

8. Advances in Breeding and Seed Production Technology of Indian Major Carps

Sanjaykumar Rambhai Vala¹, Harshrajsinh Mahendrasinh Zankat², Devika Rani H. K³, Vishnu Kiran Manam⁴

¹ Senior Research Assistant, Fisheries Research and Training Centre,
Kamdhenu University, Mahuva

²M.F.Sc Scholar, Department of Aquaculture, College of Fisheries Science, Kamdhenu University, Himmatnagar, Gujarat

³Research Scholar, DOSR in Zoology, University College of Science, Tumkur University
Tumkur, Karnataka, India – 572102

⁴Senior Scientist/DGM - R&D, IB Group,
Chhattisgarh 491411.

Introduction

Freshwater aquaculture (carps, tilapia, catfish, trout and other species) is expanding because it can supply affordable animal protein, create rural jobs, and use land and water resources efficiently. However, as farms intensify, disease becomes one of the most consistent constraints on yield and profit. In practical terms, fish disease is rarely caused by a single pathogen; it is usually the result of an interaction among host susceptibility, pathogen presence, and environmental stress (the classic “disease triangle”). When stocking densities increase, organic waste accumulates faster, dissolved oxygen fluctuates, and fish experience chronic stress—conditions that allow opportunistic bacteria, parasites, and fungi to multiply. Viral diseases may enter through the movement of seed, broodstock, contaminated water, or equipment, and then spread rapidly through close contact.

The consequences go beyond mortality. Sub-lethal infections reduce growth, worsen feed conversion, and increase grading losses from ulcers, deformities, and

poor flesh quality. Farmers also face higher costs for chemicals, therapeutics, and labour, and sometimes market restrictions when residues or notifiable diseases are involved. Because many freshwater systems are open (ponds connected to canals, shared water sources, wild fish interaction), prevention is more effective than cure. This article reviews the prevalence patterns of major diseases and provides practical, farm-level management approaches, emphasising early warning, biosecurity, water quality control, nutrition, responsible therapeutics, and integrated health planning.

1. Overview of Fish Disease Prevalence

Production system, season, species, and management intensity strongly shape disease prevalence in freshwater aquaculture. In earthen ponds, many outbreaks are seasonal: parasitic and bacterial problems often rise during warm months when pathogen replication accelerates, and oxygen stress becomes common; fungal infections may increase during colder periods or after handling injury; and viral outbreaks may show sharp peaks

linked to fish movement or temperature windows that favour viral replication. Cage and raceway systems can experience rapid farm-to-farm spread because water is shared and pathogen pressure remains constant.

Prevalence is also linked to the quality of seed and broodstock. If hatcheries supply mixed-health-status seed without screening, infections can become “built in” to the production cycle. In many carp and tilapia farms, parasitic burdens may remain chronic at low levels, flaring up when fish are stressed (e.g., during transport, grading, or sudden weather changes). Bacterial diseases frequently behave as opportunists—present in water and sediment, but causing outbreaks when immunity is compromised by ammonia, nitrite, low oxygen, or poor nutrition. Viral diseases are often less frequent but more devastating: mortality can be sudden, and control depends heavily on prevention, movement control, and early reporting.

Tracking prevalence requires simple but disciplined farm records: daily mortality, feeding responses, water-quality logs, treatments applied, and post-mortem observations. When farms adopt routine surveillance—periodic gill/skin scrapes, health checks at grading, and introductory lab confirmation, patterns become visible, allowing targeted prevention rather than repeated crisis response.

2. Major Categories of Freshwater Fish Diseases

Freshwater fish diseases can be grouped into bacterial, parasitic, viral, and fungal categories, each with distinct epidemiology and control options. Bacterial diseases are common because

many bacteria naturally occur in pond water and sediments and become harmful under stress. Parasitic diseases are widespread because many parasites have direct life cycles and spread easily in crowded ponds; they also create entry points for bacteria by damaging skin and gills. Viral diseases may be less routinely detected (often due to limited diagnostic access), but they can cause the highest mortality events and are difficult to treat once established. Fungal diseases are typically secondary-appearing after injury, poor water conditions, or other infections—yet they can severely impact eggs, fry, and stressed fish.

