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Geographical Indication Tag for Mithila Makhana and Its Prospects for Development in North Bihar, India

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Abstract

Makhana (Euryale ferox Salisb.), commonly known as fox nut or gorgon nut, is an aquatic crop of considerable economic, nutritional and cultural significance in the Kosi–Mithila region of North Bihar (Kumar & Gupta, 2022). The conferment of the Geographical Indication Tag on "Mithila Makhana" on 14 August 2022 has conferred renewed momentum to its branding, market identity and export potential. The present study examines the socio-economic profile of Makhana cultivators and evaluates the impact of the G.I. tag on production, price realisation and livelihood conditions in the region, while identifying the major constraints to sustaining the crop. The study is based on a mixed-methods design. Primary data were collected through structured questionnaires and direct interviews from 68 respondents drawn through purposive sampling in January 2025, supplemented by secondary data from the ICAR, Darbhanga, the Directorate of Horticulture and NABARD. Quantitative analyses were performed using MS Excel and IBM SPSS. The results indicate that per-hectare Makhana production rose modestly from approximately 9.08 to 10.07 quintals per hectare following the grant of the G.I. tag, while the average selling price of raw Makhana rose by 92.48 percent, from ₹133 per kg in 2021 to ₹256 per kg in 2025. However, awareness of the G.I. tag remained limited (41.2 percent), only 1.5 percent of respondents perceived a definitive positive impact, and 76.5 percent remained uncertain. Persistent constraints, including absence of formal training (82.4 percent trained only through conventional means), inadequate storage (only 5.9 percent have access), climate stress and limited institutional support, continue to constrain the sector. The study concludes that coordinated intervention through Farmer Producer Organisations, minimum support prices, processing infrastructure and effective leveraging of the G.I. tag is essential to convert the recent price gains into broad-based and sustainable livelihood improvement in the Kosi–Mithila region.

Keywords: Mithila Makhana; Geographical Indication; GI Tag; Kosi–Mithila Region; Livelihood Prospects; Agri-Entrepreneurship; Sustainable Development

1. Introduction

The Geographical Indication tag is a statutory instrument of intellectual property protection that authenticates the geographical origin of a product and signifies that its quality, reputation or other characteristics are essentially attributable to that place of origin. In India, the G.I. tag, administered under the Geographical Indications of Goods Act, 1999, has emerged as an important policy instrument for promoting regional development, safeguarding local biodiversity and traditional knowledge, and improving the economic prospects of producers of place-based products.

One of the more recent and commercially significant additions to India's G.I. registry is Mithila Makhana, the popped seed of the aquatic crop Euryale ferox Salisb. of the family Nymphaeaceae, grown in the stagnant perennial water bodies of the Mithila region of North Bihar (Kumar & Gupta, 2022). On 14 August 2022, Mithila Makhana was granted the G.I. tag under Application No. 696, providing statutory recognition to its distinct geographical identity (Government of India, 2022).

The GI tag has benefited Makhana producers in many ways. Bowen & Zapata, (2008) concluded in their study that GI products command high market prices compared to non-GI products because of the belief of consumers about the origin, quality and authenticity. In this case, the tequila GI did not produce sustained price increases for producers, but agave prices increased from 1.57 pesos/kg in 1998 to 19.08 pesos/kg in 2000. FAO, (2018) also reported that, in all nine cases of the study, GI registration had a positive impact as the product's price increased. Taliouine saffron producers belonging to cooperatives earned premiums exceeding 500%. In most cases, the price premium was between 20% and 50%.

Makhana's distribution is limited to tropical and subtropical Asia. Although the plant is also reported in Japan, Korea, China, Bangladesh and Nepal, India is by far the largest producer, with cultivation confined largely to Bihar, Assam, West Bengal, Odisha, Tripura and Manipur (Ahmad, 2020). Bihar alone accounts for 85–90 percent of India's total Makhana production, with the Kosi–Mithila belt constituting the principal production cluster. The districts of Madhubani, Darbhanga, Sitamarhi, Saharsa, Katihar, Purnia, Supaul, Kishanganj and Araria are particularly suited to Makhana cultivation from an agro-climatic perspective.

The trajectory of Makhana cultivation in Bihar has expanded markedly. In 2012–13, Makhana was cultivated on approximately 13,000 hectares in Bihar; by 2021–22, the area

had grown by 171 percent to 35,224 hectares. Makhana seed production correspondingly rose from 20,800 tonnes in 2012–13 to 56,389 tonnes in 2021–22, while the production of Makhana pop increased by 152 percent, from 9,360 tonnes to 23,656 tonnes over the same period. These figures underscore the rapid transformation of Makhana from a traditional, localised crop into a high-value commercial commodity.

In India, Makhana is used as a healthy snack and in culinary preparations such as kheer, pudding and curry, and is integral to several religious rituals, including Kojaagaraa, Parikramaa, Shraaddha Karma and the preparation of Prasaad and Panchamevaa (Kumari &Jha, 2018). Its prominence in indigenous systems of medicine, including Ayurveda, has further reinforced its commercial value. Makhana has been documented in the treatment of renal disorders, chronic diarrhoea, excessive leucorrhoea and hepatic dysfunction, owing to bioactive compounds that confer antioxidant, antimicrobial, anti-diabetic, immunomodulatory and anti-melanogenic properties (Mittal et al., 2020). These nutritional and pharmacological attributes have fuelled a steady rise in global demand and in the unit price of Makhana.

