Strategies to Boost India's Makhana Exports

Harsh Wardhan | Tanay Suntwal | Aditi Bansal
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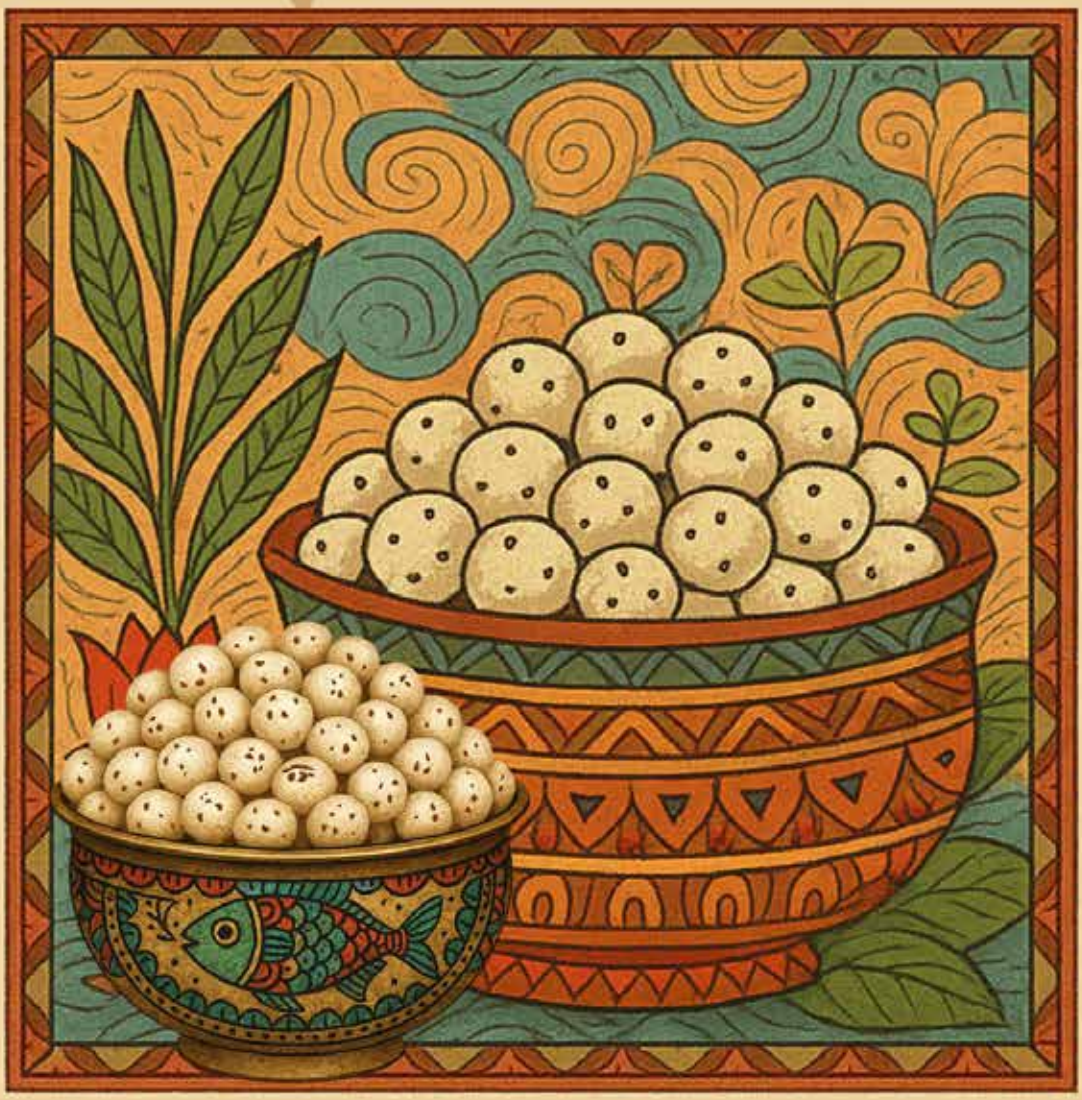

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List of Abbreviations

APEDA	Agricultural & Processed Food Products Export Development Authority
APMC	Agricultural Produce Market Committee
ASEAN	Association of South-East Asian Nations
BAU	Bihar Agricultural University
CAGR	Compound Annual Growth Rate
CIPHET	Central Institute of Post-Harvest Engineering and Technology
DNK	Daak Niryat Kendra
EAAI	Essential Amino Acid Index
EDFC	Eastern Dedicated Freight Corridor
EU	European Union
FDA	Food and Drug Administration
FPO	Farmers Produce Organisation
FSSAI	Food Safety and Standards Authority of India
GI	Geographical Indicator
GIS	Geographical Information Systems
HSN	Harmonised System of Nomenclature
ICAR	Indian Council of Agricultural Research
ICD	Inland Container Depot
ICMR	Indian Council of Medical Research
IMEDF	The Indian Micro Enterprises Development Foundation
INR	Indian National Rupee
JNPT	Jawaharlal Nehru Port Trust
KCC	Kisan Credit Card
LPC	Land Possession Certificate
MOA&FW	Ministry of Agriculture and Farmers' Welfare
MOFPI	Ministry of Food Processing Industries
NGO	Non-Governmental Organisation
NIFTEM	National Institute of Food Technology, Entrepreneurship and Management
ODOP	One District One Product
PMFME	Prime Minister's Formalization of Micro Food Processing Enterprises
PPP	Public Private Partnership
PTA	Preferential Trade Agreement
R&D	Research and Development
RKVY	Rashtriya Krishi Vikas Yojana
SAARC	South Asian Association for Regional Cooperation
SFURTI	Scheme of Fund for Regeneration of Traditional Industries
SPS	Sanitary and Phytosanitary measures
TCM	Traditional Chinese Medicines
UK	United Kingdom
USA	United States of America
USDA	United States Department of Agriculture

Foreword

Makhana, once largely confined to the Mithilanchal region of Bihar, is now receiving national and international attention for its nutritional value and health benefits. This growing recognition was reflected in the Union Budget 2025, which announced the establishment of a dedicated Makhana Board, with an initial allocation of INR 100 crore. This marks a significant policy step towards formalising the sector by promoting organised production, processing, and marketing.

Traditionally, makhana cultivation has been concentrated in northern Bihar, where it provides income and livelihood support to thousands of small and marginal farmers. Today, as demand for healthy and plant-based foods increases, makhana is gaining traction among urban consumers across India and internationally. Its Geographical Indication (GI) tag, awarded in 2022, has further enhanced its visibility and credibility. These developments suggest that makhana has the potential to evolve into a high-value agri-export commodity.

Makhana, however remains under-represented in India's agricultural export basket due to challenges related to value chain efficiency, quality standards, global market access, and branding. Addressing these challenges is necessary to enable the sector to grow and become more competitive in global markets. There was a need to undertake a detailed study and go deep to gather information about the export potential, value chain structure, and the kinds of interventions required to support its growth.

It is in this context that the present study, jointly undertaken by ICRIER and APEDA, becomes especially relevant. Drawing on ICRIER's expertise in policy-oriented economic analysis and APEDA's extensive experience in supporting agricultural exports, the report presents a comprehensive overview of the makhana sector, with a focus on strengthening its export performance. It identifies key challenges and emerging opportunities in the sector and offers short-term, medium-term, and long-term strategies for boosting its exports.

It is hoped that the insights and recommendations presented in this report will serve as a useful guide for policymakers, exporters, producer groups, and investors in making makhana a strong and reliable export product from India with global appeal.

Deepak Mishra

Director and Chief Executive

ICRIER

Abhishek Dev

Chairman

APEDA

Preface

Makhana is the popped seed of the Gorgon nut (Euryale ferox), an aquatic plant that grows in still water bodies like ponds, lakes, and wetlands. It is mainly grown in the Mithila region of Bihar, and also in parts of West Bengal, Assam, Uttar Pradesh, and Chhattisgarh. In addition to India, Makhana grows well in the tropical and sub-tropical parts of the world and is an important crop of South-East Asian countries like China, Japan, Malaysia, Thailand, Philippines, Nepal and Bangladesh. Long valued in local diets and rituals of Bihar, Makhana is now gaining attention as a healthy snack both in India and abroad. Its growing popularity reflects changing food habits that favour plant-based, low-fat, and nutritious foods.

India dominates the global makhana production, accounting for over 90 per cent of the total output, yet there is significant untapped potential in its export market. This situation highlights opportunities for enhancing efficiency within the value chains, improving data accuracy in trade records, and establishing clear classifications for makhana. Despite its cultural significance and economic importance in eastern India, there has been limited research on makhana's value chain and export dynamics. This report aims to address these knowledge gaps comprehensively, contributing to a better understanding and promotion of India's makhana industry on a global scale. The timing of this study is important for three main reasons: (i) the global surge in demand for health foods and functional ingredients, (ii) the increased domestic visibility of makhana following its GI tag, post-pandemic consumption shifts, and digital retail penetration, and (iii) the formalization of trade classification through the allocation of separate HSN codes for makhana. In addition, the announcement of a dedicated Makhana Board in Bihar in the Union Budget 2025–26 further signals government intent to support the sector's growth and export readiness.

The study aims to explore the untapped potential of India's makhana exports and develop a strategic action plan to position India as a global leader for its exports. The report has three main objectives. First, to map the makhana value chain, from production to processing to exports, both domestically and international markets. Second, to identify key challenges hindering the growth of exports, evaluate tariff and non-tariff measures. Third, to offer clear and actionable policy recommendations to boost makhana's exports and ensure farmers benefit from this growth.

The study uses both primary as well as secondary data sources. Secondary data from official sources and trade databases is complemented by fieldwork in Bihar's core makhana-producing districts, particularly Darbhanga and Madhubani. Semi-structured interviews and consultations with a cross-section of stakeholders, including farmers, Farmer Producer Organizations (FPOs), processors, traders, start-ups, and researchers from ICAR-CIPHET and ICAR-NRC for Makhana, helped capture real on-ground challenges and possible solutions. These insights are especially useful since there is limited detailed data available on this sector.

The report is divided into six chapters. Chapter 1 introduces makhana's background, the study's goals, the methods used, and data limitations. Chapter 2 looks at global and Indian production trends, the domestic and export value chains, and key players in the market. Chapter 3 discusses ways to scale up the sector, through scientific methods of cultivation practices and through mechanized processing. Chapter 4 looks at the role of government policies, trade rules, and schemes from both central and state governments. Chapter 5 identifies the major challenges and new opportunities in makhana exports. Chapter 6 presents policy actions to improve exports, support farmers, and make the sector more competitive and inclusive.

As global demand for healthy, sustainable foods continues to grow, India has an opportunity to position makhana as a flagship agri-export not only rooted in local tradition but also resonating with global trends. This will help improve farmer incomes, generate rural employment, and establish India's dominance in a niche yet growing global food category.

Authors

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We gratefully acknowledge the expert insights shared by Dr S.N. Jha, Deputy Director General (Agricultural Engineering), ICAR, Mr. Sanjay Kumar Agarwal, Secretary, Department of Agriculture and Mr. Abhishek Kumar, Director, Department of Horticulture (Government of Bihar). They generously took the time to review the report and share important feedback which contributed to sharpening the analysis and enhancing the recommendations.

