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RESEARCH PAPER

Demand System of Functional Dairy Foods and its Projection: Implications for Dairy Processing in Tamil Nadu

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ABSTRACT

The study examines the demand structure and future prospects of functional dairy foods (FDF) in Tamil Nadu using primary data collected from 220 respondents (160 consumers and 60 sales points). A double-log demand model was employed to estimate income and price elasticities, while a growth rate approach was used to project demand up to 2036. The results indicate that functional dairy foods currently account for a small but emerging segment of the dairy sector, constituting about 1.26 per cent of total milk production and 3.78 per cent of processed milk in milk-equivalent terms. The demand analysis reveals heterogeneous consumption behaviour across products, with significant expenditure elasticities observed for fortified milk, probiotic drinks, and malted milk foods. Own-price elasticities were significant and inelastic for most products, indicating relatively stable demand in response to price changes. Cross-price relationships suggest limited and product-specific substitution and complementarity effects among functional dairy foods. Demand projections under pessimistic (2.12%), business-as-usual (5.44%), and optimistic (8.18%) growth scenarios indicate steady expansion, with total demand reaching 157.44, 181.29, and 203.40 ML/year by 2036, respectively, corresponding to compound annual growth rates of 1.51, 2.61, and 3.53 per cent. The findings suggest that while the functional dairy segment is still in a nascent stage, it holds potential for gradual expansion driven by income growth and changing dietary preferences. From a policy perspective, strengthening supply chains, improving product accessibility, and enhancing consumer awareness will be important to support sustained growth in the functional dairy food sector.

HIGHLIGHTS

- The study investigates the demand system for functional dairy foods (FDF) in Tamil Nadu, India, and projects demand up to the year 2036.
- In Tamil Nadu, functional dairy foods account for 1.26 per cent of total milk production and 3.78 per cent of processed milk in milk-equivalent terms.
- Demand for functional dairy foods is relatively inelastic, showing limited responsiveness to changes in consumer income and product prices.
- The demand for functional dairy foods is projected to grow at a compound annual rate of 1.51 to 3.53 per cent, highlighting an opportunity for the dairy processing sector.

Keywords: Functional dairy foods, double log model, growth rate model, probiotic foods, fortified foods, Functional foods, Demand analysis

Functional foods have attracted considerable attention in the global food and nutrition industry for their potential to provide health benefits beyond basic nutrition. However, the concept of functional foods continues to lack a universally accepted definition (Benkouider, 2005). Various national and international bodies, academic institutions,

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and industry groups have proposed alternative interpretations, resulting in a broad spectrum of definitions. For instance, the Institute of Medicine's Food and Nutrition Board (IOM/FNB, 1994) defines functional foods as those that provide health benefits beyond traditional nutrient functions, whereas Bech-Larsen and Grunert (2003) emphasize their role as modified conventional foods designed to deliver additional physiological benefits. This definitional ambiguity has implications for both market assessment and policy formulation, as the scope of functional foods varies significantly across studies and regions (Kotilainen *et al*. 2006).

Despite these conceptual challenges, the demand for functional foods has expanded rapidly, driven by rising health awareness, changing lifestyles, and increasing prevalence of non-communicable diseases. The growing emphasis on preventive healthcare and nutrition-sensitive consumption has led to increased consumer willingness to pay for value-added food products with perceived health benefits (Verbeke, 2005; Siegrist *et al*. 2015). This trend is particularly relevant in the context of the Sustainable Development Goals (SDGs), especially Goal 3, which emphasizes ensuring healthy lives and promoting well-being for all, and is increasingly linked to policy discussions on sustainable and economically viable agri-food systems (Dhasarathan, 2025). The expansion of the functional food sector is therefore not only a market phenomenon but also a reflection of broader structural changes in consumer behaviour and public health priorities.

From an economic perspective, the global functional food market has witnessed substantial growth over the past two decades. Early estimates placed the market size at around $61 billion (Benkouider, 2004), and subsequent studies indicate a sustained upward trajectory driven by innovation, product diversification, and increasing consumer awareness (Bigliardi and Galati, 2013). Within this broad category, functional dairy foods have emerged as one of the most dynamic segments due to their compatibility with fortification, probiotics, and bioactive compounds (Sharma and Garg, 2013; Granato *et al*. 2010). In India, the functional dairy food market is expected to grow at a rate of around 5.7 per cent during 2022–2032, reflecting the combined effects of income growth, urbanization, and dietary transitions (Shireen and Aneesh, 2021).

