WIDENING PERSPECTIVES OF FISHERIES AND AQUACULTURE: LIMITS OF CARING, SUSTAINABLE LIVING AND GLOBAL CHALLENGES*

Dr. E. G. Silas
Former Vice Chancellor,
Kerala Agricultural University &
Managing Trustee, E.G. Silas Foundation
for Nature Conservation
37, Ambady Retreat,
Chilavanoor Road,
Kochi - 682020.
E-mail: silaseg@asianetindia.com

My association with Dr.T.V.R. Pillay dates back to 55 years when I first met him in Calcutta where he was carrying on researches at the All India Institute of Public Health. We had a common mentor, Dr. Sunder Lal Hora who was an abiding inspiration for all those who came to know him. Dr. Pillay's achievements are many, which chronologically speaking would take a considerable time. Suffice it to say that he had a personality of his own, a gentleman scientist, soft spoken, a good listener and a person of creative ideas who had the capacity to translate them into deeds. As a couple, Ramu and Sarojini had an outstanding innings at the CIFRI, Barrackpore. In the seventies and eighties, I had occasion to meet them at FAO Headquarters in Rome and they were always an acme of hospitality. Sarojini was a pillar of support to him in his career. Pillay's shift from capture fisheries to aquaculture which was in its infancy, led him onto pioneer many international innovative programmes, triggering long-lasting

*Pillay Memorial Lecture delivered at the College of Fisheries, Mangalore on 13th February 2006.

activities towards improving the lot of subsistence of fish farmers and the industry; recognizing the importance of the role of women in aquaculture and related issues and make critical appraisal and activate successfully programmes in a number of countries in five continents. I remember his stressing the importance of 'tilapia' the food fish of the future and shrimp was not his priority but fmfishes. He should have been the happiest person when Dr. M.V. Gupta and his colleagues developed "Gift tilapia'' through selective breeding.

Dr.Pillay had to face an uphill task in the then set up of FAO Fisheries Division which had a set mind in fostering capture fisheries, the potential of which was projected to be inexhaustible. In this scenario of the sixties, aquaculture appeared to be not of much consequence until the collapse of the Peruvian anchovietta fishery in 1972 due to the *El nino* phenomena. The complex problems and limitations in the then stock assessment models and the importance of the role of environmental parameters became more evident. So also, the complexities connected with the highly multispecies fisheries in the Tropical Seas. However, the then projected growth in capture fisheries resulted in countries building up excess capacity which only helped to hasten the depletion or collapse of most of the commercially important fish stocks round the world. Global production has been stagnating around 80 to 90 million tonnes during the past few years with no prospects of increase from conventional resources. The major change that has taken place in capture fisheries is the realization of limitations in spite of the high hopes of enhancing production with the advent of the extended jurisdiction of the Exclusive Economic Zones (EEZ) of the UN Member Nations.

Today's challenge is an *Ecosystem approach to fisheries,* which could meet societal concerns about sustainability of capture fisheries and their environment. The implementation of such a holistic approach may take time, as at present we lack in information on bio-eco interactions, scientific assessment, appreciation of the need and compliance with fishery regulations, importance of protected areas or closed seasons, need for targeted fishery for specific resources, confused or conflicting objectives, insufficient co-ordination and collaboration between organizations in charge of fisheries and environment management at the National and State levels, lack of consensus about eco-labelling, integration of fisheries in coastal area management, lack of political will to revise policies of an open entry system; and continue building up over capacity and fleet over capacity, despite dwindling resources, evaluate the relation between trade and environment *(e.g.,* on the role of WTO), and most importantly the potentially large socio-economic and political cost of such transitions.

Already fishing down the food web has become a reality. Over-fishing leads to unforeseen complexities in the food chain. A recent estimate is that there has been a drop of one trophic level in the Arabian Sea and about 0.5 in the Bay of Bengal. Such shortening of the food web could no doubt cause considerable disruption of the bio-ecosystem.