Our field visits to Darbhanga and Madhubani in Bihar in October 2024 were crucial in enhancing our understanding of makhana's production and trade ecosystem. We extend our deep appreciation to Dr Nachiket Kotwaliwale, acting Director, NRC-Makhana, Darbhanga and Director, ICAR-CIPHET, Ludhiana for his valuable insights. We are thankful to the farmers, agripreneurs, and FPOs who generously shared their experiences and perspectives with us. In particular, we would like to acknowledge Mr. Rajeev Ranjan from Manigachimidas FPC; Mr. Mahesh Mukhiya and Mr. Jagannath Sahani from Shree Mithila Makhana FPO; Mr. Faraz Ahmed and Mr. Abhishek Singh from Shhe Foods; Mr. Manish Mishra from Nutrivin Agro Pvt. Ltd.; Mr. Varun Gupta from Blacknut AgriFood Machinery Pvt Ltd.; Ms. Manju Devi and Mr. Lal Bahadur from Makhana Processing Value Addition Cluster for their valuable inputs.

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While every effort has been made to reflect these insights accurately, any errors or omissions that remain are the sole responsibility of the authors.

Authors

Executive Summary

Introduction and Background

Makhana (Euryale ferox), popularly known as gorgon nut, is emerging as a global superfood owing to its remarkable nutritional and medicinal value. India dominates global production, accounting for 90 per cent of the supply, with Bihar alone contributing 85–90 per cent. Despite this dominance, India's share in global makhana exports is disproportionately low. Only around 1–2 per cent of its produce is exported. As demand for plant-based, gluten-free, and functional foods grows internationally, India has a significant opportunity to strengthen its position in the global makhana trade.

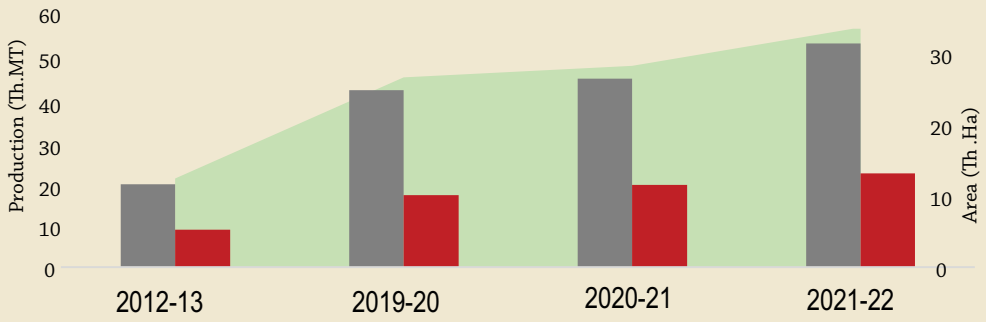
This report, drawing on secondary research and field visits to Darbhanga and Madhubani, outlines the present landscape of makhana production, evaluates value chain inefficiencies, and suggests actionable strategies to unlock India's export potential.

Makhana Production: Trends, Value Chain, and Market Dynamics

Over the past decade, makhana cultivation has expanded from 13,000 hectares in 2012–13 to over 35,000 hectares in 2021–22 (in Figure). Productivity has improved due to high-yielding seed varieties such as Swarna Vaidehi and Sabour Makhana-1. Yet, the sector remains unorganized and labour-intensive. Farmers rely on traditional pond-based cultivation, which is costlier and yields lower output compared to emerging field-based systems.

Manual harvesting and processing methods dominate, resulting in inefficiencies and inconsistent product quality. Farmers receive a limited share of consumer prices due to multiple

Area and production of makhana in Bihar



Source: Bihar Horticulture Development Society (Government of Bihar, 2024)

intermediaries, poor market access, and the absence of an APMC framework in Bihar. Mechanization is limited, and value chain actors lack adequate training and support to adopt modern technologies.

Enhancing Makhana Scalability

India's current production scale is insufficient to meet rising international demand, especially for export-quality makhana. While production has increased, only around 12,000 MT meets export standards. Traditional pond-base methods are resource-intensive and less productive, whereas field cultivation is more efficient and better suited for expansion to non-traditional regions like Uttar Pradesh, Odisha, and the Northeast.

Mechanization in processing, introduced by institutions like ICAR-CIPHET has improved efficiency and product consistency, but adoption remains low due to cost and capacity constraints. Wider adoption could significantly improve scalability, quality, and global competitiveness. To achieve this, targeted support for training, technology access, and subsidies is essential.

Policy Landscape and Institutional Gaps

Until recently, makhana lacked dedicated HSN codes, complicating trade tracking and policy-making. This data gap was a significant bottleneck. The Ministry of Finance, in the Finance Bill 2025, has now allocated specific HSN codes for different makhana products, enabling better export analysis and sector planning.

Exporters face challenges in meeting sanitary and phytosanitary (SPS) requirements, and regulatory compliance with importing countries' standards remains difficult, especially for small-scale exporters. Quality inconsistencies and poor packaging often lead to rejection in the global markets.

Multiple government schemes including PMFME (Prime Minister's Formalization of Micro Food Processing Enterprises), SFURTI (Scheme of Fund for Regeneration of Traditional Industries), RKVY (Rashtriya Krishi Vikas Yojana), and Bihar's Makhana Vikas Yojana, offer financial and technical support for seed development, processing, storage, and FPO formation. However, convergence and targeted execution are needed to maximize their impact.

Challenges and Opportunities in Makhana Exports

Key challenges include:

- An unorganized market structure and lack of formal price discovery mechanisms.
- Lack of credible data and information
- Labour-intensive, manual processing methods leading to inconsistent quality.
- Limited access to affordable finance for farmers and processors.
- Absence of dedicated export hubs near production clusters.
- Inadequate R&D, especially for value-added products, packaging, and shelf-life improvement.

Yet, significant export opportunities exist. Rising global interest in clean-label snacks, plant-based diets, and gluten-free products makes makhana an attractive commodity. High-potential markets such as the USA, UK, EU, Middle East, Japan, and Australia offer strong demand for health-oriented, value-added snack products like makhana. These markets prefer consistently sized, well-processed, and attractively packaged products, with a growing appetite for flavoured or value-added variants.

Strategies and Policy Implications

To position India as a global leader in makhana exports, a phased approach is recommended:

Short-Term Strategies

I. Streamline regulatory barriers to facilitate trade and export

- Implement and promote use of dedicated HSN code for makhana across all export

systems with training for exporters

- Develop FSSAI safety and quality standards and ICMR nutrient benchmarks aligned with international norms
- Introduce a makhana producer registration system (similar to Mangonet) to enable traceability and improve buyer access.

II. Formalize the makhana sector through the Makhana Board

- Operationalize the Makhana board under a PPP framework involving including key stakeholders; define mandate to boost productivity, processing, and trade data collection.
- Use satellite and GIS tools for mapping cultivation areas and tracking production

Medium-Term Strategies

III. Create export hubs/centralized facilities

- Set up centralized hubs near Darbhanga and Purnia for grading, packaging, and auctions; establish popping units near production and port cities.
- Improve transport connectivity to ports and customs clearance at Patna/ Darbhanga airports.
- Define makhana quality grades and establish testing labs in Mithilanchal; provide regular training on global standards and export procedures.

IV. Branding and marketing

- Promote makhana's cultural identity, GI-tag, health benefits, and eco-sustainability via global campaigns and events (e.g., "Makhana Connect").
- Partner with international distributors/ e-commerce platforms using eco-friendly packaging and global certifications.

V. Expand access to affordable finance

- Relax LPC requirement for KCC eligibility; develop alternate criteria.
- Support access to KCC, microfinance, and warehouse receipts via cooperatives/ NGOs.
- Introduce financial schemes/subsidies for exporters to establish processing units.

Long-Term Strategies Actions

VI. Scale up production via field cultivation and mechanization

- Promote makhana farming in new areas (Assam, UP, Odisha, etc.) alongside other water crops.
- Develop affordable mechanized tools; offer training, subsidies, and demo units.

VII. Foster R&D for processing, quality, and diversification

- Focused research on high-yielding, nutrient-rich varieties and preservation methods.
- Innovate makhana products (snacks, supplements, flour, medicinal use, etc.).
- Set up a scientific committee for policy guidance, certification, and commercialization of research.

1

Introduction

1.1 Background of the commodity

Makhana is a popped expanded kernel of Gorgon nut (Jha & Prasad, 1990; 1996) *(Euryale ferox)*, an aquatic crop that grows in stagnant water bodies such as ponds, lakes, and swamps. It grows well in tropical and sub-tropical climates and is mainly distributed in South-East and East Asian countries like India, China, Nepal, Bangladesh, Japan, Russia, and Korea (Sinha, 2023). While commonly known as makhana in India, it is often referred to as foxnuts, prickly water lily seeds or lotus seeds and is known by other names in different languages. However, the accurate term for makhana is "gorgon nut" and not "fox nuts" or "lotus seeds", which are misleading, as makhana is botanically unrelated to either lotus or foxnuts.

The global demand for makhana has surged by a compound annual average growth rate (CAGR) of 7 per cent between 2019 and 2023 (NIFTEM, 2023), driven by rising health-consciousness among consumers and awareness of its health benefits. As a result, makhana has become a sought-after export commodity, with its potential to dominate the global snack market as a healthier option. It is expected to expand at a CAGR of 8.5 per cent between 2024 to 2031 (Deore, 2024).

In India, makhana is a minor crop comprising approximately 35,000 ha area, has traditionally been cultivated in the Mithila region of north Bihar (Sinha, 2023). It is valued for its unique nutritional profile, rich in essential amino acids, vitamins, and minerals. Makhana is a low-fat food that offers several health benefits, including low glycemic load food, anti-aging properties, heart health support, and improved digestion and is increasingly recognized globally as a superfood. Studies have shown that Makhana's nutrient profile is superior to that of more commonly consumed nuts, such as almonds, walnuts, and cashew nuts. It's high Essential Amino Acid Index (EAAI) of 89-93 per cent and a high Chemical Score (CS) make it comparable to fish, making it an excellent plant-based protein source (Sinha, 2023). Makhana has just 0.4 g of fat per 100 g, much lower than cashews (45.2 g) and almonds (58.49 g), making it ideal for weight management and heart health. It's lower sodium levels than popcorn, makes it a healthier snack option than popcorn. With high carbohydrate content (79.18 g per 100 g), makhana serves as a quick and sustained energy source, offering more energy than almonds and cashews (Table 1). These nutritional characteristics position it as a premium health food, appealing to the global markets.

India, as the largest producer of makhana, accounts for about 90 per cent of the global supply, playing a pivotal role in meeting its global demand. Within India, the state of Bihar alone accounts for approximately 85-90 per cent of India's total production, making it the epicenter of makhana cultivation (Jha & Prasad, 1994). Despite the high volume of production, only a small fraction approximately 1-2 per cent—of the total output is exported (Government of Bihar, 2024). This highlights a significant untapped potential in the global market.

