4
Concentrated for compound animal feed	2214.93	1537	14	2
Lactose And Lactose Syrup Other than Containing 99% Or More Lactose Solid Form	78.44	479	0	1
Total	**16134**	**67570**	**100**	**100**

7.2.1 NATURE AND POTENTIAL OF THE EXPORT MARKET OF INDIA'S DAIRY INDUSTRY

Although India's dairy exports have expanded, annual exports still account for less than 1 % of dairy exports by major exporters. Unfortunately, India has lost market share in the world market for milk and cream (not concentrated), cheese, and curd, as well as for butter and ghee. Most of the share is lost for butter and ghee. On the bright side, India has increased its market share for concentrated milk and cream. Major dairy products being exported from India (Fig. 28) are Butter and Ghee (39%), followed by Skimmed milk and Whey powder (29%), raw milk of cattle (15%), and cheese (7%).

- India's export of dairy products was 63,738.47 MT to the global market value of € 243 Mn during the year 2023-24. Major export destinations (2023-24): United Arab Emirates, Saudi Arabia, USA, Singapore, and Bhutan.
- India's butter, ghee, and dairy spreads export is valued at €39 Mn with 8106.54 MT in 2022- 2023, major destinations being: Saudi Arabia, Bahrain, UAE, USA, and Qatar.
- India exported 9262.63 MT of Cheese worth€ 42Mn in 2022-23, with major destinations being: UAE, USA, Bhutan, Singapore, and Saudi Arabia.
- India exported 16,696.75 MT of Skimmed Milk in Powder worth € 57 Mn in 2022-23 with major destinations being: Bangladesh, UAE, Sri Lanka, Kuwait, and Oman
- The share of Whey, Dairy products (n.e.c) and skim milk of cows in the export market is less than 1 percent

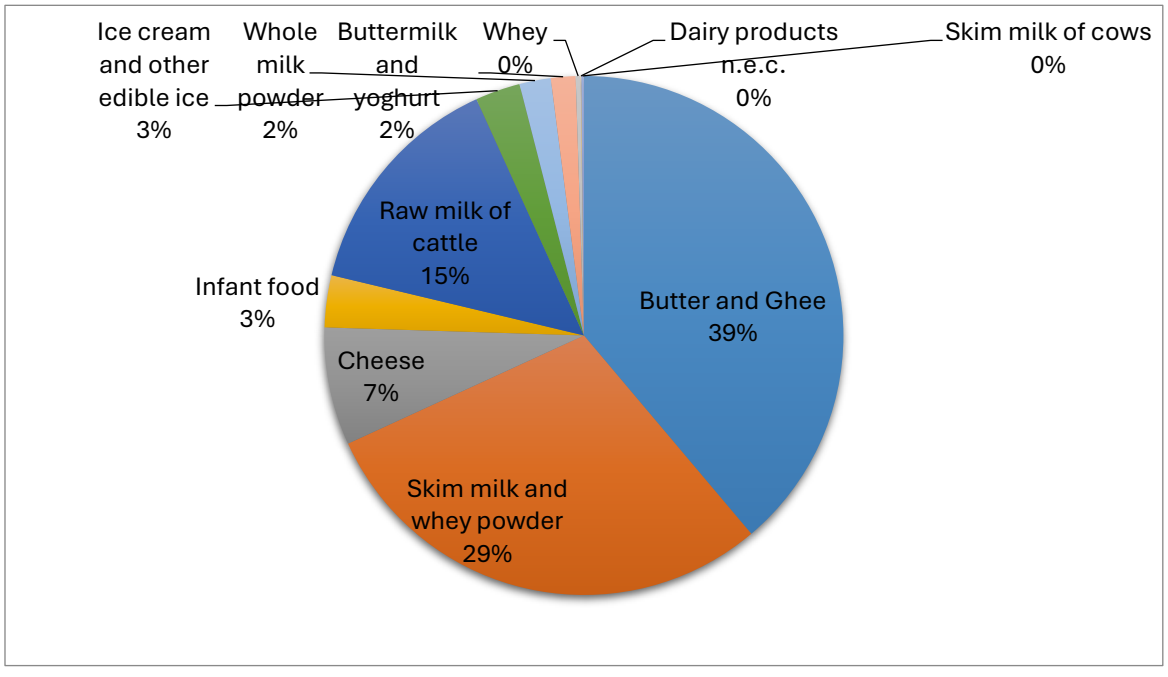


FIG 28. MAJOR COUNTRIES IMPORTING DAIRY PRODUCTS FROM INDIA SOURCE: APEDA 2023

The dominance of European countries in India's import market indicates the reliance on these nations for high-quality dairy products. Conversely, India's competitive pricing and large production capacity could be leveraged to capture a larger share of the global market, particularly in concentrated milk and cream.

The success of the dairy revolution in India has not translated into exports. Dairy export constitutes only 2.6 percent of India's agri export as reported by APEDA, which is much lower than the 24% share of milk output in value of crop and livestock output. The situation has shown a big change in recent years as the volume of export of dairy products has increased four times in four years after 2017-18. Dairy exports doubled in 2021-22 to reach € 510 Mn and increased by 64 percent in volume. Still, exports are less than 0.5 percent of the total domestic production of milk.

7.2.2 Tapping the Export Potential

It has to be noted that only 30-40 % of the world dairy market is available to India to expand its market. The major markets fall under the European Union and other developed countries with stringent Non-Triff Measures (NTMs) barriers. 13-15% of the dairy market is in the Middle East which India is already catering. **Red** indicates existing markets; **blue** indicates potential markets and black is India.

7.2.2.1 Butter

Butter is one of the products that India is already exporting to the important markets of Middle East and South-East Asia (Fig. 29). Other than these markets, India may expand to Oman, Qatar, and Kazakhstan. If traceability and NTM is fulfilled; Russia, China and some developed markets such as the United States and Japan could be an important market in this product category.

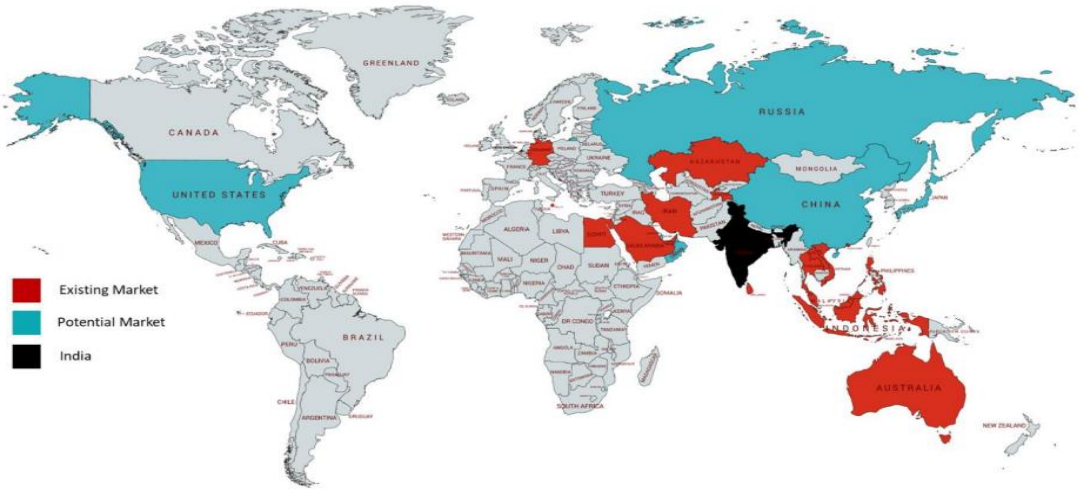


FIG 29. EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN BUTTER SOURCE: NDDB[4]

7.2.2.2 Ghee

Ghee is another important product that India is exporting to various important markets, and it is also in the competitively positioned category. In general, ghee is targeted to the Indian

[4] https://www.nddb.coop/sites/default/files/pdfs/baseline/16_Roadmap_&_strategies_to_promote_dairy_products.pdf

Diaspora and is already being sent to countries like USA, Australia, Kazakhstan, and Pakistan along with South-East Asian and Middle East countries (Fig. 30). Other potential countries where India may expand using the Indian diaspora route could be Ukraine, Poland, Tunisia, Georgia, and Laos.