Indian Scenario:

There are clear indications of over fishing and depletion of traditional fishery resources in our seas and despite scientific evidence, we lack the will to face this issue objectively. Adding to the over-capacity has become a fashion with every five-year plan. Today the situation is as follows:

On Excess Capacity:

The excess capacity should be over and above the optimum fleet size. The estimate of the excess capacity on CMFRI data shows the following:

Type of Fishing	Total Production (lakh tonnes)	Percentage of Production	Excess capacity*
Non-mechanized	1.82	7% (77,000 units)	62%
Motorized Sector	6.20	24% (5 1,000 boats)	71%
Mechanized Sector	17.40	69% (49,000 boats)	61%

***This is based on 1998 data; Fleet optimum is estimated to be 39%**

While modalities of how to define excess capacity, fleet size and related aspects may have to be looked into more critically, the situation is disturbing. The picture is one of a virtual stagnation in the marine fish production in the country during the last few years:

Year	Total Production (million tonnes)
2001	2.29
2002	2.59
2003	2.58
2004	2.54
2005	Expected to decline further

Source: CMFRI

STATEW1SE - SOME TRENDS

Gujarat~~h~~

Year	Production (lakh tones)	Remarks
1998	7.3	**99%**
2000	6.8	**mechanized**
2004	4.1	

Source: CMFRI

Maharashtra

Year	Production (lakh tones)	Remarks
2002	4.5	95-99% mechanized; decline in Bombay Duck,
2003	3.0 *	Pcnacid & non- pcnaeid prawns

Source: CMFRI

Tamil Nadu & Keraia

> No. of units operating after 2000 has gone down in Tamil Nadu.

> There has been a decline in both States after the December 26, 2004 Tsunami.

#|

These are just the tip of the iceberg. Below this, there are several undercurrents, which I do not wish to elaborate in detail. However, some significant issues are:

* The catch per unit may show an increasing trend, while the catch per hour e.g. in Keraia has shown a drastic decline from 90 kg/hr in 1986 to 45 kg/hr in 2004. The effort, which was 5-6 hrs/day, has grown up to I 3-14 hrs/day due to longer fishing trips. The result is less number of boats and less catch especially from the traditional fishing areas. More of the deeper water 'kalava' and Velamcen' are landed by the mechanized sector. This in a way indicates severe scarcity of traditional conventional resources in the coastal waters.

We have yet to have legislative approval of a National Fisheries Policy, so also the passage of an Aquaculture Bill. The existing Marine Fishery Regulation Act and other instruments in vogue lack adequacy especially in the light of the sea change that is taking place in marine fisheries and coastal aquaculture. Governance of fisheries is in many hands, with several Central and State Ministries involved, but with hardly any linkage and co-ordination. Organizational imbalances lead to subjectivity and lop-sided decisions. So here lies a major malady, which is to be set right.

For long, terms such as, 'environment' and 'conservation' were taboo in fisheries and in a way, we are paying the price for this. Responsible stewardship is vital in making the fishery sustainable through proper legislation, regulations, monitoring, control, surveillance and effective enforcement for compliance and strong research support. This could help us avoid conflicts in the use of common resources among stakeholders; avoid environmental degradation and loss of habitats such as the mangrove ecosystem and consequent reduction in potential production. Viewed globally, it is estimated that 70% of commercial fisheries have declined, some to the point of no return and a few have collapsed. Conventional management strategies and modeling have failed in a large measure, so also quota systems, due to poor implementation and non-compliance of management strategies.

Before we have an "implosion11 it is urgent that a critical appraisal of the situation be made - a "Malady - Remedy analysis" to advice the concerned Slate Governments and the Government of India, the seriousness of the situation. There are no new frontiers to thread except the deeper waters of the continental shelf and continental slope and the oceanic squid and tuna resources. Let us look at the rate of attrition of our mechanized boats annually and the numbers to be replaced instead of going on adding to them.

An FAO estimate is that the larger fishing fleet of 100 GT or 24 meters LOA, which in 1990's totalled worldwide about 24,000, when nearly 6% was 30 yrs old. In 2004, about 35% (@ 8700 vessels) should be 30 years old and lo be decommissioned within /t the next 10 years, at an average of 870 vessels per year. Theoretically, this may come to the replacement of about 300 vessels per year, with a decrease of 600 larger than 100 GT size vessels per year. With modem technology, increased efficiency and skills, the fishing capacity is not expected to diminish and fishing down the food web of species of less value is going to continue.