These categories are not isolated in real farms. Mixed infections are common: for example, gill flukes reduce oxygen uptake, fish become stressed, and opportunistic bacteria cause ulcers; or poor handling creates abrasions, fungi colonise the skin, and bacteria complicate healing. Therefore, management should not be “pathogen-only.” It should prioritise the controllable drivers: water quality stability, stocking density, nutrition, handling stress reduction, and strong farm biosecurity.

A practical way to think about disease categories is also to link them to response speed and tools: parasites often respond quickly to management and bath treatments if caught early; bacterial disease may require confirmed diagnosis and responsible therapeutics plus environmental correction; viral disease control relies on prevention (screening, quarantine, movement restrictions); fungal disease prevention depends on reducing injury and organic loading and protecting eggs and fry.

Disease Category	Common Pathogens	Key Features	Management Focus
Bacterial	<i>Aeromonas</i> , <i>Flavobacterium</i>	Ulcers, fin rot	Water quality, antibiotics stewardship
Parasitic	<i>Ichthyophthirius</i> , flukes	White spots, respiratory distress	Quarantine, antiparasitic baths
Viral	VHSV, Koi Herpesvirus	High mortality, haemorrhages	Biosecurity, quarantine
Fungal	<i>Saprolegnia</i>	Cotton-like growths	Water quality, hygiene

2.1 Bacterial Diseases

Bacterial diseases are among the most frequent problems in freshwater aquaculture, often triggered by stress and deteriorating water quality rather than a sudden “new” pathogen. Common examples include motile aeromonad septicemia (*Aeromonas* spp.), columnaris disease (*Flavobacterium columnare*), and edwardsiellosis (*Edwardsiella* spp.). Typical signs include skin haemorrhages, fin rot, ulcers, “redness” at the base of fins, swollen abdomen, exophthalmia, pale gills, and sudden mortality spikes—especially after handling, crowding, or low dissolved oxygen events.

Columnaris is notable for gill and skin lesions that can appear cottony or “saddle-back” on the dorsum, progressing rapidly in warm water.

Diagnosis should combine farm history (recent stress, transport, temperature shift), gross signs, and confirmatory testing where possible (wet mounts to rule out parasites, bacterial culture, sensitivity testing, or PCR in better-equipped labs). Treatment failures often occur because farmers treat unquestioningly without fixing the underlying stressor—e.g., antibiotics without improving oxygen or reducing ammonia.

Management is best built on prevention: stable water quality, appropriate stocking density, high-quality feed, and minimising handling injuries. When treatment is required, use responsible antimicrobial practice: correct dose, full course, veterinary guidance where available, and strict adherence to withdrawal periods. Overuse drives resistance and creates market and environmental risks. Supportive measures—salt dips (species-appropriate), probiotics, immunostimulant feeds, and rapid removal of moribund fish—can reduce outbreak intensity.

2.2 Parasitic Diseases

Parasitic diseases are highly prevalent in freshwater farms because many parasites spread efficiently in crowded ponds and can complete life cycles quickly. Major groups include protozoans such as *Ichthyophthirius multifiliis* (Ich/white spot), *Trichodina*, *Chilodonella*, and monogenean flukes (*Dactylogyrus* on gills; *Gyrodactylus* on skin). Crustacean parasites such as Lernaea (an anchor worm) and fish lice (*Argulus*) can also

cause severe irritation, wounds, and secondary bacterial infections.

Typical signs are flashing/rubbing, rapid opercular movement, excess mucus, clamped fins, lethargy, poor feeding, and gill discolouration. White spot disease presents as small white cysts on skin and fins; heavy gill fluke loads cause respiratory distress and crowding near water inlets. Parasites frequently act as “gate-openers,” damaging epithelial barriers and enabling bacterial invasion.

Diagnosis is often achievable at the farm level using a microscope: skin and gill scrapes quickly reveal motile protozoans or flukes. Because parasite loads can rise fast, early detection is critical. Management focuses on breaking transmission: reducing stocking density, improving filtration/aeration, removing organic sludge where parasites thrive, and quarantining new stock. Treatments vary by species and system and must be used carefully: salt baths, potassium permanganate, hydrogen peroxide, formalin alternatives (where permitted), and pond fallowing/drying can be effective when applied correctly. For crustaceans, physical removal, liming, and controlling intermediate hosts may be needed.