TABLE 1

Nutritional comparison of makhana with other dry fruits and Popcorn

Nutritional content (per 100 g)					
Nutrient Name	Cashew	Almond	Popcorn	Raw Makhana Seeds*	Popped Makhana
Moisture (g)	4.4	4.37	3.32	11.3	12
Ash (g)	2.25	2.62	1.42	0.45	0.38
Protein (g)	18.78	18.41	12.9	9.15	11.03
Fiber (g)	3.86	13.06	14.5	2.56	3.26
Fats (g)	45.2	58.49	4.54	0.46	0.33
Carbohydrates (g)	25.46	3.04	77.8	87.52	84.87
Minerals (mg/100g)					
Calcium (mg)	34.0	228.0	7.0	14.50	20.94
Sodium (mg)	9.0	1.5	8.0	2.92	4.06
Potassium (mg)	635.0	699.0	329.0	50.25	48.39
Magnesium (mg)	307.0	318.0	144.0	13.83	12.71
Phosphorus (mg)	500.0	446.0	358.0	132.53	124.01
Iron (mg)	5.95	4.59	3.19	5.73	2.67
Manganese (mg)	1.78	2.54	1.11	1.30	1.24
Zinc (mg)	5.34	3.5	3.08	1.50	1.04
Copper (mg)	2.23	1.08	0.26	0.71	0.76

Source: (Sharma, Patel, Vishwakarma, Mridula, & Jha, 2020); (Longvah,Ananthan, Bhaskarachary, & Venkaiah, 2017); (USDA, 2024);(ICMR,2017)

* Commonly known as Guree in Mithilanchal

Once a staple of Bihar, makhana is gaining popularity in other domestic markets post-COVID as awareness of its nutritional benefits grew. The pandemic shifted consumer preferences toward healthier, natural snack options, positioning makhana as a low-calorie, and healthy alternative. Its prominence was enhanced when makhana was granted Geographical Indication (GI) status under the name "Mithila Makhana" in 2022 (Murari, 2022). Promotional efforts, such as serving makhana to world leaders at the G20 Summit in India (2023) elevated its status as a unique offering (Ved, 2023). Availability of flavoured and ready-to-eat variants, endorsements by health experts and increased availability on e-commerce platforms boosted its popularity and made it appealing to urban and younger consumers. According to Farmley's Healthy Snacking Report (2024), makhana and dry fruits are emerging as the "snack stars," which are delicious, nutritious and wholesome snacking option.

This growing awareness has helped transform makhana from a traditional food into a mainstream health-focused snack in domestic markets. However, it has yet to be widely recognized and distributed on an international scale. This presents a unique opportunity for India to position itself as a leading supplier of makhana globally.

1.2 Objectives and scope of the study

The study aims to explore the untapped potential of India's makhana exports and develop a strategic action plan to position India as a global leader for its exports. To achieve this, the study will analyze current production, processing, and export practices globally and domestically. It will also analyze the domestic and export value chains to identify inefficiencies and areas for improvement. Additionally, the study will identify key challenges hindering the

growth of exports, evaluate tariff and non-tariff measures, along with central and state government schemes impacting the sector. Finally, the study will provide actionable policy recommendations to streamline the export value chain.

1.3 Data sources and limitations

This report draws on limited secondary data sources and available literature. The analysis was complemented by insights from interactions with key stakeholders in the makhana value chain, including farmers, FPOs, start-ups, traders, and scientists from ICAR-CIPHET Ludhiana and ICAR – NRC for Makhana, Darbhanga. However, a lack of comprehensive data posed significant challenges to analyzing the sector effectively.

There is a lack of credible global or national statistics on makhana cultivation. Although the Horticulture Division of the Government of Bihar provides district-wise production data for the FY2021-22, the methodology used in data collection is unclear. Additionally, the absence of the APMC Act in Bihar has led to an unorganized makhana trade with no recorded information on market arrivals or prices.

Being a minor crop, makhana lacked a dedicated Harmonized System of Nomenclature (HSN) code, resulting in its trade being recorded under a number of HS codes which also includes other commodities related to cereal preparations (Table 2). This led to discrepancies in available data, complicating the analysis of makhana export trends. The lack of transparency and traceability in the value chain further hampered the efforts to streamline and scale the trade.

To address these challenges, the Agricultural and Processed Food Products Export Development Authority (APEDA) had requested the Ministry of Commerce and Industry (MoC&I), Government of India to assign a separate HSN code for makhana. In this regard, separate HS codes for makhana have been allocated under the Finance Bill 2025.

The following codes have been created: 20081921 for popped makhana, 20081922 for makhana flour and powder, and 20081929 for other makhana-based products (The Finance Bill, 2025). This development is expected to facilitate better tracking and analysis of trade and export data, contributing to the organized growth of the sector.

TABLE 2

HSN codes currently associated with makhana

HS Code	*Description*	*Commodities included*
190410	Food preparations obtained by swelling or roasting cereals or cereal products	Corn flakes; poha; makka makai; phool makhana; farsan, etc.
190490	Food preparations of cereals (excluding maize) in grain form, pre-cooked or otherwise prepared.	Cereal bars, breakfast cereals, puffed rice, corn puffs, other cereal snacks, porridge mixes, cereal based pre mix, roasted/flavoured makhana.
21069099	Other Food Preparation Not elsewhere specified	Protein powders, meal replacement mixes, baking premixes, spice blends, energy drink concentrates, fortified foods, snack mixes, health supplements, makhana based food preparation.
08134090	Others Fruit Dried (Excluding Tamarind and Singoda W)	Dried peaches, dried plums, dried apples, dried pears, dried apricots, dried cherries, dried berries, dried figs, dried mangoes, dried papayas, dried guavas.

Source: APEDA and UN Comtrade

2

Makhana production: Trends, value chain and market dynamics

2.1 Global scenario

There is limited or unreliable information on the global area under makhana cultivation and the total production across different countries. This makes it difficult to assess the full scope of makhana's presence in international markets or its potential as a crop for export and global trade. India, China, and Nepal are significant producers of makhana but the available data is not consistent or regularly updated, making it hard to track trends in global production and consumption.

According to the limited literature available, makhana or gorgon nut is grown as a wild crop in several countries like China, South Korea, Japan, Russia and a few ASEAN countries. Makhana is cultivated as a crop for pop production only in India. Table 3 summarizes makhana cultivation in different countries, their distinct names, and uses.

Table 3 highlights the global diversity in makhana consumption across major growing countries. Makhana is used diversely across countries for its nutritional and medicinal properties. In India, it is a staple in snacks, sweets, and fasting foods, cultivated in Bihar, West Bengal, and other states. China integrates it into Traditional Chinese Medicine (TCM), herbal teas, and desserts, with cultivation concentrated in Hunan and Jiangsu provinces. South Korea, Vietnam, and Thailand incorporate it into teas, soups, and traditional dishes, with cultivation ranging from imported seeds to localized farming in regions like the Mekong Delta and Nakhon Pathom. Indonesia and Rus-

TABLE 3

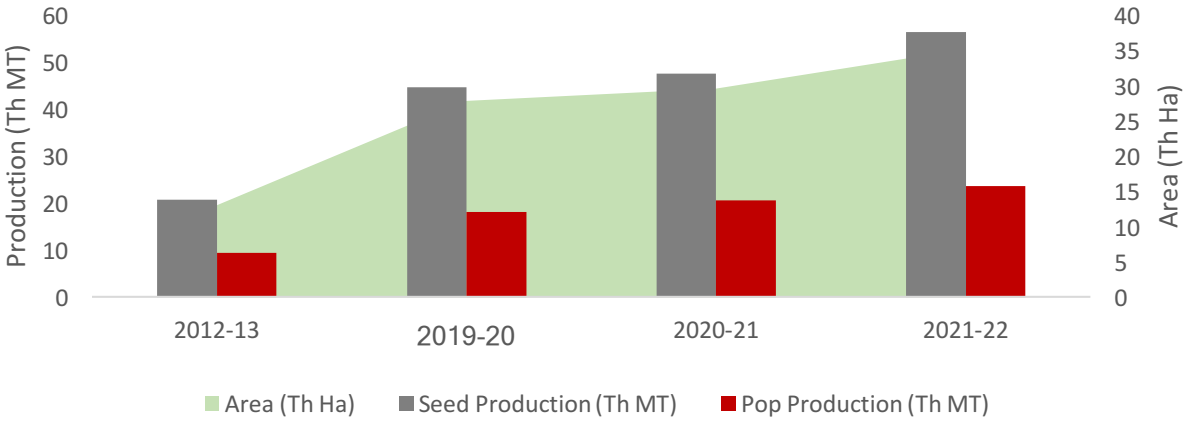
Global usage of makhana

Country	*Local Name*	*Usage*	*Areas cultivated*
India	Makhana	Roasted snack, ingredient in curries, sweets (kheer), and fasting foods; valued as a superfood	Bihar (Mithila region), West Bengal, Assam, Uttar Pradesh, Chhattisgarh
China	Qianshi	Traditional Chinese Medicines (TCM), herbal teas, soups and desserts	Hunan, Jiangsu, Fujian, and Zhejiang provinces
South Korea	Ga-si-yeon/ Euryale Seeds	Teas, health supplements, and traditional medicine	Imported primarily from China and India; limited domestic cultivation
Vietnam	Hat Sen	Soups, desserts, and traditional medicine	Cultivated in the Mekong Delta region
Thailand	Met Bua	Traditional sweet dishes, herbal teas, and snacks	Grown in lotus ponds; regions include Nakhon Pathom and Chiang Mai
Indonesia	Biji Teratai	Used in herbal remedies and health foods	Limited cultivation; primarily imported from China
Russia	Lotus Seeds	Health food products, cereals, and nutritional supplements	Primarily imported from India and China; limited cultivation
Japan	Hasu no Mi	Traditional desserts, teas, and health foods	Central Japan (Ibaraki and Aichi prefectures); mostly imported

Source: Makhana.org

FIGURE 1

Area and production of makhana in Bihar



Source: Bihar Horticulture Development Society (Government of Bihar, 2024)

sia rely heavily on imports for use in health foods and remedies, while Japan blends domestically grown and imported seeds into desserts and teas, with key cultivation in Ibaraki and Aichi.

India can focus on diversifying from its predominant use as a popped snack to developing value-added products to cater to the specific culinary and medicinal demands of countries with limited production of makhana.

2.2 Domestic scenario

The production of makhana is not systematically documented on a national scale in India. There's no official or widely acknowledged, comprehensive record of the total area cultivated under makhana and its yield across states. Makhana is grown in Bihar, Uttar Pradesh, and some parts of Chhattisgarh and West Bengal, but comprehensive, credible data at the national level is lacking. Bihar's Horticulture Division reports on district-wise area and production until 2021-22, which is the only available official source for area and production numbers for makhana (Government of Bihar, 2024).