Restoration of fish stocks to the pre -1990 levels by 2015 was the major decision taken at the ' World Summit on Sustainable Development - 2002' held in Johannesburg, South Africa, as industrialized fisheries are known to reduce the community biomass by 80% within 15 years of exploitation, especially the large predatory species of the coastal waters throughout the world oceans.

Hence, our public policies on such issues should be based on sound scientific basis. With the advent of Responsible Fishery and co-management, we could, through public policies improve or restore depleted stocks to sustainable levels, though this may be a herculian task needing co-operative effort at all levels. However, a note of caution - stock restoration efforts based on recent data alone may be misleading.

It is in the light of this scenario of capture fisheries that we have to view the vision of Dr. Pillay in laying the foundation for the global development of aquaculture through multidisciplinary research training and extension through a networking of countries such as the Latin American Regional Centre for Aquaculture (CERLA), the Network of Aquaculture Centre in Asia (NACA), African Regional Aquaculture Center (ARCA), the Caribbean Aquaculture Center, and so on, besides the National Centers. Aquaculture today is the fastest growing food production sector in the world and since 1970, the production has increased at an average compound rate of 9.2 percent as against 1.4 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems. (FAO 2002: State of the World Fisheries and Aquaculture (SOFIA) Rome, Italy).

Global production of Aquaculture:

An estimate in the 90's was that most aquaculture producers come from 181 species (*viz.*, 6 seaweeds, 43 molluscs, 27 crustaceans, and 105 finfishes. (Pullin, 1992). The last decade would have seen marginal increases. In 2000, the total aquaculture production stood at 46 million tonnes (10 million of aquatic plants) and excluding the latter valued at US $51 billion. The global production of food fish has increased by a factor of 2.5 between 1991 to 2000 (FAO: SOFIA). A strong link of the national centres to the Regional Centers and the upgradation of the skills of national level workers through the years have given a tremendous flip to the development of aquaculture. Pillay was the prime mover for the programme of action for strengthening and diversifying the support services for increased aquaculture production under Inter-regional UNDP/FAO Aquaculture Development Co-ordination Programmes (ADCP).

One of the great gifts that Dr. Pillay had was the ability to mobilize financial support from Donor's for the successful working of the Global Programmes that he initiated. This is a rare gift, as one has to be a savvy diplomat to do so, since requirements and conditions differ from country to country and regionally also. His focus was on the use of locally available food resources and the development of appropriate technologies for food manufacture and supply and the prevention and treatment of diseases of locally important species under culture. The integration of aquaculture with area development plans especially in the inland and coastal areas with allied sectors such as agriculture and forestry was one of the underlying principles of his approach to aquaculture development.

Future Prospects

Total Population size - Projected increase (in billions)

	Year					
	1990	2010	2030	2050	2070	2100
Developing Regions	4.149	6.097	8.167	9.859	10.897	10.980
Industrialized Regions	1.142	1.255	1.333	1.378	1.437	1.582
World Total	5.291	7.352	9.499	11.238	12.334	12.562

Source: Me Ncely *et al.*, 1995.

Status of World Fisheries & Aquaculture (in million tonnes)

	1990	2010	2030
Capture Fisheries	85.5	93.2	90.3
Aquaculture:			
Inland*	8.26	23.9	25.2
Marine*	4.13	15.9	16.7
Total*	12.39	39.8	41.9

Source: FAO. * plus Chinese figures considered separately by FAO

Indian Scenario (million tonnes)

Year	2000	2001	2002	2003	2004
Marine	2.69	2.32	2.59	2.88	2.54
Inland & Aquaculture	2.8	3.1	3.2	3.2	~

Source: CMFRI

Aquaculture in India (million tonnes)

	1984-85	1989-90	1994-95	2000 - 03
Yield from Aquaculture in India	0.51	1.0	1.8	2.6

Source: Pillai, N.G.K. *el cil.*, 2004

Future Scenario for World Fisheries & Aquaculture

Information		Simulation target year				
source	FAO	2010	2015	2020		2030
	statistics	SOFIA 2002	FAO study	SOFIA 2002	IFPRI study	SOFIA 2002[b]
Marine capture	86	87		87	~	87
Inland capture	9	6		6	—	6
Total capture	95	93	105	93	116	93
Aquaculture	36	53	74	70	54	83
Total production	131	146	179	163	170	176
Food fish production	96	120		138	130	150
Percentage used for food	73%	82%		85%	77%	85%
Non-food use	35	26		26	40	26

Note: All figures-other than percentages-arc in million tonnes and rounded.

