

INNOVATIVE AQUACULTURE

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Focal Points at a Glance

The authors highlight that now on genetic engineering and transgenic technology will play an important role for increasing aquaculture productivity. Asked suddenly to tell what PCR is, many probably cannot respond quickly and with ease. A simple answer to such a query is: it is a useful and most frequently used tool for shrimp viral disease diagnosis, specially WSSV. All know about GIFT (Tilapia) and Layanti Rohu, but the authors remind us of their genesis. Many more expressive and focal points of the above kind are presented by the author.

With the accelerated human population explosion, demand for fish is also increasing rapidly. In Indian context, total fish production comes from the two sectors, marine and inland. It is well evident from the production trend that the fish landings from marine sector have become either almost static or declining. So, aquaculture can be a possible avenue to increase production for meeting the fish demand. Presently, aquaculture contributes around 85-90% of total inland fish production. Aquaculture is defined as the system of breeding and farming of aquatic species in a controlled environment. While innovative aquaculture involves the applications of new and more effective ways or solutions for aquaculture management, there may be interventions related to breeding and farming techniques, aquatic environment management, disease control or animal health monitoring, nutrition and feed management of the cultured organisms, genetics and biotechnological tools which directly or indirectly play roles in improvement of aquaculture production in an environment-friendly and sustainable manner. Here are some innovations which have played or are playing or will play a significant role in the development of aquaculture sector.

1. Induced Breeding: Technological breakthrough in induced breeding of carps through hypophysation in 1957 by H. Chaudhuri and K.H. Alikunhi has revolutionised aquaculture in India. Since then carp breeding by hypophysation has been an established technology for seed production with an annual output of around 21,000 million fry. Based on this principle, various prime fish species were bred and endeavour is on to breed other commercially important fishes.

2. Composite Fish Culture: Composite fish culture, with the aim of utilising all niches of water column was started, involving the three Indian major carps, viz. Catla, Rohu and Mrigal along with three exotic carps, Silver carp, Grass carp and Common carp. It has been a mainstay in aquaculture industry since 1980s. Due to its immense popularity among fish farmers, today composite fish culture alone is contributing more than 80% of total aquaculture production of the country.

3. Wastewater Aquaculture: Wastewater aquaculture was developed in Germany at the end of nineteenth century and independently in Calcutta in 1930. At present, there are more than 130 wastewater aquaculture units in India covering about

10,000 ha. Out of it, 80% are located in West Bengal. In this system, generally multiple stocking and multiple harvesting practices are followed for a period of 3-5 months with carp fingerlings and tilapia.

4. Shrimp Seed Production and Farming: Mass production of *Marsupenaeus japonicus* post-larvae in large outdoor tanks in 1964 was the most significant path finding incident in the history of shrimp hatchery development. About 351 shrimp hatcheries are producing a total of 4 billion PL20 per year in India with maximum percentage of *Penaeus monodon* and less of *Fenneropenaeus indicus*, where "unfertilised system" or "Galveston System" is followed. Scientific shrimp farming in well-designed farms started in the late 1980s and peaked during 1994-95. Presently, about 1.5 lakh ha of brackishwater area is under shrimp farming with annual production of 1.15 lakh tonnes.

5. Genetic Engineering and Transgenic Fish: Organism with a foreign or modified gene integrated in its genome is called transgenic or genetically modified organism (GMO). Genetic engineering is only the real commercially feasible way of minimising large gaps between an organism's natural characteristics and what the aquaculturist dreams. Continuous efforts are

to be put to isolate and identify novel and useful genes like growth, antifreeze, and disease resistance genes etc. which are to be incorporated with suitable promoters of fish-origin to the genome of fish of interest. Aquaculture shows greater scope for increasing fish production with the increasing demand for fish. Thus genetic engineering and transgenic technology will have an important role to play for increasing aquaculture productivity within the permitted bio-ethic norms.

6. Molecular Diagnostic Methods for Diseases: Successful health management programme depends on prompt, efficient and appropriate diagnosis of disease and pathogen. Advances achieved in molecular biology have shown the ways for diagnosis and control of infectious diseases. Nucleic acid techniques, viz, Polymerase chain reaction (PCR), Restriction fragment length polymorphism (RFLP), Randomly amplified polymorphic DNA (RAPD), plasmid profiling, DNA-restriction fragment analysis etc. are in vogue for diagnosis of fish diseases. Among these, PCR has become a useful and most frequently used tool for shrimp viral disease diagnosis, especially White Spot Syndrome Virus (WSSV).