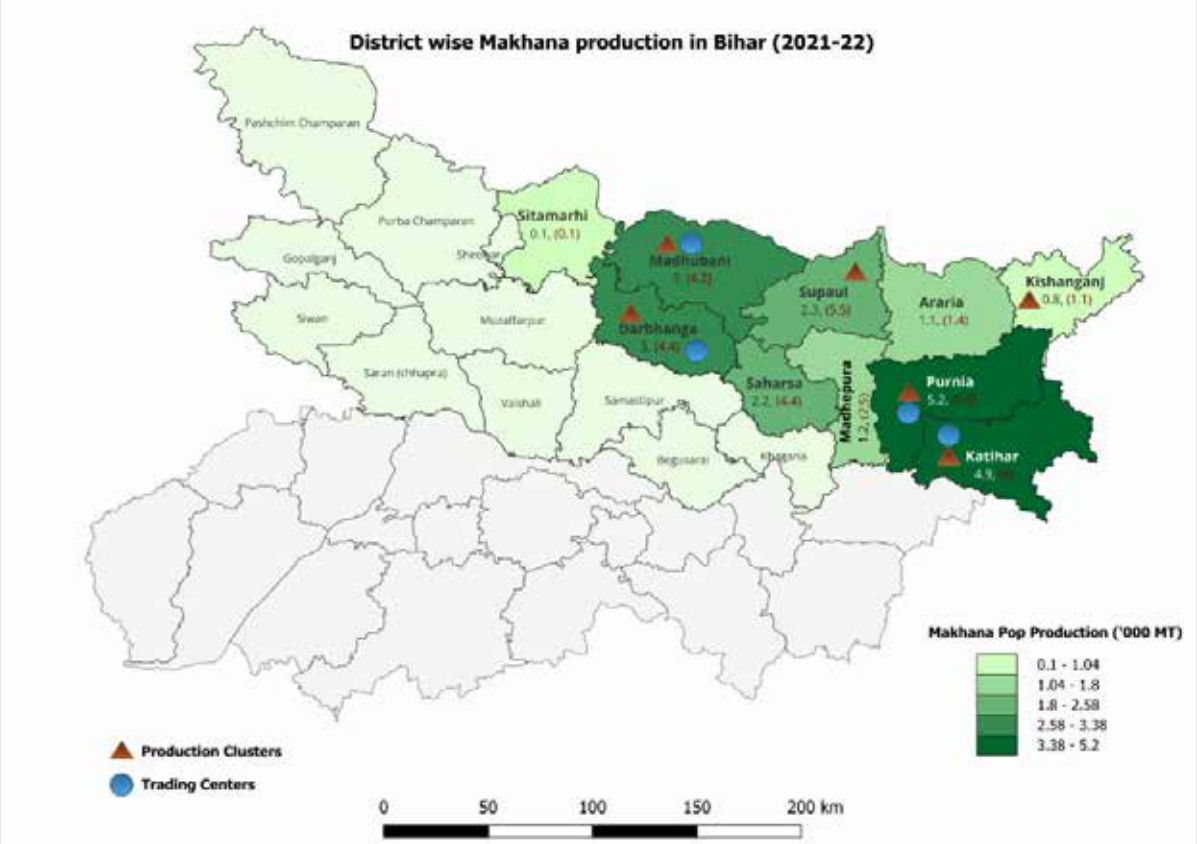
According to existing studies in literature, India is the largest producer of makhana globally, accounting for around 90 per cent of the global production Yet, official international statistics are limited, and estimates rely heavily on state-level data from Bihar. (Government of Bihar, 2024) (Sinha, 2023). Bihar contributes about 90 per cent of the production, particularly the Mithila region in North Bihar, which is known for its extensive wetland cultivation systems. It is also grown in some parts of Assam, Manipur, Tripura, Eastern Odisha, Kashmir, Madhya Pradesh, Rajasthan and Eastern Uttar Pradesh (Government of Bihar, 2024). These areas offer a conducive environment for growing makhana, as the plant thrives in shallow, stagnant water bodies. The area under makhana cultivation increased from 13000 ha in 2012-13 to 35000 ha in 2021-22 and the total seed production from 20.8 th. MT to 56.4 th. MT during the same period. Pop production also grew substantially from 9.4 th. MT to 23.7 th. MT (Figure 1).

This increase in makhana production is due to the adoption of two high yielding variety of seeds of makhana that are available for farmers at a subsidy of 75 per cent by the Governmnet of Bihar. The two seeds include *Sabour Makhana – 1* developed by scientists at the Bhola Paswan Shastri Agricultural College (BAU), Purnea, and *Swarna Vaidehi* developed by the Makhana Research Centre (ICAR), Darbhanga. The productivity of makhana has gone up from 16 quintals/hectare up to 28 quintals/hectare by using the seeds (Sinha, 2023).

Among Bihar's 38 districts, makhana is cultivated in 21 districts, out of which 10 districts contribute the most (Figure 2). Among the

FIGURE 2

District-wise makhana production in Bihar

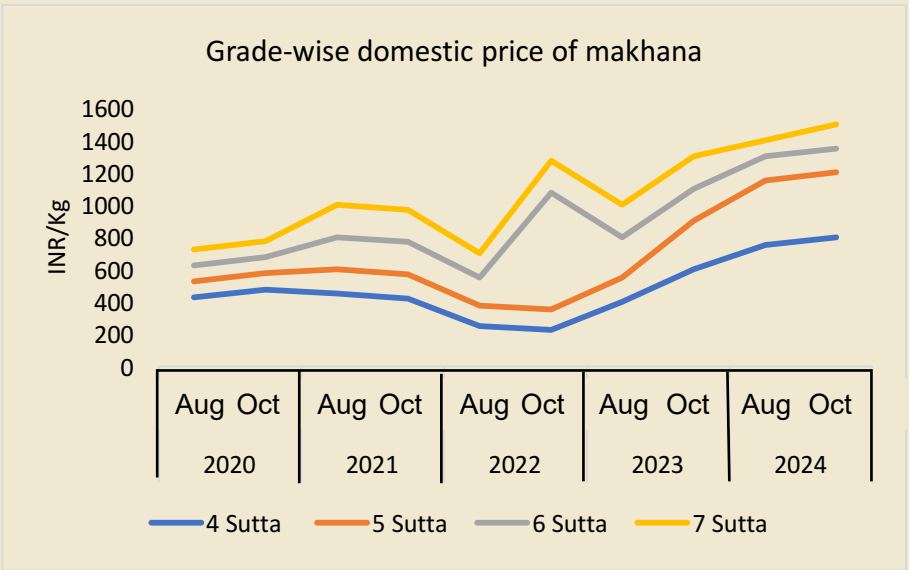


Source: Created using QGIS with data from Government of Bihar, 2024

Note: Figures in parenthesis represent area (Th. Ha)

FIGURE 3

Grade-wise domestic price of makhana



Grades
4 Sutta (12-15 mm)
5 Sutta (15-18mm)
6 Sutta (18-21mm)
7 Sutta (>21mm)

Source: Insights gathered from Shree Mithila Makhana FPO, Manigachi Midas Farmer Producer Company, and Shhe Foods.

10, Purnia and Katihar have the highest production levels of 5.2 th. MT and 4.9 th. MT of pop makhana in 2021-22. These districts are changing over from pond based cultivation to field based cultivation, unlike the traditional makhana districts such as Darbhanga and Madhubani, which majorly practice pond cultivation.

Domestic makhana prices are volatile over time, currently reaching an all-time high. This is attributed to increased domestic demand following the COVID-19 pandemic and heightened global interest after the G20 summit. Notable price dips occurred in August 2022 and August 2023 due to the cobweb effect—where fluctuating supply and demand cycles affected market equilibrium. In the last five years, makhana pop prices have nearly doubled, reflecting a consistent upward trend.

2.3 Domestic value chain

India's makhana value chain is largely unorganized, with a number of stakeholders operating at various levels of the chain. This lack of structure makes it difficult to streamline operations, ensure fair pricing, and improve overall efficiency. This not only impacts the farmers share in consumer rupee, but also hampers the potential for market expansion of makhana. The following section gives a brief description of the makhana value chain, based on interactions with stakeholders in Darbhanga and Madhubani.

Cultivation: Makhana, can be cultivated both in self-owned lands or through government/ private leased ponds or fields, most notably in the Mithila region, which spans parts of Bihar, Jharkhand, and Uttar Pradesh. Farmers with small landholdings, grow makhana in waterlogged areas that are ideal for its cultivation. As per interactions with farmers, the cost of cultivating makhana in Darbhanga (in the pond system) is approximately INR 1 lakh per hectare. This covers various inputs such as seeds, labor, water management, and other necessary agricultural practices. A study by (Singh, et al., 2020) revealed that the operational cost of makhana cultivation in the pond system was INR 88,300 per hectare and INR 1,03,500 per hectare in the field system. However, In both cases, the harvesting costs accounted for the largest share, contributing more than 40 per cent of the total cost of cultivation of makhana.

Harvesting: The harvest of makhana is predominantly carried out by the Mallah (fishermen) community of the Mithila region. The Mallah community has expertise in working in water bodies, and they use specially designed sieves to harvest the aquatic seeds. Harvesting is labour-intensive and requires skilled workers, primarily from the Mallah community, adept at working in aquatic conditions.

TABLE 4

Crop calendar for makhana in Bihar

Month	*Activity*
Nov	Sowing/Processing of seed makhana to pop makhana
Dec	
Jan	Sprouting and early leaves
Feb	Ripening of leaf
Mar	Transplantation
Apr	Growing stage (Flowering and fruiting)
May	
Jun	Monsoon season
Jul	
Aug	Harvesting
Sep	
Oct	

Source: Based on interactions with makhana stakeholders in Darbhanga and Madhubani, Oct 2024

Processing: Once harvested, the raw makhana seeds are processed by a series of traditional methods (Jha & Prasad, 1990). These are carried out by phodis or hammerers, who have inherited specialized knowledge in handling the seeds. The raw seeds are first dried, then roasted, and finally popped to produce the finished product. The popping process involves roasting seeds at high temperatures, which causes them to expand into the light, crunchy form consumed as snacks. After popping, the expanded kernel which is called makhana are carefully graded according to size and quality. The grading process determines the price of the makhana, with larger and better-quality seeds fetching higher prices in the market.

Packaging: The final product, which is popped makhana, is packaged in bulk sacks weighing

FIGURE 4

Makhana value chain from harvesting to packaging

Source: Author's own click from field visit to Darbhanga and Madhubani in Bihar

around 8 to 10 kilograms each. Additionally, smaller retail-sized packets of 250 grams are packaged for consumer markets. These smaller packets are sold directly to end consumers in local markets and through modern retail outlets.

Transportation: The transportation of makhana from the processing centers to markets is done via truck or train. The transportation cost by train is typically around INR 12 to INR 13 per kg. Rail transport is preferred for longer distances due to its relative cost-effectiveness and capacity to handle large volumes. The transportation cost by truck is higher, at approximately INR 22 to INR 23 per kg. Trucks are used for shorter distances or for deliveries that require more flexibility in routes and delivery schedules.

Farmer's share in consumer rupee

Farmer's share in the consumer rupee is an important indicator of value chain efficiency and has been analysed by a number of studies. However, the results varies across studies reflecting the differences in marketing channels. According to a study by (Minten, Singh, & Sutradhar, 2010), the farmer's share in the consumer rupee is around 55 per cent. This suggests that a significant portion of the price paid by consumers for packaged makhana products is absorbed by intermediaries, processors, and marketers. The share that reaches the farmer is relatively high compared to other agricultural sectors, but reflects the unorganized nature of the market, where inefficiencies in processing, grading, and distribution affect the overall value chain.

In contrast, (Sinha, 2023), reports a lower farmer's share in consumer's rupee between 34.20 per cent and 40.58 per cent, across three different marketing channels. In another study by (Singh, et al., 2020), the authors found that the farmers had the highest share in consumers rupee at 27.6 per cent, followed by the retailer at 19.6 per cent. This indicates that substantial variation depends on the marketing channel and the level of market organization.

