RESPONSIBLE FISHERIES AND SUSTAINABLE AQUACULTURE – A PLEDGE FOR 21ST CENTURY

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The beginning of the new millennium century the next millennium looks not only to secure enough food for the existing population but also to provide a guarantee to sustained food availability for future generation. Though scientific aquaculture has substituted the traditional practices in a big way, it cannot be fully relied upon to meet the demands of future generation. This is due to the fact that continued over fishing, heavy intensification of farms in localized areas, degradation of aquatic environment etc will put insurmountable strain on the fishery sector which is capable enough for a sustainable food supply.

India with its redoubtable potential for fish culture stood in a crossroad. This is not withstanding the fact that, our country has got an enviable genetic resource bases, millions of hectares of water bodies in the form of fresh, brackish and marine for pisciculture and of course, a sizable number of skilled, technical and non-technical man power makes an added advantage for expansion of aquaculture. The export earnings from Indian fishery has crossed Rs. 6300 crores mark and it ranks third among fish producing countries despite all the setbacks it encountered during 90's. What is not debatable is that commercial pisciculture is viable alternative for supplying cheap animal protein and it has to progress in right direction. There is

an over whelming growth in fishery sector as compare to agriculture which is facing stagnation. While contribution of agriculture to GDP is 28% fisheries sector accounts about 3-4%.

Among total export earning marine products account for 4%, of which a lion share of 70% is due to shrimp export. In this circumstances it may be noted that farm raised shrimp contributed 30% of total, rest is coming from capture sources. By 1996, world catch of shrimp from capture. Fisheries was 2.1 million tons to which India contributed 2,20,000 tons. Farm raised shrimp accounted for 7,50,000 ton to which India contributed 45,000 tons. Given the fact that shrimp industries sustain in India albeit with prescribed norms, an earnings target of 2 billion dollar would not be out of reach. All this stage, the large hue & cry on the ill-effects of shrimp farming seems unwanted, as the total area under culture is less then 10% of potential area and 40% of that involved in traditional farming activities. It may be pointed here that, intensive aquaculture, self-polluting at times, is hardly practiced in India. On the global scenario, collapse of Taiwanese shrimp industry, followed by recession of production in other South Asian countries has wake up the planners from slumbers. More recently the slump in production due to outbreak of disease in epidemic proportion in Ecuador followed by India and Bangladesh underscores the limits of aquaculture. Do doubt it has exposed the loopholes more blatantly than ever before. Nevertheless, growth of an industry can be ceased if the demand is more. We should not hasten to mean growth as production from the same unit area by intensifying the culture inputs. A matured industry behaves in a different ways. Keeping all this in mind world body met at Cancun, Mexico to formulate guidelines for all maritime nations and others countries associated with aquaculture. In this paper emphasis is given on current trends in coastal aquaculture with special reference to shrimp farming.

Negative fallouts

Recent public backlash against aquaculture activities originates form shrimp culture in coastal areas. It is truth, though hard pressed that aquaculture industry can bring an irreversible environmental change if badly planned and mismanaged. The major issues related to shrimp aquaculture are discussed below:

1) **Problems due to improper site selection**

This is a common feature associated with prawn culture, as it is hard to meet the “test book” rules pertaining to site selection. The type of land used for shrimp culture ranges from coastal land, including saltpans, agricultural land, marginal land, wetland and more importantly mangrove and supra-tidal areas. Shrimp culture has started initially in the mangrove areas and enters headway in to productive areas like agricultural land. However, the figures projected by the environmentalist group are exaggerated. Another faulty aspects, which cause severe problem, are the high density of shrimp farm in a particular area. It requires huge amount of freshwater drawn from underground aquifer, thus causing problem to near by areas leading to conflict among the users. Subsidence of coastal land may be the end result. Another problem encountered due to poor selection of site is salinisation of soil, which in turn contaminate the adjacent freshwater resource. This is not a case for the areas where hard clayey soil prevails. Further availability of porous soil with a high seepage rate, availability of freshwater resources in near by areas may aggravate the problem. If due care is taken before the construction of a farm, all these unacceptable damages can be minimized.

2) **Lose of mangrove and agricultural land**

As we have discussed earlier, mangrove areas are also sites of shrimp farming. Sadly the issue is blown out of proportion as the farmers preferably using the coastal areas away from mangrove now a day. Any imbalance in the mangrove ecosystem brings cataclysmic change, it affects the productivity and overall economics of near by areas. Reduction of fish catch, destruction of spawning ground, vulnerability of coastal zone to storm and cyclones, salt intrusion, acidification of soil and water are some of the negative impacts. Further mangroves are very much helpful in removing nutrients, heavy metals, and other toxicants from highly polluted waters.