Long-term control relies on routine monitoring, hygienic seed supply, and stress reduction, because stressed fish are less able to resist parasite attachment and proliferation.

2.3 Viral Diseases

Viral diseases in freshwater aquaculture are often underdiagnosed but can cause the most dramatic losses due to rapid spread and limited treatment options. Important examples include koi

herpesvirus disease (KHV) in carp/koi, spring viremia of carp (SVC), viral hemorrhagic septicemia (VHS) in susceptible species, and emerging viruses affecting tilapia in some regions. Viruses may enter farms through infected seed or broodstock, contaminated transport water, shared equipment, or vectors. Some infections can remain subclinical and then erupt when temperature conditions favour viral replication or when fish are stressed.

Clinical signs can be non-specific: sudden mortality, lethargy, darkening, abnormal swimming, gill necrosis, haemorrhages, ascites, and pale organs. Because signs overlap with those of bacterial septicemia, laboratory confirmation (PCR/RT-PCR, histopathology, antigen tests, where available) is crucial. A key feature of viral outbreaks is that antibiotics do not help—any apparent “response” usually reflects improved water conditions rather than pathogen elimination. Management is therefore prevention-heavy: strict quarantine of new fish, sourcing seed from screened facilities, disinfecting equipment, separating age groups, controlling farm visitors, and avoiding mixing stocks from different origins. During suspected viral outbreaks, rapid containment is essential: stop movement of fish, limit water exchange that may spread pathogens, remove dead fish promptly, and consult aquatic animal health services. In regions with established programs, vaccination may be available for certain viral diseases, but for many viruses, biosecurity and movement control remain the primary tools.

2.4 Fungal Diseases

Fungal diseases in freshwater aquaculture are commonly opportunistic and often appear after stress, injury, or poor water conditions. The best-known is saprolegniasis (water mould), which manifests as cotton-like growth on skin, fins, or gills, and can be devastating in eggs and fry. Another serious condition is branchiomycosis (“gill rot”), associated with gill tissue damage and respiratory failure under poor water quality and high organic loading. Fungal involvement frequently follows bacterial or parasitic infections because damaged skin and mucus layers provide a surface for fungal colonisation.

Farmers typically notice fluffy white/grey patches, frayed fins, lethargy, surface gasping, and poor feeding. In eggs, fungal growth spreads rapidly from dead eggs to live ones, reducing hatch rates. Diagnosis is usually clinical, plus microscopic confirmation of hyphae from skin scrapings or egg surfaces.

Management starts with prevention: gentle handling to avoid abrasions, maintaining good oxygen levels, reducing organic matter, promptly removing dead fish/eggs, and ensuring appropriate stocking densities. For hatcheries, egg disinfection protocols and water hygiene are critical. Chemical options are more restricted today because some historically effective agents have residue and environmental concerns. Safer approaches may include approved oxidising agents (species- and regulation-dependent), salt treatments in small systems, improved water exchange, and targeted disinfection of equipment and incubation units.

Because fungal disease is often a signal of underlying stress, successful control depends on correcting the root cause—injury, poor water quality, chronic parasites, or nutritional deficiencies—rather than repeating chemical baths.

3. Symptoms and Diagnosis of Fish Diseases

Adequate disease control begins with recognizing patterns and confirming causes. Many diseases share outward signs—reduced feeding, lethargy, isolation, surface gasping, flashing, fin clamping—so diagnosis must integrate history, environment, and targeted sampling. A practical field approach starts with: (1) observing behavior and mortality trend, (2) checking water quality (DO, temperature, pH, ammonia, nitrite), (3) examining external lesions and gills, (4) conducting wet mounts (gill/skin scrapes) to detect parasites, and (5) doing basic post-mortem checks (gill color, liver/spleen appearance, fluid in abdomen).