2.4 Export value chain

India holds a monopoly in the production of pop makhana and is the largest exporter globally. In recent years, makhana has gained immense popularity as a healthy snack alternative, especially in USA, UK, Japan, Aus-

tralia, the Middle East, and ASEAN countries. The rising global recognition of makhana as gluten-free, and nutritious snack has significantly boosted its demand. Currently, makhana is exported through three different channels: direct exports, international tie-ups and exports with other commodities.

Three different channels for makhana exports

- *Direct exports*: Indian exporters directly ship popped makhana to USA, UK, and the Middle East in response to specific demands from international importers. These involve customized packaging, adherence to international food safety standards, and tailored supply quantities.

- *International tie-ups*: Strategic partnerships with international companies have enabled smoother access to overseas markets. These collaborations streamline supply chains, improve brand visibility and help producers and exporters to tap into established distribution networks of global partners.

- *Exports with other commodities*: Makhana is frequently shipped with other agricultural commodities in bulk containers from the major export hubs of Maharashtra, Gujarat, Karnataka, Chennai, and Kolkata. This optimizes logistics, making it cost effective method for exporting to diverse international destinations.

Logistics and infrastructure for makhana exports

The current export infrastructure for makhana includes logistics hubs like the Daak Niryat Kendra (DNK) in Darbhanga, Bihar, which facilitates the transportation of makhana to major export ports, such as Mundra in Gujarat. The DNK initiative by India Post supports small-scale makhana exporters and processors by streamlining the export process through local post offices (India Post, 2023).

In Darbhanga, DNK facilitates cost-effective and efficient international exports. Key features such as online documentation, minimal paperwork, and direct shipment without intermediaries simplify the export process for local makhana farmers and processors. DNK has enabled exporters from Mithila region to access international markets, including the USA, UK, and Middle East, by offering packaging, tracking, and affordable shipping rates.

Importing countries, particularly in the EU and Middle East require mixed quality makhana that complicates quality control efforts. The fragmented nature of the sector in India contributes to inconsistent quality and packaging standards, reducing competitiveness in the international markets. For successful export operations, there is a requirement for makhana to be stored in conditions that preserve its quality and extend its shelf life. Air-tight packaging is required to prevent moisture ingress, with storage areas to be dry, ventilated, and free from pests, with provisions for fumigation. Proper storage protocols, including controlled ventilation and protection from sunlight and rain, ensure that makhana maintains its taste, texture, and nutritional value during transit to the overseas markets (NIFTEM, 2023).

Packaging for export is such that it protect makhana from contamination and maintain its quality during transit. Primary packaging involves food-grade materials compliant with the Food Safety Standards (FSS) Regulations, while bulk packaging may use materials like jute or jumbo bags. For retail export, sophisticated packaging options such as PET bottles, tin cans, or layered films are recommended to cater to market preferences. Packaging also accommodate labelling and nutritional information while being sturdy enough to withstand handling and transport challenges across international borders.

2.5 Major makhana companies in India

The makhana industry in Bihar has witnessed remarkable growth, fueled by a surge in consumer demand for healthy snack options, the rise of the start-up culture in India and favourable policy environment. Once a humble staple for Bihar's Mithilanchal region, makhana has transformed over the past two decades into a high demand superfood with the emergence of start-ups like Shakti Sudha (2006), Mr. Makhana (2015), Shhe Foods (2021), and

Mithila Naturals (2017). These companies have capitalized on the products nutritional value, turning regional eating habit into a national sensation.

Government initiatives such as subsidies for food processing, and the One District One Product (ODOP) scheme have significantly boosted its production and recognition. Export incentives and programs under the Ministry of Food Processing Industries (MoFPI) have facilitated the global trade of processed makhana.

Shifting consumption patterns have been pivotal, with urban consumers seeking healthier snacks due to rising health consciousness and changing lifestyles. Innovative offerings like flavoured makhana in peri-peri, cheese, and caramel have made it appealing to younger generations. Established brands like Haldiram's and Too Yumm have popularized makhana, fostering a competitive market and encouraging start-ups to innovate in quality, branding, and distribution.

E-commerce and modern retail have enabled start-ups like Shakti Sudha and Madhubani Makhana to expand their reach, solidifying makhana's position as a premium snack in domestic and export markets. The convergence of policy support and consumer demand has created a thriving ecosystem for traditional producers and modern entrepreneurs alike. GI tag for Mithila makhana have attracted an influx of entrepreneurs, start-ups, and traders eager to tap into the growing global market (Murari, 2022) (Sharma M. , 2024).

TABLE 5

Major makhana companies in India

Name	*Year of est.*	*State*	*Major Products*
AAB Makhana	1990	Madhubani, Bihar	Popped
Shakti Sudha	2006	Patna, Bihar	Popped and processed
Mr. Makhana	2015	Pusa Road, Delhi	Popped
Mithila Naturals	2017	Madhubani, Bihar	Popped and processed
Farmley	2017	Delhi	Popped and processed
Madhubani Makhana	2019	Madhubani, Bihar	Popped and processed
Sumitra Foods	2019	Darbhanga, Bihar	Popped and processed
MBA Makhana Wala	2019	Patna, Bihar	Popped and processed
Shhe Foods	2021	Darbhanga, Bihar	Popped and processed
Manigachimidas FPC	2023	Darbhanga, Bihar	Popped and processed

Source: Respective companies websites

3

Enhancing makhana scalability

Being the leading producer and sole exporter of pop makhana, India has immense potential to scale up production and establish a dominant position in the global markets. However, currently India lacks the scale of production that is required to meet the increasing demand. The traditional pond-based cultivation methods, coupled with low productivity and varying quality hinders the scalability as well as the competitiveness on the international stage. Expanding makhana production within India by improving the yields through field cultivation along with mechanization can address these challenges, enabling India to meet growing demand effectively. This section will anlayse the difference between pond cultivation vis-à-vis field cultivation, along with the role of mechanization in boosting makhana production.

Pond-based vis-à-vis field based cultivation

Pond-based cultivation system relies on natural water bodies that require depths ranging from 3 to 12 feet. This type of cultivation is done in areas with abundant swamps and lakes such as North Bihar. This dependency makes the system vulnerable to climatic fluctuations, such as droughts or floods, impacting crop yields. Additionally, pond-based cultivation is labour-intensive, particularly in weed management, which is a tedious and time-consuming process. The seed requirement in pond cultivation is significantly high at 89–90 kg/ha.

The productivity of pond-based systems is sub-optimal. Despite requiring substantial seed input (89–90 kg/ha), the yield remains low at 1.5–2 MT/ha over a prolonged crop cycle of 8–10 months, with only one harvest annually. This inefficiency limits the ability to scale up production to meet the growing demand. The lack of controlled conditions leads to inconsistent quality, which is a critical disadvantage in export markets where uniformity is essential. Environmental concerns arise from the use of natural water bodies, making this approach less sustainable in the long term.

Field-based cultivation of makhana is done under field conditions with tradtional crops such as paddy and/or fish. Unlike traditional practices, field cultivation can be done in shallow waters of about 1.5 ft levels, enabling farmers to replicate makhana-growing conditions in non traditional regions beyond North Bihar. This flexibility reduces reliance on natural water bodies and mitigates risks of climatic variability. It also requres lesser seeds compared to pond cultivation at about 20 kg/ha.

Unlike pond cultivation, field cultivation require adoption of fertilizers such as NPK and urea and scientific crop management practices. This results in higher yields and improved crop quality. Field systems can also allow for better weed management, significantly reducing labour requirements and costs. With optimized growth conditions, field cultivation can shorten crop durations from 8-10 month to 4-5 months. It also leads to increased number of harvest cycles, enabling farmers to achieve higher productivity. By addressing the inefficiencies of pond cultivation, field systems ensure consistent quality, which is essential for

penetrating global markets. The reduced environmental impact of field cultivation makes it a more sustainable option for large-scale adoption.

TABLE 6

Comparison of pond and field cultivation of makhana

Parameter	*Pond Cultivation*	*Field Cultivation*
Depth of water level	Min 3 – 4 ft (Upto 8-12 ft)	About 1.5 ft
Seed Requirement	Not required after first crop	20 Kg/ha
Source of water	Natural water bodies	Irrigation or any other source of water
Fertilizers and manure	Not required	NPK, urea applied
Weed management	Very tedious	Easy
Crop duration and no. of crops in a year	8-10 months (1)	4-5 months (2)
Seed yield	1.5 – 2 MT/ha	2.6 – 3.5 MT/ha

Source: (Government of Bihar, 2024)

The role of mechanization

Mechanization enhances the efficiency and quality of makhana production and processing. By using mechanized tools for harvesting, weed management, and processing, farmers can overcome the labour-intensive nature of traditional practices. Mechanized harvesting saves time and costs and reduces health risks to workers.

ICAR-CIPHET, Ludhiana, has developed and commercialized a fully mechanized system for processing makhana, including threshing, cleaning, grading, drying, roasting, and popping. This technology has revolutionized the traditional process, improving productivity and worker safety. Using electric-heated thermic oil in a closed, thermally insulated barrel, it eliminates direct heat exposure and manual malleting risks. Processing time has reduced from 2-3 days in case of traditional popping to 20 hours, with popping capacity increasing 8-10 times, enhancing quality and market value (ICAR, 2022) (Jha S. , 2022).

FIGURE 5

Makhana processing machines: grading, popping, mixing and packaging

Source: Author's own click from field visit to Darbhanga and Madhubani in Bihar

FIGURE 6

ICAR-CIPHET Makhana processing machines

Primary roasting machine

Makhana popping machine

Popped makhana grader

Source: ICAR-CIPHET

Launched on December 03, 2013, in Darbhanga, it has expanded beyond Bihar to Madhya Pradesh, Uttar Pradesh, Himachal Pradesh, and Telangana, receiving Bihar government subsidies and NRDC's 2014 Societal Innovation Award. With INR 15 lakh fixed cost and INR 5 lakh monthly working capital, breakeven is achieved in six months, ensuring high profits and rural employment. The innovation has also enabled instant makhana kheer mix production, adding INR 5-10 lakh monthly revenue, making makhana a scalable and profitable enterprise (ICAR, 2022).

Mechanization also supports the development of value-added products such as makhana-based snacks, health supplements, and ready-to-eat options. These products cater to evolving consumer preferences and create new opportunities for Indian makhana in export markets.

The integration of field-based cultivation with mechanized processes help create a sustainable framework for makhana production. While addressing the inefficiencies of traditional methods the integrated approach also unlocks new growth opportunities. Higher yields and consistent quality will not only improve the competitiveness of Indian makhana in global markets, but also help in scaling up the production to ensure that India meets the rising international demand.

Recently ICAR-CIPHET developed a protocol for the storage of roasted makhana seeds for popping in the off-season. Roasted makhana seeds of 15–15.53 per cent moisture content (db) packed in an airtight polypropylene packets of 100 micron thickness can be stored for 150 days and popped without significant change in popped makhana recovery and popping quality. This protocol shows the way to the makhana industry for round the year popping of makhana and processing can be done at any place (K, et al., 2024).

4

Policy analysis

4.1 Tariff and non-tariff measures

For makhana, import tariffs are imposed under two HSN codes: HSN: 190410 (food preparations obtained by swelling or roasting cereals, including makhana) and HSN: 190490 (food preparations of cereals in grain form, pre-cooked or otherwise prepared, including roasted/flavored makhana).