3) Spreading of pathogens and pollutants

A shrimp farm effluent contains a large amount of organic materials, hydrocarbons, various heavy metals, and pesticides. Microbial contamination of shrimps with *Vibrio, Salmonella* and more recently viruses like IHHNB, WSBV etc. are common. Though the zoonosis has not been confirmed, still they affect other culturable organisms present. This can only be curbed by bioremediation, biofiltration, effluent treatment, and application of probiotics.

4) By catch waste

It is alarming to note that the availability of brood stock (especially *Penaeus mondon*) along the east coast of India fall to a minimum level over the years. Naturally the shift towards wild collection of post larvae is inevitable as the induced breeding of pond-reared brood is remote possibility. The high demand of post larvae, owing to shut down of hatcheries or high price has already resulted in gearing of wild seed collection activity. As we know, the process wastes a lot of trash and it destabilizes the natural balance among the population. It is

estimated that 10 Kg of fish and shrimp larvae are killed during the collection of 1 Kg of tiger shrimp post larvae in Sunderbanas of west Bengal (Silas, 1978). Similarly, BOBP (1990) reports that up to 5,000 post larvae of other fishes and shrimps are killed for every 100 marketable post larvae. Serious attention must be paid to proper brood stock development and production of hatchery-bred seed.

FAO guidelines

Taking cognizance of all these facts, several countries met in Mexico (1992) to formulate a draft national policy for Sustainable Aquaculture for ensuing century. The FAO (1991) proposal regarding "Sustainable Development" avoided all types of ambiguities concerning the scope and the limit of the term. It says that sustainable development is "the management and conservation of the natural resource base, and the orientation of the technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable." Though the definition is originally coined for agriculture in particular, is considered fit for aquaculture system as well. That restraint is a must for sustainability of production is unequivocally accepted. This International Conference on Responsible Fishing has given clear concept, which can be incorporated in national laws and regulations. Once implemented these can be used as legal instrument while dealing with unscrupulous, the defaulting entrepreneurs or errant aquaculturists. It remains to

be seen, how the rules can be imposed with a minimum time frame. In the declaration it has also been clearly mentioned that, the laws can be modified without eroding the prime objectives, to suit the diversity of natural, social, and economic conditions and aquaculture system. Let us examine the draft of the preliminary principles for responsible aquaculture in Indian context. The generalized concept is that:

Part I

With an aim to promote responsible development and management of aquaculture, states should agree in principle to:

a) Creation of an appropriate administrative and legal framework for aquaculture. The Indian government and the policy planners have already mooted the idea to create a separate aquaculture authority under agriculture ministry. Complicated issues like property rights of water bodies, which is in a fluid state now can be amicably solved by impositions of said rules, and also penalization of rule breakers.

b) Strengthening research and development activities to develop eco-friendly packages. Since, we have not made any substantial break through in some burning issue, say disease problem in shrimp aquaculture, development of a model farm with acceptable engineering structure, effluent treatment system etc is need of the hour. A lot of research is required in these areas. Foreign collaboration for joint research is also an urgent need at this juncture. Specialized laboratory with sufficient expertise are to be set up for intensifying problem-oriented research on war footing basis.

c) Establish procedures to study the environmental impact assessment and regular monitoring to minimize adverse ecological changes resulting from water extraction, effluent discharge, indiscriminate use of drugs and chemicals and all other farming activities. This is an area which is has not been given due attention due to lackadaisical attitude of aquaculturists. No proper guidelines exist as far as threshold values of pollutants are concerned. Estimates showed that the pollutant levels arising out of commercial aquaculture outweighed by sewage and industrial effluents. Environmentalists and aquaculturists backed by poor community are at loggerheads. The psychological warfare has to be brought an end, if the industry is to sustain at all.

d) Development of candidate brood stock for culture through modern genetic tools, proper prophylaxis and quarantine methods before transportation of brood stock, fish larvae, egg etc. This is largely unattended to partly due to lack of stricter rules and ignorance. It has been seen that diseases of epidemic proportion mainly hijacked from outer areas and reached the catastrophic proportion within a short period.