The Indian dairy sector, being one of the largest in the world, plays a crucial role in ensuring nutritional security and supporting rural livelihoods. With increasing income levels and diversification of consumption patterns, there is a gradual shift from traditional dairy products to value-added and functional dairy foods. Empirical studies have shown that demand for such products is influenced by socioeconomic factors such as income, prices, education, and awareness, as well as product-specific attributes such as perceived health benefits, safety, and affordability (Dhasarathan *et al*. 2024; Dhasarathan *et al*. 2025). Furthermore, the expansion of organized retail systems and improvements in cold chain infrastructure have enhanced the accessibility and availability of functional dairy products, thereby reinforcing demand growth (Pingali, 2007; Reardon *et al*. 2012).

However, despite the increasing importance of functional dairy foods, there remains a significant gap in the empirical literature regarding their demand structure in the Indian context. Most existing studies have focused on consumer awareness, perception, or general consumption patterns, with limited attention to the estimation of demand systems that capture price and income responsiveness as well as substitution and complementarity relationships among products. In addition, very few studies have attempted to integrate demand estimation with long-term projections under alternative growth scenarios, which are essential for strategic planning in the dairy processing sector.

In this context, the present study aims to analyse the demand system of functional dairy foods in Tamil Nadu using a double log demand model and to project future demand under different income growth scenarios up to the year 2036. By combining primary data with econometric analysis and forward-looking projections, the study provides a comprehensive understanding of consumption behaviour, demand elasticities, and future market potential. The findings are expected to offer valuable insights for policymakers, dairy processors, and other stakeholders in designing strategies to enhance the production, marketing, and consumption of functional dairy foods in India.

RESEARCH METHODOLOGY

Description of study area and data sources

The study was conducted in Tamil Nadu, one of the most urbanized and economically advanced states in India, characterized by a well-developed dairy sector and growing demand for value-added dairy products. The state recorded a total milk production of 10.316 million tonnes in 2022–23, with a per capita availability of 369 g/day (BAHS, 2023). Tamil Nadu has also experienced a significant increase in milk and milk product consumption, with a growth rate of 70.8 per cent over the period 1983 to 2009–10 (Kumar *et al*. 2014). With 48.40 per cent of its population residing in urban areas (Ministry of Housing and Urban Affairs, 2024) and relatively high per capita income, the state provides a favourable environment for analysing the consumption of functional dairy foods. The presence of organized dairy networks such as Aavin and major private players further strengthens its relevance for the study.

For this research, the Chennai and Salem districts were purposively selected to capture variations in consumption behaviour across different market environments. Chennai, being a metropolitan city, represents a highly urbanized setting with higher income levels, greater health awareness, and well-established retail networks for functional dairy products. It also serves as a major commercial hub with the presence of organized dairy institutions and modern retail outlets. Salem district represents a semi-urban and emerging dairy economy with strong production and processing activities. The district ranks first in milk procurement among cooperative unions, with an average procurement of 5,13,411 litres per day (Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department, 2023). The presence of major private dairy firms further enhances its importance in the dairy value chain.

The selection of these two districts ensures representation of both advanced urban markets and emerging dairy regions, thereby capturing variations in income levels, market access, and consumer preferences. Although the study is limited to two districts, their selection based on economic and market characteristics improves the analytical relevance of the findings and allows for broader inference within similar contexts.

The study utilizes both primary and secondary data. Primary data were gathered through direct, personal interviews using a well-structured and pre-tested questionnaire. A random sample of 160 respondents was selected from diverse purchasing locations, equally representing urban/semi-urban and rural areas across the two districts. Additionally, 60 supply chain intermediaries (sales points) were also identified through random sampling, balanced between urban/semi-urban and rural areas of Chennai and Salem. Data on functional dairy food sales, including types of agencies, quantities, and pricing, were collected through a semi-structured interview schedule. Secondary data were obtained from various sources, such as research articles and websites, to supplement information on functional dairy foods, major market participants, and product details.

Analytical framework

The analytical tools employed in the study include the simultaneous equations of the demand system (double log model) for demand analysis, and the growth rate model to project demand for various functional dairy foods.