The Kosi–Mithila region is at the forefront of global Makhana production, yet the conversion of raw Makhana seed into edible Makhana pop continues to be carried out predominantly through traditional, labour-intensive methods. Cultivation and processing entail arduous work performed largely by members of the Mallah (fisherfolk) community, an Other Backward Class population in Bihar (Ahmad, 2020). According to the Bihar Horticulture Development Society, more than 50,000 families in the region are engaged in Makhana cultivation and processing. Two improved varieties—Swarna Vaidehi and Sabour Makhana-1—are cultivated prominently. Against this backdrop, Makhana has been designated as a One District One Product under the Pradhan Mantri Formalisation of Micro Food Processing Enterprises scheme, opening new institutional avenues for investment in cultivation, processing, storage, trade and marketing.

Notwithstanding India's position as the leading producer of Makhana, the country's share in global exports remains modest. Strengthening the export-oriented value chain offers considerable potential for poverty alleviation, gender-inclusive employment generation and regional economic development. The present study was conceived with the following objectives: (1) to analyse the status of Makhana cultivation in the Kosi–Mithila region of North Bihar; (2) to assess the impact of the G.I. tag on the production and income of

Makhana cultivators; and (3) to identify the principal constraints confronting Mithila Makhana production and to outline strategies for its sustainable development.

2. Study Area

The study was conducted in the Kosi–Mithila region of North Bihar, which constitutes the principal Makhana-producing belt of India. The region encompasses the districts of Darbhanga, Madhubani, Supaul, Saharsa, Purnia and Katihar, and is characterized by extensive wetlands locally known as chaurs and mauns. Within this region, Darbhanga and Madhubani—the historical core of Mithila Makhana production—were selected for intensive primary investigation. Three blocks from Madhubani district and three blocks from Darbhanga district were chosen for the sample selection.

The study area is traversed by the river Kosi and its tributaries, which create fertile hydrological basins conducive to aquatic crop production. However, the region also suffers from recurrent flooding associated with the Kosi River and from persistent infrastructural deficits, both of which affect the livelihoods and productivity of Makhana cultivators.

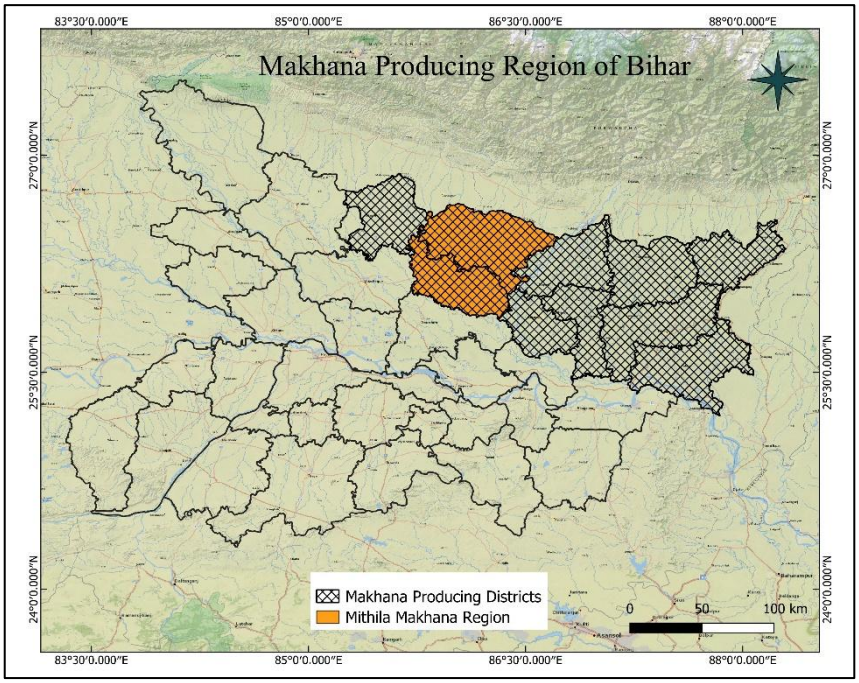

Fig. 1. Study Area Map

3. Materials and Methods

3.1 Research Design and Approach

The study adopts a mixed-methods research design that combines quantitative survey data with qualitative contextual information. A cross-sectional design was employed to

capture the contemporary status of Makhana cultivation, the impact of the G.I. tag, and the principal constraints faced by cultivators in the study area.

3.2 Primary Data

Primary data were collected from January to February 2025 through a pre-tested structured questionnaire administered through direct interviews. A total of 68 respondents were selected using purposive sampling from the six selected blocks across Darbhanga and Madhubani districts. The sample size, though modest, was determined on the basis of feasibility, logistical constraints in accessing pond-based cultivators dispersed across remote wetlands, and the exploratory nature of the study.

3.3 Secondary Data

Secondary data were drawn from the ICAR Research Centre, Darbhanga (ICAR, 2024), the Directorate of Horticulture, Government of Bihar, NABARD (2023), APEDA (2025), the GI Registry (Government of India, 2022), and other official government publications and peer-reviewed sources.

3.4 Data Analysis

Quantitative data were coded, tabulated and analysed using MS Excel and IBM SPSS. Descriptive statistics (frequency, percentage, mean and ratio analysis) were employed to summarise the socio-demographic profile of respondents, the pattern of Makhana cultivation and the impact of the G.I. tag. Comparative analysis of pre- and post-G.I. tag production and price data was undertaken to identify net changes. Inferential statistical tests, where appropriate, were used to examine relationships between socio-economic variables and outcomes such as awareness of the G.I. tag. The study area map and choropleth map were prepared using ArcGIS software. Pearson's correlation was applied for better visualisation of the relationships between the variables.