Certain signs are suggestive: white spots indicate Ich; excessive mucus with flashing suggests protozoans; ulcers and haemorrhages often point to bacterial involvement; cottony growth indicates fungal colonisation; sudden high mortality with limited external lesions may suggest viral disease or acute toxicity. However, mixed infections are common, so confirmatory testing is ideal when losses are significant. Laboratory options include bacterial culture and sensitivity testing, histopathology, and molecular diagnostics (PCR/RT-PCR).

Sampling quality matters. Collect moribund fish (not decomposed), keep them cool, and transport quickly. For pond systems, sample multiple fish

and multiple locations to avoid missing localized problems. Recording treatment history is also essential because prior chemical use can mask parasites or suppress bacteria temporarily.

A strong diagnostic culture at farm level—routine microscopy, clear logs, and early lab confirmation—reduces the tendency to “treat everything,” improves outcomes, and lowers costs and drug misuse.

4. Management and Control Approaches

Managing freshwater fish diseases requires shifting from reactive treatment to risk reduction and system resilience. The most successful farms treat health management as part of everyday production: stocking decisions, feeding schedules, water exchange, aeration plans, and handling protocols are designed to reduce stress and pathogen transmission. Disease control is also time-sensitive—early intervention at the first signs of stress (oxygen dip, appetite drop) often prevents an outbreak that later demands expensive treatments with uncertain results.

A modern approach combines five pillars: biosecurity, water quality management, nutrition, targeted therapeutics/vaccination, and integrated health planning. Biosecurity prevents pathogen introduction and spread between units. Water quality management keeps fish physiology stable and limits pathogen proliferation. Nutrition supports immune function and recovery. Therapeutics and vaccines are used strategically based on diagnosis, legality, and stewardship principles. Integrated health planning coordinates monitoring, record-keeping, training, and outbreak

response so that farms learn from each event and reduce recurrence.

Importantly, management must be practical for the local context. Smallholder pond farms may rely on simple tools—consistent aeration, liming where appropriate, routine pond preparation, seed quarantine, and microscope checks—while larger operations may add laboratory surveillance, vaccination programs, and formal biosecurity zoning. Across all scales, the focus should remain on controlling what the farmer can control daily: oxygen, stocking density, feed quality, handling stress, and seed health status.

4.1 Prevention and Biosecurity

Biosecurity is the most cost-effective disease management tool because it stops pathogens before they establish. A practical biosecurity plan begins with controlled entry of fish: source seed from reputable hatcheries, avoid mixing batches from multiple sources, and quarantine new stock (commonly 2–4 weeks depending on species and risk) while monitoring behavior, feeding, and mortality. During quarantine, conduct gill/skin scrapes and address parasites early so they are not introduced into production ponds.

On-farm biosecurity includes separating age groups, using dedicated nets and buckets per pond, disinfecting equipment between units, and controlling visitors. Footbaths, handwashing points, and restricting vehicle entry sound “industrial,” but even low-cost versions reduce cross-contamination. Water biosecurity matters too: filter or settle incoming water where possible, prevent backflow between ponds, and minimize

interaction with wild fish and birds that can act as mechanical vectors.

Operational practices are equally important: avoid unnecessary handling, disinfect graders and transport tanks, and schedule harvesting so that stressed fish are not moved through multiple units. Remove dead fish quickly and dispose safely; carcasses left near pond banks amplify pathogen load and attract vectors.

A simple written protocol—who enters, what gets disinfected, how quarantine is done, and what steps trigger an alert—helps farms respond consistently. Biosecurity is not “one action”; it is a routine culture that reduces both everyday disease prevalence and catastrophic outbreaks.

4.2 Water Quality and Environmental Management

Water quality is the central driver of fish health because fish live in—and breathe—their environment. Even when pathogens are present, outbreaks often occur only after oxygen stress, ammonia spikes, pH swings, temperature shocks, or excessive organic loading. Therefore, environmental management should aim for stability, not just “acceptable averages.” Key routine measurements include dissolved oxygen (especially early morning), temperature, pH, ammonia, and nitrite. Sudden appetite reduction is often an early indicator of water stress even before mortality rises.

