

# Inland Saline Aquaculture: A Sustainable Approach for Utilisation of Saline Water and Salt-Affected Land

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## Abstract

Increasing freshwater scarcity, degradation of agricultural land, climate variability, and growing demand for aquatic foods have created an urgent need to develop alternative production systems that can utilise resources unsuitable for conventional agriculture and freshwater aquaculture. Inland saline aquaculture represents an emerging approach for converting saline groundwater, saline surface water, salt-affected soils, waterlogged areas, and other marginal lands into productive aquatic farming systems. Inland saline water (ISW) occurs predominantly in arid and semi-arid regions, although it can also develop in areas influenced by marine-derived groundwater, geological salt deposits, irrigation-induced salinisation, waterlogging, and inadequate drainage. Unlike seawater, ISW generally exhibits considerable variation in ionic composition and may be deficient in potassium and, in some locations, magnesium, despite having elevated concentrations of calcium and other ions. Consequently, successful aquaculture in ISW depends not only on salinity tolerance but also on species-specific physiological responses and the ionic composition of the culture water.

Research conducted in Australia, the United States, India, and other regions has demonstrated the feasibility of culturing shrimp, marine fish, brackishwater species, freshwater fish, ornamental species, and freshwater prawns in inland saline environments. High-value species such as *Litopenaeus vannamei*, *Penaeus monodon*, *Lates calcarifer*, *Chanos chanos*, and *Etroplus suratensis* have demonstrated potential under appropriate salinity and ionic conditions. At the same time, increasing evidence indicates that selected freshwater species can also be cultured in low-to-moderate salinity inland waters. In India, studies on *Labeo rohita*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Pangasianodon hypophthalmus*, *Clarias batrachus*, and *Macrobrachium rosenbergii* indicate that species-specific acclimation and appropriate management can expand the use of inland saline resources. Particularly, *C. carpio* has demonstrated promising growth, reproductive performance, fertilisation, and larval survival under low-salinity inland groundwater conditions.

This review synthesises available information on the characteristics and distribution of inland saline resources, opportunities for aquaculture, salinity tolerance of candidate species, ionic requirements, freshwater fish production, breeding and seed production, culture technologies, environmental sustainability, and future research priorities. The available evidence indicates that inland saline aquaculture can contribute to resource-use efficiency, diversification of aquaculture production, rehabilitation of salt-affected land, livelihood generation, and nutritional security when supported by site-specific water-quality assessment and scientifically based management.

**Keywords:** inland saline aquaculture; saline groundwater; salt-affected land; freshwater fish; *Cyprinus carpio*; mineral supplementation; salinity tolerance; aquaculture diversification; resource utilisation; sustainable aquaculture

## Introduction

Aquaculture is an important component of global aquatic food production and contributes substantially to food availability, employment, income generation, and rural livelihoods. Aquatic organisms have developed diverse physiological mechanisms for respiration, feeding, growth, reproduction, waste elimination, and osmoregulation, enabling them to survive under a wide range of environmental conditions (Samantaray, 2015; Schubert et al., 2017). Nevertheless, aquaculture production remains strongly dependent on the availability of suitable water resources. Increasing freshwater demand from agriculture, domestic consumption and industry, together with climate change, pollution and environmental degradation, is placing increasing pressure on freshwater resources (Blanchard et al., 2017; Sharma et al., 2024).

The continuing expansion of aquaculture therefore requires production systems that make efficient use of non-conventional water resources without increasing pressure on already limited freshwater supplies. Inland saline

aquaculture has emerged as one such opportunity. It involves the utilisation of saline groundwater or surface water occurring in inland, non-coastal areas for the production of aquatic organisms (Allan et al., 2009). Such systems are particularly relevant where saline soils, waterlogging and saline groundwater have reduced the productivity of conventional agriculture.

Inland salinity is commonly associated with arid and semi-arid environments characterised by low rainfall and high evapotranspiration. However, inland saline water can also occur in regions receiving relatively high rainfall because of geological salt deposits, connate marine water, groundwater processes and other natural or anthropogenic factors (Doupé et al., 2003; Iglesias, 2020). Salinisation can further be accelerated by irrigation, inadequate drainage, rising groundwater tables, mineral weathering, waterlogging and inappropriate land-management practices.

Rather than treating saline water and salt-affected land solely as degraded resources, inland saline aquaculture provides an opportunity to transform such resources into productive systems. The approach is consistent with broader strategies for blue transformation and sustainable aquatic food production, in which improved resource efficiency and diversification are essential components of future food systems (Sharma et al., 2024).