3.5 Ethical Considerations

Respondents were briefed on the purpose of the study, and informed consent was obtained prior to each interview. The anonymity and confidentiality of respondents were maintained in data handling and reporting.

4. Results

4.1 Demographic Profile of Respondents

The age distribution indicates that Makhana cultivation engages predominantly middle-aged adults. The largest share of respondents (35.29 percent) belonged to the 41–50 age group, followed by the 21–30 age group (23.52 percent). The lowest representation was among respondents above 60 years (2.94 percent). This distribution suggests that the physically demanding nature of pond-based cultivation limits participation among older cultivators, while engagement of younger cultivators remains comparatively limited.

Gender imbalance is pronounced: 91.2 percent of respondents were male and only 8.8 percent female. This pattern reflects the prevailing cultural and occupational context in which pond-based field operations, traditionally undertaken by men of the Mallah community, are performed within a male-dominated structure. Limited involvement of women in cultivation coexists with their significant participation in post-harvest processing.

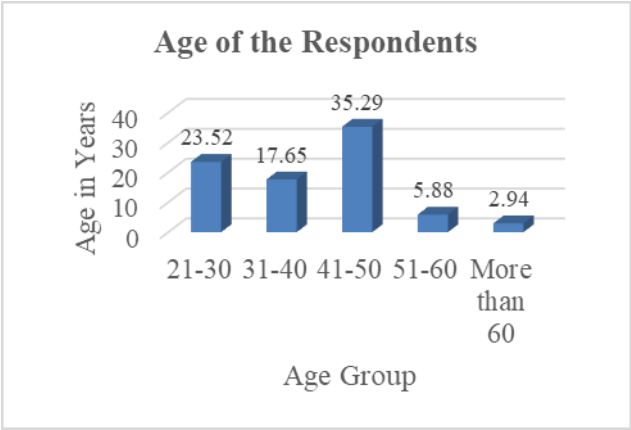

Fig. 2. Age of the Respondents

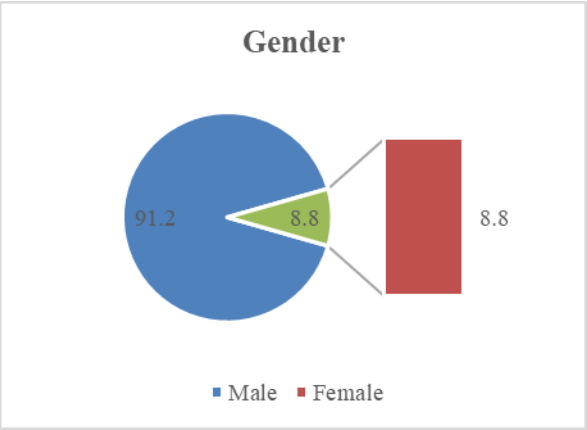

Fig. 3. Gender of the Respondents

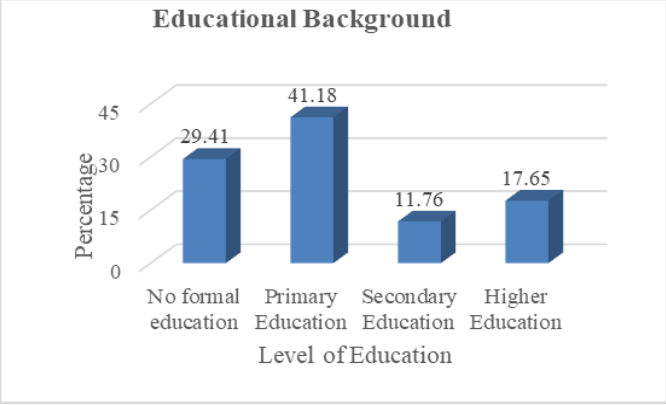

Fig. 4. Educational Background of the Respondents

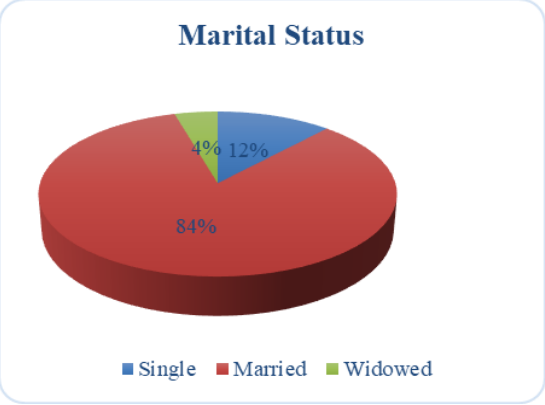

Fig. 5. Marital Status

Educational levels are modest: 29.41 percent had no formal education, 41.18 percent had completed primary education, and only 17.65 percent had pursued higher education. A majority were married (84 percent). Approximately 84 percent identified as Hindu and 16

percent as Muslim; 82 percent belonged to the OBC category (primarily the Mallah community), 15 percent to the General category and 3 percent to the Scheduled Caste category.

