Aquaculture and Environment Sustainability Issues

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- Fish play important role in food and nutrition
- Consumption of fish- unique health benefits
- Key element in healthy diet as source of high value protein
- as a unique source of essential omega3 fatty acid (EPA + DHA+ iodine)
- Development of brain and neural systems
- Found only in food from aquatic environment
- **Fish reduces heart disease by 36% (Toppe, 2012)**

Aquaculture,the fastest growing food production sector in the world

- Total fisheries production 142 million tons in 2008 (FAO, 2010)
- Cultured food fish supplies nearly 50 percent (Bartley, et.al., 2007)
- To increase to 60 percent by 2020 (FAO,2008)
- Aquaculture will supply most of the fish the people eat by 2030

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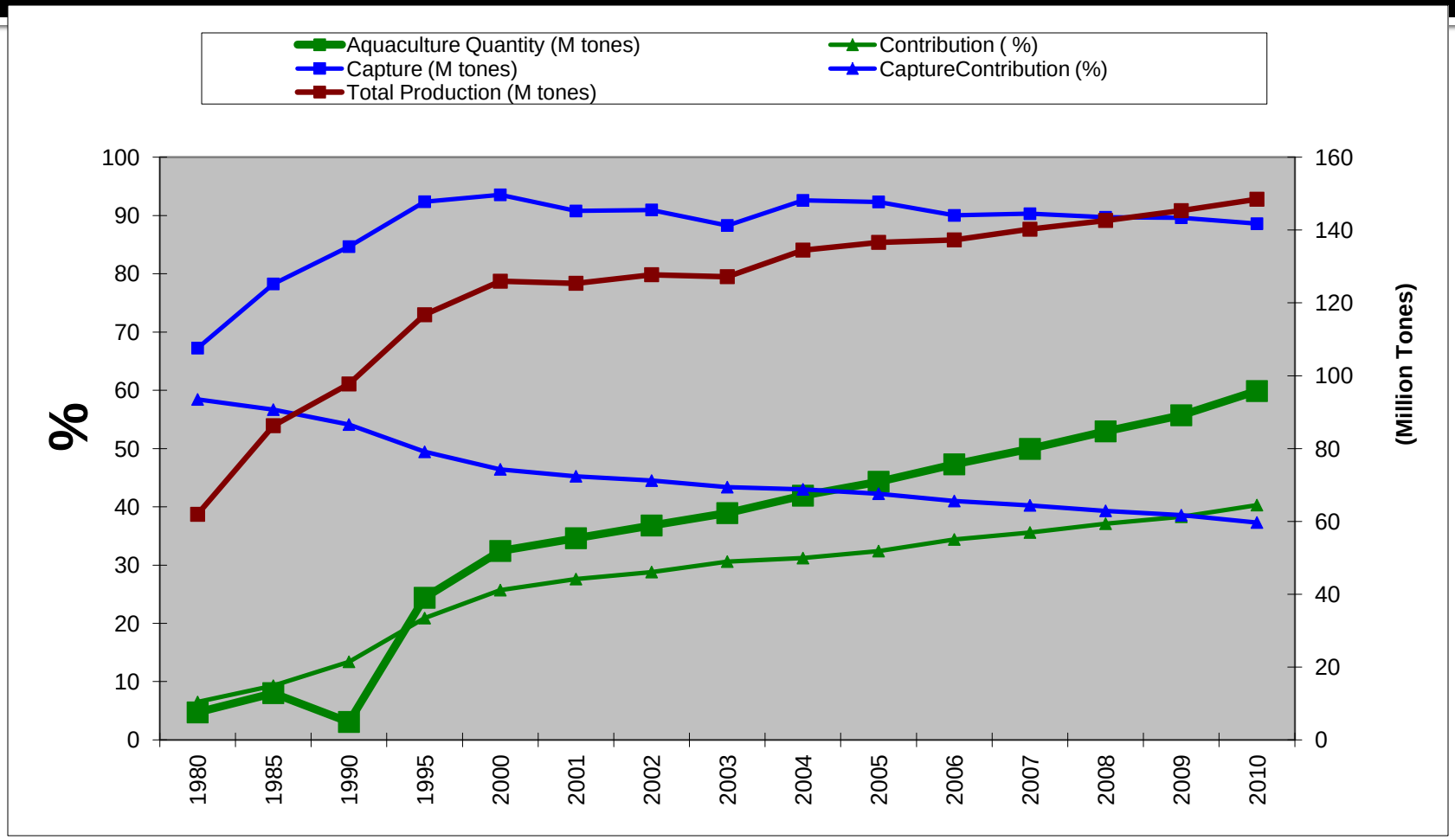
Aquaculture Quantity (M tones)
Capture (M tones)
Total Production (M tones)
Contribution (%)
CaptureContribution (%)
%
(Million Tones)
100
90
80
70
60
50
40
30
20
10
0
160
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Nutritional elements of farmed fish

		Salmon farmed	Salmon wild	carp	Tilapia	chicken	Ham
Protein	g/100g	20.4	19.8	17.5	20.1	18.6	20.3
Total lipid	g/100g	13.4	6.3	5.6	1.7	15.1	10.6
Water	g/100g	65	69	76	78	66	69
Ash	g/100g	1.1	2.5	1.5	0.9	0.8	1.1
DHA+ EPA	g/100g	1966	1436	350	91	40	3

Carps and tilapia has a lower level of essential amino acids compared to salmon but still be good sources of long chained omega fatty acids .A single meal of fish sufficient for several days requirement .Consuming 150 g will cover need for 3 days. Fish is a healthy alternative to any other means, chicken or ham . **A minimum of 250mg/g for adult and 150 mg /day of DHA+ EPA for children essential for optimum development of brain / neural development. F**armed fish has constant nutrient composition than wild fish at different periods of year, as access to feed varies .

WHO guidelines (FAO/ WHO 2011)

www.fao. Org./docrep/014/ba0136e/ba0136e00.pdf

- Consumption of any amount of fish has positive effects on health.
- Pregnant women and nursing mothers should eat enough fish
- No distinction between farmed or wild caught fish
- Farmed fish under controlled condition is a very good and healthy alternative to diets

Fish & Food Security

- Fish contribute to Food security :
- Mean per capita consumption of fish/ annum India : 8kg, China : 36.2.,UK 22.6., France, 31 kg., Korean Republic 52kg
- In Asia, 25 kg : However in island countries, Maldives as high as 190 kg
- In Kerala 18 kg per capita

to consume more fish

Changing food habits
consuming more aqua products

Japan 94kg of fish per capita/year

to consume more fish

Changing food habits
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India-Third largest producer of fish in the world

after China and Peru

- World population touched 7.0 billion in 2011
- In 2015, the world total consumption will be 6.5 % higher than today
- Increase in GDP- world fish consumption will increase to 19 kg per capita / annum in 2015
- Fish production will have to increase by 20% to satisfy the expected demand.

Impressive growth

- Annual per capita supply of food fish from aquaculture increased by 10 times,
- **0.7 kg in 1970 - 7.8 kg in 2008(6.6 percent per year (FAO, 2010).**
- Production from aquaculture increased at an average annual rate of 8.3 percent
- world population grew at an average of 1.6 percent per year

India-Fish through Aquaculture

- India (2010-11)
- Total Production : 8.03 mt of fish
- Inland fisheries : 5.1 mt (37.55 %)
- Aquaculture : 3.96 mt (80%)
- One out of two fish consumed is now cultured

Traditional aquaculture

- Traditional aquaculture in China and India, has been a low-tech affair involve a pond, use organic manures and agricultural byproducts as inputs
- Almost 80 % of the fish produced by aquaculture in such systems were **herbivores or omnivore species**
- Species mostly produced in **low density systems**
- Produced **for local consumption**
- Contributed **to alleviate nutritional deficiencies and poverty in rural areas.**

Change I - virtually revolutionized the freshwater aquaculture

- Technology of induced carp breeding
- Carp polyculture in ponds and tanks - turned the sector into a fast growing industry
- Over the years, culture practices undergone considerable intensification for obtaining high production
- Conventional farming - carp or diversified culture of freshwater prawns and to some extent catfishes
- Farming of giant river prawn (*Macrobrachium rosenbergii*) of high economic value- annual production of 30,000 tons monoculture
- AP dominated-86% (60% area) followed by WB.
- R & D and increased investment in fish and prawn hatcheries, establishment of aquaculture estates,feed mills and ancillary industries have all changed the state of affairs

- Induced Breeding (Chaudhuri and Alikunhi, 1957)

3 IMC , 3 EC

Change II . Integrated to Semi Intensive

- Brackish water farming in India age-old system *Bheris (*manmade impoundments) in coastal wetlands of West Bengal
- *Pokkali* rice fields of Kerala coast
- Salt resistant deepwater paddy is cultivated, with no additional input.
- The naturally entering juvenile fish and shrimp seed from the coastal seas have been sustaining production levels of 500-750 kg/ha/yr

Unplanned development of aquaculture-adverse impacts

- The *pokkali* fields- operated by farmers and fishers in most structured manner
- Lately in some places has given way for perennial high density shrimp culture - round the year.
- Virtually parts of *Pokkali* region
- **converted to biological desert with destruction of fresh water sources and decimation of plant cover**
- People demonstrated gross discontent - conflict and litigation
- Unplanned development of aquaculture - adverse impacts on environment

Preparation for sowing on mounds

Saline tolerant *Pokkali*


Fixing sluice – Prawn filtration
High saline phase

Indian Aquaculture- Rapid growth

- The contribution of fresh water aquaculture to inland fish production in India most outstanding

- Fresh water aquaculture contribution to inland fish increased sharply from 46.35% in 1984 to 80% in 2010
- Success stories of carp polyculture on commercial scale started in the Kolleru lake basin in AP mid 1980's
- Replicated in Punjab, Haryana, Uttar Pradesh, and elsewhere.
- **Aquaculture in India attained the status of an industry** increased employment opportunities

Slow growth -Kerala

- Kerala 10 percent of the coastline of India, supports over 20 % of the marine fish
- The state endowed with richest natural resources for inland fish production and aquaculture
- Contribute only 3% to total fish production in India
- Technology of carp culture adopted in Kerala in tune with the National agenda-grossly inappropriate.
- **predominantly acidic soil conditions, poor plankton productivity, reduced photosynthetic efficiency and low sunshine hours most part of the year owing to high rainfall**

Fish being fed on weeds *Eleocharis sp.*
A menacing weed in Kuttanad

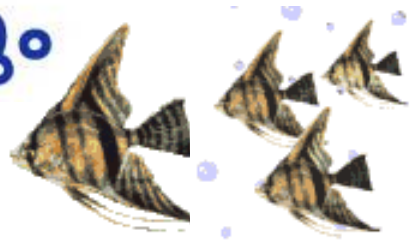
High Fish Yield 5.3 t/ha at no extra cost; 400 birds/ha