### **Inland Saline Water: Characteristics and Resource Potential**

Inland saline water differs fundamentally from seawater and conventional freshwater because its chemical composition is determined by local geology, hydrology, groundwater residence time and processes responsible for salt accumulation. Salinity may vary considerably between locations, and water with salinity ranging from slightly saline to levels approaching seawater has been utilised for different aquaculture purposes (Roy et al., 2010).

The occurrence of saline groundwater is particularly important because it provides an alternative water source in regions where freshwater is scarce or unsuitable for large-scale aquaculture. Inland saline water can originate from natural groundwater processes as well as human activities that alter groundwater movement and salt distribution (Iglesias, 2020). Consequently, two sites having similar total salinity may differ considerably in ionic composition and may produce different biological responses in cultured organisms.

A major characteristic of inland saline groundwater is its ionic imbalance relative to seawater. In many inland saline waters, potassium concentrations are considerably lower than those of seawater, while calcium concentrations may be comparatively high. Magnesium levels can also vary substantially between locations. Consequently, total salinity alone is not an adequate criterion for determining whether a particular inland saline water source is suitable for aquaculture. Water chemistry, particularly concentrations and ratios of potassium, calcium and magnesium, should be evaluated before stocking (Lakra et al., 2014; Roy et al., 2010).

These differences are particularly important for marine and euryhaline organisms because ionic regulation requires appropriate concentrations of essential ions. Studies on barramundi and shrimp have demonstrated that potassium availability can influence growth, survival and osmoregulatory performance in low-salinity waters (Partridge and Lymbery, 2008; Davis et al., 2005). Therefore, site-specific water analysis and, where necessary, mineral supplementation are important components of inland saline aquaculture.

### **Salinity, Soil Degradation and Inland Saline Resources**

Soil and water salinisation is a major constraint to agricultural productivity in many regions. Salt accumulation can reduce soil fertility, alter soil structure, impair plant water uptake and ultimately make land unsuitable for conventional agriculture. In India, salt-affected land is distributed across several arid, semi-arid and irrigated regions, including areas of the Indo-Gangetic plains and parts of western and peninsular India (Kumar and Sharma, 2020).

The reviewed source reports approximately 6.74 million hectares of salt-affected land in India and identifies important saline areas in Haryana, Punjab, Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Odisha. These regions represent potential locations for inland saline aquaculture where water and land resources are unsuitable or less suitable for conventional agricultural production.

Salinity-induced land degradation should not, however, automatically be interpreted as evidence that aquaculture is suitable. Each site requires evaluation of groundwater depth, salinity, ionic composition, pH, alkalinity, hardness, seasonal variation, soil characteristics, drainage, availability of infrastructure, and the potential environmental consequences of pumping and discharging saline water. Site-specific assessment is therefore fundamental to sustainable development.

### **Development of Inland Saline Aquaculture**

The utilisation of inland saline resources for aquaculture has been investigated in several countries. Australia has developed research and commercial approaches for using saline groundwater for euryhaline and selected freshwater

species. Studies have included barramundi, Australian snapper, black bream and silver perch (Allan et al., 2001; Fielder et al., 2001; Partridge and Jenkins, 2002; Doroudi et al., 2007).

In the United States, low-salinity inland groundwater has been used for shrimp production, particularly *Litopenaeus vannamei*. Research has demonstrated that production success depends on both salinity and ionic composition, with potassium and magnesium being particularly important considerations (Roy et al., 2010; Davis et al., 2005).

India has also developed considerable research interest in inland saline aquaculture. Work by ICAR institutions has evaluated saline and waterlogged areas for the culture of marine, brackishwater and freshwater species. Species investigated include milkfish, grey mullet, pearl spot, tiger shrimp, rohu, catla, mrigal, common carp and giant freshwater prawn.

The development of inland saline aquaculture in India is particularly relevant to states where extensive salt-affected land and saline groundwater occur. Such systems could potentially diversify rural production while reducing direct competition between aquaculture and freshwater-dependent agriculture.

### Candidate Species for Inland Saline Aquaculture

Species selection is one of the most important determinants of successful inland saline aquaculture. Candidate organisms can broadly be classified into marine, brackishwater, freshwater, ornamental and crustacean species. Their suitability depends on salinity tolerance, osmoregulatory capacity, growth performance, feed utilisation, reproductive ability, market demand and tolerance to the ionic composition of the available water.