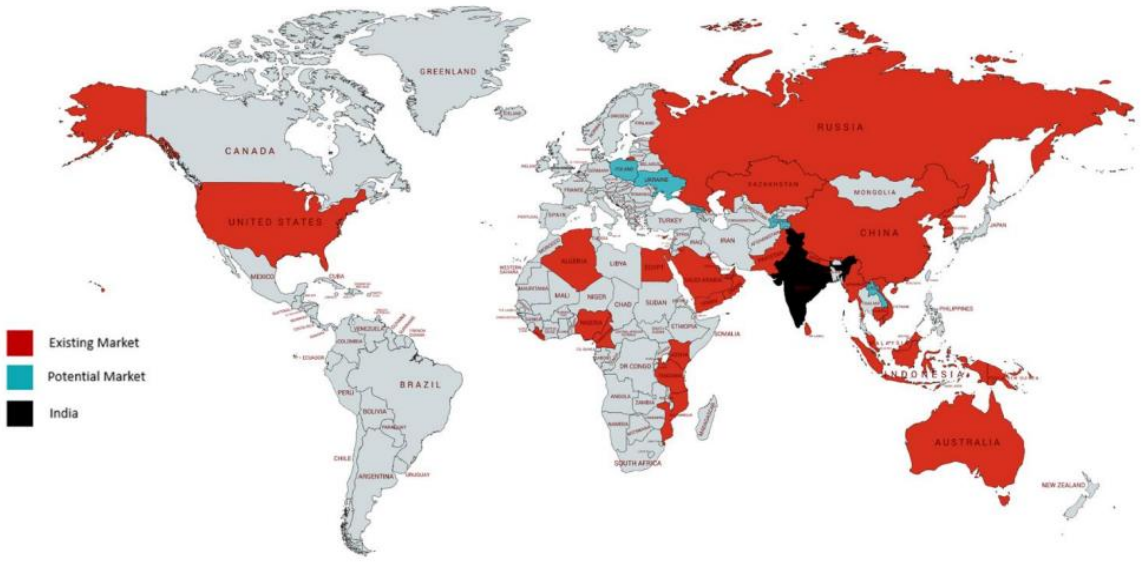


FIG 30. EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN GHEE

7.2.2.3 Whole Milk Powder (WMP)

Presently India is exporting to MENA (Middle East and North Africa) and South-East Asian countries (Fig. 31). India may also export to unexplored markets of China, Saudi Arabia, Kuwait, Egypt, Indonesia, and Russia since these countries have huge potential in trading WMP.

FIG 31. EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN WMP

7.2.2.4 WHEY POWDER (WP)

India currently exports Whey Powder to major countries like the USA, Australia, New Zealand, and other countries like Ethiopia, Vietnam, and Oman (Fig. 32). There is a huge scope for expanding its market to some Asian and MENA (Middle East and North Africa) markets including China, Indonesia, Saudi Arabia, and Egypt. The strong growth in this category is due to the high demand for energy nutrition and sports products. USA and EU are the major importers of whey and Asia is also catching up. As suggested the major focus could be on the Asian, Middle East, and African countries.

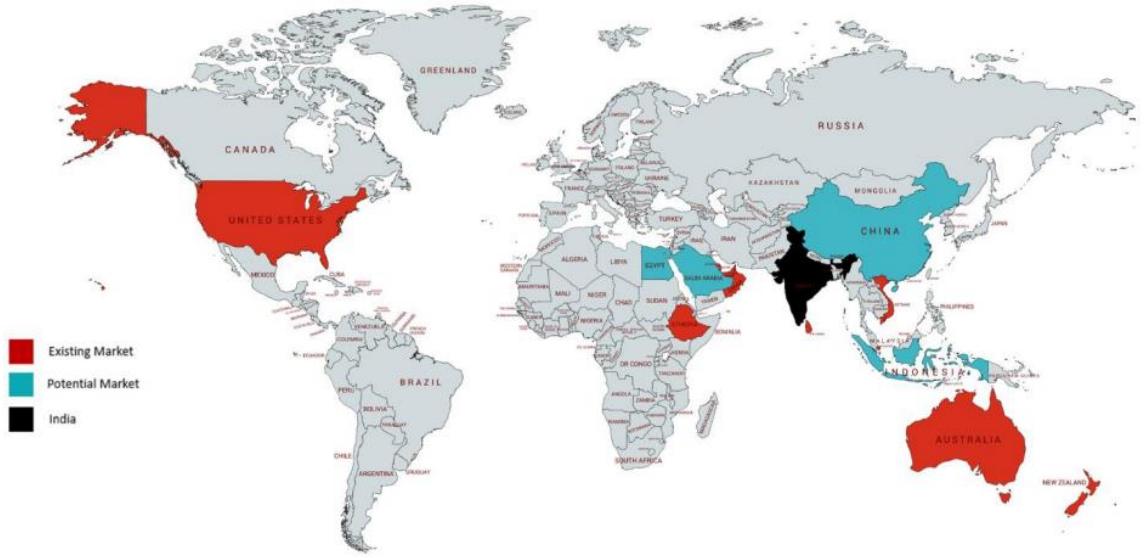


FIG 32. EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN WP

7.2.2.5 CREAM

India's current export of cream is only restricted to the USA, Myanmar, and Middle Eastern countries (Fig. 33). Cream in this category can be used in many forms: Manufacturing cream, Long life cream (UHT), Heavy whipping cream, Half-and-half (coffee cream), Flavoured creams, clotted cream, etc. India may expand to South-East Asian markets and Middle Eastern markets.