Aquatic animals other than reptiles or mammals, excluding quantities reduced in fishmeal and oil.

Sources:

Based on latest statistics of the FAO Fishery Information, Data and Statistics Unit.

FAO. 2002. *The Stale of World Fisheries and AqitacidtWL' 2002. Rome.*

SOFIA - State of the World Fisheries and Aquacullure

FAO - UN Food and Agricultural Organization

IFPRI - International Food Policy Research Institute

Inland Aquaculture and the decade of "Water of Life":

We are in the decade of "Water of Life" for the period 2005 to 2015, but the threats to freshwater biodiversity and habitats are unprecedented. The protection of freshwater biodiversity is perhaps an ultimate conservation challenge and to become fully effective, it requires constant attention to upstream drainage network, the surrounding land, and the riparian zone and in the case of migrating aquatic organisms down stream reaches. 'However, today there is indiscriminate overexploitation; eutrophication; changes affecting drainage systems; pollution; destructive fishing and habitat loss. There is also the indiscriminate, uncontrolled and unregulated manner in which exotic species are being introduced for aquaculture. Large scale industrialized fish farming has many problems and conflicting situations worldwide; a large number of artificially reared fish escape into the wild from fish farms. This causes serious repercussions especially in the spread of contagious diseases; ecological interruptions with wild populations and "disruption of genetic structure of wild populations through introgression, genetic drift and unintentional change in selection regime" (Egidim *et ai,* 1991; Hinder *et al,* 1991; Heggberget *et al,* 1993 and Jonsson and Fleming 1993).

The challenges we face are great and restoration of natural habitats becomes a prime concern for restoring the biodiversity. Our inventory of species for inland critical areas is poor, though we have sanctuaries, reserves and protected areas for plants and animals. The aquatic ecosystems even in such areas have the least protection, and every summer, destructive fishing wipes out a considerable amount of the wild fish and other aquatic biota. Traditional conservation practices of maintaining sacred ponds; tanks and sacred groves should be fostered for the protection of the gene pool.

Human activities have significantly altered the global distributions of run off of rivers. An estimate speaks of an increase during the last 300 years, of about 20% base flow and decrease of 16% in surface run off as a result of human activities. Very significant is a 300% predicted increased in consumptive use of 18
water in irrigated agriculture over the next 300 years (Kelly, 1994).

All these are leading to loss of aquatic biodiversity at an alarming

821

rate in natural systems. An estimate is that 20% of freshwater species are already extinct due to human activities (Moyle and Leidy, 1992). The seriousness of such a loss should be viewed from the constraints we are faced with to evaluate the aquaculture potential of aquatic organisms. In addition, if things go like this, it will be difficult for fish breeders to locate and collect genetic material from healthy and relatively undisturbed wild populations. This also calls for the proper documentation of wild genetic resources, but we are faced with a paucity of good taxonomists. Commendable are the works of the World Fish Center and the FAO in developing database such as 'Fish Base' 'Reef Base' and so on. In India, the NBFGR has brought out inventories of the fish genetic resources along the Western Ghats and North East India.

It is in this context of "Water of Life" that Dr.M.S.Swaminathan's plea for a National Aquarian, Policy gains importance. In fact, a draft Aquarian Policy for the State of Tamil Nadu has already been completed.

Ornamental Fishes:

An estimate is that 1.5 billion ornamental fish are traded yearly with a retail value of about US $ 6 Billion. The entire industry including accessories is estimated to be worth about US $ 14 Billion.