Table 7 presents the import tariffs applied on India's makhana under the two HS codes.The USA has a significantly lower tariff (1.1 per cent) on popped makhana under HSN: 190410 but a high 14 per cent on flavoured makhana under HSN: 190490.

India exports under HSN code 190410 to many countries, including the USA, UAE, UK, Nepal, Canada, Australia, Maldives, Bangladesh, Qatar, and Saudi Arabia. Out of these, UAE and Australia impose 0 per cent import duty on Indian makhana because of India-UAE CEPA and India-Australia CECA. This makes it cheaper and easier for Indian exporters to sell there. The USA puts a small import duty of 1.10 per cent under its standard trade rules (MFN). However, Nepal charges the highest duty at 7.25 per cent, which makes Indian makhana more expensive in that market. Other countries like Maldives, Bangladesh, Qatar, and Saudi Arabia have moderate import duties, so selling in those markets is still manageable.

Under HSN code 190490, which includes food preparations made from cereals in grain form—like roasted or flavoured makhana, Indian exporters face different import duties in major countries. The UK charges the highest duty at 21.75 per cent under its Developing Countries Trade Scheme – Standard Preference, making it the costliest market for these products. The USA also imposes a relatively high import duty on Indian exports under this code. On

TABLE 7

Effective tariff rates (%) for HSN 190410 and HSN 190490

Country	*HSN: 190410* *(Food preparations obtained by swelling or roasting cereals or cereal products which includes makhana)*	*HSN:190490* *(Food preparations of cereals in grain form, pre-cooked or otherwise prepared which includes roasted/flavoured makhana*
USA	1.10%	14%
UAE	*0%	*0%
UK	*5.43%	*21.76%
Nepal	*7.25%	*7.25%
Canada	4%	4%
Australia	*0%	*0%
Maldives	5%	5%
Bangladesh	5%	5%
Qatar	5%	5%
Saudi Arabia	5%	5%

Source: ITC Trade Map

Note: *United Kingdom imposed tariff on India as per Developing Countries Trading Scheme-Standard Preference. Nepal, Maldives & Bangladesh imposed tariff on India as per preferential tariff for SAFTA countries . Australia imposed tariff on India as per India-Australia CECA. UAE imposed tariff on India as per India-UAE CEPA.

the other hand, UAE and Australia offer zero import duty under trade agreements—India-UAE CEPA and India-Australia CECA—making them more favorable markets for Indian exporters. Other countries such as Canada, Maldives, Bangladesh, Qatar, and Saudi Arabia have moderate import duties, which still allow for fairly smooth trade.

After consultations with the exporters, apart from tariffs, there are also few sanitary and phytosanitary (SPS) measures that exporters need to address when exporting makhana from India. These include moisture control as USDA has marked major Indian companies who are exporting makhana to use Oxy absorbers to refrain getting damaged or be prone to diseases. Indian exporters generally mix the lower grade with the higher grade which isn't the requirement of the demanding country leading to rejections from the importing countries.

Exporters of makhana are also required to obtain relevant licenses and certifications under the Food Safety and Standards Act, 2006. They must adhere to importing countries' food safety norms, which include certifications like HACCP and GMP. Online applications for FSSAI licenses are processed via the FOSCOS portal, and additional permits such as trade licenses or pollution clearances may be necessary. Compliance with regulatory requirements ensures legal operations, facilitates smooth export processes, and builds trust with international buyers. (NIFTEM, 2023).

In India, export-oriented labelling is required to comply with the Food Safety and Standards (Packaging and Labelling) Regulations under the Food Safety and Standards Act (FSSAI), 2006. Labels for export-bound makhana products has to be clear, prominent, and bilingual if required, adhering to the importing country's language norms. They also have to include critical details such as the trade name, list of ingredients in descending order of composition, nutritional information, net quantity, batch identification, manufacturing and expiry dates, storage instructions, and any applicable food safety claims. Proper labelling ensures transparency, traceability, and compliance with international trade standards.

4.2 Convergence between central and state government schemes for makhana

Makhana has gained attention in recent years due to its increasing demand in domestic and international markets. Recognizing its potential, the Government of Bihar and the Government of India have introduced various schemes and initiatives to support its cultivation, processing, and export. These efforts enhance productivity, improve processing techniques, and promote makhana as a valuable export commodity, boosting the livelihoods of farmers and strengthening the makhana industry. Some of the major schemes and its features are discussed below:

i. Makhana Vikas Yojana

The scheme will expand the area of makhana cultivation, produce seeds of improved varieties, train farmers to increase production and productivity, provide equipment kits made from traditional methods in makhana cultivation and benefit farmers by increasing production and productivity. This will be done by distributing improved varieties to replace the traditional seeds. Key components of the scheme are:

- *Production of high yielding variety of seeds*: Farmers receive 75 per cent subsidy on cultivation costs, up to INR 72,750 per hectare for producing Swarn Vaidehi, Sabour Makhana-1 seeds.
- *Seed distribution program*: Promotion of high-yielding seed varieties to farmers growing native varieties with a 75 per cent subsidy to increase output from 16 q/ha to 28 q/ha.
- *Area expansion (farm system)*: Supports new makhana cultivators with a 75 per cent subsidy on cultivation costs, targeting 1200 ha.
- *Traditional equipment kit subsidy for makhana cultivation*: Provides a 75 per cent subsidy on bamboo and wooden tools essential for cultivation and processing.

ii. Rashtriya Krishi Vikas Yojana (RKVY)

RKVY is launched by Government of India (GOI) which is administered by Ministry of Agriculture and Farmers Welfare (MOA&FW). This umbrella scheme also consists of Makhana Storage Structure Scheme (2024-25) which promotes the construction of makhana storage units for which farmers can avail a 75 per cent subsidy (up to INR 7.5 lakh) for building 5 MT storage units. The scheme also supports post-harvest management to reduce wastage and improve quality. It is available to farmers growing makhana on at least 1.5 ha of land for the last two years.

iii. Prime Minister's Formalization of Micro Food Processing Enterprises (PMFME Scheme)

The PMFME Scheme was launched by the Ministry of Food Processing Industries (MoFPI) in June 2020 under the *Atmanirbhar Bharat Abhiyan*. It aims to support and formalize micro food processing units, including makhana related enterprises, promoting their growth, enhancing competitiveness, and improving market linkages. The scheme was launched with a budget of INR 10,000 crore over 5 years (2020-25) across India. Key components of the scheme are:

- *One District One Product (ODOP)*: Focuses on building food processing clusters for specific products in each district. For makhana, the identified districts in Bihar are Araria, Darbhanga, Katihar, Madhubani, Saharsa and Supaul.
- *Credit-Linked Subsidy*: Provides financial assistance of up to 35 per cent of project cost for eligible food processing units
- *Capacity Building and Training*: Offers skill development and technical knowledge to entrepreneurs.
- *Support to FPOs*: Encourages collective processing and marketing efforts.
- *Online Portal for Ease of Access*: Ensures streamlined application processes and information availability for stakeholders.

iv. Scheme of Fund for Regeneration of Traditional Industries (SFURTI)

SFURTI was started by GOI and administered by Ministry of Micro, Small & Medium Enterprises (MSME) provides targeted support to traditional industries like makhana (Gorgon Nut) processing by organizing artisans and producers into clusters to enhance competitiveness and sustainability. Makhana clusters can benefit from financial assistance for modernizing processing techniques, upgrading infrastructure, improving packaging, and enhancing market access. It aims to strengthen the makhana value chain by fostering skill development, providing common facilities, and encouraging innovation in production and marketing. This initiative helps makhana producers meet export standards, reduce costs, and improve the livelihoods of communities involved in cultivation and processing.

Some of the units implemented under SFURTI are:

- The Makhana Processing and Value Addition Cluster, Madhubani, Bihar (Functional): The cluster supports 878 artisans and has a project cost of INR 330 lakh, with INR 303 lakh funded by Government of India. Implemented by Sakhi, Madhubani, with technical assistance from Nisarg Agripreneurship Foundation and PPDC-Agra, the cluster became functional in 2023–2024, enhancing makhana value addition and livelihoods. The cluster is equipped with advanced machines for sorting, popping, flavouring and grading with an ideal capacity of 150 kg/hour costing around INR 75 lakhs, while larger plants have a capacity of 300 kg/hour costing approximately INR 1.75 crore.
- Makhana Value Addition and Processing Cluster, Darbhanga, Bihar (Proposed): The cluster under the nodal agency IMEDF, aims to support 750 artisans. The DPR was originally submitted to the Ministry on 8th

April 2024 and focuses on enhancing value addition and processing for makhana.

v. Geographical indicator tag to Mithila makhana

Mithila Makhana, a unique variety of makhana grown in Bihar, received its Geographical Indication (GI) tag on August 16, 2022. Post the GI tag, its production and area has increased. Total value of exports is at USD 1.38 million, and there are more than 50000 households producing makhana domestically.

Government schemes have strengthened the makhana value chain driving improvements in production, processing and exports. Seed production increased from 47.5 Th. MT in 2020-21 to 56.4 Th.MT in 2021-22, supported by subsidies and the introduction of high-yielding seed varieties, enhancing overall productivity. Financial support for processing units and storage facilities has improved product quality and extended shelf life. The adoption of mechanized processing of makhana contributed to 3.02 thousand MT increase in popped makhana production rising from 20.63 thousand MT in 2020-21 to 23.65 thousand MT in 2021-22. Policies such as the GI tag, infrastructure development, and market linkages have expanded makhana exports to USA, UK, and Australia. Additionally, women's participation and small-scale farmer support have ensured inclusive growth.

The convergence of central and state government schemes can significantly enhance the makhana value chain by promoting joint planning, resource integration, and coordinated infrastructure development. Through financial support, capacity building, and technology sharing, both levels of government can improve productivity, processing efficiency, and market access for Indian makhana. This will boost inclusive growth, benefiting farmers, women entrepreneurs, and small-scale enterprises while strengthening India's position in domestic and international markets.

5

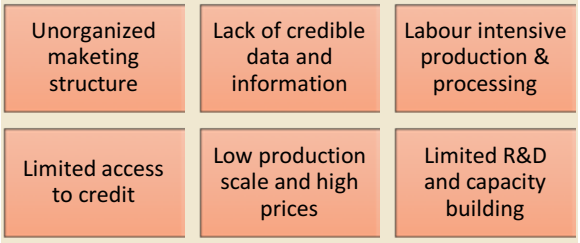
Makhana exports: challenges and opportunities

5.1 Key challenges in the makhana sector

Makhana is gaining popularity as a healthy snack option and a promising contender in the global health food industry. Despite its potential, it faces a series of systemic and operational challenges that constrain its ability to achieve sustained export growth. These challenges range from inefficiencies in traditional processing methods and high production costs to financial constraints faced by growers and a lack of market organization. The absence of robust infrastructure, standardized quality parameters, and coordinated policy support increase these issues. These barriers prevent India from leveraging the increasing international demand for makhana, limiting its economic impact and the livelihoods of the farmers. Based on our discussion with stakeholders, the major challenges affecting the makhana sector is discussed below.