Demand analysis - double log model

Various models exist for estimating income and price elasticities of demand for a commodity. Recent studies on demand have primarily focused on comprehensive demand systems that consider the mutual interdependence among numerous commodities in consumer budgetary decisions. Most of the research on demand is based on a single-equation model that establishes a relationship between consumption (expenditure), income (total expenditure) and prices. In this study, we have conducted estimations using a double log model. The complete demand system of simultaneous equations was estimated using the Generalized Least Squares (GLS) procedure and is specified as:

$$\log y_{in} = a_i + b_i \log m_n + \sum_{j=1}^{i} c_{ij} \log P_{jn} + d_i D_n + \varepsilon_{in}$$

$n = 1, 2, \ldots, N$; $i = 1, 2, \ldots, M$

The actual model is specified as:

$$y_{in} = a_i \times \prod_{j=1}^{i} P_{jn}^{c_{ij}} \times m_n^{b_i} \times e^{d_i D_n} \times e^{\varepsilon_{in}}$$

$n = 1, 2, \ldots, N$; $i = 1, 2, \ldots, M$

Where, y_{in}= quantity of consumption of the i^{th} functional dairy food in the n^{th} observation, P_{jn}= price of the j^{th} functional dairy food in the n^{th} observation, m_n= income in the n^{th} observation (or total expenditure), c_{ij} = price coefficients of the j^{th} functional dairy food in the i^{th} equation, D_n= dummy variable (to capture regional variation (0 = Rural, 1 = Urban/Semi-urban)) in the n^{th} observation, ε_n= error term for the i^{th} functional dairy food in the n^{th} observation. The estimated coefficients give elasticities in the double log specifications.

Demand projection - growth rate model

Sustained economic growth and a steady increase in per capita income are expected to substantially boost the demand for functional dairy food products. The demand for direct consumption of functional dairy foods was projected based on the following factors: per capita demand for the functional dairy foods in the base year (d_0), projections for population made by the Government of India (N_t), per capita income growth (y), expenditure elasticity of demand for the functional dairy foods (e), proportion of urban population (u), growth rate of urbanisation (u_r).

These demand projections are limited to household consumption only. The projection for 2036 was made using a growth rate model. The demand projection year was selected as 2036, based on population growth estimates provided by the Technical Group on Population Projections, which projects population figures up to the year 2036.

$$D_t = d_0 \times N_t \times \{1 + (y \times e) + (u \times u_r)\}^t$$

Where, D_t = household demand for a functional dairy food in year t, d_0= per capita demand for the functional dairy foods in the base year, y = growth in per capita income, e = expenditure elasticity of demand for the functional dairy foods, N_t = projected population in year t, u = proportion of urban population, u_r= growth rate of urbanisation.

The per capita demand of functional dairy foods was calculated by using the following procedure.

Quantity of milk and other dairy products, including functional dairy foods, sold by various sales points in Tamil Nadu = Processed milk (A) = 93,19,000 L/day

A = 34,01,435 T/year

(As of 2021, Economic Research Service, Government of India, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Basic Animal Husbandry and Fisheries Statistics (calculated from various issues))

The milk equivalent quantities (MEQ) of functional dairy foods as a percentage of total sale (estimated from the sales points – Primary data) = **(B)**

Total sale of functional dairy foods = Total demand of functional dairy foods in Tamil Nadu = B×A = **(C)**

Per capita demand of the functional dairy foods in Tamil Nadu in base year 2021 $\frac{C}{N_t}$

RESULTS AND DISCUSSION

Urban and rural areas differ significantly in terms of accessibility to markets and the availability of functional dairy foods. Urban areas typically have better access to a wider variety of functional dairy products, which could influence consumption patterns. Also, the socio-economic conditions of households in urban and rural areas often differ, leading to variations in purchasing power and dietary preferences. Analyzing consumption level based on urban and rural classifications helps in understanding the impact of these differences on the demand for functional dairy foods.

Table 1 presents the average monthly per capita consumption (MoPC) of functional dairy foods along with the number of consuming households between urban/semi-urban and rural settings. The results reveal considerable variation in both the extent of adoption and consumption intensity among different functional dairy products. The number of consumers varies significantly across products, indicating differences in market penetration and consumer acceptance. Products with a higher number of consuming households reflect greater familiarity and wider acceptance, whereas those with fewer consumers suggest limited awareness or niche demand. This pattern highlights that the functional dairy market is still in a developing

stage, with uneven diffusion of products among consumers.

The MoPC values further indicate differences in consumption intensity across products. Functional dairy products like fortified milk (2.98L [Urban]) exhibit relatively higher per capita consumption among users, suggesting habitual or regular consumption patterns, while others such as probiotic drink (0.02L [Urban]), probiotic ice-cream (0.42L [Urban]) show lower MoPC, indicating occasional or supplementary use. This distinction between adoption (number of consumers) and intensity (MoPC) is important in understanding consumer behaviour, as some products may have wide reach but low consumption levels, whereas others may be consumed intensively by a smaller segment of consumers.