Total dependence on wild stocks in this trade, whether freshwater or marine will rapidly deplete or wipe out the resources. Today the models are countries such as Singapore which is the hub of ornamental fish trade and Malaysia which has more than 1000/ 450 farms covering 1OOO ha with farm size ranging from 0.10 to 40 ha each and directly employing more than 5000 people. Singapore has 64 farms covering 133 ha as well as Agro-technology parks. In these and in most countries licensing for even selling ornamental fish, quarantine protocols and compliance with regulations and inspections at all stages in the culture and trade are routine. This is something, which we will have to emulate. Coordinated action in knowledge sharing of Ornamental Fish Research & Development (R&D) activities and support service are very essential if we are to build up an ornamental fish sector and expect it to grow further from its Rs.41 million level of export trade of today. The domestic market for ornamentals is also steadily growing.

Genetics in Ornamentals:

The increasing world demand for ornamental fish has opened the market for new varieties with novel shapes or colors, which can be supplied using transgenics. Transgenic ornamental fish popularly called as "glow fish", harbouring fluorescent genes isolated from jellyfish has recently opened new possibilities for producing new multi-coloured fluorescent fish. Clearly, this approach vastly increases the scope of possibilities and is more satisfactory than the injection of dyes or selective breeding, which are the two methods currently used to widen the availability of phenotypes. The 'green fluorescent protein' (GFP) gene is a novel gene isolated from a jelly fish *(Aequorea victoria)* and is most commonly used as a reporter gene. More recently, a new fluorescent protein cDNA encoding a 'red fluorescent protein' (RFP or dsRed) has been cloned from the Indo-Pacific sea anemone relative *(Discosoma* sp.).

The viability of genes encoding additional fluorescent proteins, such as blue (BFP), yellow/golden (YFP), red (RFP) and cyan (CFP), has enabled the production of green, blue, yellow, red or cyan fish in an almost endless variety of combinations. Because these fluorescent proteins can be observed in live biological samples for labeling cells and sub-cellular organelles, these fluorescent proteins have been aptly termed "living colors". These transgenic fish display vivid fluorescent colors that are readily visible to unaided eyes. This innovation has been taken up by many laboratories, in which novel coloured fish are being successfully produced using the florescent color-encoding genes fused to a number of tissue specific promoters. In addition, multi-coloured transgenic zebra fish were produced, showing green colouration in the skin and red in the skeletal muscles and so on. Such an approach, combined with selective breeding between fish carrying these different transgenics, could produce a wide array of multi-coloured fish in future generations.

This will have immense potential in Indian scenario, as the Lakshadweep, Gulf of Mannar, Andaman & Nicobar Islands, the

Western Ghats and North-Eastern Hills of India are reported to be the gold mines of ornamental fish varieties. Fluorescent protein genes can be introduced into less expensive and commonly available other native species such as clown fishes, glassfishes, *Puntius* spp. and *Mystus* spp. and freshwater crustaceans for value addition.

Capture based culture fisheries:

This is mainly concerned with the on growing or fattening of selected high value species such as Lobsters, Crabs, Tunas, Groupers, eels, yellowtail and so on where wild caught seed or early juveniles are used. This can be considered only as a transitional phase to aquaculture; a system that could be phased out once hatchery production and domestication becomes possible. Removal of juveniles from the wild can lead to conflicts with local fishers.

Culturing high value predatory species in mariculture is expensive; especially their feed and open sea site management issues and conflicts that may arise with coastal fishers and other users of the inshore waters. Hence, capture based culture fisheries in estuarine and coastal water need a whole set of regulations, licensing and zoning, all to be linked with Costal Zone Management. 1 am glad to say that Government of India has sanctioned substantial funds for taking up open sea mariculture.

The introduction of non-indigenous species to the Indian Seas:

In a thought provoking paper, D.V. Subba Rao (2005) has shown that for the post - 1960 period, 205 non-indigenous taxa have been introduced into the Indian Ocean, mainly through shipping activity. The taxa include 21% fish, polychaeta (<11%), algae (10%), crustaceans (10%), mollusca (10%), ciliata (8%), fungi (7%), ascidians (6%) and minor invertebrates (17%). His concern that introduction of alien fish could pose a threat to the highly productive tropical coastal waters,estuarine and mariculture sites and cause economic impacts and "ecological surprises" needs a serious consideration. The strict enforcement of national quarantine regulations on ballast water discharges in keeping with the International Maritime Organization (IMO) guidelines and longterm multi-disciplinary research on ballast water invaders becomes important for enhancing our understanding of the biodiversity and functioning of the ecosystems. The Australian Ballast Water Management Council (ABWMAC) has developed a comprehensive programme in line with the guidelines of the International Maritime Organisation (IMO), which should be considered for application and at the same time develop ballast water research in the Indian Seas.

