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Aquatic Jewel: Makhana Cultivation as a Superfood and Agribusiness Game Changer

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Makhana (*Euryale ferox Salisbury*), commonly known as foxnut or gorgon nut, is a high-value aquatic food crop with particular importance in eastern India. Unlike conventional field crops, makhana is adapted to stagnant and shallow-water ecosystems, allowing productive use of ponds, low-lying depressions and other waterlogged resources. Its cultivation is closely linked with traditional knowledge, but the crop is increasingly receiving scientific attention because of improved varieties, integrated farming systems and growing consumer demand. The release of *Swarna Vaidehi* by ICAR-Research Complex for Eastern Region, Patna, represented an important step towards varietal improvement, with a reported production potential of 2.8–3.0 t ha^{1} under farmers' field conditions. Recent research has also demonstrated the economic potential of integrating makhana with fish culture. However, labour-intensive harvesting and processing, limited access to quality planting material, technical knowledge gaps and weak mechanization remain important constraints. A coordinated approach involving improved planting material, scientific water and nutrient management, mechanization, integrated aquaculture, value addition and stronger market linkages can help transform makhana from a traditional aquatic crop into a more efficient and remunerative production system.

Keywords: Makhana, *Euryale ferox*, aquatic crop, waterlogged agriculture, Swarna Vaidehi, integrated farming, value addition

Introduction

Agriculture in eastern India is often constrained not only by scarcity of productive land but also by the presence of waterlogged and low-lying areas that are difficult to manage with conventional field crops. Makhana offers a distinctive opportunity in such environments because it is naturally suited to stagnant water bodies and shallow aquatic ecosystems. The crop belongs to the family Nymphaeaceae and produces edible seeds that are widely consumed after popping. Its cultivation has historically been concentrated in eastern India, particularly Bihar, where pond-based production and associated processing have developed as specialized livelihood activities. Scientific interest in makhana has expanded from its traditional cultivation base to questions of varietal improvement, water management, labour reduction, integrated fish production and post-harvest value addition. A major review identified makhana as a high-valued aquatic food crop with considerable potential for small and marginal pond owners, while also emphasizing the high drudgery involved in production and processing. (Khadatkar et al., 2020).



(William Tricker, Inc., n.d.)

The Aquatic Niche of Makhana



(Choudhury et al., 2026)

Makhana differs fundamentally from terrestrial field crops because its productive environment is water rather than a conventionally prepared soil surface. It is commonly grown in stagnant perennial water bodies such as ponds, depressions, oxbow lakes, swamps and ditches. Large floating leaves form a canopy on the water surface, while the plant develops within the aquatic environment. This ecological adaptation makes makhana particularly relevant to resource-use strategies in areas where seasonal or perennial waterlogging restricts conventional cropping.

Why Makhana Matters For Eastern India?

Makhana cultivation is concentrated in Bihar, which contributes nearly 80–85% of the global supply. Districts such as Darbhanga, Madhubani, Saharsa, and Purnia form the production hub, sustaining rural livelihoods. More than five lakh families are engaged in activities ranging from pond preparation and seed sowing to harvesting and popping. The sector has also emerged as a source of foreign exchange, with exports of processed makhana products steadily rising in recent years. Government initiatives, including the establishment of the National Makhana Board and a multi-crore central scheme, are aimed at modernizing cultivation practices, improving seed quality, and strengthening value chains.

Nutritional and Health Value

Component	Scientific priority	Expected benefit
Planting material	Use improved, quality planting material suited to the production environment.	Better establishment and yield potential
Water management	Maintain a suitable aquatic environment and avoid unnecessary water loss.	Stable crop growth and efficient resource use
Nutrient management	Base nutrient decisions on the production system and crop requirement.	Improved productivity and nutrient-use efficiency
Harvesting	Improved productivity and nutrient-use efficiency	Lower drudgery and harvest losses
Harvesting	Improve drying, grading, popping, polishing and packaging.	Higher product quality and value realization

Nutritionally, makhana is recognized as a “superfood.” It is rich in protein, calcium, iron, and antioxidants, making it valuable for combating hidden hunger and lifestyle-related diseases. Its low glycemic index makes it suitable for diabetic diets, while its mineral content supports cardiovascular health and bone strength. Increasingly, makhana is being incorporated into public nutrition programs such as the Mid-Day Meal Scheme and Integrated Child Development Services, reflecting its role in addressing malnutrition in vulnerable populations.

Agro-Ecological Importance



(ASG Organics, n.d.)

Makhana thrives in wetlands, oxbow lakes, and floodplains—areas where conventional crops often fail. This makes it uniquely suited to the agro-ecological conditions of Eastern India, particularly the Kosi basin and Mithila wetlands. By utilizing flood-prone ecosystems, makhana cultivation provides a sustainable livelihood option in regions otherwise vulnerable to climate shocks. The

introduction of improved varieties such as *Swarna Vaidehi* and *Sabour Makhana-1* has enhanced productivity, while field-system farming has reduced dependence on traditional pond-based methods.