FIGURE 7

Key challenges in the makhana sector



1. Unorganized marketing structure

The makhana market in India, particularly in the Mithila region, remains largely unorganized, leading to inefficiencies, price volatility, and limited bargaining power for producers. The absence of dedicated market places and reliable market data has allowed traders to dominate pricing to the disadvantage of growers. The price of makhana fluctuates significantly due to environmental factors (such as floods or droughts) and supply-demand imbalances, leaving farmers vulnerable to price swings. High logistics costs and inadequate infrastructure compound these issues, making it difficult for producers to access competitive export opportunities. Farmers lack direct access to modern retail channels and export markets that restricts their revenue potential.

2. Lack of credible data and information

Although a dedicated board for makhana has been announced and an HSN code allocated recently, credible data on key parameters such as production, consumption, exports, and imports for makhana is missing. The district-wise production data provided by the Horticulture Division of Bihar for FY2021–22 is the only source availbale, but the methodology used for data collection is not clear. Moreover, the absence of the APMC Act in Bihar has resulted in an unorganized makhana trade, with no systematic records of market arrivals or price trends, posing a major challenge to effective analysis and informed policymaking.

3. Labour-intensive methods of production and processing

Makhana production and processing relies heavily on traditional, labour-intensive methods for converting black seeds into popped makhana. These traditional, labour-intensive methods for processing makhana seeds continue to dominate the sector, resulting in inefficiencies and significant quality inconsistencies that make it challenging to meet international standards. Mechanization offers a solution but the high costs associated with setting up a small unit for producing 12 kg of pop makhana per hour—estimated at around Rs 15 lakh—deter SMEs from upgrading their operations (Kumar, 2024). Even when mechanized systems are introduced, the lack of adequate training for workers hampers efficiency and productivity. The variability in product quality leads to the rejection of consignments in international markets eroding confidence among buyers. Further, the involvement of child labour is one of the major issue in traditional processing, which affects the export and thus mechanized system should be given priority in project fundings.

4. Financial and credit challenges

Makhana growers in the Mithila region face significant financial constraints due to limited access to credit. Traditional banking systems fail to address their needs, leaving growers dependent on informal sources. While the Kisan Credit Card (KCC) offers a potential solution by providing flexible credit, its uptake among makhana growers remains low. Expanding access to such financial instruments and ensuring timely credit availability could ease cultivation and marketing pressures, enabling growers to focus on improving yield and quality.

5. Low production scale and high prices

Despite witnessing an increase in production from less than 2,000 MT in 2002 to 25,000 MT of popped makhana in 2024, the scale of production remains insufficient to meet growing global demand. Of the total production, only 12,000 MT is of exportable quality, limiting India's ability to fulfill large international orders. As there is a lack of scale in makhana production, large buyers from the food processing industry are concerned about the availability of export-quality makhana. Moreover, logistical inefficiencies, such as high freight costs and limited container capacities (4 MT in a 40-ft container and 2 MT in a 20-ft container) inflate costs. This is compounded by a 100 per cent price increase in recent years, with makhana selling for USD 8,000/Kg in the USA now compared to USD 5,000/Kg in the previous year.

6. Limited R&D and capacity building

The makhana sector suffers from a lack of research and development (R&D) and insufficient capacity-building initiatives. Without adequate R&D, opportunities for innovation in cultivation, processing, and packaging remain untapped. Training institutes are critically needed to equip farmers and workers with necessary skills to meet international quality standards. Inadequate knowledge and facilities for proper packaging affect product longevity and presentation that are crucial for success in export markets. Enhanced R&D and targeted training programs across the value chain could address these shortcomings.

5.2 Export opportunities for makhana

Makhana holds immense potential as a superfood and as an export commodity. India, with its dominant position as the world's largest producer, is well-placed to capitalize on its growing global demand with a focus on quality, variety, and value addition.

Major potential markets

The major export markets for makhana include North America, Europe, and Asia who have shown a keen interest in incorporating makhana into their diets, particularly due to its appeal as a healthy, non-GMO, gluten-free and plant-based alternative to traditional nuts and seeds. USA, Canada, and Europe (especially the UK, Germany, and France), have high demand for gluten-free and vegan snacks. Amongst

these nations, USA exhibited a CAGR of 11.5 per cent from 2019 to 2025 (Makhana.org, 2024). The Middle East, particularly countries like the UAE and Saudi Arabia presents opportunities for premium snack products. Markets in Australia, New Zealand, and Southeast Asia, such as Japan and Singapore, are increasingly recognizing the nutritional benefits and versatility of makhana.

To meet international demand, Indian exporters must ensure high-quality standards. Organic certification is important in markets like the USA and Europe, while compliance with food safety regulations such as FSSAI, FDA, and EU standards is critical. While EU and Middle Eastern countries prefer mixed-quality makhana, USA prefers consistent size and colour, with uniform white popped makhana. Nutritional labelling and accurate representation of health benefits are key factors in gaining consumer trust.

Diversification into value-added products of makhana

India produces traditional white popped makhana yet there is significant scope for exporting raw seeds and other value-added products. Developing value-added products such as flavoured snacks or ready-to-eat makhana offerings cater to diverse consumer preferences and improve export margins. Export products can include:

- *Raw seeds*: For further processing into popped makhana, medicine as one ingredient in baby/weaning foods.
- *Popped makhana*: Packaged for direct consumption.
- *Flavoured makhana*: Innovative flavours suited for importing country.
- *Value-added products*: Innovative products using makhana flour and powder like makhana bars can cater to diverse consumer preferences.
- *Un-popped makhana*: Expanded snacks, pasta, thickener.
- Decorticated kernel without popping as ingredients of other foods.

To realize the export potential of makhana, Indian producers and exporters need to invest in branding and marketing, highlighting its superfood status with nutritional and other health advantages. Establishing robust supply chains, investing in quality certification, and ensuring consistent product standards will strengthen India's competitive position in the global market.

Transport and logistics in Bihar: Opportunities for makhana exports

Bihar being a landlocked state, is dependent on its road and rail networks to transport to the nearest port. Waterways and Airways are on the cards.

Roadways

- Length of national highways: 6000 kms; State highways: 37134 km
- Golden Quadrilateral and East-West corridor passing through the state.
- Under Bharatmala initiative, a 751 km long National Highway is being upgraded.
- SAARC corridors 4 Tranche 1 and Tranche 2 that passes through India, provides connectivity to International markets of Bangladesh, Nepal, Bhutan and Myanmar.

Railways

- Total length of railway line: 3794 km.
- Eastern Dedicated Freight Corridor with length of 240 Km, passes through Bihar

Waterways

- With the implementation of National Waterways Act, 2016, 7 rivers of Bihar declared as National Inland Waterways.
- To help in easier transportation of makhana seeds to nearest ports

Airways

- Three existing Airports at Patna, Gaya and Darbhanga.
- Freight movement increased by more than six times, from 1.04 th. MT to 6.32 th. MT in the past 15 years. This development will help explore more destinations for makhana exports.

Land Ports

- State government focusing on establishing and strengthening dry ports and ICD at locations with access to rail/ road corridors.

Source: (Government of Bihar, 2023)

6

Strategies and policy implications

India is the largest producer of makhana in the world, yet its export volume remains significantly low despite growing global demand., particularly from Western countries. Over the past few years, the consumption of makhana has risen due to its recognition as a nutritious, plant-based superfood. However, India's inability to match this demand stems from low production levels, as the majority of makhana cultivation is confined to North Bihar. To expand makhana exports, the following strategies should be considered:

6.1 Short term strategies

I. Streamline regulatory barriers to facilitate trade and export of makhana

Rationale: As a minor crop, makhana lacks standardized guidelines and recommended nutrient benchmarks. This gap hampers trade tracking and compliance with the specific requirements of importing countries.

Action points:

- With the allocation of a dedicated HSN code for makhana, APEDA, the Department of Commerce, and the Department of Revenue should expedite its seamless implementation across all export documentation and customs systems. Exporters should be made aware of the new code through targeted outreach and training sessions, and its usage should be monitored to facilitate accurate tracking of makhana exports and inform future policy decisions.
- Engage with the Food Safety and Standards Authority of India (FSSAI) to formulate and publish comprehensive safety and quality standard guidelines specific to makhana, and its value-added products, addressing the requirements of importing countries. This will help ensure a standardized quality parameter, mitigating inconsistent quality issues. The Indian Council of Medical Research (ICMR) can establish and disseminate nutrient guidelines for makhana, enhancing its credibility and alignment with international standards.
- A registration system, similar to Mangonet, can be developed for makhana producers. This will help create direct connections between producers and international buyers, thereby improving transparency and boosting export opportunities.

II. Formalize the makhana sector through recently announced Makhana Board

Rationale: The makhana sector operates in an unorganized manner, with no Agricultural Produce Market Committee (APMC) framework to track prices or arrival data in Bihar, absence of reliable data on production, cultivation area, or trade. Additionally, makhana prices in recent years have inflated due to trader cartels affecting both farmers' incomes and export competitiveness. A dedicated Makhana Board has already been announced by Government of India and is in the process of establishment. This should act as the apex institution to facilitate development of makhana sector. Formal-

izing the sector through the Board will ensure transparency and efficiency.

Action points:

- With the announcement of a dedicated makhana board, focus should shift to ensuring its effective and inclusive operationalization. The board should be structured as a public-private partnership with strong representation from agri-preneurs, FPOs, exporters, research institutions, and government bodies. It should be led by a dedicated and experienced leader. The board's mandate should be clearly defined to address productivity gaps, modernize processing, and enhance export competitiveness. Additionally, the board should play a key role in improving the monitoring and collection of data related to production, cultivation area, and trade of makhana.

- Use advanced satellite imagery and GIS tools to map and monitor ponds and fields under makhana cultivation and publish comprehensive reports on area, production and yield, accessible via a central database.

6.2 Medium term strategies

III. Create export hubs/centralized facilities for exports

Rationale: The absence of centralized facilities near key makhana production areas (like Darbhanga and Purnia in Bihar) leads to inefficiencies in quality control, packaging, and price transparency. Establishing export hubs near production areas along with popping units will streamline logistics, reduce costs, and enhance competitiveness in global markets.

Action points:

- Establish centralized export hubs near Darbhanga and Purnia for grading, quality checks, and standardized packaging. Incorporate infrastructure for price discovery through auctions or digital platforms to ensure fair prices for farmers.

- Popping units/facilities near production area may be established to provide local entrepreneurs with opportunity to engage in value addition. This will also create local employment opportunities and boost the regional economy. Additionally, popping units can also be developed near port cities like Mumbai and Kolkata to reduce transportation costs. Create seamless transport systems from production hubs to ports to minimize delays and maintain product freshness.

- Establish custom clearance facilities at major airports in Bihar such as Patna and Darbhanga, to facilitate direct exports. This will reduce logistics delays and costs for exports.

- The State Government and APEDA should jointly develop a comprehensive training calendar for makhana producers and entrepreneurs in Bihar. This should include regular workshops and sessions on international standards, export procedures, and quality control to enhance their knowledge and preparedness for global markets.

- Define grade of Quality for makhana as Grade I, II, III etc. and establish Makhana Quality testing laboratory in Mithilanchal area for helping farmers, traders and exporters.