KAU, Kumarakom

Manure fed aquaculture
N : 0.34 mg/L
P : 0.05 mg/L

The Kumarakom Rice-Fish Farming Model

ഒരു നെല്ലും ഒരു മീനും



analogous to

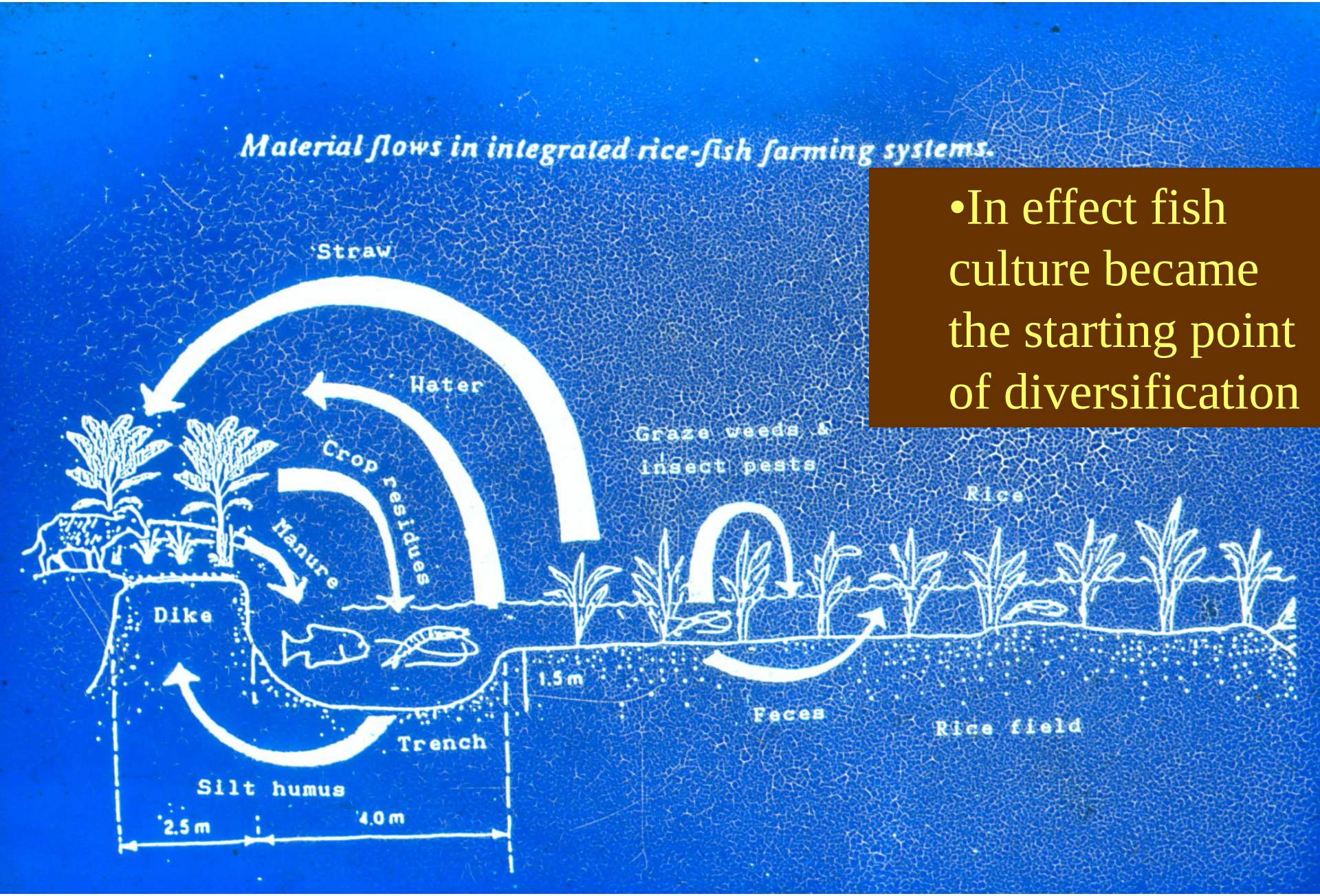
The Chinese Production model

Hundred Jin Fish Thousand Jin Rice

Strategic Intervention to Save

Our Vanishing Rice Lands!!

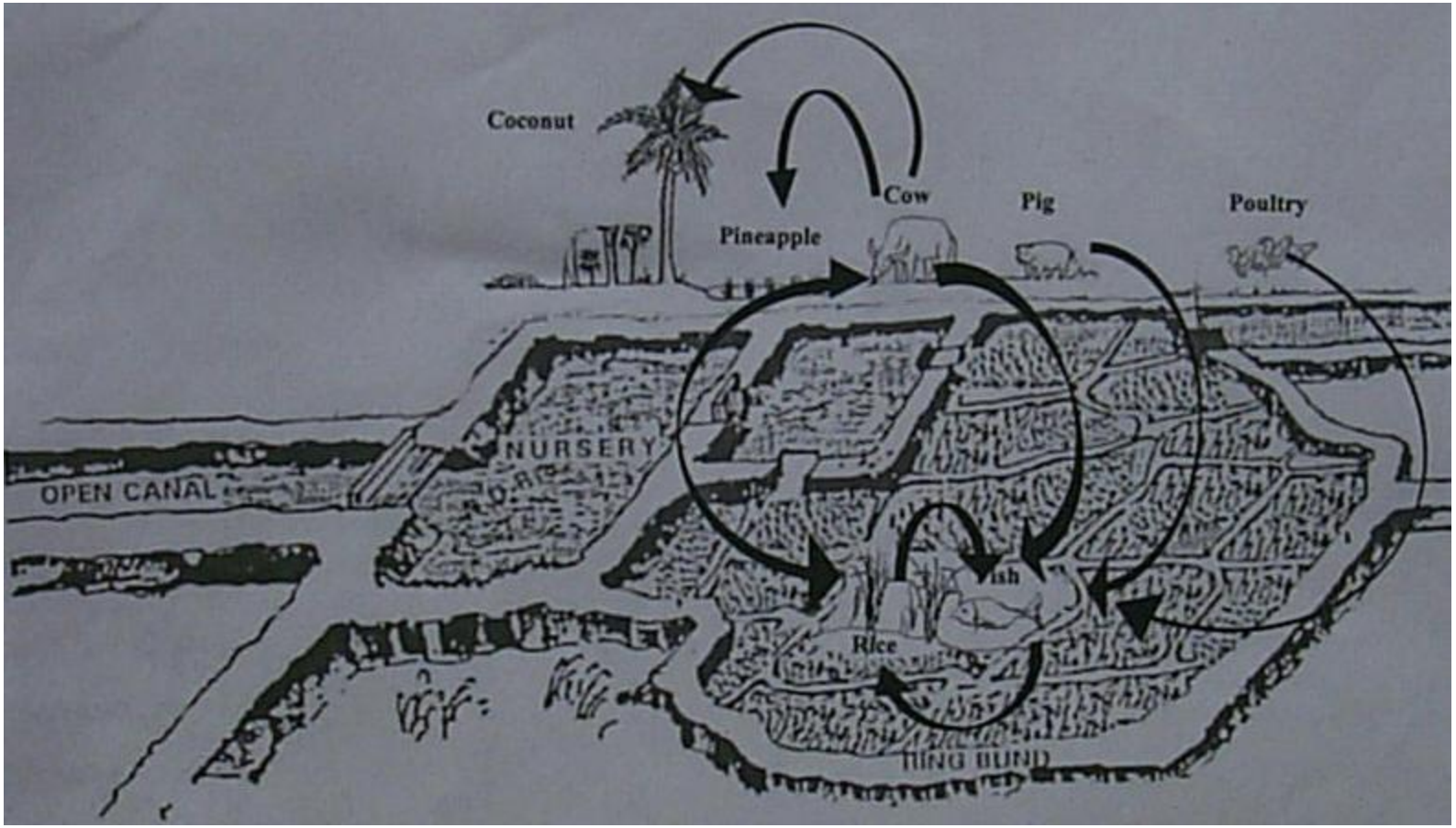

Farmers came forward to donate land for nursery
They were compensated by other farmers



- In effect fish culture became the starting point of diversification


Rice-Fish-Duck integration

Multi-level integrated farming in polders



Continual modification by involving rice and fish in low lands and coconut, pig, poultry, cattle, banana and pineapple on the dyke