In pond systems, aeration is one of the most effective disease-prevention investments because it stabilizes oxygen, reduces stress, and improves decomposition of wastes. Managing feeding to

match biomass prevents overfeeding, which otherwise increases sludge and promotes opportunistic pathogens. Periodic pond bottom management—drying, liming (where suitable), desilting, and controlled fertilization—can reduce parasite reservoirs and bacterial hotspots. Maintaining moderate phytoplankton levels can support oxygen production, but algal crashes can cause acute oxygen depletion; monitoring water color and transparency helps avoid extremes.

Water exchange can be beneficial, but it also carries biosecurity risks if the source is contaminated. Where exchange is used, it should be combined with screening/settling and timed to avoid spreading pathogens downstream. Stocking density should be aligned with carrying capacity, aeration availability, and seasonal risk. In many cases, reducing density slightly can prevent repeated outbreaks and improve net profit through better growth and survival.

4.3 Nutritional and Feed Management

Nutrition shapes immune competence, stress tolerance, and recovery from infection. Fish underfed or fed poor-quality, rancid, or imbalanced diets show reduced growth and weaker barriers (skin, mucus, gills), making them more susceptible to parasites and opportunistic bacteria. Overfeeding is also harmful: excess feed increases organic waste, worsens water quality, and raises disease pressure. Thus, feed management is both a nutrition issue and a water health issue.

Good practice starts with choosing species-appropriate feed with correct protein/energy ratio and stable pellet quality. Feed should be stored dry,

cool, and protected from pests; oxidative rancidity (especially in high-fat diets) reduces palatability and can harm health. Feeding schedules should match temperature and oxygen conditions—feeding heavily during low oxygen periods increases stress and waste. Regular biomass estimation and feeding rate adjustment prevent chronic overfeeding.

Functional nutrition can add resilience. Vitamins (such as C and E), trace minerals (e.g., selenium and zinc in appropriate amounts), and quality oils support antioxidant defenses and immune responses. Probiotics and prebiotics may help stabilize gut microbiota and reduce pathogen colonization, especially during stressful periods (handling, grading). Immunostimulants can be useful strategically, but they are not substitutes for good water quality and biosecurity.

During outbreaks, feeding must be managed carefully. If fish stop feeding, forcing feed increases waste; instead, restore oxygen and reduce stress first. As appetite returns, use highly digestible diets and maintain consistent feeding to support recovery.

4.4 Therapeutics and Vaccination

Therapeutics can be valuable when used correctly, but misuse leads to resistance, residues, environmental harm, and disappointing outcomes. The first rule is: treat based on likely cause and ideally confirmed diagnosis, and always correct the underlying stressor (oxygen, ammonia, crowding). For parasites, bath or pond treatments may work if applied early and safely; dosing must consider water volume, temperature, organic load, and fish

species sensitivity. For bacterial disease, antimicrobials may be effective only when fish are still feeding (for medicated feed delivery) and when the pathogen is susceptible; incomplete dosing and repeated “trial” antibiotics increase resistance risk.

Regulatory compliance matters: use only approved products, follow label instructions, maintain withdrawal periods, and document treatments. In many markets, residue compliance affects farm access to buyers and processors. Supportive measures—improving aeration, removing moribund fish, reducing handling, and using supportive salts/oxidizers where appropriate—often determine success more than the drug itself.

Vaccination is a preventive tool particularly useful for certain bacterial (and in some contexts viral) diseases. Vaccines reduce severity and mortality and can decrease antibiotic dependence. However, vaccine success depends on correct timing (before high-risk season), proper administration (injection, immersion, or oral), fish size, and cold-chain storage. Vaccines do not eliminate the need for biosecurity and water quality; they complement them by increasing baseline immunity.

4.5 Integrated Health Management (~250 words)

Integrated health management treats fish health as a continuous production process rather than a crisis event. It combines daily husbandry with planned monitoring, risk assessment, and structured response protocols. A farm health plan typically includes: routine water quality monitoring, scheduled fish sampling (weights, gill checks, skin

scrapes), mortality thresholds that trigger action, vaccination or prophylaxis schedules where relevant, and clear staff roles during outbreaks.