Table 1: Average monthly per capita consumption (MoPC) of functional dairy foods in different situations

Products	Particulars	Urban/Semi-urban area (n=100)	Rural area (n=60)
Fortified milk (L)	MoPC	2.98	2.49
	No. of consumer	20	14
Probiotic *lassi* (L)	MoPC	0.62	0.32
	No. of consumer	17	7
Probiotic curd (kg)	MoPC	0.54	0.33
	No. of consumer	26	21
Probiotic ice-cream (L)	MoPC	0.42	0.39
	No. of consumer	30	8
Probiotic drink (L)	MoPC	0.02	0.01
	No. of consumer	12	3
Malted milk food (kg)	MoPC	0.15	0.09
	No. of consumer	29	25

Source: *Computed by the Authors*

A comparison between urban/semi-urban and rural settings shows noticeable variation in both the number of consumers and MoPC levels. The higher consumption observed in more urbanized areas can be attributed to better availability of functional dairy products, greater exposure to health-related information, and more developed retail infrastructure. In contrast, relatively lower consumption in rural areas may be due to limited market access and lower awareness levels. Similar patterns have been observed in earlier studies, where urbanization and retail expansion play a significant role in shaping food consumption behaviour and promoting the adoption of value-added food products (Reardon *et al*. 2012; Siegrist *et al*. 2015).

Overall, the findings suggest that both product-specific factors and area characteristics influence the consumption of functional dairy foods. The variation in adoption and consumption intensity indicates significant potential for market expansion through improved distribution, awareness creation, and targeted marketing strategies, particularly in less penetrated regions.

Expenditure elasticities

Table 2 presents the estimated expenditure (income) elasticities for milk and selected functional dairy foods. The results indicate that only a few products, namely fortified milk, probiotic drink, and malted milk food, exhibit statistically significant income elasticities.

Table 2: Expenditure (income) elasticities of milk and functional dairy foods

Products	Constant (a_i)	Expenditure (income) elasticities (b_i)	R-squared
Milk	-1.194	0.019	0.381
	(1.192)	(0.108)	
Fortified milk	-0.51	0.059*	0.798
	(0.361)	(0.033)	
Probiotic *lassi*	-0.351	0.028	0.856
	(0.315)	(0.029)	
Probiotic curd	0.048	-0.003	0.890
	(0.348)	(0.032)	
Probiotic ice-cream	0.376	-0.038	0.898
	(0.467)	(0.042)	
Probiotic drink	-0.257**	0.025**	0.899
	(0.107)	(0.010)	
Malted milk foods	-1.174*	0.108**	0.796
	(0.599)	(0.054)	

Note: *Standard errors in parentheses.*

**** p<0.01, ** p<0.05, * p<0.1.*

Source: *Computed by the Authors*

The positive and significant income elasticities observed for fortified milk (0.059), probiotic drink (0.025), and malted milk food (0.108) suggest that the consumption of these products is responsive to changes in household income. This indicates

that these products are relatively more income-sensitive compared to other functional dairy items, reflecting their positioning as value-added or health-oriented products within the consumption basket. As household income increases, consumers tend to allocate a greater share of expenditure towards such products, consistent with the process of dietary diversification and the growing preference for nutritionally enhanced foods (Pingali, 2007; Herforth and Ahmed, 2015).

In contrast, the insignificant income elasticities for other functional dairy products may be attributed to factors such as limited consumer awareness, restricted availability, or their classification as niche products with low market penetration. It also suggests that non-income factors such as taste preferences, perceived health benefits, and accessibility may play a more dominant role in determining their consumption behaviour. Similar observations have been reported in studies on functional foods, where consumer acceptance is often driven more by awareness and perception than by income alone (Verbeke, 2005; Siegrist *et al*. 2015).

Overall, the findings highlight that income growth selectively influences the demand for certain functional dairy products, particularly those that are better established in the market and more widely recognized for their health benefits. This suggests that while rising incomes can support the expansion of the functional dairy sector, improving awareness, distribution, and consumer trust will be equally important for increasing the adoption of less popular products.

Among the functional dairy foods, the income elasticity for malted milk foods was relatively higher (0.108), followed by fortified milk (0.059), while probiotic drink recorded a comparatively lower but significant value (0.025).

Own and cross-price elasticities

Table 3 presents the own- and cross-price elasticities derived from the double-log demand model for milk and functional dairy products. All own-price elasticities carry the expected negative sign and are statistically significant at the 1% level, confirming the law of demand across all product categories. Plain milk exhibits the lowest own-price elasticity (−0.164), consistent with its status as a dietary staple in Indian households where demand remains relatively insensitive to price fluctuations. In contrast, malted milk food (−0.782), probiotic drink (−0.704), and probiotic curd (−0.645) display substantially higher price responsiveness, indicating that consumers treat these products as discretionary rather than essential purchases. Probiotic *lassi* (−0.493) and probiotic ice-cream (−0.330) occupy an intermediate position, while fortified milk (−0.289) is moderately elastic. The observed differences in price responsiveness between plain milk and functional dairy products reflect the premium positioning of functional foods and the presence of lower-cost alternatives, a pattern that is consistent with established findings in food demand literature (Andreyeva *et al*. 2010; Green *et al*. 2013).