7. Microbial Interventions: Microbial intervention in aquaculture acts either as bio-control (antagonist to pathogens) for host response (protective and physiological) or improves water quality (bioremediation) or through probiotics or immunostimulants and vaccines. The immune enhancement through immune modulators has become the most promising and effective method of preventing diseases in aquaculture and is revolutionising the alternative health management in aquaculture. The use of antibiotics can be avoided as it has led to the emergence of drug-resistant bacteria, immunosuppression in animals, besides harmful effects on the environment and concerns on food safety.

8. Domestication and Selective Breeding: To avoid inbreeding, genetic depression and deterioration of seed quality, an innovative breeding programme including both selection and cross/out breeding and even hybridisation together with marker assisted breeding programme (RFLP, AFLP and RAPD) can be employed to tag quantitative trait loci, (QTLs). These have been developed for some species to ensure heterosis. GIFT (Genetic Improvement of Farmed Tilapia) in the Philippines and Jayanti Rohu in India with higher growth performances are some of the promising outputs of selective breeding programme.

Successful domestication of several fish and crustaceans like tiger shrimps has also been achieved.

9. Aqua-genome Exploration: In 2001, the genome of the poisonous Puffer Fish (Fugu) has been sequenced by an international consortium of researchers and since then many other species like the zebrafish and the Japanese medaka have been sequenced and the information is available in public domains. Fugu genome is "almost like the human genome written in shorthand". Fish genome studies, gene analysis, genome mapping are rapidly progressing and with such advances in knowledge and background the biotechnological applications and innovations are inevitable. This has several potential applications like molecular disease diagnosis, gene expression during breeding programme, gene therapy, and other applications of proteomics and genomics in aquaculture.

10. Application of Nanotechnology in Aquaculture: Nanosensors to monitor the stock, cleaning fish ponds with nanotechnology devices, DNA nanovaccines in nano-capsules containing short strands of DNA are added to a fish pond where they are absorbed into the cells of the fish. Ultrasound is then used to rupture the capsules, releasing the DNA and eliciting an immune response from the fish. Using iron nano particles to speed up the growth of fish, and automated drug delivery system are very fast becoming reality by this innovative technology.

11. Transgenesis via Embryonic Stem Cells and Cell/Nuclear Transplantation: This is a new approach to transgenesis that yields better transgene integration and expression compared to the direct transgenesis with the availability of a fish embryonic stem (ES) cell line. ES cells can be transfected with a particular gene construct or expression cassette and screened for being homologous. The transfected cells can then be transplanted into early embryos/blastulae, either directly or via removal of nucleus and nuclear transplantation. Transgenic technology can be used to induce or enhance other traits in fish once the relevant genes are known. Research is being pursued to produce transgenic fish carrying genes that encode antimicrobial peptides such as lysozyme or genes encoding against viral RNA through antisense and ribozyme techniques.

12. Cloning and Preservation of Genetic Resources: On one hand the establishment of sperm or seed banks for aquaculture, facilitating preservation and dissemination of stocks thus assisting

breeding programmes and on the other hand cell lines, particularly ES cell lines, offering another means of genetic conservation. Again, biodiversity can be restored from cells by cloning through nuclear or cell transplantation. Thus it will help in maintaining aquatic biodiversity for long run.

13. Sound Generating Instrument: This is ultrasonic sound generating equipment marketed by a Kolkata based company. It is designed for use under water in hatchery pools and also in brooder, nursery, rearing and grow-out ponds. Some reports say that it gives encouraging results in carp hatcheries by reducing the hormone dose, providing higher fertilisation and hatching rate and also in nurseries with spawn reaching fry stage five days in advance.

14. Bioactive Compounds and their Uses in Aquaculture: Aquatic organisms can play an increasingly important role in biotechnology and medicine. They are rich sources of novel and structurally divergent compounds. Some of these bioactive compounds could serve as models for new drugs, antifouling compounds, morphogens, signal substances, pheromones, neurotransmitters and antifertility compounds. Some potential areas are preparation of an inventory of anti-viral and anti-bacterial compounds with the applications in disease control of cultured species and development of fermentation technology for production of enzymes and enrichment of aqua feeds using microbes isolated from aquatic organisms.

15. GIS Applications in Aquaculture: Sustainable aquaculture requires a suitable aquaculture resource allocation system. GIS (Geographical Information System) is an appropriate tool to implement in a flexible planning approach to facilitate resource allocation. GIS has an adequate database which is vital to its use as a powerful analytic and decision-making tool for the development of aquaculture. Applications of GIS in aquaculture are : as a tool for determining actual resources suitable for aquaculture, finding out potential sites for specialised culture systems like cage or pen culture, analysing and predicting shrimp aquaculture development, decision making for utilisation of large and open water bodies etc.

Many of the innovations remain untraced or ignored by the scientific community due to their physical distance from farming community. This gap requires to be minimised so that their innovations can be accessed, validated and later extended to aqua farmers by the scientific groups jointly with the help of fish farmers to ultimately augment fish production.

