

Pathway analysis of India's fish meal import and export trade using time series data

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Abstract

The current paper examines the trade dynamics of fish meal import and export under the HS code 230120 to assess the market dynamics, forecast future movements, as well as to identify key challenges and opportunities in India's fishmeal trade. India's fish meal trade shows contrasting trend, with imports recording negative growth, while exports achieved an average compound annual growth rate of 21.3%. A trade balance index score of nearly 0.9, further indicates that India has emerged as a source market rather than a destination market for fish meal in the global arena, especially after 2010. South-East Asian countries like Bangladesh, Vietnam, Thailand, Saudi Arabia, Malaysia and China are the main export destinations for fish meal from India; collectively accounting for almost 80% of the total export volume and value. In the future, rising aquaculture production and growing global demand for fish meal from India, are expected to drive both domestic consumption of fish meal by the feed industry and a gradual increase in imports, particularly with the recent reduction of import duty from 15 to 5%.

Introduction

Fish meal production in India is a major industry that converts forage fishes, bycatch and processing waste into high protein non-consumable products intended for both domestic use and international trade. There are over 40 fish meal production plants that are well-equipped to meet export standards including those required by European markets. The western coast of India, particularly Karnataka, serves as a central location for fish meal processing establishments (Ponnusamy *et al.*, 2012). This industry plays a vital role in fulfilling the protein requirements of aquaculture and poultry production not only in India but also in other regions. India stands as the second largest marine capture fisheries producer globally, contributing approximately 25% of the total fish production in India and 2% of the global fish production. The majority, approximately 80%, of the total marine fish production is utilised as edible food, while the remaining 20% is directed towards non-edible applications (FAO, 2021) such as fishmeal production (Barlow, 2003).

A considerable quantity of fish meal in India is produced by the drying and pulverisation of whole fish. In addition, processing waste from other seafood industries, such as fish filleting and surimi production, is also converted into fish meal with a relatively lower protein content and higher ash content. This type of fish meal is typically blended with high protein meal to achieve the desired protein levels. The price of the meal is determined based on protein content and other quality parameters. While overall demand is increasing to satisfy rising domestic demand and capitalise on export opportunities, capture fishery has remained stagnant for the past two decades. Consequently, future growth in Indian fish production will rely primarily on aquaculture, where feed plays a major role. Despite ongoing efforts to replace fishmeal with alternative low-cost protein sources (FAO, 2002), it continues to be an essential ingredient in aquafeeds. In this context, understanding the current status of India's fish meal trade is critical for assessing market trends and planning future strategies.

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Keywords:

Export, Fish meal, Growth rate, Import, Market dynamics, Trade balance

Received : 01.03.2024

Accepted : 24.09.2025

The global and Indian aquaculture fish production has superseded the capture fish production, driving a growing demand for fishmeal as a protein-rich feed ingredient for the aquaculture sector. This rising demand has diverted a portion of fish catch for fishmeal production (Peron *et al.*, 2010). International trade in fishmeal is under the Harmonised System (HS) code 230120, which is a sub-category of HS-2301, which covers flours, meals and pellets of meat or meat offal, fish, crustaceans, molluscs or other aquatic invertebrates, that are unfit for human consumption. According to FMI (2023), the global fishmeal market is expected to grow from USD 8000 million in 2021 to USD 15000 million by 2032, reflecting a compound annual growth rate (CAGR) of 7.7%.

The growing demand for high-quality protein sources in animal feed, particularly for the aquaculture and livestock sectors, has led to significant expansion in the global fish meal market in recent years (Natale *et al.*, 2013). Feed costs are a major component in aquaculture production, with high-protein diets containing premium fish meal accounting for as much as 40-60% of total operating costs in certain systems (Taylor, 2011). Because of its high protein content and nutritional value, fish meal is in high demand in the aquaculture industry and remains a crucial ingredient in feed formulations for carnivorous fish species. However, concerns regarding sustainability of fish meal as a key aquafeed component are increasing due to overexploitation of fisheries resources and rising fish meal costs (Mothe and Paquet, 1998).

Globally, several countries contribute significantly to fishmeal production, with Peru being the largest producer, followed by Chile. Other major producers include USA; Norway and Denmark in Europe as well as China, Thailand and Vietnam in Asia. Collectively, these countries together account for about 61% of total global fishmeal production. The domestic consumption of fishmeal in Peru is minimal and most of the production is directed toward export market (EUMOFA, 2021). India, the second largest producer of marine capture fisheries, also plays a prominent role in the international fishmeal trade through both exports and imports of fishmeal.