Significant production

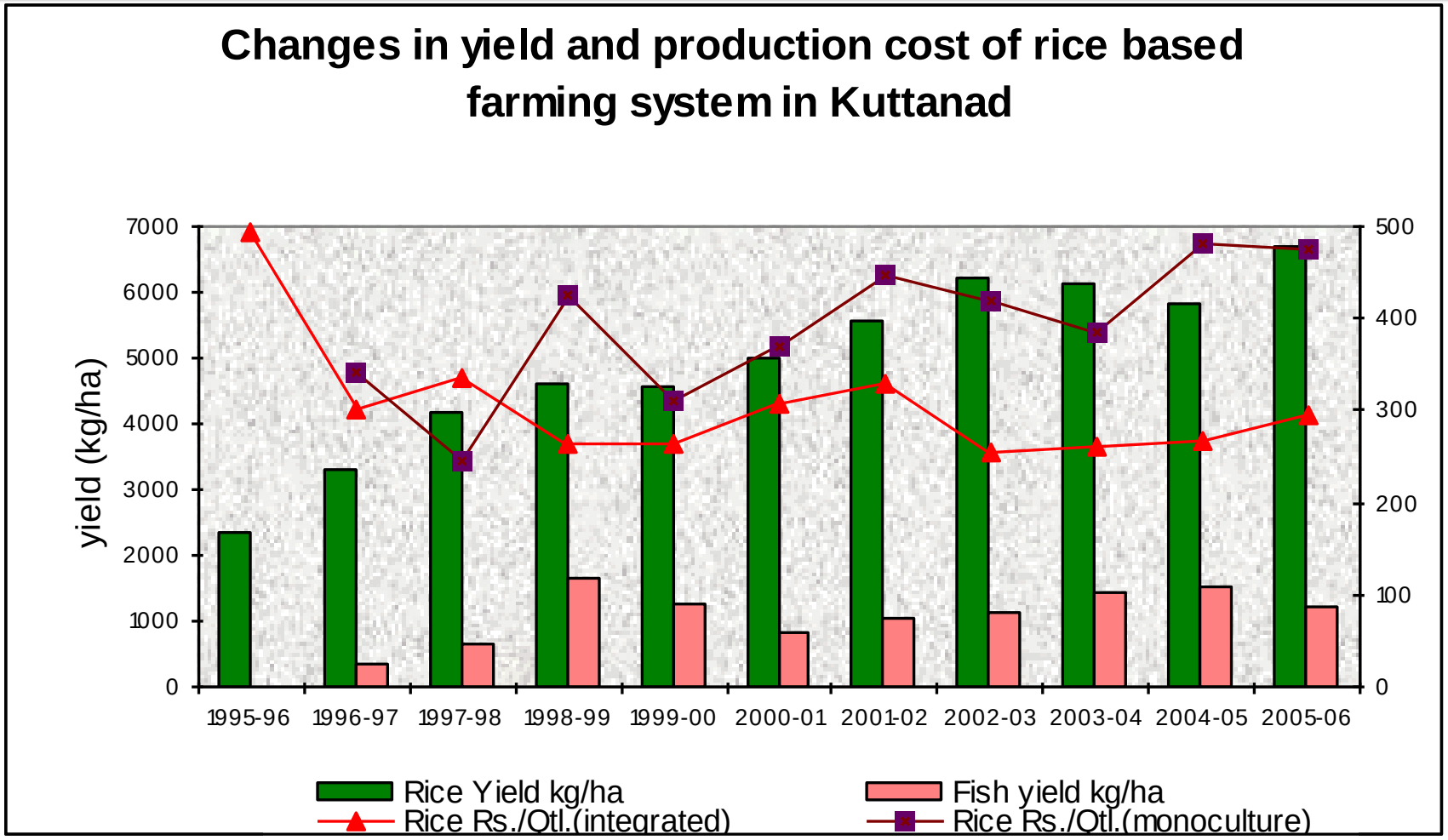
Emergence of Integrated Farming Models

Field before and after fish

Multi integration

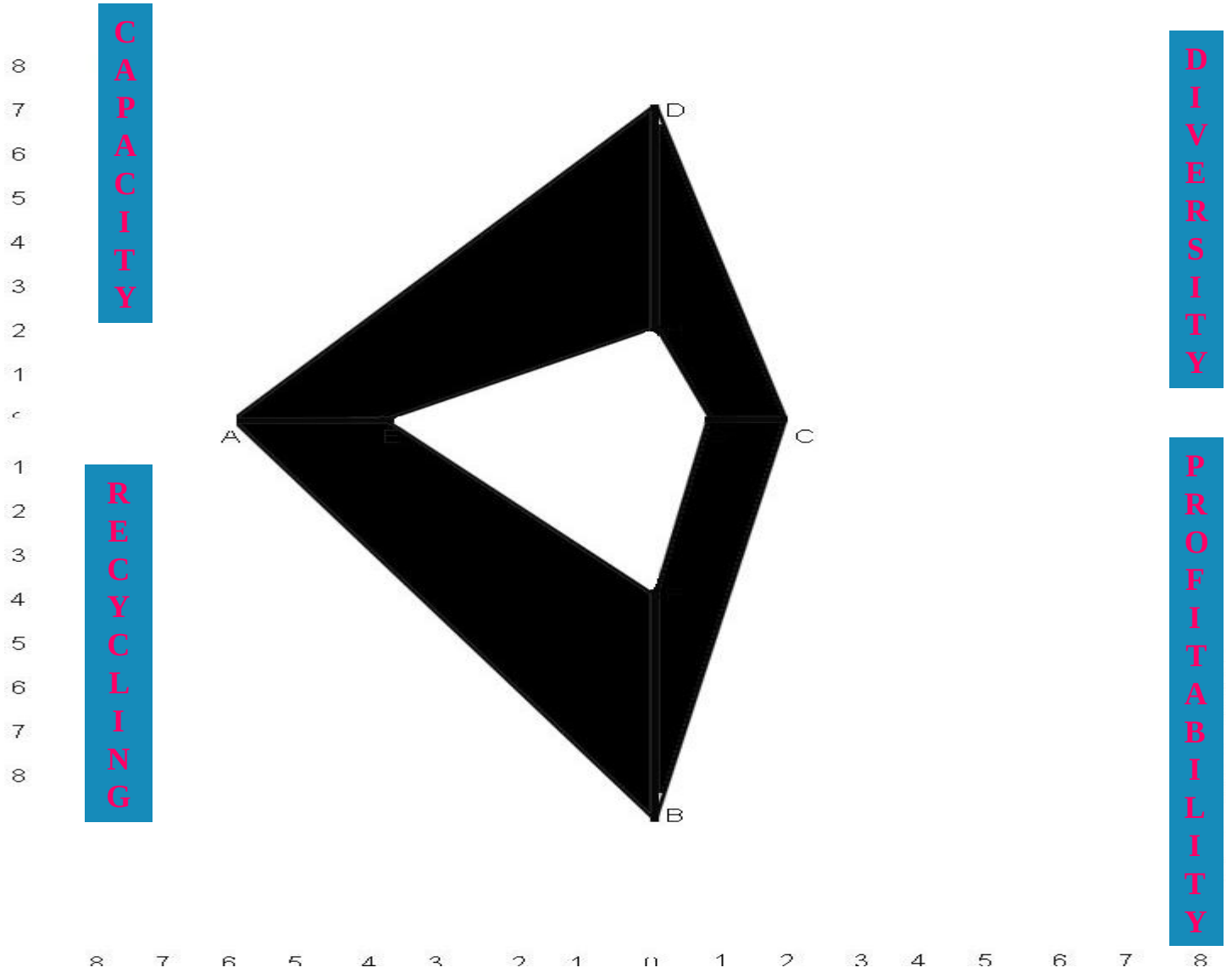
Oru Nellum Oru meenum

Historical contribution of RARS to IFS development



Sustainability Kite index– Rice- Fish GFF

N.Kuttanad




ഗാന്ധിസ്മാരക ഗ്രാമസേവാകേന്ദ്രം,S.L.പുരം
ജൈവനെൽകൃഷി കൊയ്ത്ത്ഉത്സവവും,
വശക്തികൃഷി സെമിനാറും.
ർഷകൻ:ശ്രീ.ദിനേഷ്കുമാർ.പുല്ലങ്ങടി.
7, വല്ലാട്ടുരുപറ [തകഴിഗ്രാമ പഞ്ചായത്ത്]

- Brackish water aquaculture- confined to a single species, *Penaeus monodon*, farming began during the early 1990's
- Destruction of wetlands & mangroves, dispersion of chemicals and nutrients and the salination of soils

- Introduction of white leg shrimp (*Litopenaeus vannamei*) to Asia

- Boom in the farming of this species in China, Thailand, Indonesia and Viet Nam in the last decade
- Complete shift from the native giant tiger prawn(*Penaeus monodon*) to this introduced species
- In India, the interdiction on introduction and culture of white leg shrimp was lifted in 2008
- Major impacts predicted on the country`s shrimp farming sector in the years to come

Culture based capture Fisheries

Reservoir fisheries

Constructed mainly for hydel power fishery potential very high India has 975 large (> 5000 ha) and medium (1000- 5000 ha) reservoir . Fish productivity vary 50- 300 kg/ ha/ yr. Average yield 20 kg/ a. Production only 0.93 lakh ton. Can be enhanced to 2.45 lakh ton
Major carps indispensable
Indian major carps ill suited to utilize phytoplankton, chinese carp also essential
Introduction of carps, in reservoirs on the Western Ghats river systems- projected deleterious effect on indigenous species has been a subject of controversy

Controversy

- Reservoir is part of the head river system.

  Vs

- Reservoir itself is not a natural system but a manmade artificial impoundment.

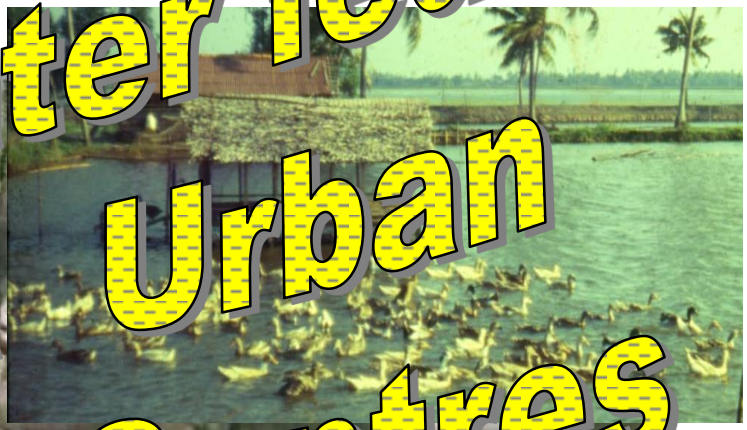
- Diversified stocking involving endemic species is one option
- Establishment of multispecies fisheries- to utilize all food niches necessary

Waste water fed Aquaculture

- Practice of utilizing fish for treating waste waters and agro-based industrial effluents, add new dimension to aquaculture
- Aquaculture become eco-restoring, environment compatible and economical
- By 2020, it is estimated that over 50 percent of our population will be urban, whereby human food chain and nutrient cycles are going to become unstable
- Nitrogen, Phosphorus and other nutrient elements in waste waters are not going to be returned

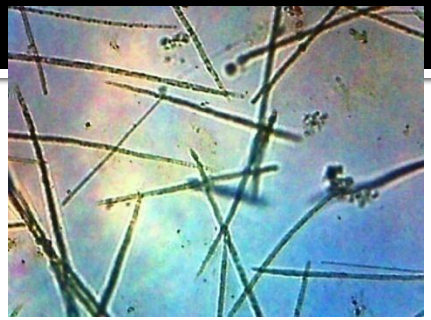


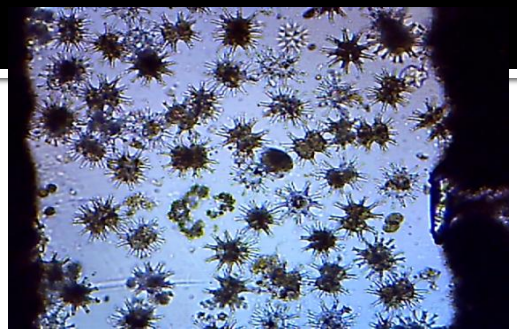




Wastewater fed Agri-Aqua Urban Production Centres

Waste water fed Aquaculture

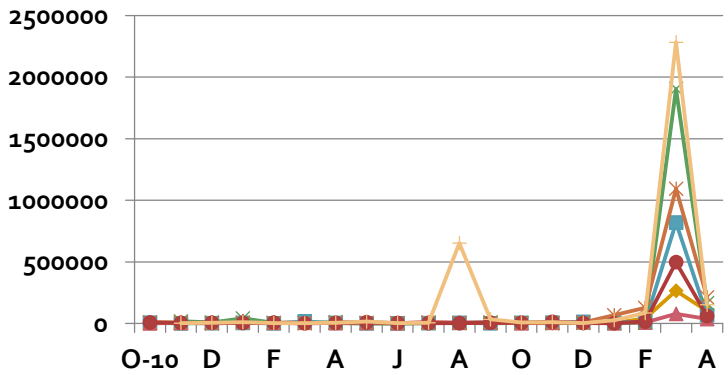




Straustrum bloom at Irupathinalayiram in **August 2011.** Plankton count **6,52,992** Nos/L.
Closterium gracile bloom **in March 2012.** Plankton count upto **22,82,860** Nos/L.

