Sustainable freshwater snail farming: Advancing nutrition security and rural livelihoods in Northeast India

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A tribal woman harvesting river snails.

Northeast India struggles with nutrition security, especially in rural and tribal areas. Data from the National Family Health Survey (NFHS-5) show worsening nutrition indicators across the region. Meghalaya has the highest stunting rate at 46.8%, followed by Nagaland (32.7%), Tripura (32.3%), and Mizoram (28.9%).

This crisis presents multiple concerns. Four northeastern states have seen an increase in stunting among children under five. Wasting and underweight rates have also risen in several states, including Assam, where underweight rates increased from 29.8% to 32.8%. Early breastfeeding initiation has declined in six of the eight northeastern states. A growing double burden of malnutrition adds to the problem, as undernutrition now coexists with rising obesity rates. This situation harms child development and future economic productivity. Research shows that stunted children earn about 20% less as adults. A 1% reduction in adult height due to childhood stunting is linked to a 1.4% drop in economic productivity.

Food and nutrition security challenges in Northeast India are worsened by the region's unique agricultural conditions and environmental vulnerabilities. Despite having the highest per capita consumption of calories and carbohydrates in India, the region suffers from a serious nutritional imbalance.

This issue arises from the region's dependence on agriculture, which is highly vulnerable to climate variations. These changes affect both crop yields and diversity. As a result, while caloric intake is high, deficiencies in essential proteins and micronutrients are widespread. This imbalance highlights the need for innovative, locally adapted solutions. Such approaches must not only provide sustainable sources of high-quality nutrition but also enhance the resilience of local livelihoods against environmental challenges.

Local children collecting freshwater snails from paddy fields in Northeast India.

Understanding the nutritional crisis

Nutritional challenges in Northeast India arise from several interconnected factors. Poor maternal health, weak healthcare infrastructure, limited access to diverse foods, and socioeconomic constraints all contribute to persistent malnutrition. Anemia is a major concern, affecting both children and pregnant women. This condition harms immediate health and long-term development.

Climate change worsens the problem by reducing agricultural productivity. Northeast India's agriculture is highly sensitive to climate variations, which impact both crop yields and nutritional quality. To address this, climate-resilient food sources must be explored. These should provide essential nutrients while ensuring environmental sustainability.

Freshwater snails: A promising Solution

Research from the ICAR Research Complex for NEH Region's Tripura Centre identifies freshwater snails as a potential solution to regional nutritional challenges. Several indigenous species have been found to offer excellent nutritional value, particularly in protein and minerals.

The apple snail (*Pila globosa*) has the highest protein content at 15.59%. The Bengal trumpet snail (*Bellamya bengalensis*) and the costuled river snail (*Brotia costula*) contain between 11.18% and 13.14% protein. While these levels are lower than some fish species, they exceed many plant-based protein sources and compare well with traditional livestock products.

The mineral profile of freshwater snails highlights their exceptional nutritional value, especially their high calcium content. With calcium levels ranging from 142.50 to 312.50 mg per 100 g, these snails provide significantly more calcium than common sources like beef, eggs, and milk.

Their iron content is also notable, ranging from 4.0 to 6.8 mg per 100 g. This compares well with iron-rich foods like organ meats and provides much more iron than fish. Additionally, these snails offer essential minerals such as phosphorus (55.39–121.17 mg per 100 g), potassium (118.20–182.28 mg per 100 g), and zinc (1.47–2.17 mg per 100 g). This well-balanced mineral composition makes freshwater snails a valuable option for addressing widespread micronutrient deficiencies in the region.

Table 1: Nutritional composition of selected freshwater snails from Tripura.