Marine and euryhaline species such as *Sciaenops ocellatus*, *Pagrus auratus*, *Acanthopagrus butcheri*, *Lates calcarifer* and *Litopenaeus vannamei* have been investigated extensively. Red drum, for example, has demonstrated survival and growth in saline groundwater with appropriate calcium concentrations (Forsberg et al., 1996). Australian snapper has also demonstrated the potential to utilise inland saline groundwater when potassium concentrations are appropriately managed (Fielder et al., 2001).

Brackishwater species such as *Chanos chanos*, *Mugil cephalus* and *Etroplus suratensis* represent additional candidates. Their physiological capacity to tolerate changes in salinity makes them suitable for selected inland saline environments (Jan et al., 2006; Barman et al., 2005; Chandrasekar et al., 2014).

Freshwater species are increasingly important because they may provide additional production options where salinity remains within their tolerance range. Research on Indian major carps, common carp, catfish and striped catfish has demonstrated that some traditionally freshwater species can survive and grow under low-to-moderate salinity conditions.

### Freshwater Fish in Inland Saline Aquaculture

The use of freshwater fish in inland saline systems represents an important area for further development. Traditionally, saline aquaculture has focused on marine and euryhaline organisms because of their natural ability to regulate body fluids under elevated salinity. However, evidence from experimental and field studies indicates that selected freshwater species can tolerate moderate salinity, particularly when acclimation is gradual.

The physiological response of freshwater fish to salinity is species-specific. Salinity affects osmoregulation, metabolism, feed consumption, growth, tissue function, reproduction and energy allocation. At increasing salinity, fish may divert increasing amounts of metabolic energy toward maintaining ionic and osmotic balance, potentially reducing the energy available for growth and reproduction.

Studies with freshwater species such as *Labeo rohita*, *Cirrhinus mrigala*, *Cyprinus carpio* and *Pangasianodon hypophthalmus* indicate varying levels of salinity tolerance. Patel et al. (2023) demonstrated that *L. rohita* could tolerate temporal increases in inland saline groundwater. Arockia Sharmila et al. (2022) reported salinity tolerance in *C. mrigala*, while Kumar et al. (2017) evaluated the response of *P. hypophthalmus* to inland saline water.

Among freshwater fish, common carp has received particular attention. Iffat et al. (2020) investigated the effects of different salinities on breeding and larval development of *C. carpio* in inland saline groundwater. Their results indicated that low-salinity groundwater, particularly up to approximately 5 ppt, supported favourable growth, gonadal development, fertilisation and larval survival.

These findings are important because they indicate that freshwater species should not automatically be excluded from inland saline aquaculture. Instead, species should be evaluated according to the specific salinity and ionic characteristics of individual water sources.

### Common Carp as a Candidate Species

Common carp (*Cyprinus carpio*) is one of the most widely cultured freshwater fish species because of its adaptability, broad feeding habit, established seed-production technology and tolerance of a range of environmental conditions. These characteristics make it a particularly interesting candidate for low-salinity inland saline aquaculture.

The available research indicates that common carp can tolerate substantially higher salinity than is traditionally assumed, although growth and reproductive performance decline as salinity increases. Iffat et al. (2020) reported favourable reproductive and larval responses under low-salinity conditions, while previous research has examined the effects of salinity on food consumption, growth and energy conversion in common carp fingerlings (Wang et al., 1997).

Field studies have also demonstrated the potential for freshwater carp production in salt-affected waterlogged areas. Ansal et al. (2013) reported production of freshwater carps in inland salt-affected waterlogged areas of Punjab. Chandra and Joshi (2015) likewise reported growth and survival of carps in salt-affected ponds.

The reviewed document indicates that common carp demonstrated promising growth and maturity at moderate salinity and considerable survival during exposure to higher salinity, although higher salinity should not be interpreted as an optimal production condition. The distinction between survival tolerance and optimum production salinity is particularly important for aquaculture planning. A fish may survive a particular salinity but may not achieve economically desirable growth, feed conversion, maturation or reproductive performance at that salinity.

### Salinity and Fish Physiology

Salinity influences fish physiology through osmotic and ionic stress. Freshwater fish generally maintain body fluids at concentrations considerably higher than the surrounding water, whereas marine fish experience the opposite osmotic gradient. Transition between different salinity regimes therefore requires coordinated regulation of ions and water.