***Straustrum* Bloom** ***Closterium gracile* Bloom**

PHYTOPLANKTON COUNT IN LAKE STATIONS (Nos./L)



- ecological problems of eutrophication in all our water bodies
- The signs of distress due to waste disposal have begun to surface in all our metropolitan cities.
- Utilization of sewage and waste waters for aqua farming is one of the suggested methods for treatment of sewage wastes

The black clam Support a lucrative shell fishery

Contribute 90% of the country's lime shell production

Resource base of several Industries

Facing threat of depletion- indiscriminate exploitation

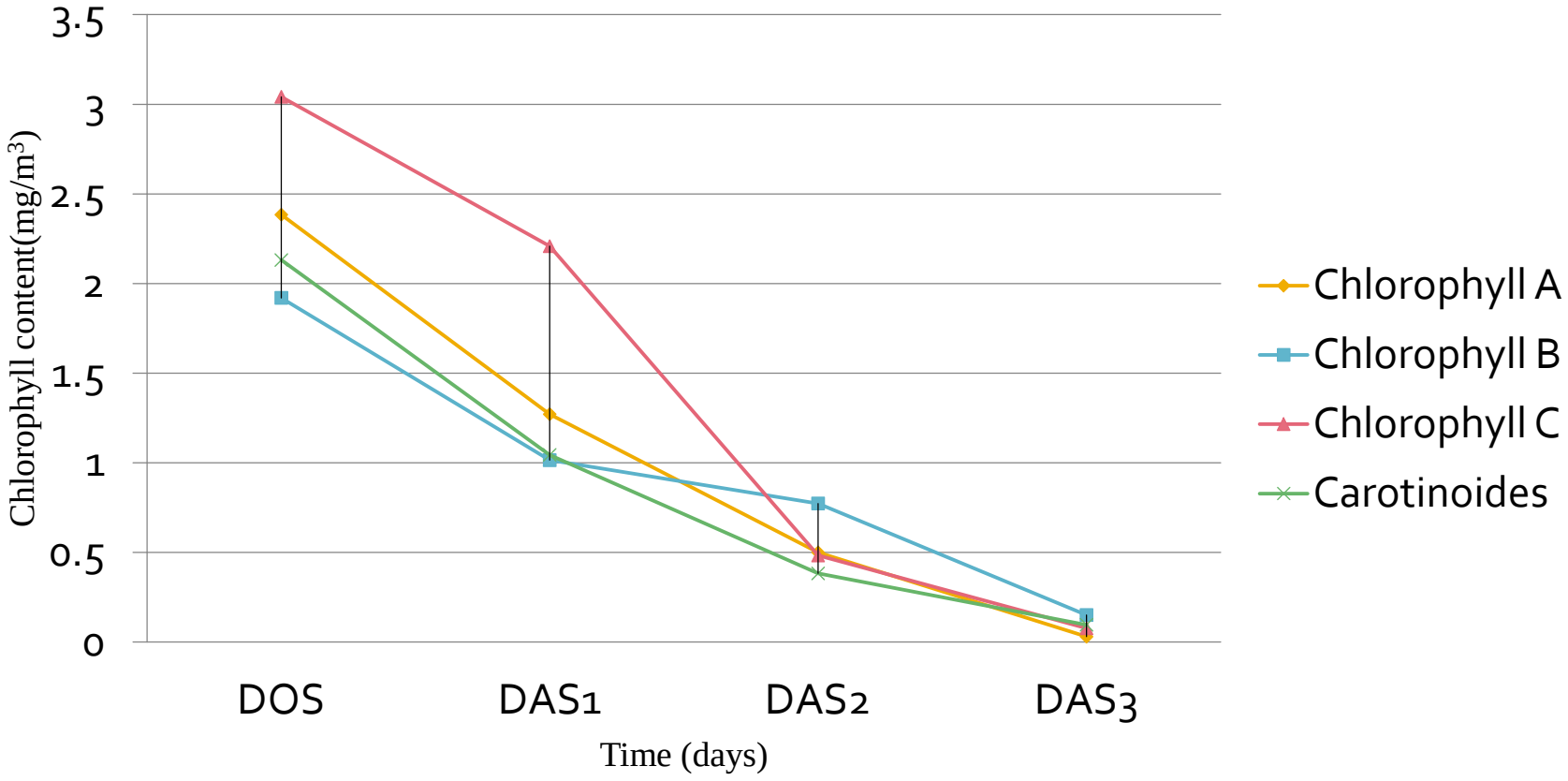
Salinity around 17-18 ppt needed for successful spawning

The black clam
Villorita cyprinoides

Bioremediation Properties of Black Clam *Villorita cyprinoides* Demonstrated (Teena and Padmakumar, 2011)

Black clam, *Villorita cyprinoides* effective as a bioremedial agnt to control eutrophication of water bodies and aquaculture systems

Graph 4: Chlorophyll analysis in field trial



Black clam (tons)

1977 - 77000

1980's - 13000

1990's - 7200

2000's - 37000

2004- 42000

Farming in soft trays

- Soft tray made of a polyester mesh material in the form of a bag.
- The bag staked to the bottom using PVC pipe or fence post wire.
- Bags shall be “belted” together in units of 5 to 10 and planted in rows.
- Only the product and bag are removed from the bottom at harvest

Off Bottom cage culture-immense potential

Fish Keeping for Waste Utilization

- **In a state having highest literacy rate it is ironical that the major civic problem is waste disposal.**
- **The centralized waste dumping and garbage treatment plant has become a misery for people residing near dumping centers**
- **Thus a small kit of waste produced everyday in our houses has become the biggest social problem in Kerala. This has begun to haunt not only the administrators and political leaders but also the general public**
- Waste management at source have not succeeded as the people have not been passionate to such ideas
- Technology is not communicated properly and required motivation has not occurred
- .

Waste Utilization by Fish keeping

- Utilization of organic wastes generated at home the same at place of origin and at time of origin itself
- It become utilized for one of our charming hobbies, that make one smile
- Utilization of household organic wastes, be it the food wastes, vegetable wastes, peelings, dining table remains or cookery wastes for converting it to live food fish
- **Popularizing kitchen tanks maintained in serene surroundings as an exciting Fung-shui fervor that fish bring fortunes at home.**

Fish for waste management

- Fish species such as Pangassius catfish, *Pangassius sutchi* or such other hardy species that feed voraciously on food wastes
- Suited to high density farming conditions has been demonstrated to be of use for waste recycling
-
- Promoted in Fung-shui fervor to raise fish by recycling biodegradable wastes for fortune and income.

Kitchen Pond Fish Farming for Home waste management

Modular design- Kitchen tanks

Farming Sutchi catfish

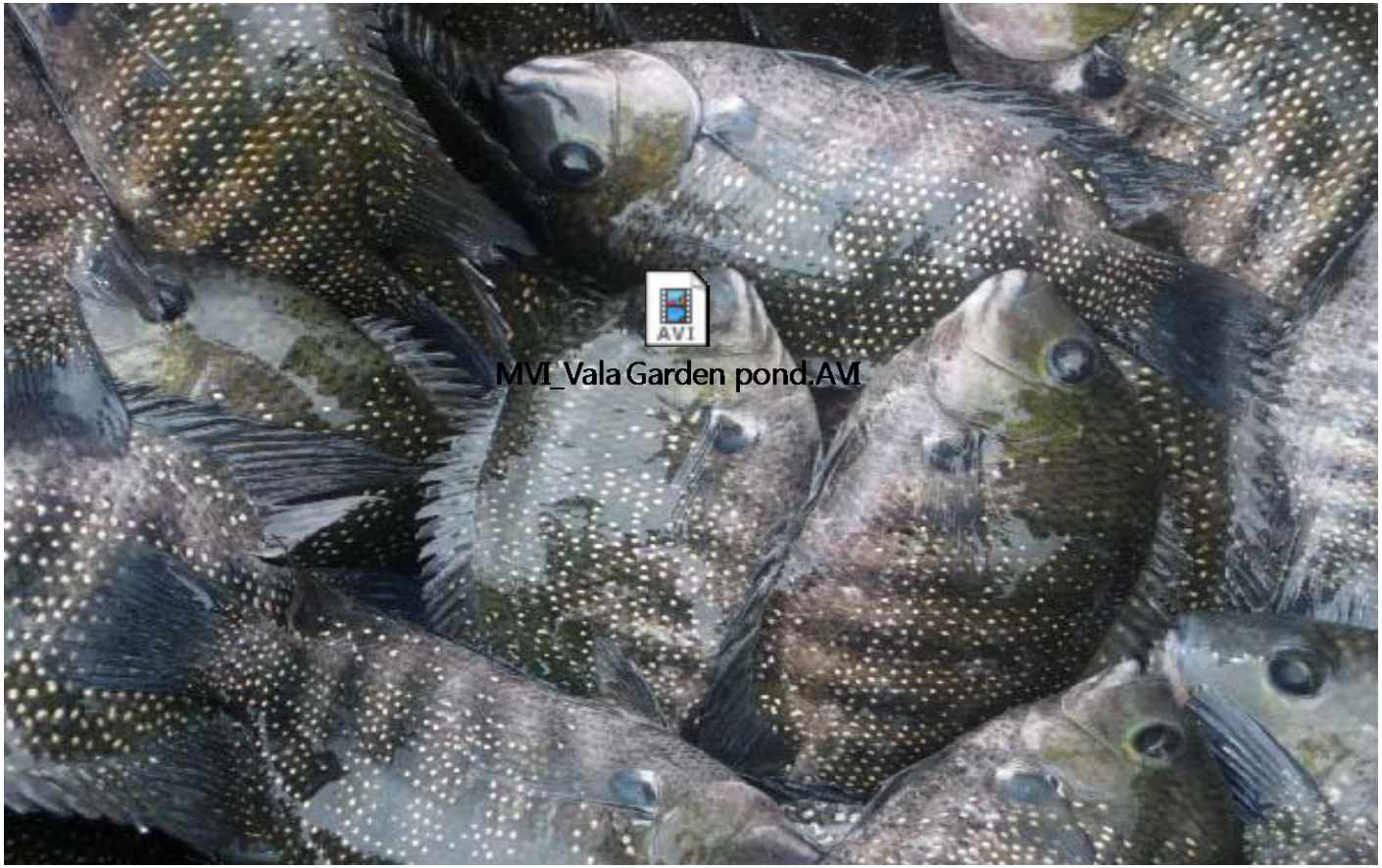
Adapted to high density farming

Easy to manage and feed

Utilization of food and household bio waste in Kitchen pond farming

Garden Tank Fish to utilize waste

Kitchen tank Farming- Karimeen


AVI
MVI_Vala Garden pond.AVI

Open water Aquaculture-Cluster

- Land is the most scarce resource in Kerala, scope for expanding land based aquaculture limited
- technology of open water farming in cages developed and demonstrated in the open Vembanad lake
- Can bring about magnificent improvement in productive utilization of our natural waters
- Technology yet to catch up on large scale