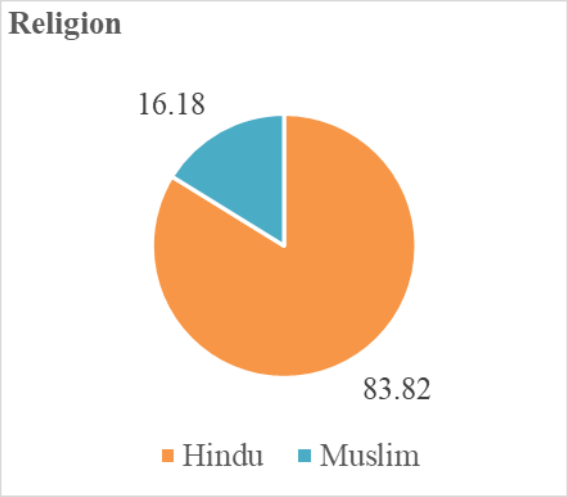

Fig. 6. Religion of the Respondents

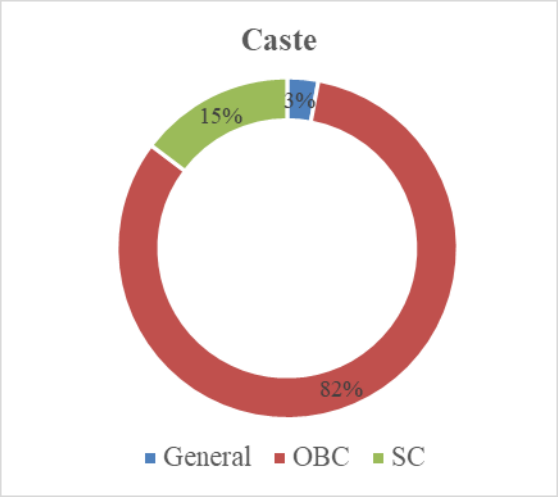

Fig. 7. Caste of the Respondents

4.2 Status of Makhana Cultivation

Table 1 presents the district-wise distribution of Makhana cultivation area and production in North Bihar for 2024. Katihar reported the highest area (6,143 ha) and production (12,900.30 MT), while Sitamarhi reported the lowest (146 ha; 277.40 MT). The data confirm the emergence of the Seemanchal districts as new growth centres, while traditional districts continue to account for substantial area but exhibit comparatively moderate yields. The table below indicates the production of Makhana in ten districts of Bihar, but the present study covers specifically two districts, namely Darbhanga and Madhubani.

Table 1. District-wise Makhana Production in North Bihar, 2024

District	Area (ha)	Production (MT)
Darbhanga	3,534	7,421.40
Madhubani	3,467	7,280.70
Sitamarhi	146	277.40
Purnia	5,549	11,652.90
Katihar	6,143	12,900.30
Saharsa	2,549	5,352.90

Supaul	2,468	5,182.80
Madhepura	1,461	2,907.29
Araria	1,427	2,639.95
Kishanganj	1,143	2,000.25

Source: ICAR Research Centre, Darbhanga (ICAR, 2024).

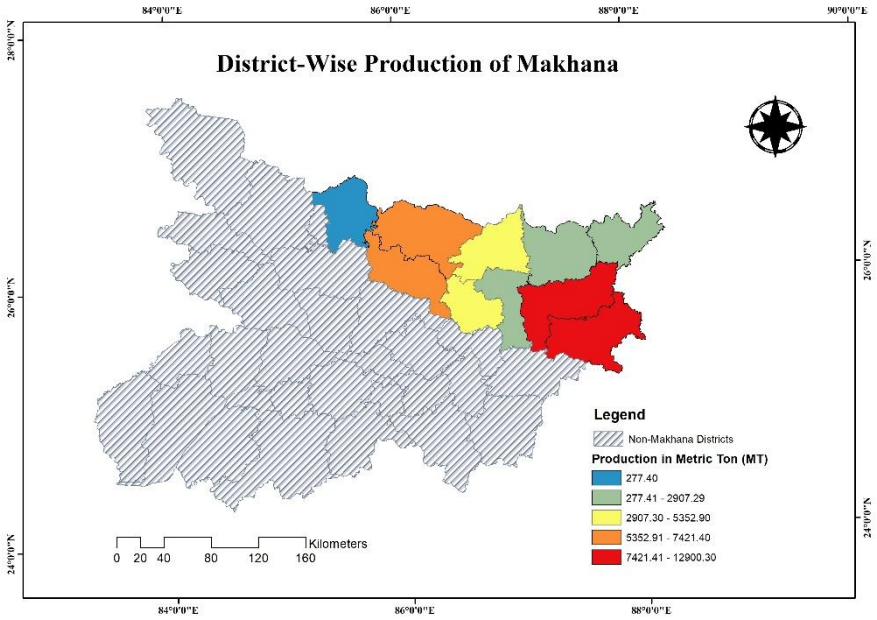

Fig. 8. Production of Makhana (District-Wise)