The cross-price elasticity results reveal a largely segmented market structure, where most off-diagonal elasticities are statistically insignificant, suggesting that the majority of functional dairy products operate as independent goods in consumer budgets rather than as close substitutes or complements. This market segmentation likely reflects the distinct consumption occasions, health positioning, and consumer profiles associated with each product category.

A key cross-price relationship is observed between plain milk and fortified milk. An increase in the price of fortified milk leads to a rise in the demand for plain milk, indicating a substitution effect (0.095). This suggests that some consumers shift to plain milk when fortified milk becomes relatively more expensive. However, the reverse relationship is negative (-0.045), implying that an increase in the price of plain milk does not lead to higher demand for fortified milk, but instead slightly reduces its consumption. This asymmetry indicates that fortified milk caters to a relatively distinct consumer segment whose demand is less responsive to price changes in conventional milk.

Among other significant relationships, probiotic lassi shows a positive response to increases in the prices of both milk (0.095) and fortified milk (0.018), suggesting limited substitution between these products. Malted milk food demand increases when the price of probiotic *lassi* rises (0.013), indicating substitution, but decreases slightly with an increase in fortified milk prices (-0.015), suggesting a weak

Table 3: Own and cross-price elasticities of milk and functional dairy foods (c_{ij})

Products	Milk	Fortified milk	Probiotic lassi	Probiotic curd	Probiotic ice-cream	Probiotic drink	Malted milk food
Milk	-0.164***	-0.045***	0.003	-0.002	0.000	-0.004	-0.006
	(0.038)	(0.011)	(0.010)	(0.011)	(0.015)	(0.003)	(0.019)
Fortified milk	0.095**	-0.289***	-0.012	0.004	0.012	0.003	-0.022
	(0.047)	(0.014)	(0.012)	(0.014)	(0.018)	(0.004)	(0.024)
Probiotic *lassi*	0.095***	0.018*	-0.493***	0.008	0.010	-0.004	0.037**
	(0.035)	(0.011)	(0.009)	(0.010)	(0.014)	(0.003)	(0.018)
Probiotic curd	0.029	0.001	-0.002	-0.645***	-0.011	0.001	-0.010
	(0.030)	(0.009)	(0.008)	(0.009)	(0.012)	(0.003)	(0.015)
Probiotic ice-cream	0.077***	0.005	0.008	0.006	-0.330***	-0.006***	-0.006
	(0.025)	(0.008)	(0.007)	(0.007)	(0.010)	(0.002)	(0.013)
Probiotic drink	0.007	0.010	0.011	0.007	0.013	-0.704***	-0.000
	(0.037)	(0.011)	(0.010)	(0.011)	(0.014)	(0.003)	(0.019)
Malted milk food	0.014	-0.015**	0.013**	0.001	-0.000	0.001	-0.782***
	(0.021)	(0.006)	(0.006)	(0.006)	(0.008)	(0.002)	(0.011)

Note: *Standard errors in parentheses.*

**** p<0.01, ** p<0.05, * p<0.1*

Source: *Computed by the Authors.*

complementary relationship. Similarly, probiotic ice-cream demand increases with rising milk prices (0.077), confirming substitution between the two, while its negative response to changes in probiotic drink prices (-0.006) indicates mild complementarity within that segment.

Overall, these results highlight that substitution and complementarity relationships exist within the functional dairy market, but they are generally weak and product-specific, reflecting differentiated consumer preferences and usage patterns, as documented in previous demand system studies (Andreyeva *et al*. 2010; Green *et al*. 2013; Mutuc *et al*. 2007).

Demand analysis of functional dairy foods by the double log model

To provide a comprehensive understanding of the demand for functional dairy foods in Tamil Nadu, demand analysis was conducted. This approach involved converting the quantities of various functional dairy foods into their milk equivalent quantities. By standardizing the quantities in terms of a common base (milk equivalents), it was possible to create a unified measure that allowed for a more accurate and meaningful comparison of demand across different types of functional dairy foods.

Once all functional dairy food quantities were converted to their milk equivalents, the overall quantity consumed was determined by summing these milk equivalents. This provided a single, aggregated measure of consumption for all functional dairy foods, facilitating a clearer understanding of consumer preferences.