The physiological cost of osmoregulation can increase as environmental conditions become more challenging. Changes in salinity may affect feed intake, digestion, nutrient absorption, growth, blood chemistry, metabolism and reproductive development. MacLeod (1977), for example, reported reduced digestive absorption efficiency in rainbow trout at elevated salinity. Similar salinity-related effects on digestibility have been reported in milkfish and other species (Ferraris et al., 1986).

However, the response is not uniform across species. De Silva and Perera (1984) found limited effects of salinity on digestibility in Nile tilapia under their experimental conditions. These differences emphasise the importance of evaluating each candidate species individually rather than applying a universal salinity threshold.

### Mineral Composition and Ionic Management

One of the principal challenges in inland saline aquaculture is that salinity does not necessarily represent the ionic balance required by cultured organisms. Seawater contains relatively predictable proportions of major ions, whereas inland saline groundwater may have a substantially different ionic profile.

Potassium is particularly important in many low-salinity aquaculture systems. Barramundi and shrimp studies have shown that potassium supplementation can improve physiological performance when inland saline groundwater is deficient in this ion (Partridge and Lymbery, 2008; Davis et al., 2005). Magnesium can also become important in specific water sources and production systems.

Mineral supplementation should therefore be based on water analysis rather than applied routinely at fixed rates. Potential supplements include potassium chloride and magnesium salts, although the appropriate dose depends on species, salinity, ionic concentration, culture biomass and production objective.

Research with *L. vannamei* has demonstrated that supplementation of potassium and magnesium through culture water and diet can influence growth, survival and osmoregulation (Jahan et al., 2018). Similar work with shrimp has highlighted the importance of potassium, magnesium and other ions in inland low-salinity groundwater (Davis et al., 2005).

For freshwater species, mineral requirements may differ considerably from those of marine organisms. Consequently, the economic and biological necessity of mineral supplementation should be assessed separately for freshwater and euryhaline species.

### Shrimp and Prawn Culture

Shrimp production has become one of the major applications of inland saline water in several regions. *Litopenaeus vannamei* has attracted particular interest because of its broad salinity tolerance and commercial value. Studies in the

United States and elsewhere have demonstrated that whiteleg shrimp can be cultured in inland low-salinity waters when essential ionic requirements are adequately addressed (Roy et al., 2010; Samocha et al., 1998).

*Tiger shrimp* (*Penaeus monodon*) has also been investigated in inland saline environments. Raizada et al. (2015) examined survival and growth under potassium-supplemented inland saline water, demonstrating the relevance of ionic management.

The giant freshwater prawn, *Macrobrachium rosenbergii*, represents another promising species. Although fundamentally a freshwater species, it has demonstrated the ability to tolerate low levels of salinity. Raizada et al. (2005) investigated monoculture of giant freshwater prawn in inland saline ecosystems, while later work highlighted the importance of potassium, magnesium and calcium in larval production.

The culture of shrimp and prawns therefore demonstrates that inland saline aquaculture can include organisms with different physiological strategies, provided that water chemistry is appropriately managed.

### **Ornamental Fish and Other Candidate Species**

Inland saline environments may also provide opportunities for ornamental fish production. Ornamental species such as swordtail, clownfish and goldfish have been examined under different salinity regimes.

Nanda et al. reported that swordtail (*Xiphophorus hellerii*) showed favourable performance at low salinity and was capable of tolerating higher salinity under experimental conditions. Dhaneesh et al. (2012) investigated breeding, embryonic development and salinity tolerance of skunk clownfish (*Amphiprion akallopisos*), demonstrating considerable salinity tolerance.

Goldfish (*Carassius auratus*) and crucian carp (*Carassius carassius*) have also been evaluated under different salinity and temperature combinations. Küçük (2013) and Imanpoor et al. (2012) demonstrated that moderate salinity can be tolerated, although increasing salinity beyond the favourable range negatively affects growth and physiological performance.

Such studies expand the potential application of inland saline resources beyond food fish and shrimp. Ornamental fish production may be particularly relevant for small-scale enterprises where high-value products can be produced using relatively small culture facilities.

### **Breeding and Seed Production in Inland Saline Water**

Successful commercial aquaculture depends not only on grow-out production but also on reliable seed production. Therefore, the ability of candidate species to reproduce and complete early developmental stages in inland saline water is an important criterion for long-term adoption.