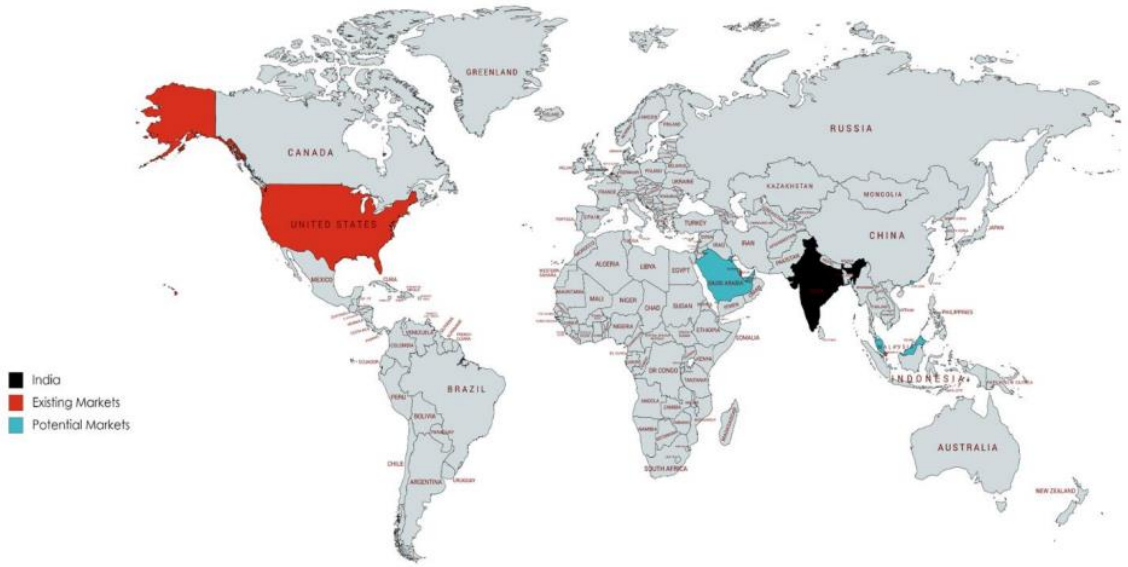


FIG 33. EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN CREAM

7.2.2.6 YOGHURT

India's current export is only restricted to UAE, Singapore, Hong Kong, Bangladesh, Nepal, Bhutan, and Pakistan (Fig. 34). As potential markets open up India may expand to China, Russia, Philippines, and Oman.

FIG 34: EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN YOGHURT

7.2.2.7 BULK AND PACK MILK

India is exporting to markets like Myanmar, Ghana, Malaysia, Qatar, Singapore, Sri-Lanka, Philippines and some countries in the African continent (Fig. 35). Indian dairy companies may

expand to countries like Oman and It may expand to Russia as well as China if major NTMs are fulfilled

FIG 35: EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN BULK AND PACK MILK

7.2.2.8 CHEESE

India is exporting cheese to some of the countries in South-East Asia, Middle East, and Africa (Fig. 36). India may Increase the existing exports to these countries or may Expand to new markets like Vietnam, Kuwait, Indonesia, and if some additional NTM requirements are met, India Could also enter new markets like China, Israel and Russia. India is in the emerging category in case of Processed cheese, however, other forms of cheese used for cooking and as spread are in great demand

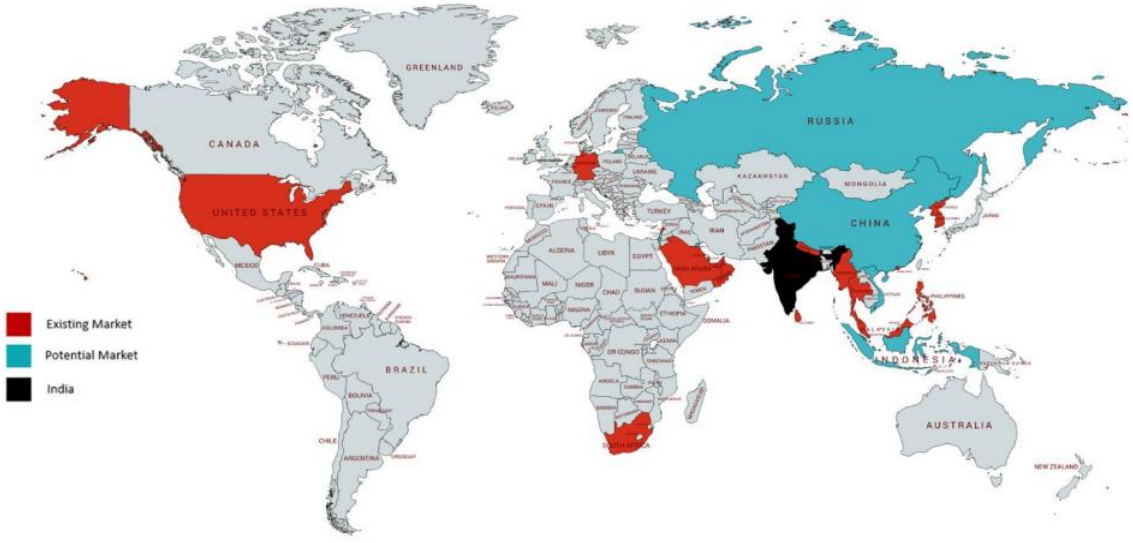


FIG 36: EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN CHEESE

7.2.2.9 Skimmed Milk Powder (SMP)

India exports to markets like: Russia, MENA countries and South-East Asian countries (Fig. 37). Since India has already captured major markets such as the United States, South-East Asia and Middle East; India may expand to China in this category

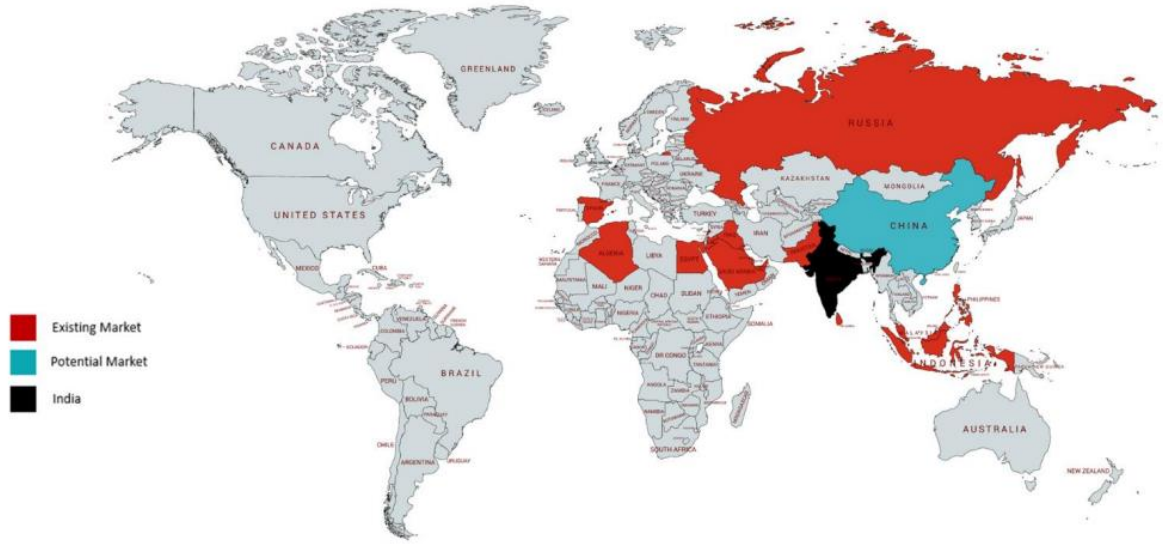


FIG 37: EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN SMP

7.2.2.10 Infant Milk/ Malted Milk Product

India is exporting infant milk food to Russia, Scandinavia, Middle East, South-East Asia, and Middle East regions (Fig. 38). Additional markets that could be explored for this category includes Algeria and Kazakhstan.