Understanding the dynamics of India's fishmeal trade is crucial for identifying emerging opportunities and potential challenges. This study aims to analyse the import and export patterns of fish meal in India using a time-series approach by examining historical data on trade volumes, prices, policies and key markets. The insights generated from this analysis will help the policymakers, industry stakeholders and market participants to make informed decisions, to enhance the sustainability of fish meal production, improve the competitiveness of India's fish meal trade and formulate effective strategies to address future challenges.

Materials and methods

The study collected and used secondary data on import and export of fish meal to and from India under a specific designated HS code (HS-230120) from the COMTRADE database (<https://comtrade.un.org/>) maintained by the United Nations, for the period from 2000 to 2022. The average compound growth rate (ACGR) for total quantity of fish meal exported and imported was computed using Malthus model given in Equation (1). The parameters were estimated by Levenberg-Marquardt algorithm using ordinary least square (OLS) method using SAS 9.3. The goodness of fit of the

model was assessed by coefficient of determination (R^2) and root mean square error (RMSE).

$$Y_t - Y_0(1+r)^t e_t \dots\dots\dots(1)$$

where ' Y_t ' is the total quantity of fish meal traded at time ' t ', ' Y_0 ' is the initial value, ' r ' is the growth rate, ' t ' is the time and ' e_t ' is the error term assumed to follow normal distribution with mean '0' and constant variance σ^2 (Seber and Wild, 2003). The fitted model was then used to predict the future values of fish meal trade quantity.

Normalised trade balance index for fish meal was computed using the Equation (2) to see the import trade performance of fish meal under the head HS-23012 over export trade performance.

$$Z_t = (E_t - I_t) / (E_t + I_t), -1 \leq Z_t \leq 1 \dots\dots\dots(2)$$

where Z_t is the normalised trade balance of fishmeal at time t , E_t is fishmeal export quantity or value and I_t is fishmeal import quantity or value at time t .

The proportional contribution of import and export quantity and value to the total fish meal quantity and value was computed by Equations (3) and (4), respectively.

$$PoQ_{ij} = Q_{ij} / TQ_i \dots\dots\dots(3)$$

$$PoV_{ij} = V_{ij} / TV_i \dots\dots\dots(4)$$

where, PoQ_{ij} and PoV_{ij} are the proportion of quantity and value of j^{th} country exported/imported in the i^{th} year, Q_{ij} and V_{ij} are the quantity and value of j^{th} country exported/imported in the i^{th} year, TQ_i is the total quantity of fish meal exported/imported in the i^{th} year and total value of fish meal exported/imported in the i^{th} year.

An exponential model was fitted to see the effect of total marine fish production and the total quantity of fish meal exported from India to the destination markets.

Results and discussion

The import of fish meal under the code HS-230120 exhibited a blend of ups and downs during the period 2000-2022. Fishmeal imports exhibited a sharp upward trend up to 2004, followed by a steep decline up to 2008. From 2008 to 2014, imports remained relatively stagnant after which alternating periods of increase and decrease were observed during 2015-2022. The general trend of import quantity and value is depicted in Fig. 1a. The highest volume of fish meal imported to India was recorded during 2003-2005, reaching approximately 44800 t worth 35 million USD before declining sharply in subsequent years. In 2020, imports again rose to nearly 40000 t worth 49 million USD. The lowest import quantity was observed in 2014, when only 1304 t worth 2.35 million USD was registered. The estimated ACGR of fish meal imports to India was -0.027, indicating a negative growth trend. The fitted Malthus model is given in Fig. 1b.

Major source countries exporting fish meal to India under HS-230120 were Chile, China, Norway, Oman, Peru, Thailand, UAE, Malaysia, Mauritania and Morocco. While Peru and Chile were the major contributors in the earlier years, recent trend show increasing contributions from Norway, Oman and UAE. The proportionate contributions of each country on import quantity and value are given in Fig. 2a and b, respectively.