Similarly, an overall price for functional dairy foods was calculated. This was achieved by taking the weighted average of the prices of different functional dairy foods, with the weights being the milk equivalent quantities. Mathematically, this can be expressed as the sum of the products of the price and milk equivalent quantity of each functional dairy food, divided by the total milk equivalent quantity across all functional dairy foods. The use of a weighted average ensures that the aggregated price reflects the relative importance of each functional dairy food in the overall consumption pattern.

By using these overall measures, both for quantity and price, the demand analysis provides a holistic view of the demand for functional dairy foods. The findings help to identify overall consumption trends and consumer sensitivity to price changes across the different types of functional dairy foods. The

demand analysis was done by using a double log model, and the results are shown in Table 4.

Table 4: Demand analysis of functional dairy foods

Variables	Per capita functional dairy foods consumption
Monthly family income	0.333* (0.178)
Price of functional dairy foods	-0.203*** (0.038)
Area dummy (Base = Rural)	
Urban/semi-urban	0.031 (0.210)
Constant	-4.265** (1.956)
Model adequacy check	
Observations	160
R-squared	0.163
Standard errors in parentheses	

*** p<0.01, ** p<0.05, * p<0.1.

Source: *Computed by the Authors.*

The demand analysis revealed that the expenditure elasticity (proxied by monthly family income) for functional dairy foods is relatively inelastic (0.333), implying steady but moderate demand expansion with rising incomes. The magnitude, being less than unity, suggests that these products behave as necessities at the aggregate level. This finding complements the product-level results in Table 2, where only a subset of products exhibited significant income responsiveness, indicating that aggregation captures broader consumption behaviour across functional dairy items.

The own-price elasticity is negative and highly significant (−0.203), consistent with the law of demand. The relatively inelastic response suggests that demand for functional dairy foods, at the aggregate level, is not highly sensitive to price changes. This may reflect the combined effect of habitual consumption and perceived health benefits associated with these products. The result aligns with Table 3, where most individual products exhibited inelastic to moderately elastic price responses. The model indicates that location does not have an independent effect on functional dairy consumption once income and price are controlled for. This suggests that observed differences in consumption across regions are largely explained by economic factors rather than purely geographic influences, although unobserved factors such as awareness and access may still play a role.

Demand projections for functional dairy foods

Per capita demand for the functional dairy foods

To estimate the per capita demand of functional dairy foods in Tamil Nadu, the calculations were done based on the methodology used in this study.

Quantity of milk and other dairy products, including functional dairy foods, sold by various sales points in Tamil Nadu → = Processed milk (A) = 93,19,000 L/day; A = 34,01,435 T/year

The MEQ of functional dairy foods as a percentage of total sale (estimated from the sales points – Primary data) → = 3.78 % of processed milk **(B)**

Total sale of functional dairy foods = Total demand of functional dairy foods in Tamil Nadu → = B×A = 12,84,73,900.61 L/year **(C)**

Per capita demand of the functional dairy foods in Tamil Nadu in base year 2021 → $\frac{C}{N_t}$ = 1.68 L/PC/year (d_0)

We found that functional dairy foods currently account for 1.26 per cent of total milk production and 3.78 per cent of processed milk in Tamil Nadu.

Projections for population and urbanisation

Tamil Nadu registered a decadal variation in the population of 15.60% during the decade 2001-11. The population change during the previous decade was 11.70 per cent. During the past decade, the growth rate has been slowing down, from 6.8 per cent in 2011-15 to 4.7 per cent in 2016-20 (Ravichandran, 2018). Most experts expect the growth rate to slow down even further in the future, but the population in number has reached 72.147 million in the year 2011. For our analysis, we have taken the population projections as per the report of the "Technical Group on Population Projections" (GOI, 2020), and the projections are shown in Table 5.

The proportion of the urban population was taken from the website of the Ministry of Housing and Urban Affairs, and it was found that among major states, Tamil Nadu continues to be the most urbanized state with 48.4 per cent of the

population living in urban areas. Also, the growth rate of urbanization was calculated from the report of "Technical Group on Population Projections" (National Commission on Population, 2020). The compound annual growth rate of urbanization of Tamil Nadu was found to be 1.45 per cent.

Table 5: Projections for the population of Tamil Nadu

Year	2011	2016	2021	2026	2031	2036
Population (000′)	72147	74635	76402	77546	78082	78067

Source: *Technical Group on Population Projections, GOI, 2020.*

Per capita income growth

In the study, three scenarios for income growth rates in the per capita Net State Domestic Product (NSDP) at constant prices were considered: 2.12 per cent, 5.44 per cent and 8.18 per cent. The 2.12 per cent rate represents the most pessimistic historical scenario. The demand predictions for functional dairy foods, based on the 5.44 per cent growth rate, are considered "business as usual" for the future, as it reflects the compound annual growth rate observed from 2011 to 2023 (Calculated from per capita NSDP at constant prices taken from Handbook of statistics on Indian states by RBI, 2022-23). However, recent policies aimed at achieving a $1 trillion economy across various sectors may accelerate growth, potentially reaching up to 8.18 per cent, the highest growth rate achieved during the 2011-2023 period, as the most optimistic scenario.