Food Safety Issues in Aquaculture and Environmental Certifications:

We should be aware of the risks associated with seafood consumption. Aquaculture and capture based aquaculture are subject to a wide spectrum of risks at all stages of production, harvesting, post-harvest processing, transportation and marketing which if properly managed with appropriate food safety standards should pose no problems. Education and training in food safety controls is a must as these are basic pre-requisites for Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) as well as implementing the Hazard Analysis and Critical Control Point (HACCP) principles. It is estimated that over 65 per cent of the total international fish trade is presently carried out under HACCP - based regulations. This also calls for the compliance with good aquacultural practices (e.g. non-use of antibiotics; feeds without toxic residues and heavy metals; pathogens; uncontaminated stocks etc.) and the commitment of the farmers and processors towards this. In the case of capture-based culture fisheries, the system should control production and delivery of the products, from day one when the fish are held in captivity to the time it reaches the consumer.

Today we look at quality assurances in the food we consume. Environmental Certification in Aquaculture is becoming more and more important and the earlier the aquaculturist is aware of this and abides by the necessary protocols, the better for him. Consumers even now can make a choice to reject or avoid purchasing products produced in an environmentally unsustainable manner.

Agenda 21 of the UN Conference on Environment and Development held in 1992 at Rio de Janeiro as well as the 2002

UN World Summit on Sustainable Development have triggered eco-labelling initiatives. The labelling of a product as "Environmentally Certified" is based on an assessment of its entire cycle, extrapolated both upstream and downstream and is dependent on a systems approach, e.g. Environmental Management Systems (EMS) to production, distribution and marketing (Ottolenghi *et al.*, 2004). The trend and magnitudes of the problems will be clear if the following quote directed to the private sector of aquaculture from an NGO, the Environment Defence Fund (EDF) is considered: "Organic Certification and potentially other eco-certification programmes should be established that empower consumers to choose aquaculture products grown in an environmentally sound manner" (www.edf.org).

Eco-labelling is gaining acceptance and the Aquaculture Certification Council (ACC) presently involved with shrimp and prawn, has developed a certification system based on an initiative from the producer organisation, the Global Aquaculture Alliance (GAA).

The ASH/FAO/UNESCO sponsored workshop on "Molecular Techniques in Aquaculture on Seafood Safety" being held in the UNESCO Microbial Resources Centre for Marine Biotechnology of this College where training is to be imparted starting today for participants from seven countries of the Asia-Pacific Region on "Molecular Techniques in Aquaculture on Seafood Safety" is testimony to the emerging importance of this subject area. This also reflects on the "Karunasagar Effect" in the excellence this College has attained in microbial or epidemiological research - a vital service to fisheries, aquaculture and seafood technology.

Fish Genetics:

The last decade has seen a considerable amount of work initiated and ongoing on fish genetics in a number of organisations in the country. The initiatives of Dr. Pandian and his colleagues at the Madurai Kamaraj University have received national acclaim. The NBFGR has taken up a wide spectrum of programmes, giving leadership to fish genetic research in the region. Despite all these, our application of genetics in aquaculture is in its infancy. Breeding through selection such as *Jayanti Rohu* is an achievement as it could enhance aquaculture production in both quantity and quality.

The subject area is very vast. I would like to specifically address few issues:

1. In Capture Fisheries, we are aware that when populations are depleted, the surviving population may loose a significant portion of its alleles, which may change the genetic constitution of the population drastically. The implications of the dramatic losses of alleles, though unclear at present, should be investigated as allelic diversity is important for an organism's potential to'survive and adapt to the changing environment (Ryman *et al.*, 1994). Loss of heterozygosity has been seen in our marine fish *Lactarius lactarius* and four other endangered # freshwater fishes *Horabagrus brachysoma, Puntius denisonii, Labeo dussumieri* and *Gonoproktopterus curmuca* from the Western Ghats watersheds investigated by the NBFGR.