Salinity can influence gonadal development, spawning behaviour, fertilisation, embryonic development, hatching and larval survival. In freshwater species, excessive salinity can increase osmoregulatory stress and divert metabolic energy away from reproduction.

The work of Iffat et al. (2020) is particularly relevant to common carp because it examined broodstock performance and larval development rather than only short-term survival. The study demonstrated that low-salinity inland groundwater could support reproductive development and larval production, with favourable responses reported up to approximately 5 ppt.

Research on *Clarias batrachus* also demonstrated the possibility of breeding and larval rearing in low-salinity water. Chaturvedi et al. (2012) reported successful breeding and larval rearing under low-salinity conditions, although some developmental differences occurred relative to freshwater.

These findings suggest that breeding programmes could be developed specifically for inland saline environments. Broodstock maintained under gradual salinity exposure may potentially produce offspring with improved tolerance, although this hypothesis requires systematic genetic and physiological validation.

### **Culture Systems and Production Approaches**

Inland saline aquaculture can be implemented through several production systems, including earthen ponds, lined ponds, tanks, recirculating systems and floating tank systems. The appropriate system depends on soil permeability, water availability, salinity, target species, investment capacity and environmental conditions.

Semi-intensive ponds are particularly attractive where large areas of salt-affected land are available. Existing waterlogged and saline areas can potentially be modified for aquaculture where pond construction, water retention and drainage are technically feasible.

Floating tank systems provide another approach. Partridge et al. (2006) demonstrated the use of a semi-intensive floating tank system in a static inland saline water body for finfish production. Such systems can reduce direct

interaction between fish and surrounding sediments and may facilitate better management of feeding, stocking and water quality.

Recirculating aquaculture systems may offer additional opportunities where water availability is limited. RAS can reduce water consumption, improve control of water quality and facilitate treatment and reuse of saline water. However, their economic feasibility in rural inland saline regions requires further assessment.

### **Environmental Sustainability and Waste Management**

The sustainability of inland saline aquaculture depends on careful management of water extraction, effluent, chemicals, nutrients and salinity. Converting saline land into productive aquaculture systems should not create new environmental problems.

Aquaculture effluents may contain suspended solids, nutrients, organic matter, chemicals and biological contaminants. Poorly managed discharge can affect surrounding water bodies and soils. Burridge et al. (2010) highlighted environmental concerns associated with chemical use in aquaculture, reinforcing the importance of responsible disease management and chemical stewardship.

Integrated approaches can reduce environmental risks. These may include sedimentation ponds, biological treatment, constructed wetlands, biofilters, probiotics, improved feeding strategies and partial water reuse. The integration of aquaculture with salt-tolerant agriculture or other compatible production systems may further increase resource-use efficiency.

Chemical use should be minimised through preventive health management, biosecurity, appropriate stocking densities, balanced nutrition and regular water-quality monitoring. The development of environmentally responsible production protocols is particularly important before large-scale expansion of inland saline aquaculture.

### **Socioeconomic Opportunities**

The conversion of salt-affected and otherwise unproductive land into aquaculture production has potential socioeconomic benefits. Where agriculture is severely constrained by salinity, aquaculture can provide an alternative income-generating activity.

Freshwater fish species may be especially relevant to small and marginal farmers because established hatchery and culture technologies already exist for common carp and Indian major carps. Existing knowledge of pond preparation, feeding, stocking and harvesting can potentially be adapted to low-salinity systems.

Higher-value shrimp, marine fish and ornamental fish can provide additional opportunities where infrastructure, market access and water chemistry are suitable. However, profitability cannot be assumed solely from biological survival. Economic assessments should include pumping costs, pond construction, mineral supplementation, feed, seed, electricity, labour, disease management, harvesting, transportation and market prices.

Therefore, site-specific techno-economic analysis should accompany biological evaluation before commercial development.

### **Major Constraints**

Despite its potential, inland saline aquaculture faces several limitations.

- **Water-quality variability:** Salinity and ionic composition can vary spatially and seasonally. A site suitable during one season may become unsuitable during another.
- **Ionic imbalance:** Potassium and magnesium deficiencies can reduce performance of certain marine and euryhaline species.
- **Limited species-specific information:** Many freshwater species have been tested only under short-term experimental conditions. Long-term reproductive and commercial-scale studies remain limited.
- **Seed availability:** Commercial hatchery protocols for some species under inland saline conditions are not yet sufficiently developed.
- **Technical expertise:** Farmers require training in salinity monitoring, acclimation, mineral management, biosecurity, feeding and water-quality control. The reviewed article also identifies inadequate technical knowledge among farmers as a major constraint.
- **Environmental risk:** Poorly managed saline effluents and chemical use could create secondary environmental impacts.
- **Economic uncertainty:** The costs of pumping, mineral supplementation, infrastructure and water treatment can vary substantially between locations.