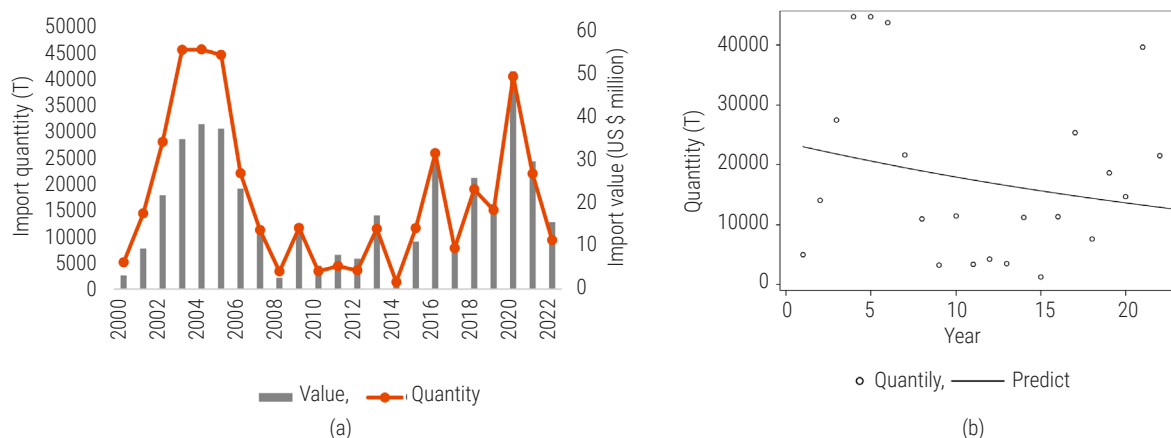


Fig. 1 (a) Trend of fishmeal import to India and (b) Fitted Malthus model for fish meal import to India

Fish meal exports from India witnessed a consistent upward trend during the period 2000-2022. Exports remained below 1000 t until 2005, which later rose sharply, reaching 88182; 88372 and 77599 t worth 99; 106 and 79 million USD in 2017, 2018 and 2019, respectively. An exponential trend on the export of fish meal from India was observed since 2013 (Fig. 3a). The estimated ACGR of export of fish meal from India was 0.213, which indicates an average

annual increase of 21.3% in the export quantity during the study period from 2000 to 2022. The fitted Malthus model describing this trend is presented in Fig. 3b.

The major destination countries for fish meal export from India were Bangladesh, Vietnam, Thailand, Saudi Arabia, Malaysia and China. All these countries together contributed nearly 80% of total

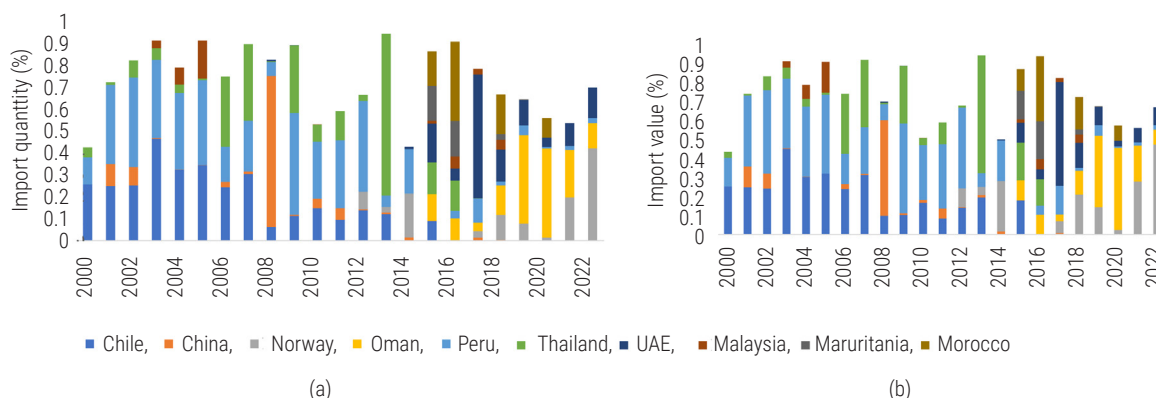


Fig. 2. Proportion of source countries in (a) Fishmeal import quantity and (b) Fishmeal import value