Openwater Fish Culture


Farming of Karimeen
in Cage Enclosures

Pioneering studies at RARS has shown that

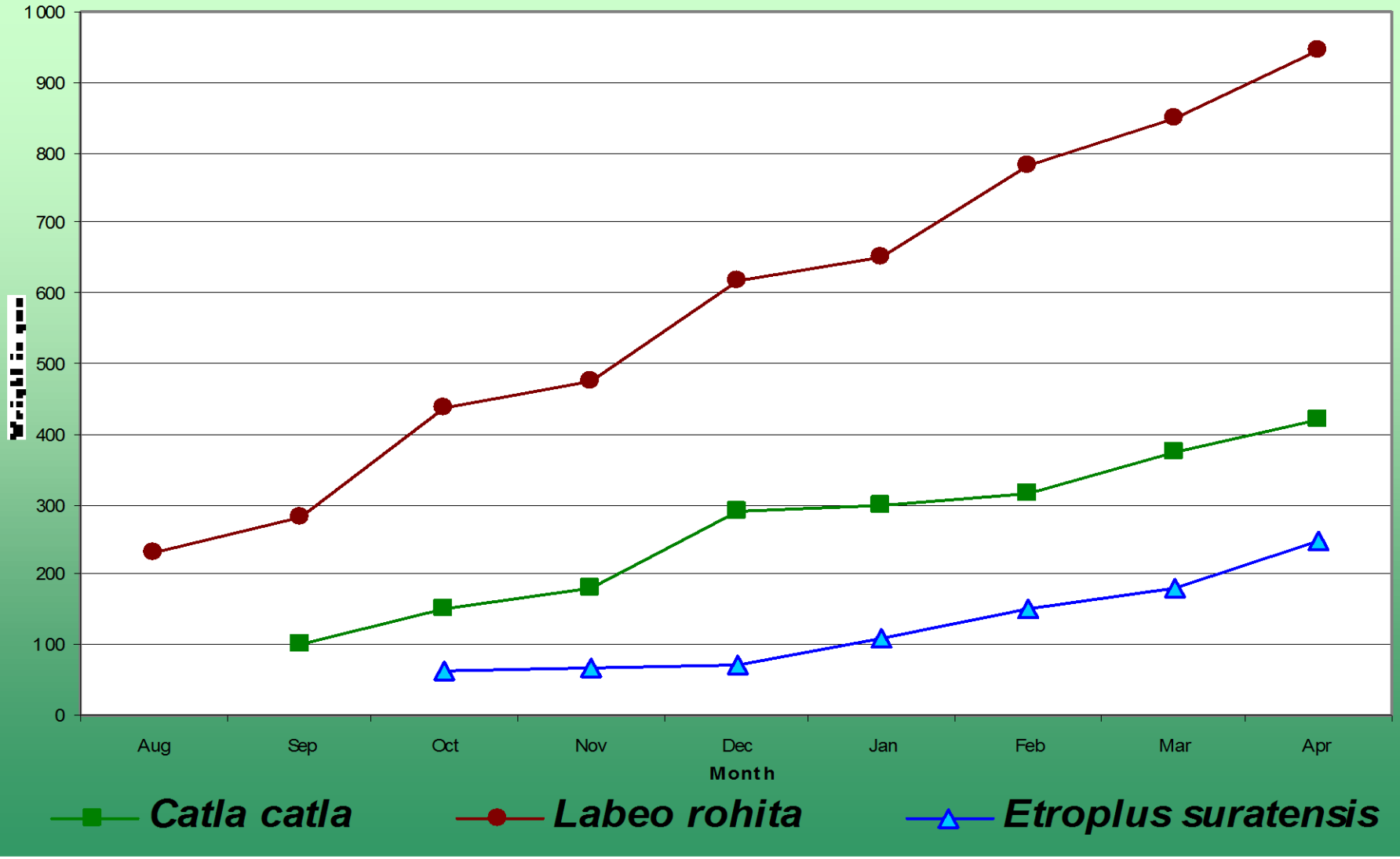
- Karimeen is the most appropriate candidate species for cage farming
- Omnivorous , accept hand feeding
- High value species with great demand
-
- Growth better in cage condition than in ponds
- Unique s breeding habit, Scrubbing species
- gentle and suited for high density farming
- Short culture period
- Hatchery techniques standardized – seed problem is addreessed
-

Commercial Farming of fishes in cages


C2
C1
D1
C3

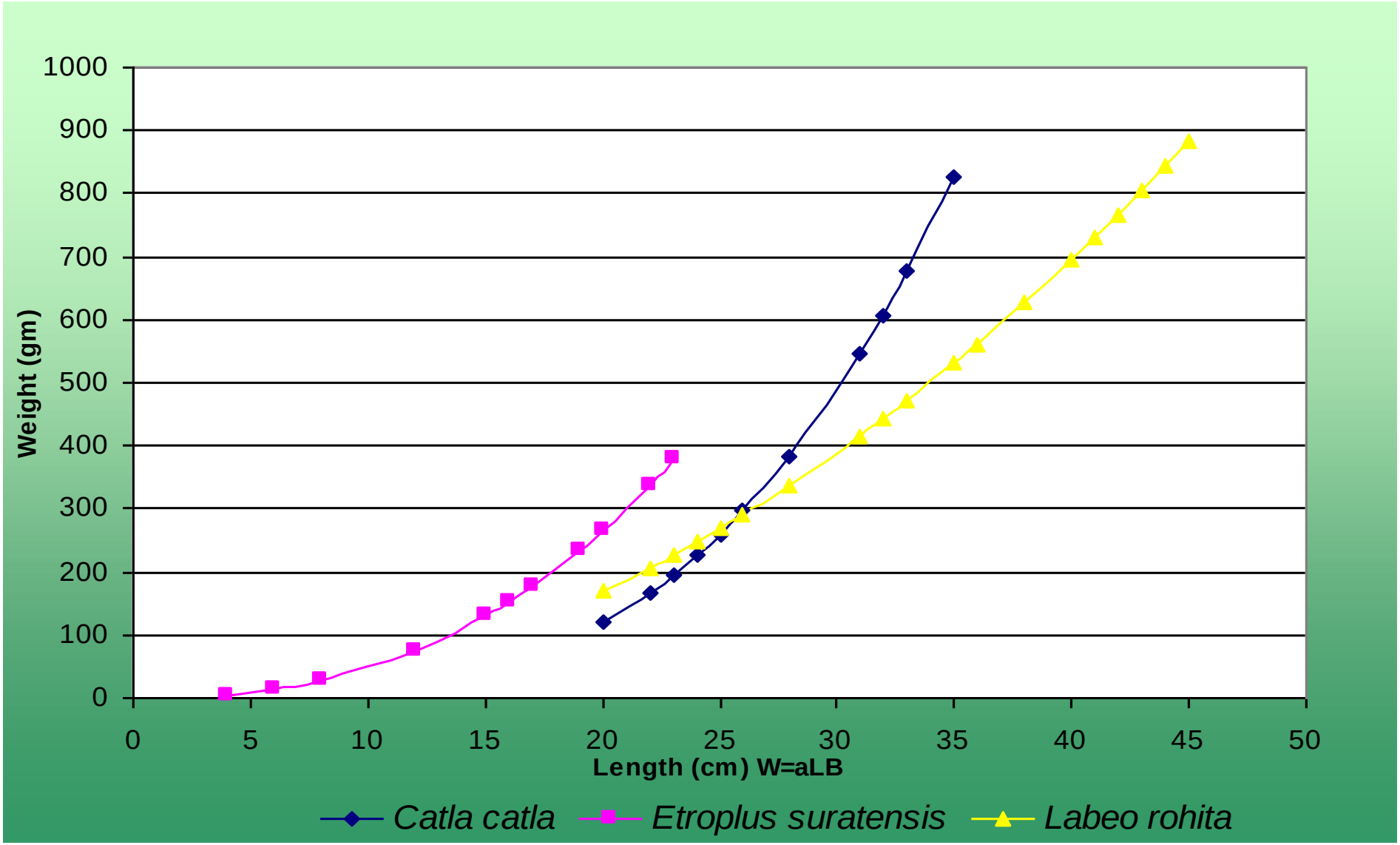

A-14

Growth performance of selected fish species in low volume- high density cages in Vembanad lake