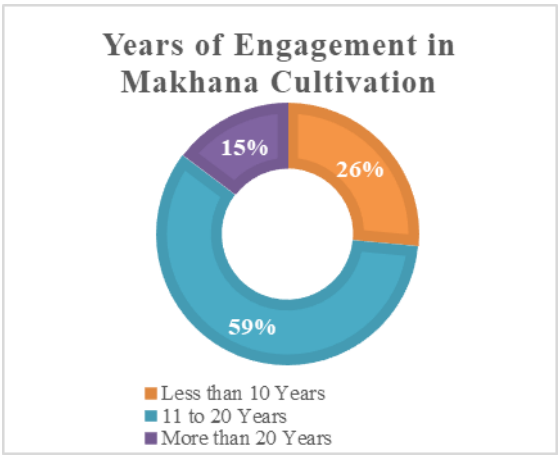

Fig. 9.Years of engagement

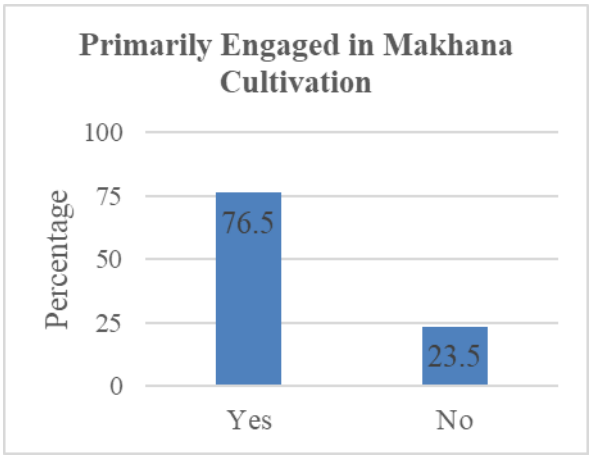

Fig. 10. Type ofEngagement

Approximately 59 percent of respondents had 11–20 years of experience in Makhana cultivation, 15 percent had more than 20 years and 26 percent had less than 10 years. With respect to engagement, 76.5 percent reported Makhana cultivation as their primary occupation, while 23.5 percent reported it as a secondary source of income. Land ownership

patterns reveal that only 5.9 percent cultivate exclusively on owned land, 35.3 percent solely on leased land, and the remainder on a combination. Aggregate land under cultivation comprised 32.17 ha owned and 166.33 ha leased. The contribution of Makhana-related activities to total household income was substantial: 63.53 percent of average family income was derived from Makhana cultivation and processing.

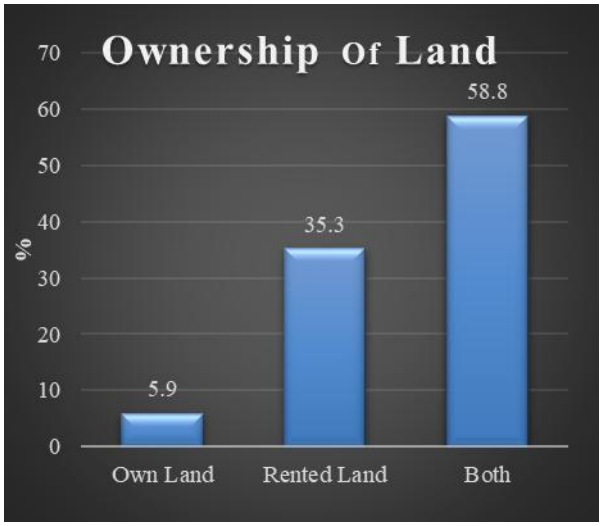

Fig. 11. Ownership of Land

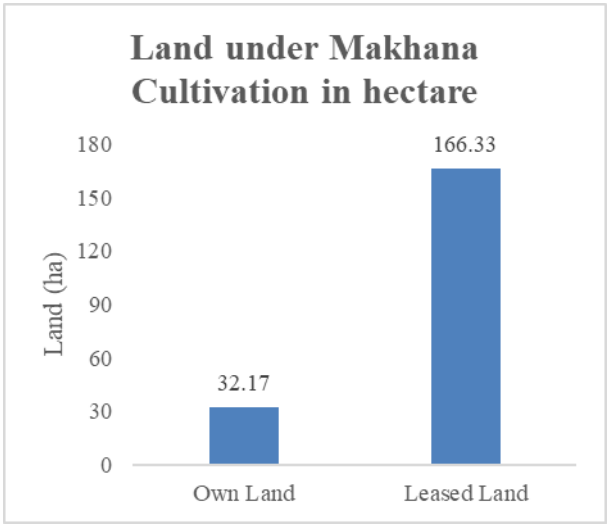

Fig. 12. Land Under Makhana Cultivation

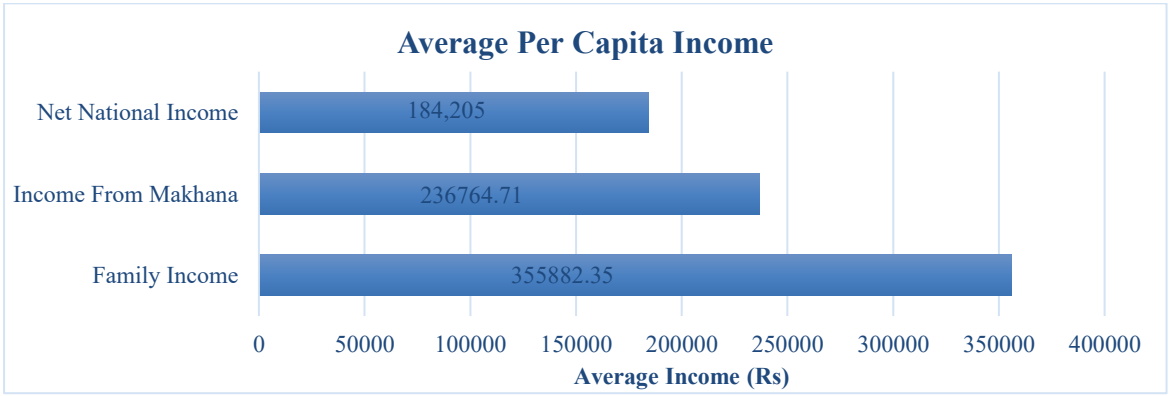

Fig. 13. Average Per Capita Income of the Households

4.3 Impact of the G.I. Tag

Despite the significance of the G.I. registration on 14 August 2022, only 41.2 percent of respondents were aware of the tag. Only 1.5 percent believed that the G.I. tag had brought positive benefits in terms of production, marketing and distribution, while 22.1 percent considered that it had not yielded such benefits, and 76.5 percent remained uncertain.

