of the available potential water area. The semi-intensive culture can result in promising production levels of 4 to 6 t/ha in a crop of 4-5 months. The growth of the sector however was hindered subsequently by several factors including the regulation of farming in the CRZ, white spot disease and the depressions in export market. However, the industry has made certain modifications in pond management like moderate stocking densities, good farm management and health management to control the disease outbreaks and mass mortalities. With respect to species diversification, no other species has come up as a potential species in the culture systems. Culture of crab species say *Scylla serrata* and *S. tranquebarica* is also taken up by some entrepreneurs. Finfish species viz., *Mugil cephalus, Liza parsia, L. macrolepis, L. tade, Chanos chanos, Lates calcarifer, Etroplus suratensis* and *Epinephelus tauvina* are identified as potential candidates for farming in coastal regions. Nevertheless, the farming has been restricted only to the seabass, *Lates calcarifer* due to issues in the availability of technology for seed production and farming.

Successful breeding of cobia, *Rachycentron canadum* and silver pompano, *Trachinotus blochii* has been achieved recently at CMFRI. These experimental trials should be focused further for diversifying the culture practices. In this line, the coastal cage culture trials are now initiated with cobia, seabass, silver pompano, groupers, red snapper, breams, lobsters and mussels and showed encouraging results. The efforts on technology development for mariculture over last three decades have led to development of technologies for farming of mussels, oysters, seaweeds and crab and lobster fattening. With the rack, longline and raft culture technologies for green mussel, *Perna viridis* and brown mussel, *P. indica*, the cultured mussel production of the country has increased from about 20 tonnes in 1996 to around 20,000 tonnes in 2011. Further, the farming of edible oyster, *Crassostrea madrasensis* has shown high growth potential in recent years. These technologies can be strengthened and transferred to different coastal regions of the country to augment the coastal fish production and to provide the livelihood security to the coastal people.

6. Sustainability and Biodiversity Issues In Aquaculture

Aquaculture is also under public scrutiny because of its possible impacts on biodiversity. The critical aspect seems to be the exploitation of wild populations for culture operations as well as on the negative impact caused by cultured animals on the environment. Aquaculture is very much essential in the coming future to provide fish protein for ascertaining food security, to ensure socio-economic wellbeing through the generation of livelihood opportunities. However, we may have to consider the aspects of aquaculture that are expected to affect the biodiversity and their quantification in terms of impact. In the initial phases of aquaculture sector, there was a greater dependence on wild seeds of fish, especially for shrimp and marine finfish culture. This have resulted in a high degree of loss of biodiversity through the overexploitation of larval stages of undesired species as well as diminished the recruitment to capture fisheries. With the development of artificial propagation techniques for most of the major cultured species, the dependence on wild stock has reduced. On the other hand, the artificial methods were promised to augment conservation of depleted species. The development and commercialization of the artificial propagation technologies of the candidate species would be rather an adequate solution to all these problems.

7. Planning and Policies

Indian aquaculture has emerged with less scientific input and is also lacking promising inputs in terms of seed, feed, health management and marketing support. To optimize production from aquaculture, the programmes should be focused to improve commercial production and supply of quality seed and feed, management of culture environment and efficient utilisation of available water resource for culture. The miserable performance of FFDAs and Brackish water Fish Farmer's Development Agencies (BFFDAs) and inefficient extension methods has reduced the expected output from aquaculture. Therefore, these two field-level agencies have combined to form a single unit called as Fisheries and Aquaculture Development Agency (FADA). This agency is anticipated to modulate the fishery extension system and undertake extension of new technologies, promote networking among farmers and fishermen. This unit can also act as link between farmers and developmental agencies such as the Krishi Vigyan Kendras (KVKs) and the Agriculture Technology Management Agencies (ATMA). The Centrally Sponsored Scheme on 'Development of inland fisheries and aquaculture' during the Eleventh Plan was aimed at enhancing inland fish production, creation of employment opportunities, diversification of aquaculture practices, provide hands on training to farmers through the FFDAs and BFFDAs. As a result of this scheme during this period there was a significant improvement in the area brought under fish cultivation and training for farmers.

The treatment of aquaculture on par with agriculture must be the first concern while developing policies. This will help the aquaculture farmers to avail the benefits of taxation, water and power tariff, allocation of resources, leasing of water bodies for aquaculture and mariculture purposes, etc. Inland fisheries and aquaculture bill can be focused on the sustainable development of the sector. To achieve the targeted production of 11.58 mmt during the Twelfth Five Year Plan period, an amount of Rs. 6000 crores is required for HRD, institutional strengthening, policy reforms and overall improvement in the management and governance aspects. The improvement of production from freshwater, brackish water and coastal waters is necessary for achieving the targeted production. Some of the measures recommended for the sector wise development of aquaculture are the following

1) **Fresh water aquaculture: The fish food security of the country in future lies in the augmentation of fresh water aquaculture. A growth rate of 8% per year is expected which will supply 7.5 mmt of fish to the country. We should focus on the following points for achieving this target.**
   - Utilisation of more water area under ponds and tanks for aquaculture and increase the area availability through reclamation of weed choked waters.

- Diversification of species and diversification of farming systems such as integrated farming, ornamental fish culture and waste water aquaculture.
- Customized cold chains for marketing support
- Public private partnerships for culture operations and marketing the fish

2) **Mariculture: Expected production in 2020- 0.2 mmt. We should focus on the following aspects to achieve the same.**
   - Identification of suitable culture sites and appropriate leasing policy
   - Brood bank and hatchery facilities for high value fish and shellfish, ornamental fish and sea weeds
   - Cage culture in open seas and island ecosystems through public-private partnerships and effective market linkages
3) **Coastal aquaculture: Expected production in 2020- 0.3 mmt. The focus should be on following points.**
   - Increased area utilisation for culture through species diversification
   - Adequate quantity of quality seed and feed
   - Inland saline aquaculture for selected candidate species
   - Public private partnerships and market linkages

8. Conclusion

Increased demand for food grains and protein will cause a price hike in a country like India, where population is quite high. Aquaculture can undoubtedly serve as a cheap protein source of fish in the future to feed the 1.5 billion people. The different sectors of aquaculture have to be strengthened in demand based manner to approach the target levels of production. India can play a major role in the production and distribution of the farmed fish around the world. The planet will have a reduced space for farming in the coming future. The vertical and horizontal expansion of the farming practices including the IMTA (Integrated Multi Trophic Aquaculture) should be initiated without compromising the biodiversity and germplasm. The strategies can be increased area utilization, improved status of feed, seed and supplements, Institutional strengthening, demand based production, disease control and surveillance, species diversification, efficient utilization of water resource, generation of database on cultivable areas and species, creation of demand for domestic and export markets, diversification of the culture practices, utilization under-utilized areas like inland saline waters, proper policy options for the management and the initiation of public-private partnerships. The future demand can be met sustainably, if the aquaculture will go hand in hand with the environment. The focus for the future should be producing more per drop of water and within the spatial limits.

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