Demand projections

Tables 6 to 8 present the projected demand for functional dairy foods under pessimistic (2.12%), business-as-usual (5.44%), and optimistic (8.18%) growth scenarios. Across all scenarios, demand shows a consistent upward trend over the projection period from 2024 to 2036, indicating the expanding market potential for functional dairy products.

Table 6: Demand projections for functional dairy foods (FDF) at 2.12 per cent growth (pessimistic growth)

Year	Population (000′)	Projected demand of FDF (('000) L/year)
2024	77088	131453.12
2025	77317	133699.47
2026	77546	135983.02
2027	77653	138088.12
2028	77760	140225.55
2029	77867	142395.79
2030	77974	144599.34
2031	78082	146836.72
2032	78079	148898.28
2033	78076	150988.78
2034	78073	153108.64
2035	78070	155258.26
2036	78067	157438.05

Source: *Computed by the Authors.*

However, the magnitude of growth varies considerably across scenarios. Under the pessimistic scenario, total demand increases from 131.45 ML/year in 2024 to 157.44 ML/year in 2036, reflecting a modest growth trajectory with a CAGR of 1.51 per cent. In contrast, under the business-as-usual scenario, demand rises more substantially to 181.29 ML/year, with a CAGR of 2.61 per cent. The optimistic scenario projects the highest growth, with demand reaching 203.40 ML/year by 2036 and a CAGR of 3.53 per cent.

Table 7: Demand projections for functional dairy foods (FDF) at 5.44 per cent growth (business as usual growth)

Year	Population (000′)	Projected demand of FDF (('000) L/year)
2024	77088	132887.10
2025	77317	136632.35
2026	77546	140481.92
2027	77653	144212.87
2028	77760	148042.62
2029	77867	151973.79
2030	77974	156009.05
2031	78082	160151.15
2032	78079	164171.21
2033	78076	168292.18
2034	78073	172516.59
2035	78070	176847.04
2036	78067	181286.20

Source: *Computed by the Authors.*

The widening gap between scenarios over time highlights the sensitivity of functional dairy demand to income growth and market development conditions. Higher growth rates are likely to accelerate dietary diversification and increase the

consumption of value-added and health-oriented dairy products. This pattern is consistent with the nutrition transition framework, where rising incomes and urbanization drive increased demand for functional and processed foods (Pingali, 2007; Reardon *et al*. 2012).

Table 8: Demand projections for functional dairy foods (FDF) at 8.18 per cent growth (optimistic growth)

Year	Population (000')	Projected demand of FDF (('000) L/year)
2024	77088	134068.99
2025	77317	139073.56
2026	77546	144263.67
2027	77653	149412.20
2028	77760	154744.18
2029	77867	160266.14
2030	77974	165984.82
2031	78082	171907.24
2032	78079	177789.71
2033	78076	183873.47
2034	78073	190165.40
2035	78070	196672.64
2036	78067	203402.55

Source: *Computed by the Authors.*

Overall, the projections indicate that while demand for functional dairy foods will grow under all scenarios, the pace of expansion will depend critically on economic growth and consumer awareness. This underscores the importance of policy support, market development, and awareness creation in realizing the higher growth potential of the functional dairy sector.

Fig. 1 illustrates the projected demand trends for functional dairy foods under pessimistic, business-as-usual, and optimistic growth scenarios from 2024 to 2036. The figure clearly shows a steady increase in demand across all scenarios, with the growth trajectories diverging over time. The optimistic scenario exhibits the steepest upward trend, followed by the business-as-usual and pessimistic scenarios, reflecting differences in assumed growth conditions.

The divergence among the three trajectories becomes more pronounced in the later years, indicating that small differences in growth rates can lead to substantial variations in long-term demand. This reinforces the importance of sustained economic growth and market development in driving the expansion of functional dairy consumption.