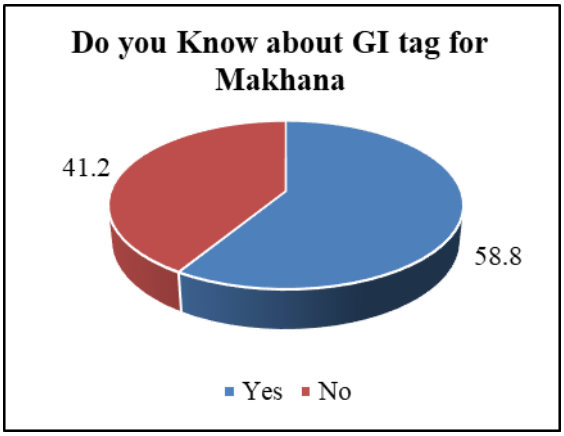

Fig. 14. Awareness of GI Tag for Makhana

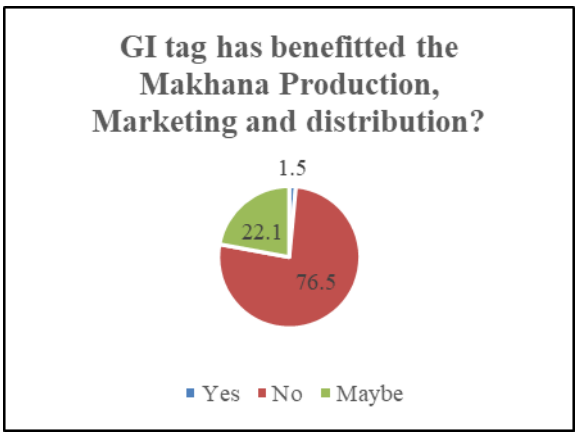

Fig. 15. Impact of GI Tag on Makhana

Table 2. Average Price of Makhana in India (INR/kg)

Year	Average Price in India (per kg)
2021	550
2022	500
2023	800
2024	900
2025	1250

Source: APEDA, September 2025

Table 3. Comparison of Makhana Production and Price: Pre- and Post-G.I. Tag

Period	Production (q/ha)	Average Selling Price of Raw Makhana (₹/kg)	Growth in Price (%)	Average Selling Price after Processing (₹/kg)
Pre-G.I. (2021)	9.08 (approx.)	133	—	500
Post-G.I. (2025)	10.07 (approx.)	256	92.48	1040

Source: Sample Survey, January 2025

The domestic price of Makhana in India has seen a substantial increase from ₹550 per kg in 2021 to ₹1250 per kg in 2025, mainly because of the change in food habits and health-awareness among people.Per-hectare production rose modestly from 9.08 to 10.07 quintals. More strikingly, the average selling price of raw Makhana rose from ₹133 per kg in 2021 to ₹256 per kg in 2025—an increase of 92.48%. While the yield response was modest, the price response was substantial, reflecting broader market recognition conferred by the G.I.

registration. Benefits remain unevenly distributed: small cultivators often lack the resources and institutional connectivity required to capture the G.I. premium.

4.4 Constraints of Makhana Cultivation

A substantial 82.4 percent of respondents received training only through conventional (indigenous, family-based) methods, while 17.6 percent reported receiving no training at all; none reported training from government institutions or NGOs. Access to storage is critically limited: only 5.9 percent reported having such facilities. Approximately 76.47 percent reported receiving subsidies, yet small and marginal cultivators continue to face difficulty bearing high production costs. Climate and environmental stress remain acute: respondents highlighted lack of rainfall, rising temperature, reduction of wetlands and shortage of trained labour as principal constraints.