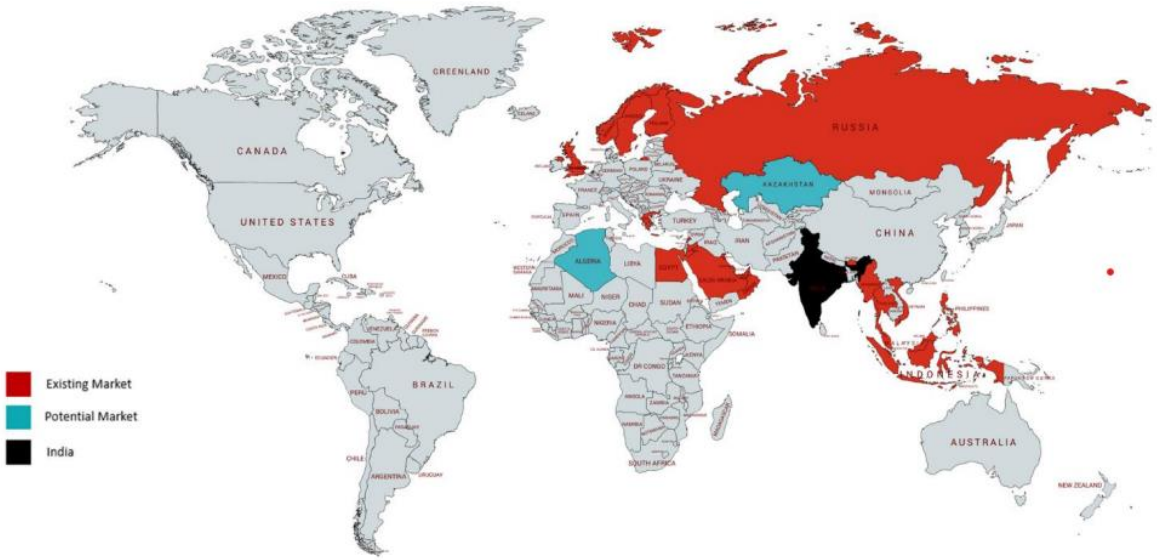


FIG 38: EXISTING AND POTENTIAL EXPORT MARKETS FOR INDIAN INFANT MILK

In order to cater to the recommended markets, export requirements with consistent export supply, the dairy industry needs to overcome the challenges impacting the Indian domestic dairy sector. The major challenges that need to be addressed are:

- **Price Competitiveness:** India's milk and milk product Prices are not in line with the world price due to several reasons such as low productivity, poor production efficiency, lack of process innovation efficiency and absence of an integrated value chain.
- **Process Innovation Efficiency:** India's dairy product export is challenged by many countries on quality grounds; it is essential to innovate processes which can improve the quality of milk and milk products.
- **Quality Enhancement and Adherence to International Standards:** Major quality issues prevailing in the Indian dairy sector is related to the use of contaminated water, milk adulteration, use of veterinary drugs, heavy metals, mycotoxins, and pesticides.

KEY INSIGHTS

India's contribution to global dairy product imports is below 1%. Major dairy products imported by India are whey, infant food, ice cream, and other edible ice and cheese. Out of the total dairy imports, whey contributes a share of about 53 % followed by infant food and ice cream. The top five importing countries for dairy products are France, Italy, United Kingdom, Germany, and Denmark. Considering the total import value in terms of Euros, France has the highest share of 35.30% followed by Italy (7.49%), and the Netherlands' share is only 3%. India imports cheese and lactose acids from the Netherlands and there is scope for other feed additives and milk products

Similarly, India’s share of exports is less than 1%, and exports mostly to South-East Asia, and Middle East, and Africa. There is scope for improvement if NTM requirements are met and traceability is adopted with strict quality compliance.

CHAPTER VIII: Regulations- Import and Export of milk and milk products

India's Ministry of Fisheries, Animal Husbandry and Dairying/Department of Animal Husbandry and Dairying (DAHD) published on its website, a revised integrated veterinary health certificate (VHC), that incorporates the DAHD's sanitary requirements along with those of the Ministry of Health and Family Welfare/Food Safety and Standards Authority of India's (FSSAI) (national food safety authority) food safety requirements. These two Indian government agencies have now aligned their technical aspects, producing a revised integrated veterinary health certificate.

8.1 Recent changes in legislation: Milk and Products

- DAHD has mandated the requirement of an integrated Veterinary Health Certificate (VHC) for import of milk and milk products into India incorporating DAHD's sanitary requirements and requirement of FSSAI's food safety to be certified by the exporting country along with the consignments to be exported into India.
- The exporting country may issue single Veterinary Health Certificate, certified by an Official Veterinarian or certificate with annexure as per its regulation.
- To facilitate trade and address concerns raised by trading partners, DAHD extended the transition period until June 30, 2024.
- The import of non-food lactose or non-food whey products concentrates, will be permitted with self-declaration by importers that the said import into country is for use in non-food lactose or non-food whey products concentrates only. For that purpose, the concerned Department will create a window on Custom's ICEGATE wherein importers could self-declare. Accordingly, the Custom will not refer such Bill of Entries to the concerned Partner Government Agencies (PGAs) i.e. FSSAI and/or AQCS.
- The import of lactose or whey products concentrates, to be used as dairy products (food items) for human consumption will be permitted subject to fulfilment of the requirements of integrated Veterinary Health
  Certificate
- Prohibition on the import of milk and milk products (including chocolates and chocolate products and candies/ confectionary/ food preparations with milk or milk solids as an ingredient) from China is extended until the capacity of all laboratories at ports of entry has been suitably upgraded for testing melamine.
- Milk and Cream, Concentrated or Containing Added Sugar or Other Sweetening Matter; In powder, granules or other solid forms, of a fat content, by weight not exceeding 1.5%.
- Skimmed milk powder standard grade must conform to IS 13334 (Part 1) and extra grade must conform to IS 13334
- Milk and Cream, Concentrated or Containing Added Sugar or Other Sweetening Matter: In powder, granules or other solid forms, of a fat content, by weight exceeding 1.5%.

- Milk Powder: Not containing added sugar or other sweetening matter, must conform to IS 1165 and partly skimmed milk powder must conform to IS 14542.
- Other, Sweetened Ultra-High Temperature treated condensed milk must conform to IS 12176
- Condensed Milk, Condensed milk, partly condensed milk and skimmed condensed milk: must conform to IS 1166

Dairy sector to be exempted from maintaining Average Export Obligation to support dairy sector to upgrade the technology under Foreign Trade Policy, 2023.

8.2 GUIDELINES FOR IMPORT AND EXPORT OF BOVINE GERMPLASM-2019

Trade of livestock and livestock products are regulated as per the Foreign Trade Policy of the Government of India which is implemented by the Department of Commerce.

The Department of Animal Husbandry and Dairying regulates the import of livestock and livestock products in accordance with provisions of Section 3 and Section 3A of the Livestock Importation Act., 1898 to prevent the ingress of exotic diseases through the import of such livestock and livestock products.

Import of live animals falls under the category of the restricted list (it is not free to import) as per EXIM Policy for which the importer has to obtain a license from the Director General of Foreign Trade (DGFT). The DGFT issues licenses based on the recommendation of this department after examining the proposal and conducting risk analysis. Apart from the EXIM Policy, the Central Government is empowered to regulate, restrict and prohibit import of live animals in accordance with Section 3 of the Livestock Importation Act., 1898. Notifications S.O. 1495(E) and 1496(E) dated 10 June 2014 under Section 3 of the Livestock Importation Act has been issued by the Department of Animal Husbandry and Dairying. Through these notifications, the department has notified the classes of animals that can be considered as "Livestock" and has laid down the import and quarantine procedure for live animals.