Part II

a) The draft policy also recommend to protect international seas, rivers and lakes there by preserving the living resources through i) planned management procedures, ii) knowledge dissemination and data sharing from national, regional and global level, iii) through co-oriented research programme, exchange of knowledge and technical assistance on aquaculture systems, iv) encouraging regional trade in equipment,

feed, drugs, and technologies, v) preventing the extinction of genetic resources of endangered species through stock manipulation there by conserving the genetic diversity. Here we must pay enough attention to unrestrained introduction of the exotic species. The case of Thai magur, *Clarias gariepinus* is a recent menace to Indian aquatic system. Our earlier experience with some of the exotic species tilapia, silver carp in reservoirs is disappointing. As far as Thai magur is concerned farmers can be easily lured by its rapid growth, suitable steps are to be taken before it establish in our natural aquatic systems.

b) As the proverb goes “charity begins at home” the process should start from the grass root level by undertaking efforts to I) involvement of traditional and artisan fishermen, farming communities in management practices, ii) careful selection of feed with significant tilt towards natural one with limited, choiced feed additives, iii) successful application of natural manure and restriction of fertilizers, iv) use of modern technologies like application of hormones, antibiotics and other medicines after proper counseling preferably on the strict vigil of an expert, v) efficient post harvest handling, development of on site processing, in-storage and quick transportation of the products, vi) promote the use of appropriate procedures for brood stock selection and seed production.

Recommendations/Suggestions for the responsible aquaculture

1) Development of a separate aquaculture authority of India with a good representation of environmentalists, scientists, policy planners, and aquaculturists.

2) A separate Aquaculture authority of India already established and the authority made the following guidelines for adopting an integrated approach towards sustainable aquaculture:
    - Low stocking density should be aimed at the production of 2.0-4.0 tones/ha in two crops
    - Aquaculture farms should be located away from agricultural lands and mangrove areas
    - Fish farm above 5.0 ha should be provided with the facilities for waste treatment
    - Beneficial microbes in the form of probiotics should be used to reduce the load of pathogens
    - Feed quality and feeding techniques reduce nutrient enrichment by the use of high-energy diets and extended diets should be improved. Also, it is wise to practice semi-intensive farming coupled with the use of low pollution feed.
    - The count of fecal coliforms in the pond water should be less than 103/100 ml, in order to make fish microbiologically safe for human consumption.
    - Use of biodegradable pesticide should be encouraged.
    - Remote sensing should be used for identification of potential aquaculture sites.
    - A buffer zone of freshwater must be provided in the aqua farm in order to avoid ecosystem damage in the neighboring areas.

- Beneficial co-existence of coastal aquaculture and agriculture should be promoted by the use of rotational system of rice- fish or rice -shrimp culture.
- Low cost fish farming integrated with livestock should be promoted.

3) Designing of models with special specifications pertaining to the carrying capacity of coastal environment will come a long way for stocking below the carrying capacity there by reducing the pressure on ecosystem.

4) Encouragement of traditional farming practice necessarily with modifications help augmenting participatory farming at local level. An area which has been unlooked for till date is government initiative to encourage farm practicing eco-friendly traditional technologies such as effluent treatment, optimization of culture inputs etc. Government tax initiatives and export advice would certainly boost the moral of farming communities.

   It is observed that many of our research projects were formulated without identifying the pressing problem faced by the farmers of a particular locality. Therefore, the research results may not have direct use to the farmers. Therefore, before taking up of a research project, problem identification of that area is very important. Again, participation of farmers in formulating the research project is must. It is always advisable to collect all the indigenous technological knowledge available in the area so as to get a base line research.

5) Identification and monitoring of sensitive eco-system is another aspect of responsible aquaculture.

   Sensitive eco-system includes mangrove areas, bays, reservoirs etc. the mangrove act as a barrier to storm and wind erosion and above all a booming feeding and breeding ground of fishes. It is reported that between 27 and 50 % of the total mangrove areas have been destroyed for aquaculture activities in some countries in South East Asia. Any attempt to encroach these areas must be thwarted.

6) Shifting the aquaculture sites from productive agricultural lands to open sea, abundant water bodies, swamps, marshy areas etc. will open new avenues and encompass a broad spectrum of candidate species for culture. Culture of sea bass, *Lates calcarifer*, grey mullets, *Mugil cephalus*, Pearl spot, *Etroplus suratensis*, sand whiting, *Sillago sihama*, mud crab, *Scylla serrata* are species which can fill the void created by loss of shrimp farming.

7) Resorting to pen and cage culture in open sea area and relatively inaccessible other inland water bodies may prove successful if it followed deterministically.

8) Application of integrated farming approach wherever possible is better then mono-species culture.