2. We talk about ranching for enhancing natural fish stocks by releasing hatchery reared larvae and fingerlings. One study shows that results in genetic effect on conspecifics vary from no detectable effects to complete introgression (Hinder *et al.*, 1991). When genetic effects on performance traits have been detected, they appear always negative in comparison with unaffected populations.

3. Even in brood stock collected from local populations for hatchery purposes, the changed selection regime during rearing may change the genetic structure of the recipient population (Ryman *et al.*, 1980; Waples 1991).

Ex siti4 conservation and Gene Banking programme is underway at the NBFGR. Sperm cryopreservation, Tissue repository and Live Gene Banking are the main mode for the endangered fishes and commercially important fishes from the wild and from fish farms. As of now, eight endangered species of fish and seven commercially important species, four indigenous and three exotic have been investigated.

Bio-prospecting the marine biota for novel genes, bioactive molecules and products have been receiving considerable attention throughout the world. We have an Indo - US collaborative project on "Bioactive Substances from the Indian Ocean" resulting in over 450 extractions from marine organisms collected from the west and east coasts of India, the Lakshadweep and Andaman-Nicobar Islands and these have been evaluated for pharmacological, antibacterial, anitfungal, antiviral, antifertility, antiprotozoal, antihelminthic and hypoglycemic activities.

Both field and laboratory oriented prioritized researchable areas for marine bio-prospecting have been delineated and R & D programmes are underway in different organizations. New and exciting results are expected to arise from this.

I am mentioning these to emphasize the need for enlarging the scope of our work on fish genetics to also encompass problems that could arise in capture fisheries and aquaculture.

Change Agents:

I must conclude on a note of some of the positive actions that are taking place in our fisheries scenario, the type of which we would like others in the sector to emulate. Earlier I mentioned about the "Karunasagar Effect" which has helped to develop a center of excellence in Microbiology and Epidemiology in this college and make it an International Center for research, training and extension.

Another success story is the arduous efforts put in by Mrs. Krishna Srinath to enhance the role of women in fisheries through the organizations of self-help women groups in Kerala to take up post-harvest technologies and product development including preparation of shrimp feed and the like to improve the quality of life. She is a recipient of the NAGA Award and several other national level recognitions for her initiatives.

Tamil Nadu is witnessing a major upheaval in employment and income generation in coastal fisher communities in diversified activities. This is mainly through the initiatives of Dr. K. Sakthivel whose work among the grass root level has led to the formation of several self-help women groups for seaweed farming, especially the cultivation of *Kappaphycus* for carragenan in the Gulf of Mannar and Palk Bay. The significant aspect is convincing the State Bank of India to release a loan of Rs. 1.0 lakh per family of the self-help group without collateral security and a guaranteed buy back arrangement encompassing over 1000 families.

At the same time, Dr. Sakthivel has been promoting the hatchery technology of mud crab to propagate crab farming in the abandoned shrimp farms in Andhra Pradesh and Tamil Nadu and in FRP cages in Pulicat Lake. Here, he has been able to mobilize up to Rs. 1 lakh per family from the Indian Overseas Bank. Another thrust area has been his efforts to enhance the income of Panchayats in and around Chennai and adjacent Districts through stocking Panchayat and PWD tanks with scampi *(Macrobrachium rosenbergii)* and carp seed assisted by aqua farms. These are creating waves and making things visible with awareness buildup from grass-root level upward to technocrats, administrators, funding agencies and policy makers. Such holistic approach is needed for any work and success. I call this the "Sakthivel Effect".

What we need today is proven research results to be taken up for community programmes for a positive participatory mode and the industry. We can have scores of such "Effects" and latent potential of the same needs to be unearthed.

Knowledge is strength. Depth of knowledge and keeping abreast of changes and advances in ones own field of specialization is a basic pre-requisite for a researcher. Most subject areas are today closely linked, but many scientists still live in watertight compartments of their own world of thinking. There is need for more interdisciplinary work, information management and communication skills.

A rethinking is necessary and that has to start at the higher education level. A system of knowledge sharing, creativity and innovative thinking would lead to excellence. The TVR Pillay Foundation - Indian Chapter could play a synergistic role in diversifying and reorienting fisheries curricula and other participatory roles of societal concerns. The best tribute we can pay to late Dr.T.V.R. Pillay will be dedicated work to achieve food and ecological security for the nation and the livelihood security of the rural poor.