The livestock products are categorized under Open General License (OGL) as per EXIM Policy. Apart from the EXIM Policy, the Central Government is empowered to regulate, restrict, and prohibit import of livestock products in accordance with Section 3A of the Livestock Importation Act., 1898. In this regard, the Department has issued notification S.O. 2666(E) dated 17 October 2015 listing out the livestock products and procedure for import of livestock products. The import of these products is allowed subject to a Sanitary Import Permit which is issued by the department after examining Import Risk Analysis. Sanitary Import Permits (SIPs) must be obtained prior to shipping from the country of origin.

Imports of animal and animal products are only allowed through seaports/ airports of Bangalore, Chennai, Delhi, Hyderabad, Kolkata, and Mumbai where animal quarantine and certification services are available.

The policies implemented by the Indian Government aim to transform the dairy sector into a modern, efficient, and globally competitive industry. By addressing each stage of the dairy value chain, from fodder and breeding to processing and export, these initiatives seek to ensure sustainable growth and development. The integration of advanced technologies, quality assurance practices, and infrastructure improvements reflects the government's commitment to achieving a holistic and sustainable dairy sector.

Moreover, the stringent regulations for import and export underscore the importance of maintaining high standards of safety and quality. Aligning sanitary and food safety requirements with international standards facilitates trade and protects domestic consumers. These measures, coupled with strategic initiatives like the National Program Dairy Development (NPDD), Dairy Processing and Development Fund (DIDF), Rashtriya Gokul Mission (RGM), and Animal Husbandry Infrastructure Development Fund (AHIDF), provide a robust framework for the continued growth and modernization of India's dairy industry.

KEY INSIGHTS

Trade of livestock and livestock products are regulated as per the Foreign Trade Policy of the Government of India which is implemented by the Department of Commerce. The import and export of cattle/ buffalo germplasm is under the restricted list and is allowed against license(s) issued by the Directorate General of Foreign Trade, Ministry of Commerce on the recommendation of the Department of Animal Husbandry Dairying & Fisheries. Import of bovine germplasm will be permitted for breeding purposes only.

DAHD has mandated the requirement of an integrated Veterinary Health Certificate (VHC) for the import of milk and milk products into India incorporating DAHD's sanitary requirements and requirement of FSSAI's (Food Safety and Standards Authority of India) food safety to be certified by the exporting country along with the consignments to be exported into India.

The dairy industry is in the process of modernization since the last three decades. However, cattle productivity is yet to be boosted to meet the felt need, which can be achieved partially through imparting training to various stakeholders of the dairy supply and value chain. Training in dairy farming practices like breeding, feeding, fodder, management, and animal healthcare, are necessary to improve the productivity of dairy cattle and thereby make dairy farming a more profitable enterprise. However, the training needs in dairy farming practices by the cattle owners does not appear to be satisfactory. With further anticipated growth in milk production at the rate of more than 4% and the fact that a substantial number of experienced professionals at various levels will retire or superannuate in the next few years, it is high time and prudent to have a well-thought-out plan for the industry on training and development.

CHAPTER IX: Training Needs and Netherlands Expertise

Training needs in the dairy industry primarily focus on animal health management, milk quality and hygiene practices, animal nutrition, breeding, housing and environmental management, as well as proper handling and processing techniques, all with an emphasis on maintaining high standards of food safety and quality.

9.1 TRAINING SCENARIO IN INDIA

A study conducted by NDDB to assess the training needs of professionals are

- Clean Milk Production (CMP)
- Quality & Food Safety Management System
- Total Productive Maintenance
- ISO 50001, Energy Management System
- Total Quality Management
- Milk Drying Operations and Safety Measures
- Animal fertility, AI delivery, and monitoring system

Some of the major observations by NDDB and the recommendations shared with the Dairy cooperatives based on the field visits and the plant inspections are highlighted below:

- Food safety & raw milk – a matter of great concern making CMP training (Awareness, Practices, AMCU, BMCU), a universal demand at all levels starting from village coops to end marketing of milk and milk products

- Concern on the rising cost of milk production – Ration balancing, GAPs like management, feeding, breeding (AI) and disease control, and a robust monitoring system
- Concern on Quality and Food safety of milk & milk products

  » Modernization of the milk procurement system through the introduction of AMCU & BMCU and elimination of can-milk reception.
  » Introduction of ISO 9001 & ISO 22000.
  » Compliance to Food Safety and Standards Act, 2006 and sequel Rules & Regulations, 2011.
  » Human safety, Plant Safety, Environmental safety and Energy Conservation & Management.
  » Introduction of OHSAS 18001, ISO 14001 aligned to Q-systems: ISO 9001 & ISO 22000.
  » Plant efficiency & Energy conservation

    ✓ Replacement of old milk pasteurizers with newer ones having regeneration efficiency of more than 90%.
    ✓ Phasing out the pneumatic milk packaging machines with the mechanical ones (preferably high-speed machines).
    ✓ Refrigeration, being the weak operational area, the quality & food-safety issues are on the rise
    ✓ Introduction of ISO 50001

9.2 Netherlands Expertise in Training and Capacity Building

9.2.1 Holland Door

Netherlands Holland Door offers training across the globe to various stakeholders in agriculture and livestock professionals and farmers to build their capacity for improving their skills and efficiency. A few trainings offered in dairy sector by HollanDoor is listed below.

Value chain training to empower small-scale dairy farmers: The training on value chain practices and marketing and sales strategies provides deeper understanding of the market needs and potential market opportunities. The training finally helps in problem-solving actions or opportunities for beneficial improvements.

Development of the online Dairy Training Center (DTC): Provides dairy farmers with the knowledge and skills they need to operate in this ever-evolving industry.

Online training on dairy farming sustainable feed Hydroponics and waste management.

Training on developing skill sheets in fields such as milking, animal health, and feed and fertility.

CowSignals®: A tool for feeding, health, housing, reproduction, and milking for extension workers offered for improving health and reproduction on dairy farms

9.2.2 Dairy Training Centre

Dairy Training Centre (DTC), formerly known as PTC+ Oenkerk, is a leading, international training center for practical dairy training located in the Netherlands and working worldwide. For over 40 years now DTC conducts international training programs, consultancy and capacity building alongside the implementation of training projects all over the world.

DTC has developed an E-Learning platform, especially to be used by franchise partners all over the world. Improved technologies, improved connectivity, smartphones and cloud computing make E-Learning a realistic option for DTC students all over the world.

The practical trainings that are typical for DTC are combined with online interventions in the form of E-learning modules and preparation of back home assignments. Using blended learning, DTC is able to offer more effective and highly personalized training. Via the E-Learning platform, DTC allows their students to gain knowledge and insights, 24 hours per day, 7 days a week.

9.2.3 Bles Dairies Consultancy (BDC)

BDC is the international specialist in marketing agrarian business knowledge. They offer consultancy services within the entire dairy value chain, from feed to factory gate. They advise on all aspects of dairy farming (both rural and large scale), milk collection and processing to a wide range of clients.