   Integrated fish farming efficiently recycles all the wastes from the animal, agricultural crops and related processing industries, resulting ultimately protein-rich food at considerable low investments. A farm integrating agriculture, horticulture,

fish culture, diary and poultry has become a popular model of farming in different parts of the world with varying degrees of success. The rationale behind raising fish on animal manure become apparent when it is found that 72-79 % of Nitrogen, 61-87 % of phosphorus and 81-92 % potassium in the diet ration fed to animals are recovered in their excreta. It is reported that the net profit on rice-fish integration system significantly higher than rice monoculture farm by a margin ranging from 7-65 %. It is also observed there is a 12-fold increase in economic benefits from integrated rice-fish systems combined with vegetable or fruit crops grown on the bunds, as compared with traditional rice farming.

9) In order to minimize risk of disease transfer, the adoption of appropriate practices for the genetic improvement of broodstock through selective breeding and gene manipulation, production of healthy egg and fry is necessary.

   A major aspect of concern in farm breeding programmes is with regard to inbreeding depression that has not taken care of by the fish farmers in our country. Indiscriminate use of hormones for breeding, production of mono sex population for somatic growth is an issue to be considered in the wake of intensifications of fish culture practices in recent years.

10) Protection of endangered species by suitable conservation measures.

   India has blessed with rich diversity of fish fauna of 2,200 species, which is about 11.0 % of the global fish faunal resources (about 20, 000 fish species) occurring in cold and warm waters, both freshwater and marine. It has been reported that out of

79 threatened species listed so far, 63 species belongs to freshwater (46 from warm and 17 from cold water). Species like *Ompok pabda*, *Ompok pabo, Tor mussullah* in warm water and *Gymnocypris biswasi* in cold water have become endangered. Therefore, there is an urgent appeal to all the aquaculturists to protect these endangered species, which are at the different degrees of extinction.

11) Protection of the interest of resource poor traditional fish farming community.

Many a times it is observed that the ultimate sufferers in the fisheries activities are the resource poor farmers. In fish farming, the middleman intervenes and gets maximum profit by purchasing the farm produce at the site itself in a reasonably low price. Therefore, the formation of fisherman cooperative societies and the suitable cold chain for the preservation of the perishable commodities like fish is of utmost important. Similarly, in capture fisheries, the mechanized fisherman encroaches the area meant for capturing the fish for the poor traditional fishermen and take the advantage. Therefore, a strict law is required which can be enforced strongly.

12) Efficient waste disposal mechanism is required to avoid environmental pollution.

India being an agrarian economic based country, a huge amount of agricultural waste is produced from the processing industry which can be judiciously used as feed and fertilizer after they are suitably processed by biological/mechanical means.

13) A suitable regulatory mechanism governing the introduction of the exotic species.

Over 300 exotic varieties have been introduced to the country so of which most of them are ornamental fishes. Among the species introduced, while a few have proved to be a boon the aquaculture the accidental or deliberate introduction of some other had caused havoc to the aquatic environment. The tilapia, *Oreochromis mossambicus* which was introduced in the country during 1952 found to be adversely affect the growth of carp in polyculture system but also eliminated were other fishes including Gangetic carps in a number of reservoirs. In Jaisalmand Lake of Rajasthan not only resulted in reduction of average weight of major carp, but also pose a threat to species like mahseer (*Tor tor* and *Tor putitora*) which are in the verge of extinction. The silver carp, *Hypophthalmichthys molitrix* was introduced in India in 1959 which is accidentally introduced in the Govind Sagar reservoir drastically reduced the fishery of the native *Catla catla* and *Tor putitora*. The African catfish, *Clarias gariepineus* is another exotic catfish, which has made its way in to the Indian water through Bangladesh and now established in all part of our country. As they are very large in size and are highly cannibalistic in nature, it could be disastrous when they find entry to the neighbouring pond and any open water like major riverine and reservoir systems.

14) Use of technologies and procedures, which improve quality and quantity of aquaculture products and conserve the ecosystem.

15) Recycling the agro-waste as feed and fertilizer for fish culture and in turn production of animal protein and economic gain.

In terms of solid wastes, the agro-waste amounting to 321 million metric tones per year are available in the country. Bioconversion of these lignocellulose wastes can be applied to fishponds as manures/feed which process also results in usable products like single cell protein and biogas. There is also 10,000 million litres of spent wash available from the 150 distilleries, which can be used in the fishponds after biomethanation process.