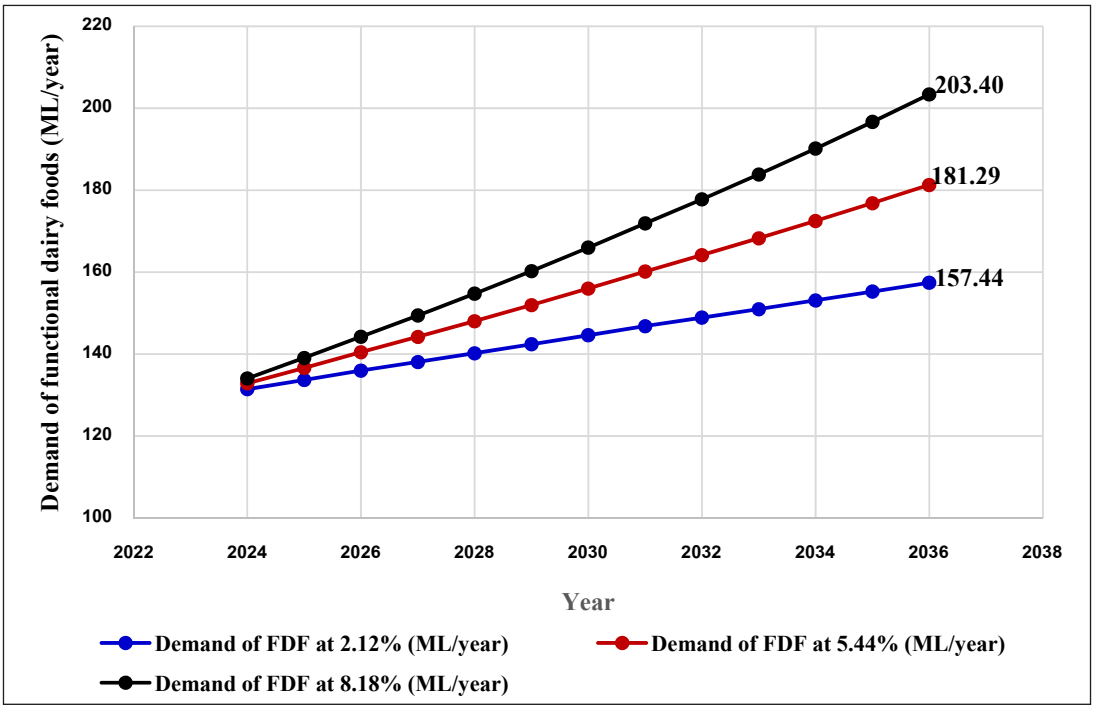

Fig. 1: Demand projections for functional dairy foods

CONCLUSION

The study reveals that functional dairy foods currently constitute a small share of the overall dairy sector in Tamil Nadu, accounting for 1.26 per cent of total milk production and 3.78 per cent of processed milk in milk-equivalent terms. This indicates that, despite increasing consumer interest, the segment is still at a relatively early stage of market development.

The demand analysis suggests that functional dairy foods exhibit inelastic price responsiveness at the aggregate level, implying that consumption is relatively stable in the face of price changes. At the same time, income was found to have a positive and significant effect on demand, indicating that rising incomes will continue to support gradual expansion of this segment. The product-level analysis further highlights that demand behaviour is heterogeneous, with only selected products showing strong responsiveness to income changes.

The cross-price relationships between milk and functional dairy products indicate the presence of substitution in certain cases, although these effects are generally weak and product-specific. This suggests that functional dairy products are not perfect substitutes for conventional milk but rather occupy a differentiated position within the dairy consumption basket.

The demand projections indicate steady growth under all scenarios, with annual growth rates ranging from 1.51 to 3.53 per cent over the projection period. Although the growth is moderate, it reflects consistent expansion driven by income growth, urbanization, and evolving dietary preferences.

Overall, the findings suggest that the functional dairy sector in Tamil Nadu has considerable scope for expansion, but its growth is likely to be gradual and uneven across products. Strengthening market penetration, improving product accessibility, and enhancing consumer awareness will be important for sustaining long-term growth in this segment.

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Appendix

Table A1 Major functional dairy food groups available in Tamil Nadu

Product group	**Products and brands**
Fortified milk	Aavin delite
Probiotic *lassi*	Milky Mist, Aavin
Probiotic curd	Akshayakalpa, Aavin and Milky Mist
Probiotic ice-cream	Mercelys
Probiotic drink	Yakult from Yakult Danone India Pvt. Ltd.
Malted milk foods	Boost, Horlicks, Complan, Bournvita
Other functional dairy food products	Fruit *lassi* of various brands (Milky Mist, Akshayakalpa), Cavin's fortified lassi, Fruit/ probiotic yoghurt of various brands (Milky Mist, Epigamia), Sugar free desserts of various brands (Aavin and Amul sugar free chocolates, Gold sweetener sugarfree), Low calorie products of various brands (Amul lite (low fat low cholestrol bread spread), Milky Mist low fat cream)