Component	*Pila globosa*	*Bellamya bengalensis*	*Brotia costula*
Proximate composition (%)			
Moisture	73.80 ± 4.87^{b}	65.80 ± 9.49^{a}	69.86 ± 3.68^{ab}
Crude protein	15.59 ± 1.14^{b}	13.14 ± 1.82^{a}	12.91 ± 2.52^{a}
Lipid	1.15 ± 0.17^{b}	0.96 ± 0.14^{a}	0.82 ± 0.16^{a}
Ash	3.82 ± 1.80^{a}	8.11 ± 2.56^{b}	7.28 ± 2.15^{b}
Carbohydrate	5.62 ± 5.83^{a}	11.97 ± 6.96^{b}	9.12 ± 2.81^{ab}
Mineral content (mg/100g)			
Calcium	312.50 ± 12.67^{c}	227.13 ± 31.96^{b}	236.07 ± 23.66^{b}
Phosphorus	121.17 ± 10.17^{c}	93.53 ± 1.65^{b}	116.87 ± 9.76^{c}
Potassium	182.28 ± 8.02^{d}	143.80 ± 8.81^{b}	161.87 ± 7.11^{c}
Magnesium	18.50 ± 4.12^{ab}	21.43 ± 0.74^{b}	17.93 ± 2.84^{ab}
Iron	6.86 ± 3.45^{b}	4.81 ± 1.21^{a}	5.07 ± 1.85^{a}
Copper	0.84 ± 0.08^{b}	0.69 ± 0.19^{a}	0.73 ± 0.35^{ab}
Zinc	2.17 ± 0.35^{b}	1.57 ± 0.21^{ab}	1.47 ± 0.31^{a}
Manganese	5.33 ± 1.10^{b}	3.17 ± 0.35^{a}	3.13 ± 0.31^{a}

Values are presented as mean ± standard deviation. Values in the same row with different superscript letters (a, b, c, d) are significantly different (p<0.05). Data sourced from Debnath et al., Fishery Technology 53 (2016): 307-312.

Production systems and management

Freshwater snail farming can be implemented through three distinct production systems, each suited to different operational needs.

The pond-based culture system integrates snail farming with existing fish ponds. It maximises resource use by utilising unused ecological niches and organic waste. This system requires careful environmental management, with pH levels between 6.5 and 8.5, water temperatures of 24–30°C, and dissolved oxygen levels above 5 ppm. These conditions reduce the need for supplementary feeding while ensuring sustainability.

The paddy-cum-snail culture system uses rice fields for snail production during the growing season. It improves nutrient cycling, enhances rice yields, and provides an additional protein source. This method is particularly beneficial for small and marginal farmers, as it makes use of existing infrastructure.

The backyard cultivation system involves raising snails in cemented tanks. This method is ideal for households with limited space. Controlled environments allow for intensive production through careful water quality and feeding management. It makes snail farming accessible to urban and peri-urban farmers who lack access to ponds or paddy fields.

Economic analysis

A multi-tank freshwater snail farming system can be set up using three cemented tanks, each measuring 3 m × 2 m × 1 m. Based on stocking density guidelines and industry experience, each tank can support 100–120 adult snails for optimal growth and reproduction.

With a quarterly harvest cycle, each tank can produce an estimated 200–250 kg of snails per year. This suggests a total system yield of 600–750 kg annually.

Mature apple snails (Pila globosa), showcasing their distinctive shell morphology and size characteristics that make it suitable for aquaculture.

Mature costuled river snail (Brotia costula), displaying its distinctive ribbed shell pattern and robust appearance, which set it apart from other freshwater snail species.

Adult Bengal trumpet snail (Bellamya bengalensis), showing its characteristic spiral shell structure and natural coloration patterns.

Nutritional impact analysis

A backyard snail farming system with three cemented tanks can produce up to 1,800 kg of snails annually. If 50% is reserved for home consumption (900 kg per year), this provides a daily availability of 2.47 kg of whole snails. With an edible meat yield of 40%, this translates to 0.99 kg of consumable meat per day for family nutrition.

The nutritional impact analysis highlights significant contributions to daily dietary needs for a family of five. The protein content of *Pila globosa* (15.59%) supplies approximately 62.4–93.6% of daily protein requirements, with children benefiting the most from their portions. This increased protein intake represents a major improvement in household nutrition security.

The mineral content also offers substantial benefits. A 100 g serving of *P. globosa* provides about 31% of an adult's daily calcium requirement, making it a valuable source for families with limited dairy access. Its iron content is particularly high, supplying up to 86% of daily iron needs for adult men and 38% for women. This helps address anemia, a widespread issue in the region. Zinc intake is also significant, covering 20–43% of daily needs depending on age and gender.

With half of the production available for sale (900 kg per year), backyard snail farming creates income opportunities while ensuring household nutrition. The consistent daily availability of nutrient-rich food (0.99 kg of meat) provides year-round access to essential nutrients, establishing a sustainable foundation for both nutritional security and economic stability.