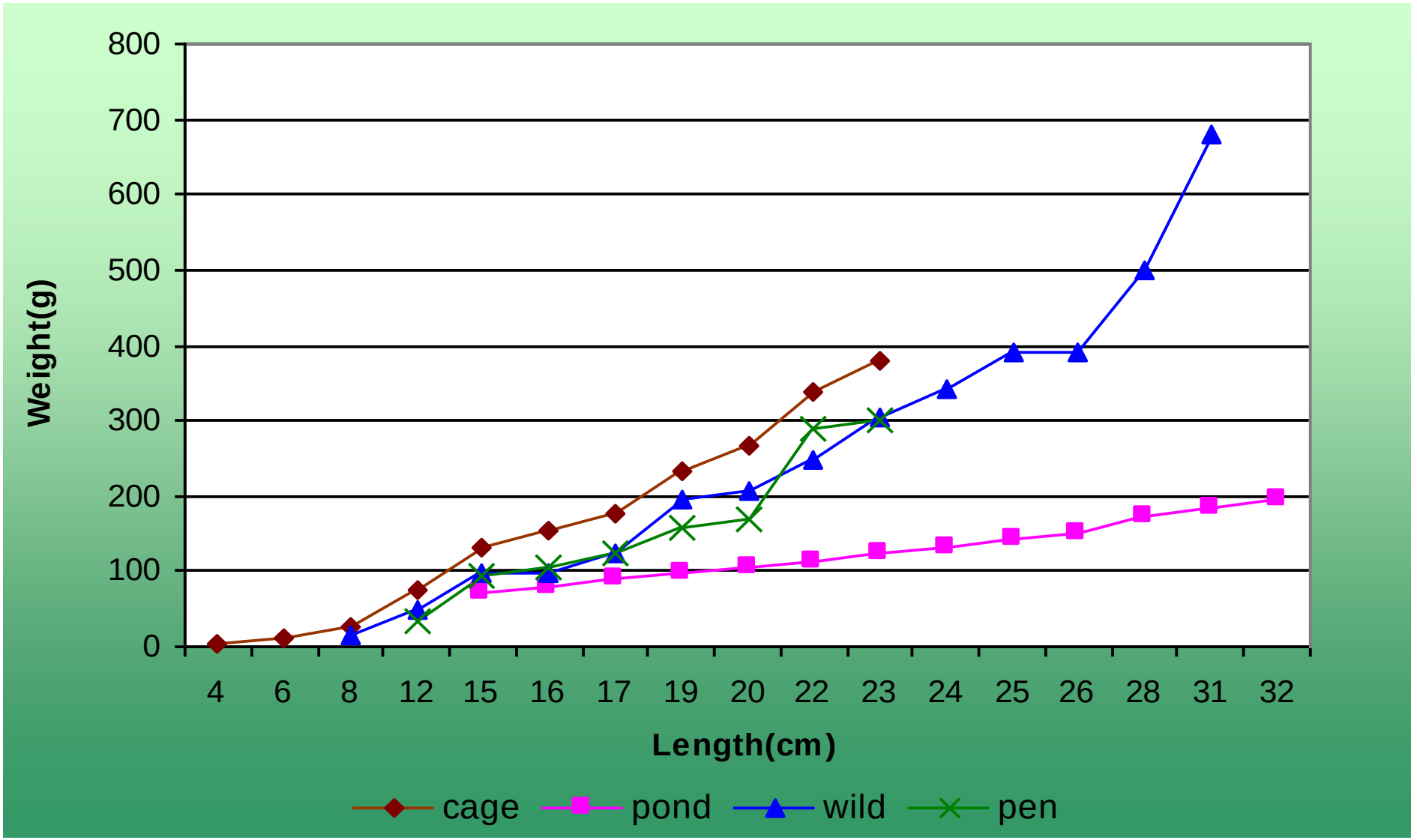


Length-Weight relationship of Cage Cultured fishes

(*Catla catla, Labeo rohita and Etroplus suratensis*)



Relative performance of *Etroplus suratensis* under different farming situations



Growth performance of *E.suratensis* in cage enclosures at Thanneermukkom

Cage No.	period (days)	rate (%)	stocking		harvest		Biomass / cage (kg)	accrual (g/day)	harvest	
			L(cm)	W (g)	L(cm)	W (g)			L(cm)	W (g)
1	378	100	10.1	27	18.9	222	44.4	0.52	25.0	480
2	214	100	7.8	12	16.0	115	23.0	0.48	17.0	150
3	207	98	7.8	12	18.0	167	32.7	0.75	23.0	320
4	207	81	7.8	12	17.2	136	22.0	0.60	19.0	200
5	275	100	5.8	7	15.8	133	26.6	0.46	22.0	280
6	274	49	5.8	7	16.8	139	36.2	0.48	20.0	240
7	242	96	6.3	6	16.0	106	20.4	0.41	20.0	200
8	283	100	5.8	7	16.8	146	29.2	0.50	20.0	250
9	266	45	7.8	12	16.3	198	17.8	0.70	20.0	300
10	266	98	7.8	12	17.2	145	28.4	0.50	20.0	240
11	260	63	7.8	12	17.3	148	18.6	0.52	21.0	225
12	242	75	7.8	12	16.6	136	17.1	0.51	20.0	225
13	231	78	6.3	6	16.0	115	17.9	0.67	20.0	225
14	229	87	6.3	6	15.9	125	21.8	0.52	20.0	225
15	214	83	6.2	6	15.8	127	21.1	0.56	21.0	275
16	197	85	6.3	6	17.7	184	31.3	0.90	24.0	410

Water quality parameters in the cage culture site, Vembanad lake

Month	DO(s) mg/l	DO(b)	pH	Nitrate ug/l	Nitrite ug/l	Phosphate ug/l	Salinity ppt
Sep'99	10.00	8.60	7.00	0.0007	0.015	0.006	0.119
Oct	7.00	7.00	7.00	0.135	0.0006	0.0005	0.06
Nov	6.40	6.00	6.50	0.035	0.02	0.055	0.076
Dec	7.80	7.00	7.00	0.067	0.03	0.02	3.493
Jan'00	8.00	8.00	7.00	0.00	0.00	3.75	2.73
Feb	10.10	9.90	7.00	0.055	0.35	1.00	1.954
Mar	8.00	6.00	7.00	0.015	0.40	0.45	0.4235
Apr	9.60	9.80	7.00	9.00	3.00	76	2.00031
May	9.00	8.00	7.00	13.60	4.00	60	1.842
Jun	7.80	7.80	7.00	1.60	0.20	72	0.17997

Cage Fish to meet consumer Demand

Openwater fish culture

in pens

Pen culture - opportunities unlimited

Unregulated Aquaculture - Issues

- monstrous development of coastal shrimp farming,- environmental impacts of during 1990's.
- Welfare of society was negatively affected by unregulated aquaculture development
- It is pollution and environment damages that most people now associate with aquaculture.
- supporters argue that aquaculture promises to meet the shortfalls in marine capture fisheries that has become more and more exhausted.

Fish Feed Issue

- Critics have a louder voice- they contend that farmed fish is fatty and is stuffed with antibiotics.
- More over they say that modern fish farming is unsustainable as it is fed with fish meal - caught from the wild putting greater and greater pressure/damage on marine life.

- feed formulations more digestible and that leach less waste in to environment are developed
- Improving nutrition, feed development, and fish health - considerations of some feed companies.
- Efforts to reduce use of antibiotics in aquaculture- Vaccines

Fish meal Controversy

- Critics say that modern aquaculture industry has a fatal weakness as several kilos of wild caught fish is needed to feed every kilo of farmed carnivore fish such as sea bass now popularized
- modern aquaculture is increasing and not reducing pressure on marine fisheries
- Now aquaculture contribute to 50% of fish we consume- yet no corresponding boom in natural catches in marine or inland

- 40 % of the world's supply of fish oil and 31 % of fish meal is only used in aquaculture farms.
- FAO predict a worldwide shortage of fish oil within a few years
- Diversion of low value fish from the mouths of people in developing countries in to mouths of the well fed rich people in developed countries.

Issue of By-catch/Discard -as fish meal

- By-catch in fishing amounts to tens of thousands of million tons every year
- High demand for 'by-catch' or 'discards' from marine fishing, which is again a marine collateral damage
- On the Kerala coast, it is over 2.25 - 2.62 lakh tons annually (Bijukumar and Deepthi, 2006)

By catch

- 30 % of the total fish caught from the state's coastal seas and around 79 % of the landings in trawling operation (George et.al., 1981).

  Finfish-1.0 lakh ton,can be utilized as Fishmeal

  Abundant scope for fish feed production units

- Now fish meal content in feed is being deliberately reduced from 70 % to 35% now
- China is biggest importer of fish meal today.
-]
- Chinese researchers are working on yeast based protein supplements as substitute for fish meal.

Feed making-rural enterprise


PULVERIZER UNIT
MIXER UNIT
FEED EXTRUDER UNIT
FEED DRIER UNIT

A fish feed mill established and run by the women produce utilzing agro based byproducts.


MEENOOT
FISH FEED

Domesticating New Breeds Increasing diversity index

- Essential need to identify the endemic species that can be utilized for pond culture
- Attempts made to prioritize endemic species for conservation.
- Captive breeding protocols for a variety of cultivable species developed in Kerala (Padmakumar et.al. 2004)

Diversified production of indigenous species also did not turn out

- Un availability of quality seed in adequate numbers
- Seed production protocols for several endemic species of commercial value standardized
- *Etroplus suratensis, Claria dussumerii, Labeo dussumeerii, Horabagrus brachysosma, Macrobrachium rosenbergii, Wallago attu, Channa* spp, *Heteropneusteus fossilis*

New breeds- Global Initiatives

- similar to in Green revolution, blue revolution has seen companies breeding fish to improve traits such as growth rate, conversion efficiency of feed to flesh, resistance to disease, tolerance to water quality, and fertility.
- Modern aquaculture of the kind that began in case of salmon almost 3 decades ago in the west and the coastal shrimp farming
- This involved technology demanded great deal of knowledge about habits and life cycle of each species
- Development of tilapia strain that is hardier and grows 60% faster than its wild variety
- Development of Jayanti Rohu by CIFA

Genetically modified fish

- **There is talk of genetic modification in fish farming**
- Scientists are thinking of tinkering with genes for growth hormones which make fish grow bigger and faster
- This most controversial than GM crops because of concerns if such fish escape
- **No GM fish is being farmed for food at present**

New Breeds for commercial aquaculture

- Farmed salmon is the most popular sea food in America
- Cod is the great hope of European producers- There tough competition from salmon farms in Chile
- Intensive research efforts are on way in France, Norway and Scotland to farm cod with complete predictability
- It has been a difficult business unlike salmon, as cod fry do not have large yolks that they can live off in early days of life cycle

Experiences of working on karimeen

- They must be fed and fed correctly almost as soon as they have been hatched.- similar problem of fry rearing in Karimeen
- Years of research needed to domesticate a new species
- Stocking densities, water quality, breeding conditions, animal behavior, health care, precise nutritional needs, all have to be worked out

Establishing Seed Farms for endemics

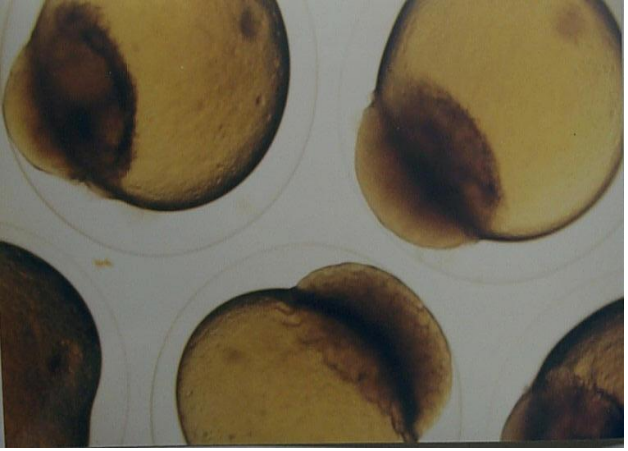

Labeo dussumerii

Horabagrus brachysoma

H. brachysoma, Manjakoori breeding

Developed by RARS,Kumarakom

Stripping in *H. brachysoma*



First report

Captive breeding

Horabagrus brachysoma

CAPTIVE BREEDING AND SEED PRODUCTION OF *ETROPLUS SURATENSIS* IN CONTROLLED SYSTEMS

Karimeen in cement tanks

- Mature fishes (100-140) of size vary between 15-23 cm were stocked
- Artificial pairing of the fish was facilitated by depositing substrates and pits
- substrates were placed at 1m distance to maintain territoriality
- In order to enable pit caring of the young ones artificial pits of 6cm dia. & 4cm deep were also provided