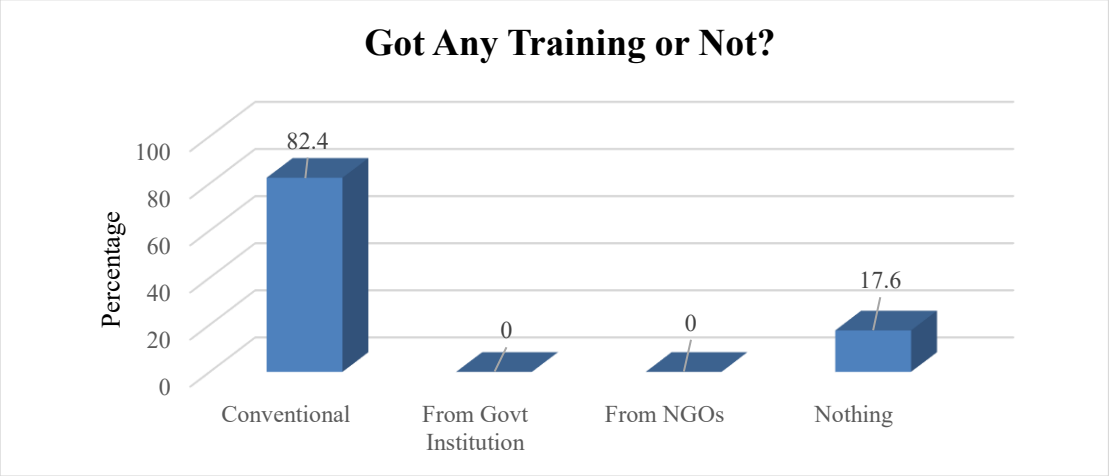

Fig. 16. Centres for Training of Makhana Cultivation

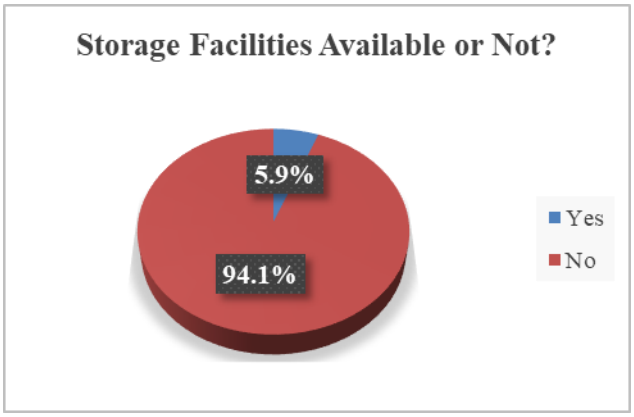

Fig. 17. Availability of Storage Facilities

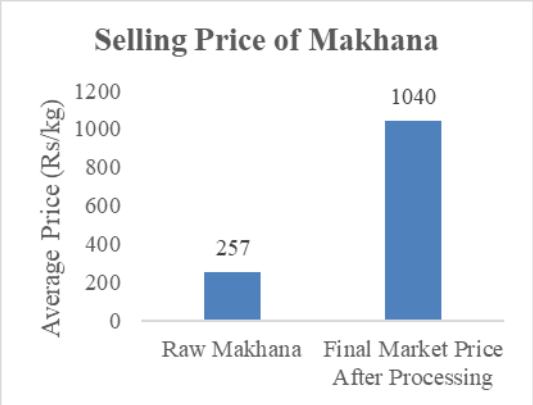

Fig. 18. Prices of Makhana

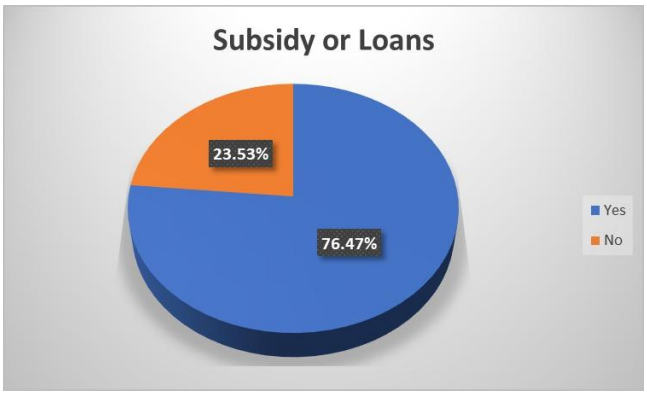

Fig. 19. Assistance from Government

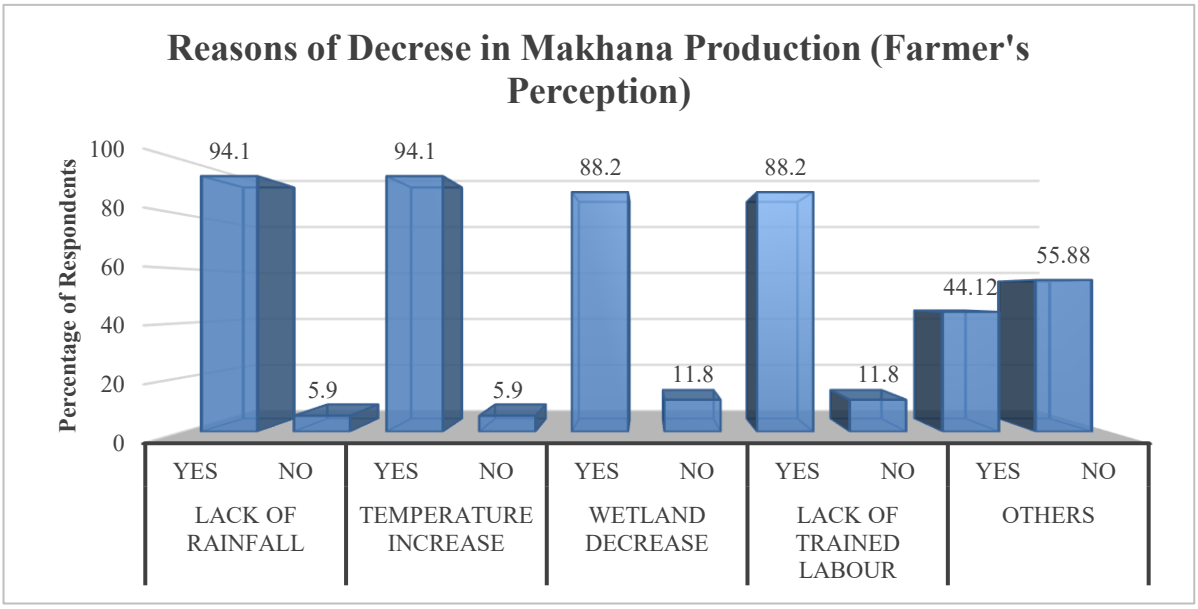

Fig. 20. Farmers Perception on the Reasons Behind Decrease in Makhana Production

5. Discussion

The findings corroborate and extend the existing literature on Makhana cultivation in the Kosi–Mithila region. The rapid expansion of cultivation area from 13,000 hectares in 2012–13 to 35,224 hectares in 2021–22 positions the region as the global hub of Makhana production. However, the production and price gains attributable to the G.I. tag have not yet translated into commensurate improvements in cultivator awareness, training or institutional access.

Two observations merit emphasis. First, the modest rise in per-hectare yield following the G.I. tag suggests that the principal benefits of the tag operate through price realisation rather than productivity enhancement—a price-led rather than yield-led growth pattern characteristic of many Indian G.I.-tagged commodities. Second, the limited awareness of the G.I. tag (41.2 percent) and the high proportion expressing uncertainty (76.5 percent)

underscore an implementation gap between formal registration and effective on-ground communication and uptake by cultivators.