Major Management Priorities for Efficient Makhana Production

Component	Scientific priority	Expected benefit
Planting material	Use improved quality planting material suited to the production environment	Better establishment and yield Potential
Water management	Maintain a suitable aquatic environment and avoid unnecessary water loss	Stable crop growth and efficient resource use
Nutrient management	Base nutrient decisions on the production system and crop requirement	Improved productivity and nutrient use efficiency
Harvesting	Improved productivity and nutrient use efficiency	Lower drudgery and harvest losses
Harvesting	Improve drying grading, popping, polishing and packaging	Higher product quality and value realization

Makhana-cum-Fish: Increasing Returns from the Same Water Body

Integration of makhana with fish culture is one of the most promising directions for improving the economic performance of aquatic production systems. Instead of relying on a single output, an integrated pond can generate both seed and fish while making use of different components of the aquatic environment. This approach can diversify farm income and spread production risk. A 2025 study published in the *Indian Journal of Fisheries* evaluated sole makhana cultivation and an integrated makhana–fish system across four locations in Bihar. Sole makhana produced 1.78 ± 0.133 ha^{1} seed, while the integrated system produced 1.55 ± 0.085 t ha^{1} seed along with 1.48 ± 0.15 t ha^{1} fish. The study reported higher economic returns from the integrated system, demonstrating the potential of combining aquatic enterprises rather than evaluating makhana only on seed yield. (Raut et al., 2025)

Success Stories and Experiments

Development / study	Key observation	Relevance
Swarna Vaidehi, ICAR-RCER	2.8–3.0t ha^{1} production potential reported under farmers' field conditions.	Provides improved varietal option for productivity enhancement.
Makhana agronomic review, (Khadatkar et al. (2020)	Highlights aquatic adaptation, nutritional value, traditional production and major drudgery/management constraints.	Provides a scientific framework for improving the production chain.
Makhana–fish study, (Raut et al. (2025)	Integrated system produced seed plus fish and showed stronger economic performance than sole makhana in the study.	Supports diversification of income from water bodies.

Nutritional and Market Significance

Makhana has acquired a strong position as a value-added food product because the edible seed contains substantial carbohydrate and protein while being relatively low in fat. The nutritional profile, combined with the product's established cultural uses and expanding ready-to-eat snack market, creates opportunities beyond the sale of raw seed. Scientific literature has therefore considered makhana not only as an aquatic crop but also as a potential rural enterprise linked to processing and food diversification. The economic value of makhana can rise substantially after grading, popping, quality sorting, packaging and product diversification. This means that improving the post-harvest chain can be as important as improving biological yield. Small processing units, producer groups and local enterprises can

potentially capture a greater share of the final product value, provided quality, food safety and market standards are maintained.

Major Constraints in Makhana Production

1. High labour requirement and physical drudgery during cultivation, harvesting and processing.
2. Limited availability and accessibility of quality planting material in some production areas.
3. Need for stronger location-specific recommendations for water, nutrient and crop management.
4. Low mechanization and inadequate access to suitable harvesting and processing equipment.
5. Shortcomings in post-harvest handling, grading, packaging and organized value chains.
6. Limited technical knowledge and uneven access to credit, markets and extension support.
7. Need to balance intensification with water quality, ecological sustainability and worker safety.

Way Forward: From Traditional Aquatic Crop to Modern Agribusiness

The future of makhana should be built around a complete production-to-market approach rather than a narrow focus on seed yield. First, improved planting material such as *Swarna Vaidehi* should be combined with locally validated management practices. Second, mechanization research should prioritize operations that generate the greatest drudgery, particularly harvesting and post-harvest handling. Third, integrated makhana–fish systems should be promoted where ecological and economic conditions are suitable, with attention to stocking, water quality and market demand. Post-harvest value addition deserves equal attention. Standardized drying, grading, popping, polishing, hygienic packaging and product development can improve consistency and consumer acceptance. Farmer producer organizations, self-help groups and local enterprises can support aggregation and market access. Digital marketing and organized retail channels may further help producers move from commodity sales toward branded and differentiated products. Finally, future research should address the crop as a complete aquatic agroecosystem. Priority areas include efficient nutrient management, water-quality monitoring, low-cost mechanization, improved processing technologies, climate resilience, integrated aquaculture and long-term economic assessment. Such a systems approach can help convert makhana's natural affinity for waterlogged environments into a dependable livelihood opportunity.

Conclusion

Makhana represents a distinctive pathway for productive use of aquatic and waterlogged resources in eastern India. Its ecological adaptation, food value and compatibility with integrated fish culture give it considerable potential for diversified rural livelihoods. The development of *Swarna Vaidehi* and recent research on makhana–fish integration show that scientific intervention can strengthen an established traditional production system. Nevertheless, labour drudgery, mechanization gaps, quality planting material, post-harvest losses and market organization remain important challenges. A coordinated strategy combining improved varieties, scientific management, mechanization, integrated farming and value addition can help makhana move from a traditional niche crop toward a more efficient and competitive aquatic agribusiness.

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