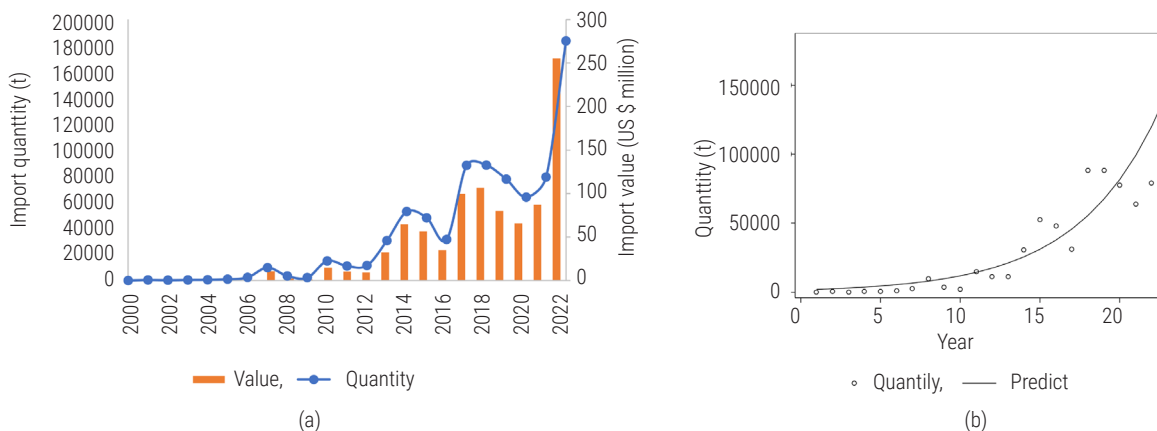


Fig. 3. (a) Trend in export of fish meal from India and (b) Fitted Malthus model for fish meal export from India

export quantity and value of fish meal from India. The proportionate contributions of each country on import quantity and value are depicted in Fig. 4a and b, respectively. Time series analysis of India's fishmeal trade reveals that, in recent years exports have surpassed imports indicating that India has transitioned from a destination market to a source country in the global fish meal trade. Trade balance data further indicates that, India remained a net importer of fishmeal in terms of quantity and value until 2010, after which it became export-oriented (Fig. 5). This shift is likely driven by rising demand from South-east Asian countries for fish meal sourced from India.

Marine fish catch serves as the primary source of raw material for fish meal production, with an average yield of approximately one fourth of the raw material processed. Analysis revealed a strong positive relationship between marine fish production and fish meal export quantity, with a correlation coefficient of 0.9 ($p < 0.05$) (Fig. 6). An exponential trend function fitted to fish meal export quantity as a function of marine fish production, revealed an estimated growth rate was 0.55 lakh t with an R^2 value of 0.85, indicating a robust fit. The results suggest a significant interaction between marine fish production, fish meal production and export dynamics. Natale *et al.* (2013) also reported similar interaction between aquaculture production and fishmeal production.

South-East Asian countries have shown strong demand for fish meal from India, driven primarily by the rapid growth in aquaculture production in the region (Chiu *et al.*, 2013; Kobayashi *et al.*, 2015). Globally the proportion of fishmeal used in the aquaculture sector was 63% in 2009, rising to around 70% between 2010 and 2017-2019 and further increasing to 78% in recent years. In 2019, the aquaculture sector utilised fishmeal primarily as feed for crustaceans (25%), salmon and trout (15%), marine fish (17%) and freshwater species (21%), with the rest allocated to tilapias, cyprinids and eels. Asia accounts for the major share of fishmeal consumption for aquaculture feed in 2019, with China utilising 34% and other Asiatic countries consuming 35% of the global supply. In comparison, Europe consumed 9%, Latin-America 11% and Middle East 7% of the total fish meal production.

Trade balance data indicate that, India's fish meal requirements were largely met through imports until 2010. Since then the country has become increasingly self-sufficient in fish meal production, while also exporting substantial quantities to the South-east

Asian countries. Government-led promotional schemes aimed at boosting fish production are expected to further enhance the aquaculture output and, consequently the fish meal production. On the other hand, restrictions on establishing new fish meal plants for export market remain in place. Careful observation of current trends implies that domestic consumption of fish meal by the feed industry will continue to grow, while global demand for Indian fish meal is also likely to increase. Imports are projected to rise gradually, especially in light of the recent reduction in import duty of fish meal from 15 to 5% by the government of India, which will make the shrimp industry more competitive in the country and boost the export of shrimp-based products, as fish meal constitutes 40% of the cost of production of shrimp. However, there is a lack of reliable