- Curriculum development and training of technical experts and management
- Technical assistance on all subject matter related to dairy farming such as feeding, forage production, farm management, herd administration, farm economics and business planning
- Dairy sector studies (dairy value chain)
- Feasibility and investment studies (dairy farming, milk collection, milk processing);
- Technical audits related to investment and mergers
- Establishment of quality-based milk payment systems
- Food safety i.e., milk quality improvement programs
- Provision of short-term and long-term management support
- Technical assistance on all subject matter related to milk quality, collection, and processing
- Design and engineering of dairy farms, milk collection centers and milk processing plants
- Rural dairy sector development

9.2.4 The International Dairy Federation (IDF)

IDF represents the global dairy sector and ensures the best scientific expertise is used to support high quality milk and nutritious, safe and sustainable dairy products. For the last 120 years, IDF has contributed to the development of standards for the dairy sector and has closely collaborated with key stakeholders to share its expertise for milk and dairy products, with safe, sustainable and fair- trade practices.

9.2.5 Dutch Farm Experience (DFE)

DFE is a leading company organizing exchange and training programs with the Natural Livestock Farming (NLF) network on challenges related to sustainable dairy farming and milk quality. An important focus is on the improvement of milk quality by improving cattle health and reducing the use of antibiotics and other pharmaceuticals through the NLF 5-layered strategy.

The exchanges and training include proof of concept of practices, including:

- Good animal management strategies: Feeding, water provision, housing, general care and animal treatment, hygiene, and grassland management
- Breeding of robust animals well adapted to local conditions through (1) strategic three-way crossbreeding programs, or (2) local breeds improvement programs.
- Safe and effective use of medicinal plants for prevention and cure of common cattle diseases. Set up local herbal gardens and create an inventory of medicinal plants in the local area.
- Training on milk quality control on chemical residues.
- How to improve farm income through reduced costs and stimulating direct marketing initiatives, for example with local breed products.

Pilots with these strategies have been done in India, Ethiopia, and the Netherlands

Overall, Dutch companies can offer best-in-class training and capacity building activities for Indian dairy farmers, unskilled and skilled workers and entrepreneur's skill set development.

KEY INSIGHTS

- Training needs have been identified across the supply and value chain but majorly in genetic improvement, food safety, and quality compliance.
- Train the Master Trainers at the senior level
- Develop Training modules in local languages for lower strata of the organization
- Develop online modules for middle and senior management.

CHAPTER X: Policies for Dairy Development

India's domestic dairy policy has evolved through different phases, including "Operation Flood," the "Perspective Plan" and the current National Dairy Plan period. The National Dairy Development Board, a key player in implementing national dairy policy, enhanced milk procurement, processing, and marketing during Operation Flood by setting up dairy cooperatives to connect small rural producers with urban consumers.

The focus under the NDP has now changed to enhancing animal productivity, with a targeted approach in 14 key milk-producing states. These states contribute approximately 90 % of the total milk production. The strategy will revolve around genetic enhancement, better animal nutrition, and bolstering village-based systems for milk procurement.

There have been constant efforts to strengthen India's dairy sector to make it more competent in the entire dairy value chain process. Government initiatives intend to transform the conventional method of dairy farming into a more modern and sustainable approach. Components such as the implementation of ICT, setting up of high-quality labs, selective breeding, breed conservation, strengthening of cold chain infrastructure, adoption of modern food safety and quality assurance practices etc., suggests the government's aspiration for achieving a holistic development of the dairy sector.

These schemes cover almost every aspect of the dairy business value chain such as:

- Fodder Development
- Breeding, Conservation and Rearing of Milch animals
- Capacity Building and Skill Development
- Strengthening of Production and Procurement Infrastructure
- Establishment of ICT and Communication Technologies in Dairy Sector
- Quality Assurance and Food Safety
- Lab Testing of Milk Products
- Cold Chain Strengthening
- Marketing Assistance and Incentives for Exports of Dairy Products from India

The major government initiatives to develop dairy sector in India are:

- National Programme for Dairy Development (NPDD)
- Dairy Processing and Infrastructure Development Fund (DIDF)
- Supporting Dairy Cooperatives and Farmer Producer Organizations engaged in dairy activities (SDCFPO)
- Rashtriya Gokul Mission (RGM)
- National Livestock Mission (NLM)
- Animal Husbandry Infrastructure Development Fund (AHIDF)

10.1 National Programme for Dairy Development (NPDD)

Objectives:

- **Creation of infrastructure**
- **Training of dairy farmers**
- **Linking farmer to cooperatives**
- **Strengthening consumer**

Year: 2021-22 to 2025-26 **Beneficiaries:**

- State Cooperative Dairy Federations/ District
- Cooperative Milk Producers Union **Type of Assistance:**

1. Grants for Strengthening Procurement and Cold Chain Infrastructure
2. Grants/Assistance for setting up and strengthening of Laboratories

Impact:

- 15,054 dairy cooperative societies organized/ revived with an enrolment of 1.50 million new farmers/ milk producers and procurement of 3.912 million litres of additional milk from farmers.
- 23,798 dairy cooperative societies strengthened with the installation of an Automatic Milk Collection Unit to bring transparency in milk testing and payments to farmers.
- 3,220 Bulk Milk Coolers with 6.42 million litres chilling capacity have been installed to provide market access to farmers and reduce milk spoilage.
- 4,243 Electronic Milk Adulteration Testing Equipment and 120 FTIR Technology-based Milk Analyser/Food Scan/NIRS Tech Milk Powder Analyzers have been installed for checking adulteration in milk and milk products. This will encourage farmers to produce quality milk.
- 2.29 million litres per day of new milk processing capacity established to process and market additional milk procured from farmers.
- Establishment of State Central Laboratory in 15 States and strengthening of milk testing laboratories of District Cooperative Milk Unions to check milk quality and increase consumer acceptance and market

10.2 Dairy Processing & Infrastructure Development Fund (DIDF)

Year: 2017-18 to 2030-31

Modernize milk processing plants and machineries

Create additional milk processing capacity

Provide greater opportunities to rural milk producers

Increase price realization to milk producers

Beneficiaries:

Milk processing plants, producer owned and controlled institutions

Type of Assistance:

Long Term Credit assistance for Dairy processing Plants, producer owned and controlled institutions

Impact:

- 9.5 million milk producers will be benefited by covering 50,000 villages.
- Establishment of 28,000 Bulk Milk Coolers with 14 million litres per day as additional milk chilling capacity.
- Creation of an additional 210 Metric Tons per day Milk Drying capacity.
- Modernization, expansion and creation of milk Processing capacity of 12.6 million Litres per day.
- Creation of infrastructure of 5.978 million litres per day capacity for value-added dairy products to ensure remunerative prices to milk producers.
- Providing 28,000 milk testing equipment to check adulteration in milk.

10.3 RASHTRIYA GOKUL MISSION (RGM)

Year: 2014 to 2026 (under the umbrella scheme Rashtriya Vikas Yojna)

Enhance bovine's productivity and increase milk production

Promote breeding of high genetic merit bulls

Strengthen artificial insemination coverage

Promote conservation of indigenous bovines

Beneficiaries:

Rural cattle and buffalo keepers in the country

Types of Assistance:

Farmers incentives/competitions for best practices

Impact:

- **Accelerated Breed Improvement Programme using IVF:**
  - ◊ Leveraging IVF technology and artificial insemination with sex-sorted semen to produce female calves for dairy farmers.

◊ IVF allows for rapid genetic upgradation, equivalent to 7 generations in 3 years for cattle and buffaloes.

◊ Potential to increase farmers' income significantly by producing high-yielding female calves.

◊ 0.2 million IVF pregnancies planned in the next five years with a subsidy of ₹ 5000 per assured pregnancy.