Integration is important because single interventions rarely work alone. For example, treating parasites without reducing stocking density may lead to rapid reinfection; using antibiotics without improving oxygen may fail and increase resistance risk. An integrated plan also emphasizes learning loops: after each outbreak, farms review what changed (weather event, feed issue, new seed source, aeration failure), update SOPs, and adjust risk controls.

Technology can support integration at any scale. Small farms can use simple logbooks and periodic microscope checks; larger farms may use digital dashboards, automated oxygen alerts, and routine lab screening. Selective breeding and genetics are also part of long-term health management—choosing robust strains, maintaining good broodstock practices, and avoiding inbreeding-related weakness.

Integrated health management aligns with “One Health” thinking: prudent antimicrobial use protects human medicine; safe effluent management protects ecosystems; and biosecurity reduces disease spread to neighbouring farms. Ultimately, integrated systems reduce recurring losses and stabilize production, which is the foundation of sustainable freshwater aquaculture.

5. Case Studies and Regional Perspectives

Disease patterns differ across regions because climate, species composition, farming intensity, and seed supply chains vary. In many South Asian

carp pond systems, disease events commonly follow monsoon-driven fluctuations: sudden dilution, temperature shifts, and organic runoff destabilize water quality. Farmers may observe parasite flare-ups (gill flukes/protozoans) followed by bacterial ulcers when fish are stressed and skin is damaged. The most successful pond clusters often focus on pond preparation (drying/desilting), cautious stocking densities, early-season parasite monitoring, and strong aeration during hot months. Tilapia farming in tropical regions often experiences chronic parasite pressure and periodic bacterial disease associated with crowding, low oxygen at night, and handling. Where farms improve oxygen management and enforce seed quarantine, outbreaks reduce significantly even without frequent chemical use. Catfish culture can show bacterial septicemia outbreaks linked to high organic load and feed wastage; improvements in feeding discipline, sludge management, and water exchange practices can dramatically change outcomes.

Trout raceways in cooler regions highlight a different challenge: waterborne spread between units and rapid transmission. Here, biosecurity zoning, disinfection protocols, and strict movement control are essential, along with rapid diagnostic confirmation. Across all contexts, the shared lesson is that disease control is more reliable when it is system-based (seed quality + water stability + handling reduction + monitoring) rather than treatment-based.

Conclusion

Major fish diseases in freshwater aquaculture—bacterial, parasitic, viral, and fungal—remain a primary barrier to consistent production. Their prevalence is rarely random; it reflects the farm’s environment, stocking pressure, seed health, and daily management decisions. Parasites and opportunistic bacteria often dominate routine losses, while viral outbreaks, though less frequent, can cause sudden catastrophic mortality and require strong prevention and containment measures. Fungal problems commonly signal underlying stress, injury, or poor hatchery hygiene. The most effective management approach is prevention-first: secure seed sourcing and quarantine, practical biosecurity, stable water quality supported by aeration and waste control, and nutrition that strengthens immune function. When disease occurs, early recognition and diagnosis—especially gill/skin microscopy and basic post-mortem checks—prevent wasted treatments and reduce spread. Therapeutics should be targeted, legal, and stewardship-driven, with clear records and withdrawal compliance. Vaccination, where available and feasible, reduces dependency on antibiotics and improves survival, but it must be integrated with good husbandry rather than used as a standalone solution.

Ultimately, sustainable disease control comes from integrated health management: planned monitoring, SOPs, training, outbreak thresholds, and continuous improvement. Farms that treat health as a production discipline—like feeding or water management—achieve more stable yields, lower costs, improved market trust, and better environmental outcomes.

References

- “Common Diseases of Cultured Fish”. (2018). Ohio State University Extension.
- “Fish Disease Diagnosis and Treatment”. (n.d.). GoAbroadEdu PDF.
- MSD Veterinary Manual. (2024). *Viral Diseases in Aquaculture*.
- MacAulay, S. (2022). *Moving towards improved surveillance and earlier diagnosis of aquatic diseases*. PMC.
- Mishra, S.S. et al. (2017). *Present status of fish disease management in freshwater aquaculture in India*. Herald Open Access.
- Texas A&M Fisheries & Aquaculture. (n.d.). *Parasites & Diseases*.
- Thesprucepets (2019). *Saprolegnia in Freshwater Fish*.