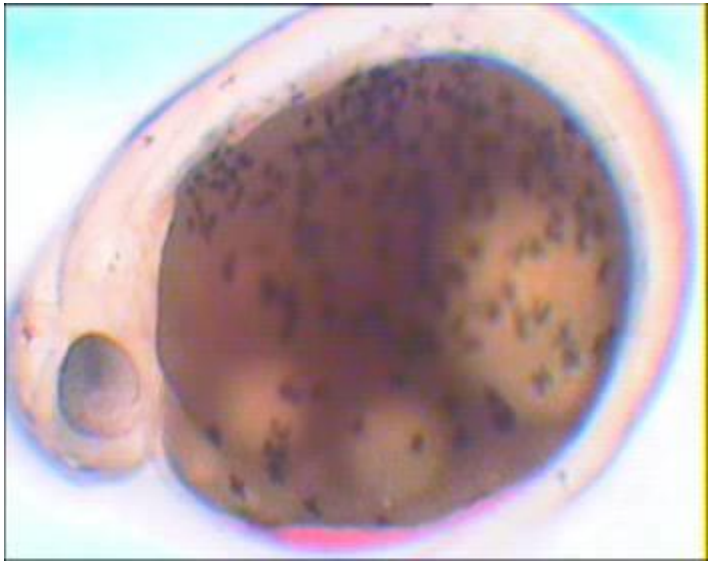
Nesting substrates

Artificial pits

Captive breeding Karimeen Developed by RARS, Kumarakom

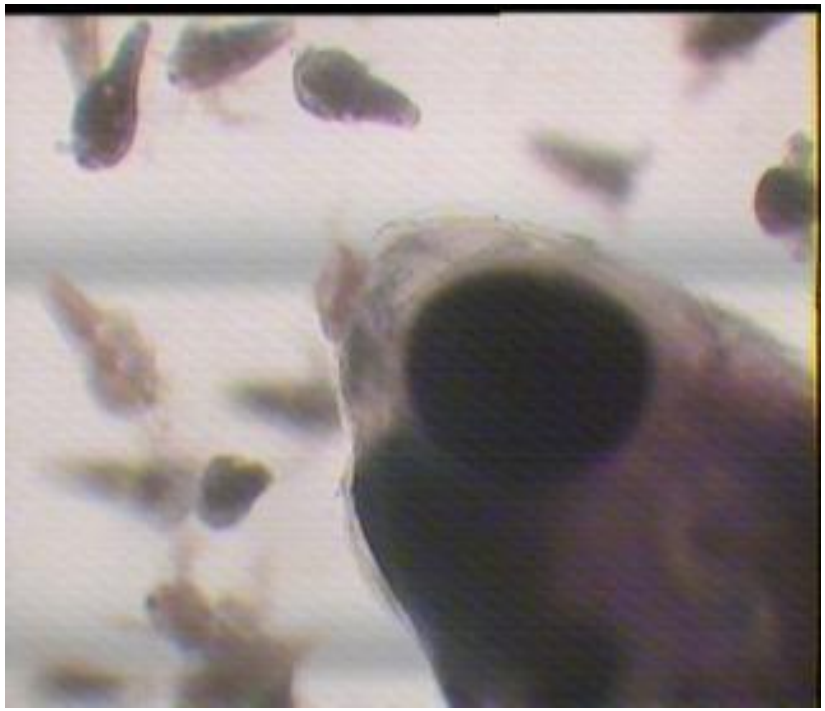
Larval Development

- Hatchling - 4.5mm
- 2nd day fry - 5mm
- 3rd day - 6mm
- 4th day - 6mm
- 5th day - 6.5mm
- 6th day - 6.5mm
- 1 month old - 2 cm
- 2 month - 3 -3.5cm



Pearlspot fry fed on Artemia nauplii

- Fry fed on live feed artemia



Fingerlings of *E.suratensis* produced in raceway hatchery system

Biodiversity Protection and Conservation

- It is most essential to protect natural fish habitats as recognized aquatic sanctuaries for conservation of fish germplasm
- life history traits of fish population is important and indispensable for planning conservation and management
- Pioneering attempt in the Vembanad lake by (RARS), Kumarakom, to establish a protected fish sanctuary or fish refugia for endemic fish Karimeen

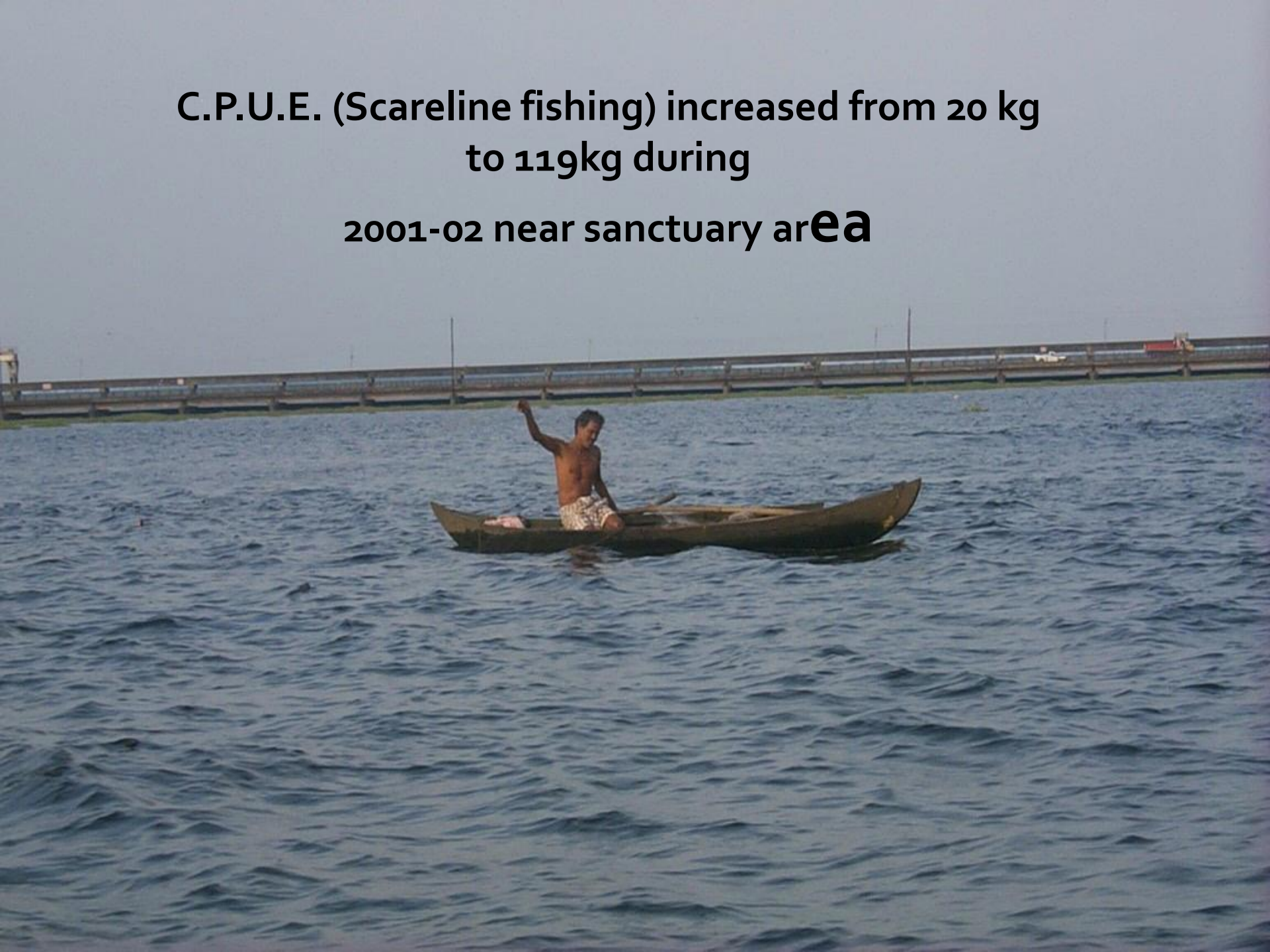
In situ Conservation and Stock Enhancement of Endemic Fish Resources through Captive Breeding and Artificial Sanctuaries

First Fish sanctuary-India Rars-Kumarakom

Model Fish Sanctuary

C.P.U.E. (Scareline fishing) increased from 20 kg to 119kg during

2001-02 near sanctuary area




Ranching

Most serious ecological backlash

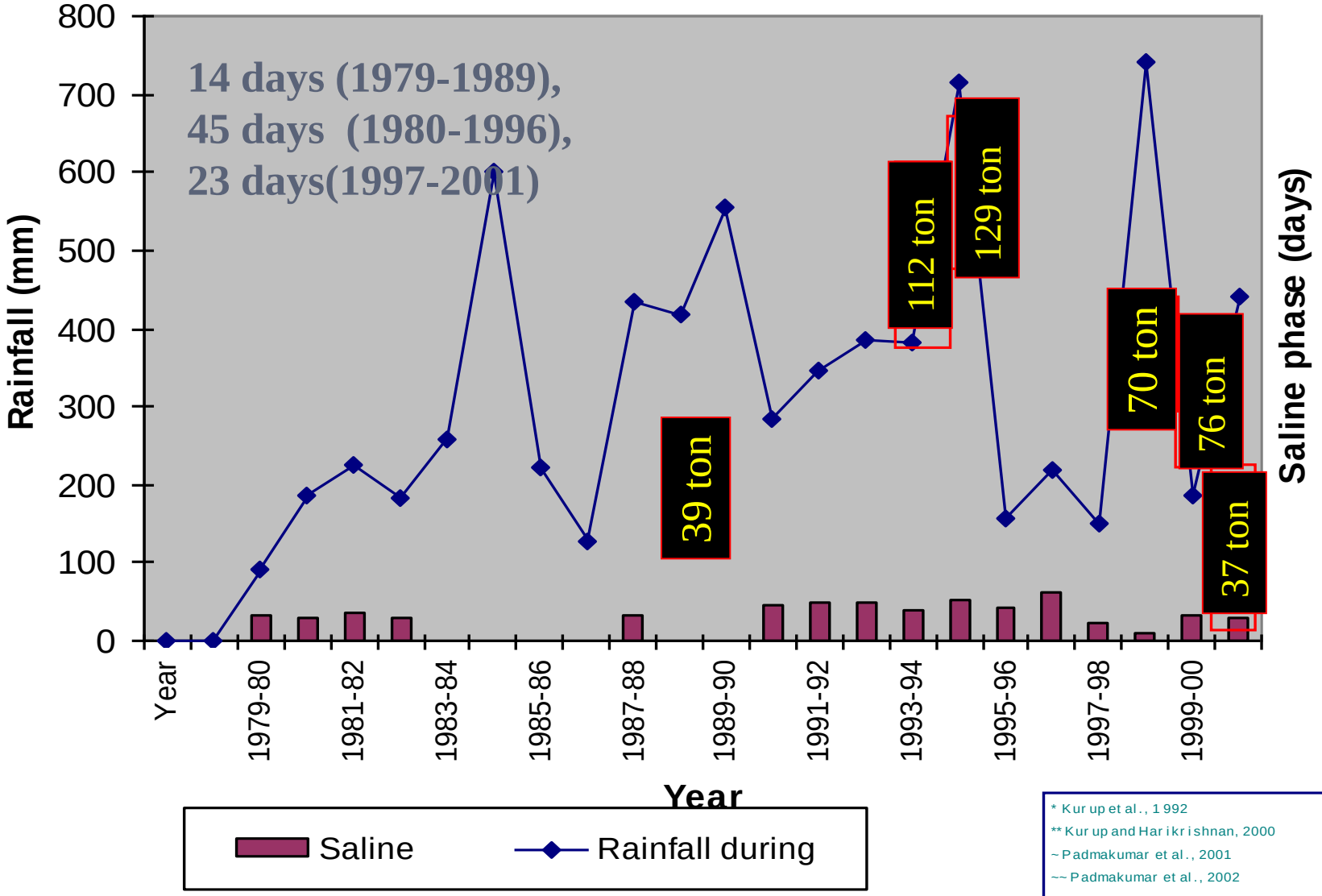
Disruption of physical and biological continuity