◊ 33 IVF labs sanctioned, 20 labs operational, with 17,547 viable embryos produced, 7,704 transferred, and 1,270 calves born.

- **Sex Sorted Semen Production:**
  - ◊ Introducing sex-sorted semen production with up to 90% accuracy for female calves.
  - ◊ Aimed at enhancing milk production and controlling stray cattle population.
  - ◊ Targeting 5.1 million pregnancies in the next five years, with a subsidy of ₹ 750 or 50% of the sorted semen cost.

- **Establishment of Breed Multiplication Farms:**
  - ◊ Providing a 50% subsidy (up to ₹ 20 million crores per farm) on capital cost for private entrepreneurs establishing farms with a minimum herd size of 200 bovines.
  - ◊ Aims to address the challenge of procuring high-quality heifers, attract investment, and create a hub-and-spoke model for dairy farming.
- **Nationwide Artificial Insemination Programme (NAIP):**
  - ◊ Launched in 605 districts to deliver quality AI services free of cost at farmers' doorstep.
  - ◊ Covered 44.1 million animals, performed 54.4 million AI, and benefitted 29.3 million crore farmers.
  - ◊ Targeting 30 million inseminations in 592 districts in 2023-2024.
- **Induction of MAITRIs:**
  - ◊ Project for establishing Multi-Purpose AI Technicians in Rural India (MAITRIs) under RGM.
  - ◊ Trained and inducted 35436 MAITRIs,
- **Progeny Testing and Pedigree Selection:**
  - ◊ Implemented for producing high genetic merit bulls, with 4,490 bulls produced and inducted at semen stations
- **Genomic Selection:**
  - ◊ Introduced genomic selection for indigenous breeds to reduce bull production cost from ₹ 0.6 million to ₹ 85,000.

◊ Genomic chips developed for high-accuracy selection, to be extensively used in the next five years.

- **Establishment of Gokul Gram:**
  ◊ Integrated indigenous cattle development centers established for conservation and development of indigenous bovine breeds.
  ◊ Funds released for 16 Gokul grams, with 14 completed for civil works and animal induction.
- **National Gopal Ratna Award 2022:**
  ◊ Awarded to best dairy farmers, AI technicians, and dairy cooperatives, with cash prizes up to ₹0.5 million.
- **Animal Husbandry Startup Grand Challenge 2.0:**
  ◊ Organized to address sector problems, with cash prizes up to ₹1 million for winners and ₹ 0.7 million for runners-up.
- **National Kamdhenu Breeding Centre:**
  ◊ Two centers set up to conserve and develop indigenous breeds, supplying certified germplasm to farmers.
- **Farmer Awareness Programme:**
  ◊ Conducting fertility camps and releasing funds for awareness generation among farmers.
- **e-GOPALA app:**
  ◊ Launched as a comprehensive breed improvement marketplace and information portal for farmers.

10.4 National Livestock Mission

Objective


Feed and fodder development


Breed development


Extension and Innovation

Year: 2014- still running

Beneficiaries:

Various Stake Holders in Indian Animal Husbandry Sector

Types of Assistance:

1. Back ended subsidy for setting up of Dairy Units

2. Credit assistance for setting up of Dairy Units Promote milk exports

10.5 Animal Husbandry Infrastructure Development Fund (AHIDF)

Objectives

- Increase processing capacity and product diversification
- Promote milk exports
- Foster entrepreneurship and generate employment
- Quality feed at affordable price

Year: 2020-2026

Beneficiaries:

Individuals, Private Companies, FPO, MSME, Section 8 companies

Types of Assistance:

1. Beneficiaries are required to contribute a minimum of 10% as margin money.

2. The remaining 90% is provided as a loan component by scheduled banks.

Impact:

- Leverages private investment, potentially 7 times the initial investment.
- Encourages farmers to invest more in inputs, leading to higher productivity and increased income
- Tap in latest technologies to improve Dairy processing and product diversification, Breed multiplication, Veterinary vaccine and drug production facilities, Animal Waste to Wealth Management

10.6 Additional Schemes and Innovative Development Programmes:

NDP Phase-2 (Mission Milk)

Five-year program from 2020-2025

Focus: Develop milk processing infrastructure

Establish milk quality testing equipment at critical procurement points.

Implemented through National Bank for Agriculture and Rural Development(NABARD) for self-employment and infrastructure development of the dairy sector

- **Scheme to support Dairy Cooperatives and Farmer Producer Organizations (SDCFPO)**

Implemented by **NDD**B to provide stable market access to dairy farmers

- **Production Linked Incentive Scheme**

Focus on dairy products such as mozzarella cheese, ice cream, milk-based beverages, and Indian traditional sweets

Aims to encourage investments by dairy sectors in VADPs (value-added products) and help in integrating the entire dairy supply chain.

Beneficiaries: Proprietary Firm or partnership firm or Limited Liability Partnership (LLP) or a company
registered in India, co-operatives, small and medium enterprises

- **Nandi - NOC Approval for New Drug and Inoculation System - Portal**

Laid out as part of the Animal Pandemic
Preparedness Initiative (APPI). This online portal has been developed by the Department of Animal Husbandry and Dairying (DAHD) to pave the way to a resilient animal health sector in India by streamlining and digitizing the regulatory approval process. DAHD Online Portal aims to speed up the process to assess and examine the safety, efficacy, and essentiality/desirability of veterinary product proposals received in the department to achieve the goal of developing a global manufacturing hub for veterinary products in the country and stimulating research and development focused on improving animal health.

- **NCDFI e-market**

National Cooperative Dairy Federation of India (NCDFI), with the technical support of NCDEX e-markets Limited (NeML) has launched the NCDFI e-market in 2015. It is an electronic marketplace for efficient buying and selling of bulk commodities across the country.

Commodities being traded are:

Dairy products, cattle feed ingredients, edible oils, packaging materials, sugar, chemicals, scrap, etc. apart from transport services.

10.2 GOVERNMENT INTERVENTIONS FOR DAIRY PROCESSING SECTOR

Government of India has taken up various initiatives to boost the dairy processing. Government of India has from me to me adopted policies that benefit the dairy processing sector directly. This ranges from FDI regulations, imposing tariffs on dairy imports, easing requirements for operating dairy processing units etc. Some of the prominent policies are listed below:

Easing FDI regulations

- 100% FDI in the food processing, including Dairy Products, through the automatic route.
- 100% FDI in Retail Trade, including e-Commerce, for the food products manufactured and/or produced in

Milk and Milk Product Order (MMPO), 1992

Promulgated under the Essential Commodities Act, this order regulates milk and milk products production in India. The order requires permission only for units handling more than 10,000 litres per day of milk or 500 tons per annum milk solids.

Income Tax exemptions

Corporate tax has been substantially reduced in the budget announcement of 2019, making India among the countries with lowest corporate tax. where new companies

Corporate tax slab

New companies: 15%
Existing companies: 22% + cess

Enabling Environment

The government classified food processing sector including dairy processing under 'agricultural activity' and is considered under Priority Sector Lending for ensuring credit availability in the sector.

Special fund of ₹ 2000 Cr set up in NABARD (National Bank for Agricultural and Rural Development) to provide affordable credit to boost food processing sector.