Integration and resource optimisation

Integrating snail farming with laying hen operations creates valuable synergies in rural agricultural systems. A typical rural household keeps 10–15 laying hens, which require consistent calcium supplementation for optimal egg production. Snail shells, containing up to 312.50 mg of calcium per 100 g along with essential trace minerals, provide an excellent natural supplement.

A three-tank snail farming system producing 1,800 kg of snails per year generates about 1,080 kg of shells. This is enough to supplement multiple small-scale laying operations. When properly processed and ground, these shells can fully replace commercial calcium supplements in poultry feed. This reduces production costs while maintaining high egg quality and consistent laying patterns.

Table 2: Economic analysis for multi-tank backyard freshwater snail farming in Tripura.
System specifications: 3 tanks, each 3 m × 2 m × 1 m = 6 m³

Category	Details	Amount (Rs.)
Initial investment	Cemented tanks construction (3 tanks including labour)	$517
	Centralised water supply and drainage system	$92
	Water quality monitoring equipment	$57
	Basic equipment (nets, containers, harvesting tools)	$57
	Initial broodstock (1,800-2,160 snails)	$52
	Aeration system (air pump, tubing, stones)	$86
Total initial investment		**$862**
Annual operating costs	Supplementary feed	$166
	Water and electricity charges	$124
	Tank maintenance and repairs	$69
	Labor (part-time hired help + family labor)	$276
	Marketing and packaging expenses	$832
	Water quality management (testing, treatments)	$41
Total operating cost		**$759**
Annual revenue	Production (1,800 kg @ US$1.725/kg)	$3,105
Net annual profit		**$2,346**
Key financial indicators	Monthly income potential	$195
	Return on investment (%)	272
	Investment recovery period	4-5 months
	Profit margin (%)	75.5

1 Indian Rupee (INR) = 0.01150 US Dollars.

This integration is especially relevant in Northeast India, where backyard poultry farming is a key part of rural livelihoods. Small-scale farmers can create an efficient closed-loop system where snail farming provides two benefits: primary income from meat sales and cost savings from shell utilisation. Research shows that hens fed with processed snail shell supplements produce eggs with shell quality and laying frequency similar to those receiving commercial calcium supplements.

Additionally, this integrated approach creates new employment opportunities in shell processing, feed preparation, and local distribution.

Implementation strategy and recommendations

The successful adoption of freshwater snail farming in Northeast India requires a coordinated approach across four key areas.

First, research and development should focus on establishing standardised breeding protocols, optimising locally sourced feed formulations, and assessing environmental impacts to ensure sustainable production.

Second, extension services must provide comprehensive training programs that integrate traditional knowledge with modern aquaculture techniques. These programs should cover production methods, health management, and post-harvest handling. Regular monitoring and feedback mechanisms will help improve effectiveness.

Third, market development is essential. Establishing strong value chains through collection centers, standardised grading systems, and efficient distribution networks will enhance market efficiency. Value-added products and consumer education campaigns highlighting the nutritional benefits of snails will help expand demand.

Finally, government support is crucial for scaling up snail farming. Existing programs through NAFDB and NABARD provide 100% subsidies for Northeast Indian farmers, making snail farming more accessible. These initiatives should be strengthened with quality certification systems and market linkage support to ensure long-term viability.

High-quality freshwater snails produced in a cemented tank system, demonstrating the successful implementation of controlled cultivation methods for optimal growth and yield.

Conclusion

Freshwater snail farming offers a practical solution to Northeast India's nutritional and economic challenges. It provides high protein and mineral yields along with strong economic returns. However, successful implementation requires strict biosecurity measures. Proper sanitation, regular health monitoring, and quality control can help prevent disease risks.

The region's cultural acceptance of snail consumption supports market development. Value-added products, such as ready-to-eat snail meat and processed calcium supplements, can further expand demand. The low entry barriers and simple technical requirements make snail farming an excellent opportunity for women and youth entrepreneurship.

Integrating snail farming with existing agriculture, particularly poultry farming, increases economic viability by utilising snail shells as a calcium source for laying hens. To fully realise these benefits, collaboration between research institutions, extension services, and policymakers is essential. With the right support, freshwater snail farming can improve nutrition security, create sustainable livelihoods, and empower marginalised communities, making it a valuable tool for regional development in Northeast India.

Figure 1: Daily mineral contributions from a 100 g serving of *Pila globosa* meat across different demographic groups, showing the percentage of the recommended daily allowance (RDA) met for calcium, iron, and zinc.