The near-complete absence of formal training and the inadequate storage infrastructure reveal deep structural vulnerabilities that may erode long-term gains from the G.I. tag if not addressed through coordinated policy intervention. Sustainable growth will also require climate-resilient cultivation practices, conservation of wetland ecosystems and development of drought- and flood-tolerant varieties.

Table 4. Correlations among variables

		Education	**Awareness of GI tag**	**GI tag has benefits**	**Annual Family Income**	**Annual Income from Makhana**
Education	Pearson Correlation	1	.547**	.585**	.151	.217
	Sig. (2-tailed)		.000	.000	.219	.076
	N	68	68	68	68	68
Awareness of GI tag	Pearson Correlation	.547**	1	.560**	.069	.181
	Sig. (2-tailed)	.000		.000	.576	.140
	N	68	68	68	68	68
GI tag has benefitted	Pearson Correlation	.585**	.560**	1	.313**	.397**
	Sig. (2-tailed)	.000	.000		.009	.001
	N	68	68	68	68	68
Annual Family Income	Pearson Correlation	.151	.069	.313**	1	.971**
	Sig. (2-tailed)	.219	.576	.009		.000

	N	68	68	68	68	68
Annual Income from Makhana	Pearson Correlation	.217	.181	.397**	.971**	1
	Sig. (2-tailed)	.076	.140	.001	.000	
	N	68	68	68	68	68
****. Correlation is significant at the 0.01 level (2-tailed).**						

Here, the Pearson's correlation analysis indicates that respondents who have higher educational qualifications are more aware of the GI tag for Makhana ($r = 0.547$, $p < 0.01$) and they also believe that the GI tag has benefitted the Makhana production, marketing, and distribution positively ($r = 0.585$, $p < 0.01$). Similarly, awareness of the GI tag is moderately associated with a positive perception of its benefits ($r = 0.560$, $p < 0.01$). There is also a moderate positive relationship between the GI tag and both annual family income ($r = 0.313$, $p < 0.01$) and annual income from Makhana ($r = 0.397$, $p < 0.01$) which indicates that households earning more, particularly from Makhana cultivation are more likely to view the GI tag more favourably. The strongest correlation exists between annual family income and annual income from Makhana ($r = 0.971$, $p < 0.01$) which also reflects that income from Makhana production is a major contributor to their total household income. However, education and GI tag awareness do not have significant direct relationships with income, as their correlation values are weak and statistically insignificant ($p > 0.05$).

5.1 Recommendations

1. Minimum Support Price and Crop Insurance: A notified MSP for Makhana and expanded crop insurance schemes would insulate cultivators from price volatility and production risk.

2. Extension Services and Capacity Building: Government institutions, in coordination with ICAR and NABARD, should institutionalise systematic training programmes covering scientific cultivation, post-harvest management, G.I. certification and digital marketing.

3. Strengthening of FPOs and Cooperatives: Expansion and professionalisation of FPOs and cooperatives would reduce intermediary influence and enable direct market linkages.

4. Local-Level Processing, Storage and Packaging Infrastructure: Decentralised units at the block level would minimise post-harvest losses and increase the share of value addition accruing to cultivators.

5. Climate-Resilient Research and Development: Continued investment in high-yielding, climate-resilient varieties and technological innovation is essential.

6. Effective Leveraging of the G.I. Tag: Brand-building campaigns, certification literacy drives, traceability mechanisms and market promotion should ensure the tag translates into tangible benefits.

7. Export Diversification and Value Addition: Diversified export destinations and value-added products would broaden the market base.

8. Makhana Board with Cultivator Representation: A dedicated Makhana Development Board with cultivator representation should coordinate policy, research, marketing and export promotion.

5.2 Limitations of the Study

The study is constrained by its sample size (n = 68), which, while adequate for an exploratory assessment, restricts statistical generalisability. The purposive sampling design introduces potential selection bias, and the cross-sectional nature of the data does not allow causal inference regarding the impact of the G.I. tag. Future research with larger, randomised samples and longitudinal designs would strengthen the evidence base.

6. Conclusions

The Geographical Indication tag for Mithila Makhana represents a significant milestone in the formal recognition of the cultural and economic identity of this traditional aquatic crop. The present study indicates that the G.I. tag has produced tangible benefits, including a substantial rise in the average selling price of raw Makhana (92.48 percent between 2021 and 2025) and modest gains in per-hectare production. However, these gains have been unevenly distributed, with awareness of the tag, training, storage infrastructure and institutional access remaining critically low among cultivators.

The developmental potential of the G.I. framework for the Makhana sector can only be realised through a coordinated, multi-stakeholder approach involving government, research institutions, cooperatives and cultivators. Strengthening post-harvest processing, establishing cold chains, fostering climate-resilient cultivation, promoting export-oriented value chains and ensuring effective utilisation of the G.I. tag through branding and certification are imperative for converting recent price gains into sustainable livelihood improvements. With appropriate policy backing and institutional reform, Mithila Makhana can emerge as a

flagship example of how G.I. protection can promote inclusive rural prosperity and sustainable wetland management in the Kosi–Mithila region.

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Author Contributions

SK Amirul Islam: Conceptualization, field survey, data analysis, writing—original draft. Aktar Hussain: Data collection, analysis, writing—review. Shubham Kumar: Data curation, visualization. Dr. Md. Nazim: Supervision, methodology guidance, writing—review and editing. All authors approved the final manuscript.

Data Availability Statement

The anonymised primary survey data are available from the corresponding author upon reasonable request. Secondary data are publicly available from ICAR and NABARD reports.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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