# CMFRI

# Course Manual

*Winter School on*

***Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish***

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*Compiled and Edited by*

***Dr. K. Madhu, Senior Scientist and Director, Winter school***

***&***

***Dr. Rema Madhu, Senior Scientist and Co-ordinator***
***Central Marine Fisheries Research Institute***

भाकृ अनुप
ICAR

**Central Marine Fisheries Research Institute**
**(*Indian Council of Agricultural Research*)**
**P.B.No.1603, Marine Drive North Extension,**
**Ernakulam North ,P.O.**
**Cochin, KERALA – INDIA - 682018**

**INTEGRATED FARMING OF SEAWEED AND SHRIMP**

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**Reeta Jayasankar,**
*Principal Scientist, Central Marine Fisheries Research Institute, Kochi -682018.*
*e -mail : reetajayasankar@yahoo.com*

Coastal aquaculture involves the cultivation of marine and brackish water species in ponds, protected Bays, Gulfs and Lagoons. Aquaculture became an important commercial food production since 1960s (Chua, 1986; 1994) and lateer in 1970s the aquaculture transformed rapidly with the success in breeding work of fish, shellfish, seaweed, artificial feed and genetic improvements. In particular Shrimp farming spread far and wide within three decades and became the prime export earning industry in many parts of the World (Liao, 1990). In the last two decades, many intensive aquaculture enterprises have suffered severe losses due to disease outbreaks (ADB and NACA, 1991) due to poor farm management. The quality of aquatic environment began to show a sign of unsustainability in many countries. U$ 1 billion dollar has been lost due to shrimp disease in Asia (FAO and NACA, 1995). It was reported in many countries like Taiwan, Thailand, Philippines, China and India. The environmental impact of aquaculture is becoming a matter of concern in the present scenario due to increase in industrialization, intensified aquaculture development, urbanization, population increase, pollution of coastal water due to sewage-industrial and agricultural waste. Intensification of culture practices has led to environmental deterioration both within the system and in the surrounding areas. The code of conduct for Responsible Fisheries evolved by the Food and Agricultural Organization, Rome in 1995 (FAO, 1995) is adapted by 168 countries including India. India is a signatory to implement many aspects besides the major issues related to aquaculture i.e. assessment for the discharge of effluents, use of drug and chemicals during aquaculture activities. Sustainability has become the major challenge to aquaculture development.

After rapid expansion throughout the World, the aquaculture industry is beginning to realize the economic and environmental limitation of monospecific approach. The development of integrated aquaculture practice is necessary and timely in light of using a balanced ecosystem approach. Seaweed used in the system can be used as biological nutrient remover. Balance of ecosystem is maintained by regular cycling of matter. In aquatic environment microbes like bacteria, fungi and virus play key role in carrying out the chemical reactions involving complex enzymes and thereby providing soluble absorbable form of matter to the next trophic level. Excessive bloom of phytoplankton tends to affect the water transparency, absence of oxygen in bottom layer, accumulation of toxic compounds such as ammonia, nitrite and hydrogen sulfide. Balancing of the ecosystem by nutrient budgeting is an important task for aquaculture management and the sustainability. Macroalgae play a very important role in absorbing the excess nutrient in the system. Integrated approaches will develop responsible practice, optimizing the efficiency of aquaculture system and diversify the activities while maintaining the health of the aquaculture system and the surrounding waters. Bioremediation provides mutual benefit to the co-cultured organisms and economic diversification by producing value added marine crops. Seaweed is one such important cultivable group in the integrated systems, which acts as a nutrient trapper and maintains the system and also generate additional revenue from the cultured crop.

Water quality in the shrimp ponds influenced by sewage discharge, runoff from the agricultural field, adjacent shrimp farm, organic matter from the mangroves and also environmental condition such as heavy rainfall, reduction in salinity, temperature, pH, etc. The environmental issues related to the culture of Penaeid shrimp in tropical coastal environment include, the water and soil quality of the shrimp ponds, discharge of effluents to the natural water bodies after treatment and the control of disease by farm management and integrated farming. The present work justifies the need of integrated farming of shrimp and seaweed to improve culture practice towards sustainability.