I wish the Foundation and its Indian Chapter, a very bright future.

Thank you.

References:

David Dudgeon, A.H. Arthington, M.O. Gessner, Zen - Ichiro Kawabata, D.J. Knowler, C. Leveque, R.J. Naiman, A.H. Prieur - Richard, D. Soto, M.L.J. Stiassny and C.A. Sullivan. 2005. Freshwater biodiversity: importance, threats, status and conservation challenges. Biol. Rev., 1 - 20. Cambridge Philosophical Soc. U.K.

Egidirn E., Jonsson B., and Naerdal G. 1991. Mutual impact of wild and cultured Atlantic Salmon in Norway. /. du Conseil International de /' Exploration de la $_{mar}$. 47:404-410.

Heggberget T.G., Johnson B.O., Hinder K., Jonsson B., Hamsen L.P., Hvidston N.A., and Jenson A.J. 1993. Interaction between wild and culturedl Atlantic Salmon: A review of the Norwegian Experiment. Fisheries Research. 18: 123 -146.

Hinder K., Ryman V., an Utter F. 1991. Genetic effects of cultural fish on natural fish populations. Canadian Journal of Fisheries & Aquatic Sciences, 48: 945 -957.

Jonsson B and Fleming I.A.1993. Enhancement of wild salmon populations. In : Sunder G. (ed) Human impact on self-recruiting population. Pp. 209 - 238. The Royal Norwegian Soc. Sci. & Lett. Foundation, Tapir Publishers, Trondheim, Norway.

Kelly K.I994. Out of Control: the rise of New-biological civilizations. Addison Wesley, Reading, Mass.

Leong C.W. 2006. The status of the ornamental fish industry in Malaysia. Pp. 19-21, In: Souvenir - International Seminar on Ornamental Fish Breeding, Farming and Trade. 05 - 06 February, Cochin, Kerala.

Moyle P.B. and Leidy L.D. 1992. Loss of Biodiversity in Aquaculture System: Evidence from Fish Farmers. In: Fielder P.L. and Jain S.K. (eds): Conservation Biology: Theory and Practice of Native Conservation, Preservation and Management. Pp.127 - 170. Chapman and Hall, New York.

Nerem, R.S. 1995: Global mean - sea level variations from TOPEX/POSEIDON altimeter data; Science, 268: 708 - 710.

Ottolenghi F., C. Silvestri, P. Giordano, A. Lovatelli and Michal B. New. 2004. Capture based Aquaculture. FAO Rome. 1 - 308.

Pillai N.G.K., Pradeep K. Kathia 2004. Evolution of Fisheries and Aquaculture in India. Published by ICAR, World Fish Centre, NCAP, CMFRI and CIFRI. -

Pullin R.S.V. 1992. Aquaculture and Biodiversity. Paper presented at the Centenary Symposium of the Port Erin Marine Biological Station, Isle of Man, U.K. 17- 18 Sept. 1992.

Ryman N. and Stahl .G. 1980. Genetic changes in hatchery stocks of brown trout (Salmo trutta). Canadian Journal of Fishery and Aquatic Science, 37: 82 - 87.

Ryman N., Utter F. and Laikre L. 1994. Protection of Aquatic Biodiversity. In: Voigtlander, C.W. (ed). The state of the world fisheries resources. Proceedings of the World Fisheries Congress, Plenary Session Athens, Greece. 3-8 May 1992: pp.92 - 115, Oxford & IBH. Publishing Co., New Delhi.

Singh Tarlochan and V.K. Dey. 2006.Trends in World Ornamental Fish Trade. Pp-09 -18, Souvenir - International Seminar on Ornamental Fish Breeding, Fanning and Trade. 05 - 06 February, Cochin, Kerala.

Subba Rao, D.V. 2005. Comprehensive review of the records of the biota of the Indian Seas and introduction of non-indigenous species. Aquatic Conservation: Mar Freshwater. Ecosystem, 15: 117 - 146.

Waples, R.S. 1991 Genetic interactions between hatchery and wild salmonids: Lessons from Pacific Northwest. Canadian Journal Fish & Aquatic Sciences. 48 (supplement 1): 124- 133.