Key Insights

The pro-industry policies of India for the dairy sector gives a positive impact on small and medium-scale industries for vertical and horizontal expansion. However, they might require support in capacity building and skill development, strengthening of production and procurement Infrastructure, Establishment of ICT and communication technologies in the dairy sector, quality assurance, and food safety, lab testing of milk products, cold chain strengthening, marketing assistance and incentives for exports of dairy products from India.

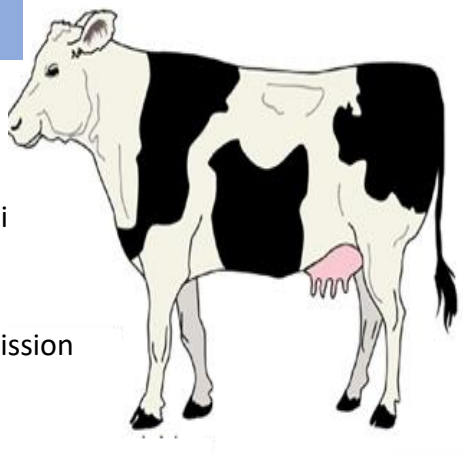
CHAPTER XI: Roadmap for Dairy Sector Development

ROADMAP FOR DAIRY SECTOR DEVELOPMENT

Farmers are increasingly choosing to raise buffalo over cattle due to a significant increase in milk prices in 2023, particularly for milk fat. As the population continues to grow, the demand for dairy products is increasing, providing a large consumer base for the industry. Rising consumption is the major driving factor of the Indian dairy industry. Population growth and increasing income levels are fuelling this rise. Rising affluence has also enabled a larger segment of the population to spend more on nutritious food items, with dairy products being a traditional staple in Indian diets. Hence an attempt was made to outline the integration of the Indian dairy industry with global markets with a glance of current opportunities in the challenges faced by the Indian dairy sector.

The Indian dairy sector is brimming with diverse opportunities across various segments, from upstream innovations to downstream market expansions. In the upstream sector, the rapidly growing sex-sorted semen market, along with crossbreeding initiatives and an increasing demand for compound cattle feed, presents significant avenues for growth. Additionally, there is a burgeoning market for feed additives and innovative solutions for heat stress management and manure management. On the downstream side, products like cheese, yoghurt, and ghee are witnessing high margins and increasing demand, alongside advancements in packaging technology and quality control measures. The integration of blockchain technology and IoT offers further enhancements in traceability and efficiency. Furthermore, capacity building initiatives in areas such as artificial insemination and regulatory compliance are essential for fostering sustainable practices. With strong potential for exports, particularly among the Indian diaspora, and support for startups and small companies, the Indian dairy industry stands poised for robust growth and innovation.

Opportunities in Upstream Market



- Cross Breeding with exotic & indigenous breeds
- Growing sex-sorted semen market
- Expanding demand for compound cattle feed
- Growth in ionophores as feed additives for emi reduction
- Growing demand for compound cattle feed
- Innovative manure management methods for gas emission control
- Balanced feed production techniques
- Early detection kits & vaccinations for diseases (mastitis, F&M, brucellosis)
- Low-cost technologies to mitigate heat stress specifically in in Northen states
- Silage production and training opportunities in Punjab, Haryana, UP, Rajasthan, Northeast states
- Feed additives, amino acids, binders, minerals & probiotics comprise 60.5% of the market's total value. Lysine and methionine are the leading in amino acids market.
- Concentrate Feed Segment is dominant in the cattle feed market, commanding 43.5% of the total market share in 2024

Opportunities in Downstream Market

- 39% of the total market is occupied by companies with less than 1% of the market share. This leaves a lot of scope for technology transfer and knowledge sharing High-Margin Dairy Products: Cheese, Yoghurt, and Ghee
- Milk is commonly packaged in plastic pouches made from high-density polyethylene (HDPE) or low-density polyethylene (LDPE). Aseptic packaging is becoming more popular, as it helps to increase the shelf-life of dairy products.
- Expanding Markets for Diverse Milk and Curd Variants
- Expansion of Cheese and its Variants
- Blockchain Technology in Supply Chain Management
- IOT and Data Analytics for Enhanced Operations
- Detection kits for Adulterants, Somatic Cell Count, and Mycotoxins

Training and Knowledge Sharing

- Food Safety and Quality Control Training
- Capacity Building in Artificial Insemination (Sex-Sorted Semen)
- Regulatory Compliance and Certification Education
- Knowledge Exchange on Waste Management
- Trainings for master trainers in at senior level
- Develop training modules in local languages for lower strata of organization
- Develop online modules for middle and senior management

Growing Markets with Export Potential

- Export Potential for the Indian Diaspora
- Opportunities for Exporting Milk Products with Quality and Traceability Checks

Nurturing Business

Nurturing small companies and providing identification, training, technology transfer, testing, and financial support for medium and large herd size dairy farmers.

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About

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a pioneering, international non-profit scientific research for development organization, specializing in improving dryland farming and agri-food systems. The Institute was established as an international organization in 1972, by a Memorandum of Agreement between the Consultative Group on International Agricultural Research and the Government of India. ICRISAT works with global partners to develop innovative science-backed solutions to overcoming hunger, malnutrition, poverty, and environmental degradation on behalf of the 2.1 billion people who reside in the drylands of Asia, sub-Saharan Africa, and beyond.

Asia

ICRISAT - India (Headquarters)
Patancheru 502 324, Hyderabad
Telangana, India
Phone: +91 8455683071
Fax: +91 8455683074
Email: icrisat-ind@icrisat.org

ICRISAT - India (Liaison Office)
CG Centers Block
NASC ComplexDev Prakash Shastri Marg, New Delhi 110012, India
Phone: +91-11-25840294
Fax: +91 1125841294
Email: icrisat-ind@icrisat.org

West and Central Africa

ICRISAT - Mali
(Regional hub WCA)
BP 320 Bamako, Mali
Phone: +223 20 709200
Fax: 223 20 709201
Email: icrisat-mli@icrisat.org

ICRISAT - Niger
BP 12404
Niamey, Niger (via Paris)
Phone: +(227) 20722725, 20722626
Fax: +227 20734329
Email: icrisat-ner@icrisat.org

ICRISAT - Nigeria
PMB 3491
Sabo Bakin Zuwo Road
Tarauni, Kano, Nigeria
Phone: +234 7034889836
Email: icrisat-nga@icrisat.org

ICRISAT - Senegal
c/o Africa Rice
Mamelles Aviation, Villa 18
BP 24365 Dakar, Senegal
Phone: +221 338600706
Email: icrisat-sen@icrisat.org

Eastern and Southern Africa

ICRISAT - Kenya
(Regional hub ESA)
PO Box: 39063, Nairobi, Kenya
Phone: +254 20 7224550
Fax: +254 20 7224001
Email: icrisat-ken@icrisat.org

ICRISAT - Ethiopia
C/o ILRI Campus
PO Box 5689, Addis Ababa, Ethiopia
Phone: +251-11 617 2541
Fax: +251-11 646 1252, +251 11 646 4645
Email: icrisat-eth@icrisat.org

ICRISAT - Malawi
Chitedze Agricultural Research Station
PO Box 1096, Lilongwe, Malawi
Phone: +265 1 707 297/071/067/057
Fax: +265 1 707 298
Email: icrisat-mwi@icrisat.org

ICRISAT - Zimbabwe
Matopos Research Station
PO Box 776, Bulawayo, Zimbabwe Phone: +263 292 809314/315
Fax: +263 383 307
Email: icrisat-zwe@icrisat.org