Decline of endemic prawn *M.rosenbergii,* in its home ground

Closure of the barrage during post monsoon months for summer rice, disrupted breeding migration down stream migration of PL back to home grounds - Kuttanad

Critical saline phase period upstreams Vembanad

Influence on scampi fishery (1980-2001)



* Kurup et al., 1992
** Kurup and Harikrishnan, 2000
~ Padmakumar et al., 2001
~~ Padmakumar et al., 2002

RARS,
Kumarakom

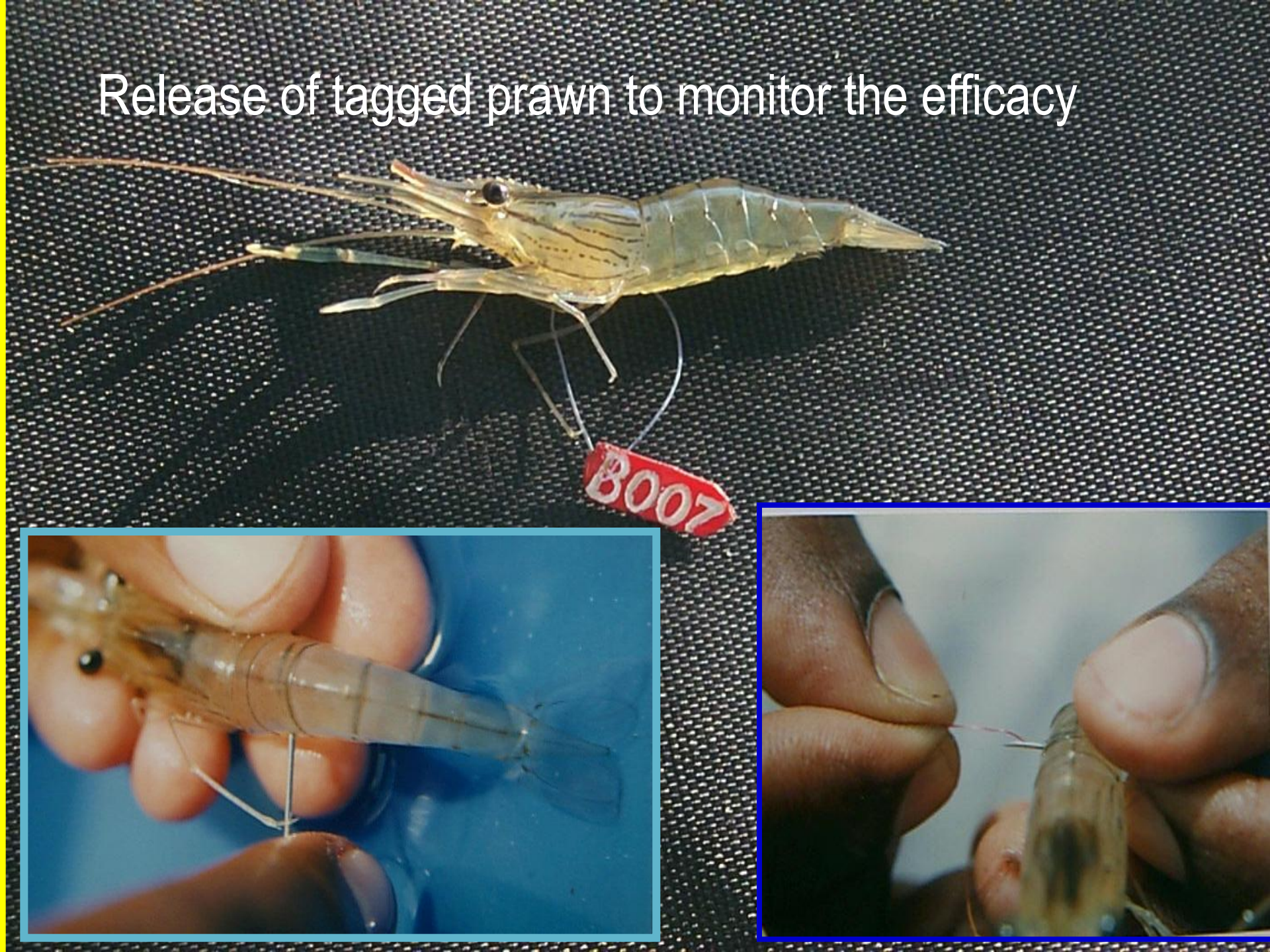
Open water Fishery enhancement Ranching of Kuttanadan Konchu

Nursed prawns for release

Ranching for fishery enhancement

M.rosenbergii, Pampayaar

Release of tagged prawn to monitor the efficacy



Recovery-marked prawns

Issue of genetic introgression- Kuttandan Konchu

- Giant Freshwater prawn *Macrobrachium rosenbergii*, '*Kuttanadan konchu'* the fastest growing freshwater prawn species in the world - endemic to Vembenad
- Several hatcheries have sprung up in different parts of India
- most of these hatcheries utilize the berries of pure wild stocks collected from Vembanad lakwe
- **Geographical indicator for Kuttanad -prawn germplasm yet to be be protected from contamination from genetic introgression**

Bioremediation effects

- Use fishes such as tilapia or catfishes to mop up the shrimp waste.
- Chinese concept, "multitrophic aquaculture to reducing negative impacts on the environment through nutrient stripping
- Studies at the RARS, Kumarakom indigenous filter feeding bivalve, *Villorita cyprinoides* used miraculously efficient in bioremediation of natural waters off algal eutrophication problems (Teena and Padmakumar, 2010).

Aquaculture and Environment- Concerns

- Waste from fish farms, and uneaten food accumulate and destroy environment.
- Over use of antibiotics threaten both aquatic environment and human health
- Farmed Fish may transmit diseases to wild stock
- Might interbreed with wild stock- genetic pollution.
- Reported that over I million non native Atlántic salmon have escaped from fish farms and established in streams in North West America
- In Norway, 90 % of the fish have escaped from its coastal farms
- .

- in Vietnam, the world's fifth largest producer of farmed shrimp, revealed that

- In Mekong, mangrove cover is now only 30% of what it was in 1975

Aquaculture- great advantages

- As aquaculture is easily managed -Environmental pressure can force the industry to change as happened in Indian shrimp aquaculture
- In open seas nations ferociously compete for the dwindling supply of wild fish
- Aquaculture can compete in cost to even heavily subsidized open sea fishing
- At some point of time it will help relieve pressure on wild fisheries.

Impact of aquaculture on environment is mixed

- Aquaculture offering relief to over exploited fish stocks
- Cause detrimental impacts on the environment- effluent discharge
- Envt contamination from use of drugs and introduction of exotics
- The most serious effects are on ground water contamination and social conflicts caused by resource access (Philip and Subhasinghe, 2008).

- As people get richer they eat more fish
  Consumption doubled over last 50 years

- Rise in prices of fish most remarkable for fish as compared to beef, chicken, pork and milk which has actually reduced in real terms over 30 years

- People have been able to eat more fish in spite of over exploitation of wild fisheries is because aquaculture production has been flourishing

- Half of the fish consumed in India is now farmed.

What should we do ?

- **Writing on the wall clear** - aquaculture should grow in environmentally sustainable ways
- **Public pressure should compel the sector to mitigate its environmental impacts**
- Aquaculture shall not create disruption and inequalities and lead to conflict over resource
- Equity shall be the policy agenda. There should be commitment to involve women, fishers and other underprivileged sections in agenda setting and policy making.

Integration-Ecologically Harmonious

- Increasing need to integration aquaculture with other farming practices -not as a discourse but as a practice.
- **Integrated farming paradigms *Oru Nellum Ooru Meenum* developed in response to proven setbacks of Green revolution technologies in Kuttanad**, suggested as a solution to the economic and environmental problems in coastal wetlands (Padmakumar et al., 1993., 200).

Regenerative Farming

- eco-friendly land use practices are considered economically nonviable -is feared to compromises on yield
- Multi-integrated farming models (AAA)-(Padmakumar,1993.,2006) challenges the argument
- **Integrated resource management models are not just theoretical construct but more realistic approaches**

- **Experiences, nevertheless, demonstrate that diversification is not only ecologically harmonious but also more productive and profitable**
- This is a typical instance, that demonstrate that **aquaculture can play a possible role and can also contribute to land based agriculture** making it more environment restoring

Codes of Practices and Guidelines

- FAO -Code of Conduct for Responsible Fisheries (CCRF) adopted by 168 countries, including India stipulate that
- state should promote responsible development and management of aquaculture, based on the best available scientific information
- Ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected Minimize harmful effects of introducing 'non-native species' or genetically altered stocks for culture
-

- Appropriate environmental assessment and monitoring for minimizing adverse ecological changes resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals

Way Forward

- **No one shall underscore the tremendous changes to food fish availability through aquaculture world wide**
- An internationally recognized certification scheme to alert consumers to sustainability of the farmed fish they are eating
- Standards vary widely from one country to another,-raising standard in one place will drive the industry to somewhere else with weaker rules

- Bestow greater emphasis on promoting and recognizing sustainable models

- Follow an Ecosystem Approach to Aquaculture(EAA)
- Limit production within the assimilating capacity of the ecosystem
- **Make Blue revolution more green by infusion of environmentally benign technologies.**

Rio+20

(June 20-22 2012)

- **Green Growth** is the iteration of concept of sustainable development
- **Focus shall be to**:
- 1. Strengthening political commitment to sustainable development
- 2. Responding to new emerging challenges of societies with diverse water and land based farming systems

……

- Aquaculture is growing from subsistence to industrial scale
- Being the fastest growing food production sector, the business can grow and stay green only by resolving the issue of

Competition for water, Decreasing quality of water

High cost of feed, Objections to feeding fish with fish

Bio security emergencies, Climate variability & Economic crisis


THANK YOU