### Research Priorities and Future Directions

Future research should move beyond simple salinity-tolerance experiments and focus on integrated production performance. Important research priorities include:

- Development of site-specific water-quality classification systems for inland saline aquaculture;
- Determination of ionic profiles required for individual candidate species;
- Optimisation of potassium, magnesium and calcium supplementation;
- Development of gradual acclimation protocols;
- Evaluation of broodstock reproductive performance under long-term saline exposure;
- Selective breeding and genetic improvement for salinity tolerance;
- Development of salt-tolerant strains of freshwater fish;
- Optimisation of feed formulations under saline conditions;
- Evaluation of immune responses and disease resistance;
- Development of low-cost water-quality sensors;
- Integration of probiotics and environmentally safer health-management approaches;
- Development of ras and biofloc-based approaches for saline water;
- Assessment of nutrient recovery and saline effluent treatment;
- Techno-economic analysis under different indian production scenarios;
- Development of farmer-oriented production protocols; and
- Establishment of regulatory and environmental monitoring frameworks.

The development of digital technologies can further support inland saline aquaculture. Sensor-based monitoring of salinity, temperature, dissolved oxygen, pH and other parameters can help farmers respond rapidly to environmental changes. Digital decision-support systems may eventually assist in predicting water-quality changes and optimising stocking, feeding and mineral supplementation.

Genetic improvement is another promising area. If candidate freshwater species such as common carp can be selectively bred for improved tolerance to moderate salinity without compromising growth and reproductive performance, their usefulness in salt-affected regions could increase considerably. However, such programmes should be based on multi-generation evaluation rather than short-term survival observations.

### Integrated Resource Utilisation

The greatest potential of inland saline aquaculture lies not simply in replacing freshwater with saline water but in developing integrated resource-use systems. Salt-affected land, saline groundwater, aquaculture nutrients and biological wastes can potentially be linked with other production activities.

For example, aquaculture ponds may be combined with salt-tolerant plants, algae production or other compatible enterprises. Spirulina production using inland saline water has already been investigated, indicating the possibility of developing additional products from the same water resource (Sandeep et al., 2013).

Such integrated systems could improve resource-use efficiency, diversify farm income and reduce waste generation. However, each integration model requires independent assessment of water balance, nutrient flows, disease risks, economics and environmental impacts.

### Conclusion

Inland saline aquaculture represents a promising resource-utilisation strategy for regions where freshwater is limited and substantial areas of land are affected by salinity or waterlogging. The available literature demonstrates that inland saline water can support the culture of a wide range of marine, brackishwater, freshwater, ornamental and crustacean species when appropriate water-quality and ionic conditions are maintained.

The evidence reviewed in the source document indicates that India possesses considerable potential for inland saline aquaculture, particularly in saline-affected areas of Haryana, Punjab, Rajasthan, Uttar Pradesh, Gujarat, Madhya Pradesh, Maharashtra and other regions. Research on freshwater carps and other freshwater species is particularly important because it provides opportunities for farmers who may not have access to marine seed, specialised infrastructure or established shrimp-production systems.

Among freshwater species, *Cyprinus carpio* represents an important candidate because of its established culture technology, adaptability and demonstrated ability to reproduce and develop under low-salinity inland groundwater conditions. Nevertheless, survival at a particular salinity should not be considered equivalent to optimum commercial

production. Production decisions must consider growth, feed utilisation, reproductive performance, seed quality, water chemistry and economic returns.

The future development of inland saline aquaculture should therefore follow a site-specific, species-specific and ecosystem-based approach. Water and soil characterisation, mineral management, selective breeding, improved seed production, environmentally responsible effluent management, farmer training and economic assessment should form the foundation of commercial development.

Ultimately, inland saline aquaculture can contribute to a broader transition from resource degradation to resource utilisation by converting selected saline and waterlogged lands into productive aquatic-food systems. Further interdisciplinary research and carefully monitored field-scale demonstrations are required to establish economically viable and environmentally responsible production models for India and other saline-affected regions.

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