16) Use of high quality feed to reduce the organic load in culture system.

The major impacts of feed and feeding technique used in intensive aquaculture consist of hypernutrification. The most important pollutant being the nutrient which normally limit the primary productivity, namely inorganic phosphate and nitrogen. It is reported that about 80 and 90 % of the nitrogen and phosphorus inputs of the feeds, respectively are not utilized by the cultured organism as a result are wasted which in turn pollute water.

17) Culture of low-valued fish which is affordable to poor men of our society should be given priority. Otherwise the poor people of our society may be devoid of consuming the highly nutritious animal protein. Very little attention has been given to estimate level of consumption and wastage of feed supplements when provided in moist form. Moist feeds, besides polluting environment poses the risk of disease transfer through unprocessed animal ingredients.

18) More awareness about the culture practices, culture species, and environment protection.

The successful culture practices, the economic candidate species along with their impact on culture system should be popularized in order to get economic gain and also to conserve the nature.

19) Declaration of closed season in capture fisheries, sanctuaries to a particular areas for a particular species, regulation of mesh size, recruitment of depleted stock by aquaranching etc may be followed for balancing the ecosystem and to conserve the natural stock from extinction.

20) Use of chemicals, fertilizers and medicines which are biodegradable and do not have the bio-accumulative properties in fish muscle and soil. Use of organopesticide must be banned. These chemicals not only kill the beneficial microorganism but also result developing drug resistant microorganism.

About 44 kinds of pesticides are in use in our country. The average consumption of pesticides in our country increased from 3.2 g/ha in 1954-55 to over 400 g/ha in 2000. In Andhrapradesh alone consumed 25,000 tones of pesticides and insecticides for agriculture purpose. It is polluting the major water system due to surface run-off which is used for aquaculture purpose. It is estimated that by the turn of century the demand for the pesticides will be 200,000 tones. Among the pesticides used , organochlorine & carbamates are most toxic. They persist in soil and water for long

time. For example DDT & DDD have half-life of 10-14 years. Some pesticides such as DDT &BHC even at very low concentrations have been found to be biomagnified by aquatic food chain which resulted in large accumulation of these chemicals in fish tissues.

21) Finally, the industry has to tackle the initial problems tactfully before being matured as established industry. To cope the all time demand suitable market structure, product distribution, value-addition etc solve many an impending hurdle and help it to emerge successful.

22) State should establish, maintain, & develop an appropriate legal & administrative framework which facilitates the development of responsible aquaculture. To promote responsible fisheries development impact of aquaculture project on the effect of genetic diversity and ecosystem of a particular area must be thoroughly studied in advance based on the available scientific information and expertise. State should respect their responsible aquaculture practices within their national jurisdiction. If necessary to ensure the aquaculture development ecologically sustainable, state should produce and regularly update aquaculture development strategy and plan.

23) Fish quarantine measures should be strictly followed while importing fish species to our country.

Till now for quarantine & certification procedures does not exist in our country .So fish imported from other country straight way released to the importer, which may cause serious problem in disease spreading if any present in the imported fish.

CONCLUSION

In India, about 80,000 ha of coastal lands are currently under shrimp culture practices and additional areas of 1,22,000 ha have now been identified for farming in future. Bacterial pathogens like *Vibrio, Pseudomonas, Aeromonas* and *Corynebacterium* have contributed to the generic composition of the bacterial colonies isolated from water and sediment samples. Industry should comply with the regulations and any denial of environment protection will not be in the favour of the industry in the long run.

Scientifically, mangrove areas are not always conducive for shrimp farm, thanks to its high organic load and acidic properties. Again, mangrove forest and wetlands are highly efficient in enhancing the removal of solids and nutrients from aquaculture effluents. It can be meaningfully converted to acts a treatment zone for aquaculture effluents. So mangrove reforestation and wetland preservation are two aspects which every aquaculturist are like to practice. It is in the benefit of aquaculturist to dilute the farm affluent before allowing it to the open water bodies, as most farms in take and out put water resources are one and the same. Reduction of the nutrient loads is innocuous and assimilates to open water bodies.

The commonly used chemicals like liming materials, zeolite and chlorine are not bioaccumulative and proved to be non-toxic. The use of objectionable chemicals like different antibiotics, enzyme products, bacterial amendments are still doubtful. We can

simply go without it and preferably go for different probiotic treatments. Antibiotic therapy should be the last resort of an aquaculturist while fighting to curb the bacterial pathogen. Government can restrict their use by promulgating standard rules and regulations.

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