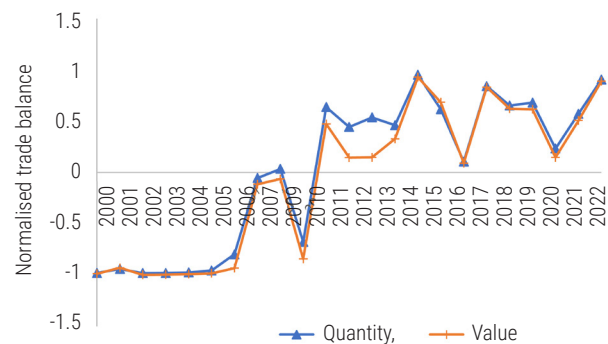


Fig. 5. Trend of normalised trade balance for fish meal in India

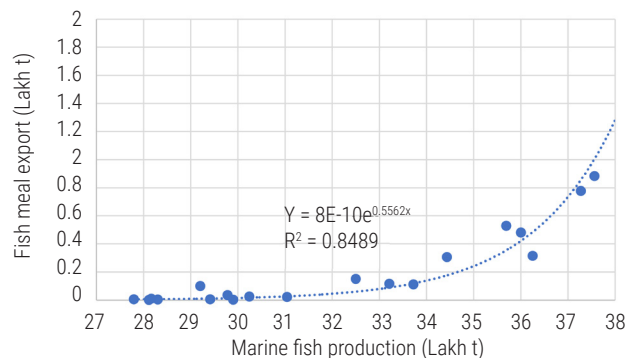


Fig. 6. Exponential model for fish meal export vs marine fish production

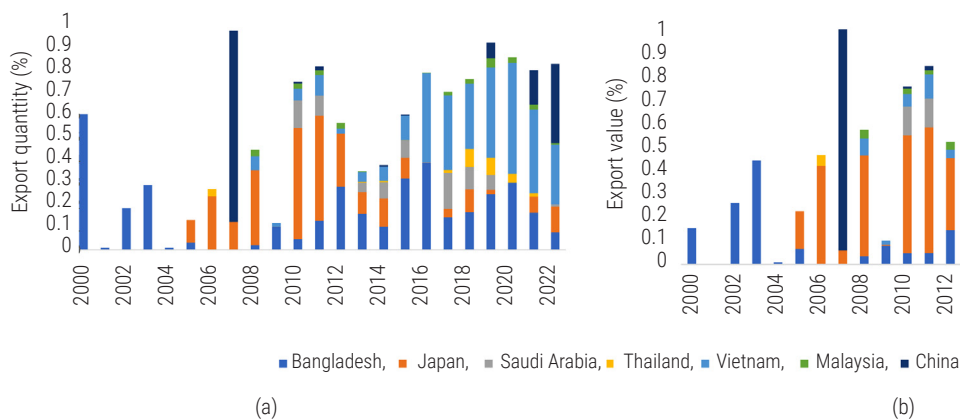


Fig. 4. Proportion of destination countries in (a) Fishmeal export quantity and (b) fishmeal export value

data on fishmeal consumption within Indian fish and poultry feed sectors. The primary raw material for fishmeal will likely shift from trash fish, and high nutritional food fishes like sardines toward fish and shrimp processing waste, particularly from seafood export industries. Similar sustainable practices have been reported earlier, for e.g., Ido and Kaneta (2020) demonstrated the use of fishery-byproducts to produce fish meal and fish oil, thereby enhancing the sustainability of production.

Fish meal imports to India under the HS code HS-230120 exhibited a mixed trend during, 2000-2022, while exports showed a steadily increasing exponential pattern. Major export destinations including Bangladesh, Vietnam, Thailand, Saudi Arabia, Malaysia, and China collectively accounted for nearly 80% India's total export quantity and value. Over time, India's fish meal exports have consistently outperformed imports, signifying the country's transition from a destination market to a key source country for fish meal in the global trade. Until 2010, India relied heavily on imports to meet domestic demand, however, it has since become more self-sufficient in fish meal production and emerged as a significant exporter to South-east Asian countries. Intensive government schemes for promoting fish production are expected to further boost aquaculture output, thereby enhancing fish meal production and trade in the coming years.

Acknowledgments

The authors thank the Director, ICAR-CIFT, Kochi, for granting permission to carry out this work and this technical staff of AKMU, ICAR-CIFT, for the support given for the study.

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