IV. Branding and marketing

Rationale: A strong branding can enhance the export potential of makhana by establishing its identity in global markets complemented by marketing campaigns highlighting India's unique role as the sole producer and emphasizing the cultural and ecological significance of makhana. This will create a distinctive identity for the product.

Action points:

- Highlight makhana's cultural heritage, ecological sustainability, nutritional benefits, and premium snack status through targeted campaigns on digital platforms, social media, and traditional media. This can be done through participation in international trade fairs, expos, and by organizing "Makhana Connect" events across major cities and countries to showcase makhana's

uniqueness and engage with potential buyers. The GI status of Mithila Makhana will play a crucial role in strengthening the branding of makhana by reinforcing its unique regional identity.

- Collaborate with international distributors, retailers, and e-commerce platforms to increase global reach, while focusing on eco-friendly packaging and certifications (FSSAI and international food safety standards) to appeal to health-conscious and environmentally aware consumers.

V. Facilitate affordable and timely financing and credit opportunities for growers

Rationale: Makhana growers from Bihar face financial challenges due to limited access to flexible credit options. The requirement of a Land Possession Certificate (LPC) to be eligible for Kisan Credit Card (KCC) excludes many tenancy farmers, leaving them unable to secure the necessary funds for cultivation and subsequent harvest cycles. Addressing these barriers will ensure better financial security to the growers. Additionally, financial schemes or subsidies are needed to support makhana exporters in setting up and expanding processing units, which are essential for value addition and boosting exports.

Action Points:

- Work with state governments to ease the LPC requirement for KCC issuance, allowing tenancy farmers to access credit and developing alternative eligibility criteria, such as using cultivation history or farmer cooperative membership and local verifications.

- Assist eligible growers in obtaining KCCs or other credit and finance options such as microfinance and warehouse receipt system. Provide support through agricultural cooperatives or NGOs to assist farmers in completing paperwork and applications.

- The government should consider introducing dedicated financial schemes or subsidies for makhana exporters in Bihar to strengthen the state's export potential. This could include interest subsidies on export loans or grants for setting up export-oriented processing units, helping entrepreneurs scale up and become more competitive in global markets.

6.3 Long term strategies

VI. Scale up makhana production by promoting field cultivation and mechanization

Rationale: The gap between demand and availability of quality makhana is increasing. This is because traditional methods of pond cultivation and processing makhana are labour-intensive, time-consuming, and leads to lower output. It exposes farmers to health hazards due to prolonged contact with water and phodis to heat and repetitive manual tasks. This affects the competitiveness of Indian makhana in global markets. Mechanization can improve efficiency, reduce health risks, ensure uniform quality standards, and lower production costs, making Indian makhana more competitive internationally.

Action points:

- Promote scientific makhana cultivation in non-traditional areas to increase area under cultivation. Makhana can be cultivated along with paddy, water chestnut, fish and other water intensive commodities in fields. States with similar topography such as Assam, Uttar Pradesh, Odisha, West Bengal and North East can be explored to scale up production levels in the country to meet the growing demand.

- Collaborate with research institutes and manufacturers to design cost-effective, farmer-friendly harvesting and processing equipment and provide subsidies/low-interest loans to farmers and training programs and set up demonstration units in makhana-producing regions to encourage adoption. Higher adoption of mechanization will help use leftover seeds and allow for longer popping season.

VII. Foster R&D in makhana processing to improve quality, shelf life and diversify to value added products

Rationale: Processing makhana into value added products suffers from limited research into areas such as improving crop quality, extending shelf life, and developing innovative value-added products. This lack of R&D has led to inconsistent quality and reduced competitiveness in global markets. Additionally, the limited availability of diverse makhana-based products restricts its consumer base. As demand for high-quality, value-added makhana products rises, focused research will address these challenges, enhance product appeal, and meet international standards.

Action points

- Launch targeted R&D programs to create high-yielding makhana varieties with enhanced nutritional value and traits suitable for processing such as improved shelf life and quality along with innovative packaging and preservation techniques. Introducing more standardized and mechanized processing techniques could reduce labour costs, improve quality consistency, and increase productivity.
- Encourage the creation of innovative makhana-based products like snacks, health supplements, and ready-to-eat options. Makhana seeds should be explored for other uses such as medicinal products, pickles, flour for starch. Support collaborations with food technologists and private firms for product diversification and encourage public-private partnerships (PPP) to commercialize research outcomes effectively.
- Establish a dedicated scientific committee/ board for policy formulation, guiding research and establishing quality grade and certifying the same for accelerated development of makhana and its export.

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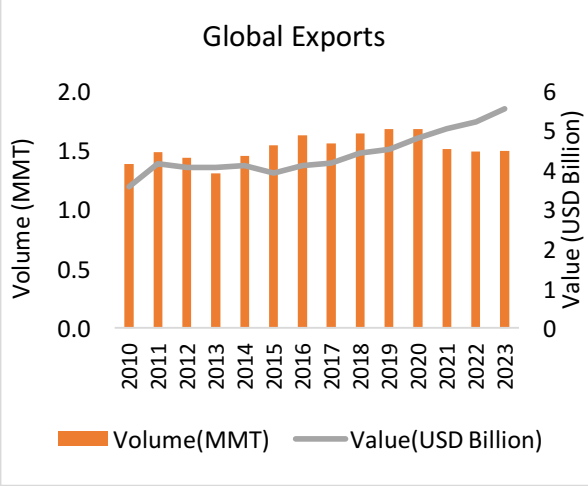
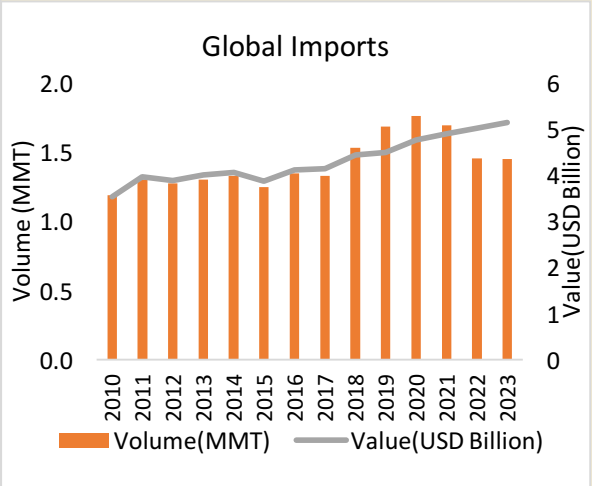
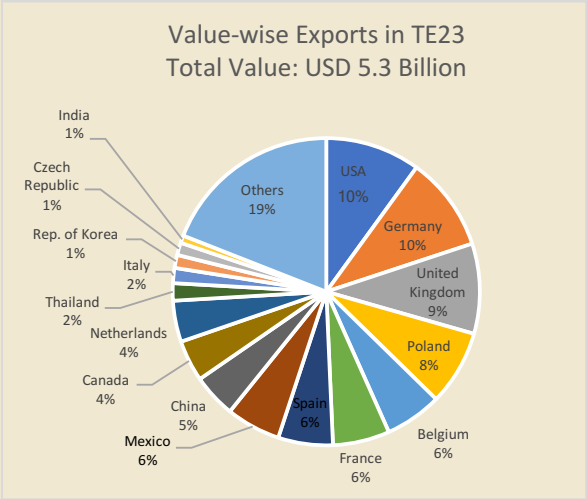
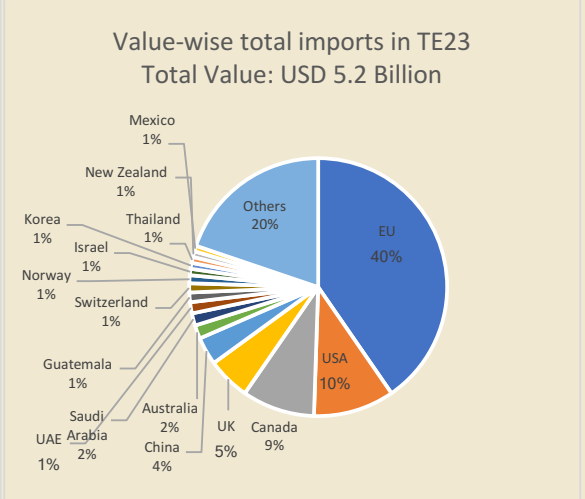
Annexures

Global Exports and Imports of HSN 190410
(Food preparations obtained by swelling or roasting cereals or cereal products)



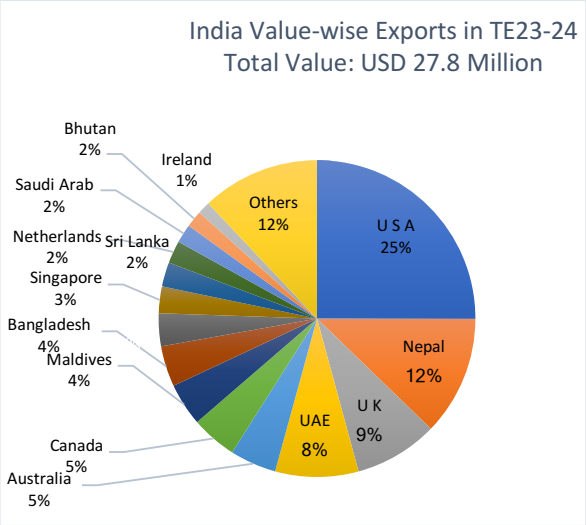




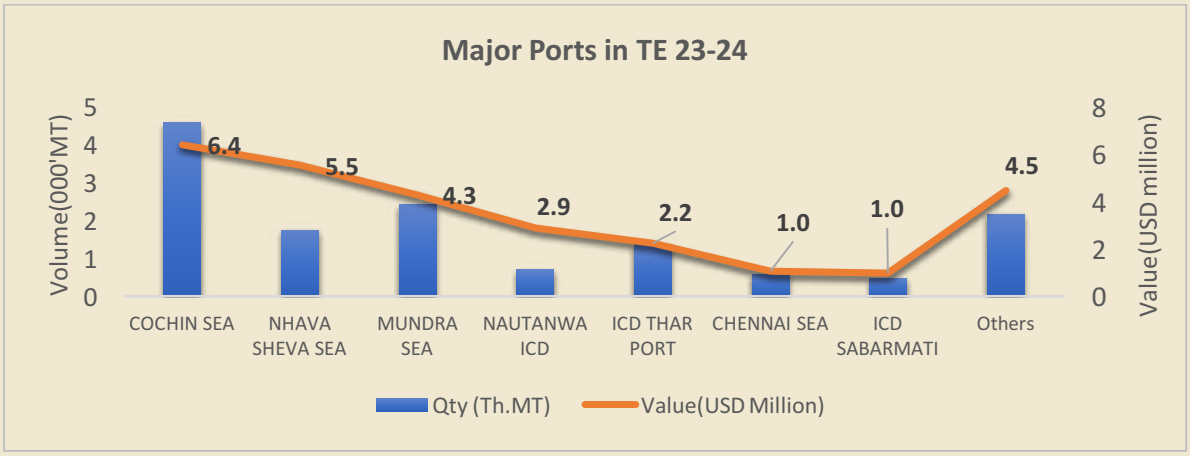


Source: ITC Trademap,2024

Domestic Exports and Imports of HSN 19041090
(Food preparations obtained by swelling or roasting cereals or cereal products)



Source: DGFT,2024



Source: APEDA,2024

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