CMFRI has carried out few experiments using *Ulva lactuca* and *P.monodon* in controlled environmental condition. The nitrate-nitrogen concentration registered an increase in the control tank ranging from 1.02 to 28.39 µmol nitrogen/l compared to 24.22 µmol nitrogen/l in the treatment tank showing an increase of 33.02 % per day in the control tank. The nitrite load was found to be higher in control tank ranging from 0.119 to 14.51 µmol nitrogen/l, in contrast to the 9.03 µmol nitrogen/l in treatment tank after 20 days of experiment. The ammonia concentration increased from 3.8 to 249.5 µmol nitrogen/l in the control tank and 17.2 µmol nitrogen/l in the treated tank after 20 days. The control tank recorded ammonia load @ 41.73 % per day till 20 days of culture period, compared to 15% in the treatment tank. In the closed polyculture system of shrimp and seaweed, the decline of ammonia concentration in the treatment tanks was found to be always more than nitrate and nitrite. This is due to the efficient utilization of ammonia by the seaweeds, as ammonium is frequently the preferred N source for growth of macroalgae. (D'Elia and DeBoer, 1978). The productivity of species in a mixed culture system is dependent on the performance of both the species in the system. When conditions are not optimal for both species, the co-culture system can produce negative results. Thus, environmental and physiological condition should be optimum. Maximum care should be taken in the stocking density of co-culture species.

Seaweed can also be used to treat the effluent released from the aquaculture practice. Experiments were conducted at CMFRI using *Gracilaria corticata* and *Ulva lactuca* to treat the shrimp and fish effluents released from aquaculture practice. The decline of ammonia in treatment tanks ranged from 82 % in *U. lactuca* to 84 % in *G. corticata* within 20 days of treatment. The nitrate content was declined from 54 and 72 % in *G.corticata* and *U.lactuca* respectively. In *G.corticata* the nitrite content declined to a greater extent by 63.7 % on 20 DAT over the initial value where as the decline was marginal in control tank. In *Ulva* the nitrite content declined to 96 % after 20 DAT.

*Gracilaria verrucosa*, also an important agar yielding species of red algae has got wide level of tolerance of salinity. This species is found throughout the Indian coast, including the lake like Chilka (Orissa), Muthukad (Chennai) and in the backwaters of Kerala near Quilon. Already it is reported by few farmers regarding good growth and prevention of disease consecutively for three years when the shrimps were grown in the pond having natural vegetation of *Gracilaria verrucosa.* Similar work was carried out at Narakkal, transporting the seaweed from Chennai and introduced in the pond water conducted the integrated farming of seaweed and shrimp taking *Gracilaria verrucosa* as the candidate seaweed species with *P.monodon.*

In the first year the seaweed grew profusely showing a harvest of 1013 kg from the pond bottom. In the consecutive year the growth rate of *G.verrucosa* reduced but the shrimp did not show any disease. The reduction in seaweed growth may be due to non-availability of excess nutrient. Nitrogen is found to be the very important nutrient for the growth of seaweed may be a limiting factor in the second year.

The work was taken to the farmer's field taking *Enteromorpha intestinalis* as the candidate species of seaweed grown with *P.monodon*. The farming was carried out in water area of less than a acre with low stocking density (15,000 seeds of *P. monodon*) from December to March 2008 with zero water exchange. The seaweed *E. intestinalis,* which appeared after 15 days of pond preparation, was allowed to grow in the pond with the shrimp. No feed was given to the shrimp throughout the culture period. The shrimp grew to a size of 43 g within 60 days of culture period with a mean length of 20 cm. Further It grew to 56 g on 75 days of the culture period. Unusual summer shower during March influence on retardation of growth of the shrimp but gained average weight of 55 g and harvested 150 kg shrimp from the pond. Monitoring of water quality during the culture period showed that silicate and phosphate contents were comparatively higher than the nitrogenous compound. Silicate was found to be 118.67 m atom /l, where as phosphate showed a value of 3.25 m atom/l. Nitrate was found to be zero, nitrite content was 0.47 m atom/l and ammonia value was 14.625m atom /l. Excess accumulation of silicate might be due to zero water exchange and these nutrient might not have been directly utilized by seaweed. This type of shrimp farming was conducted for two years in the same pond. In the present experiment there was no WSSV recorded during the farming practice for two years consecutively. The seaweed was spongy and found to be accumulating good quantity of oxygen in their intercellular space. This has prevented to develop anoxia condition to the shrimp during night. The whole culture was done without any additional expenditure except for pond preparation and purchase of seed.

In the present system of integrated farming the output from one subsystem (Shrimp) becomes an input of the other (seaweed) resulting in a greater efficiency to create a favourable environment. Green algae in general are found to have good antibacterial properties and high photosynthetic activity. Thus the nitrogenous waste released from shrimp in the form of nitrate, nitrite and ammonia after bacterial mineralization can very well utilized for the growth of seaweed making the system enriched with more oxygen and less nutrient load. If the algae were able to trap these nutrients, the total nutrient retention of algae would increase and the produced algae could be used for animal feeds or as fertilizer. This method not only generates a potentially valuable algal biomass in parallel with aquaculture management through uptake of inorganic nutrients by the algae, it will also help to reduce the environmental impact of shrimp aquaculture. This is found to be a suitable ecofriendly and economically feasible method of shrimp farming. Low and marginal farmers having less than 1 acre of field should be encouraged to adapt such farming technology.

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