GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD

FOURTEENTH FIVE-YEAR PLAN
(2022-2027)

WORKING GROUP ON
HARVESTING THE POTENTIAL OF INLAND AQUACULTURE: TOWARDS A PLAN OF ACTION

REPORT

Agriculture Division
March 2022

FOREWORD

Kerala is the only State in India to formulate and implement Five-Year Plans. The Government of Kerala believes that the planning process is important for promoting economic growth and ensuring social justice in the State. A significant feature of the process of formulation of Plans in the State is its participatory and inclusive nature.

In September 2021, the State Planning Board initiated a programme of consultation and discussion for the formulation of the 14th Five-Year Plan. The State Planning Board constituted 44 Working Groups, with more than 1200 members in order to gain expert opinion on a range of socio-economic issues pertinent to this Plan. The members of the Working Groups represented a wide spectrum of society and include scholars, administrators, social and political activists and other experts. Members of the Working Groups contributed their specialised knowledge in different sectors, best practices in the field, issues of concern, and future strategies required in these sectors. The Report of each Working Group reflects the collective views of the members of the Group and the content of each Report will contribute to the formulation of the 14th Five-Year Plan. The Report has been finalised after several rounds of discussions and consultations held between September to December 2021.

This document is the Report of the Working Group on "Harvesting the potential of inland aquaculture: Towards a plan of action". The Co-Chairperson of Working Group was Dr.Riji John. Dr.R.Ramakumar, Member of the State Planning Board co-ordinated the activities of the Working Group. Sri.S.S.Nagesh, Chief, Agriculture Division was the Convenor of the Working Group and Smt.Vidhya K, Assistant Director, Agriculture Division was Co-Convenor. The terms of reference of the Working Group and its members are in Appendix 1 of the Report

Member Secretary

PREFACE

As part of formulation of the 14th Five Year Plan, the Kerala State Planning Board had constituted working groups of experts in all the major sectors. In Agriculture and Allied Sectors, 6 working groups were constituted viz. Agriculture and Cooperation, Animal Husbandry and Dairy, Inland and Marine Fisheries, Forest and Environment, Water Resources and Regional Packages. To discuss and frame policies in each of these sectors, the working groups were further divided into 28 Expert Sub-Groups (ESG) with specific mandates.

Each Expert Subgroup held at least three meetings beside one focused group meeting before finalising the report. I, the Co-Chair, place my deep appreciation and gratitude to all the esteemed members of the ESG for their valuable contributions in preparing the report. I am extremely grateful to Dr. V. K. Ramachandran, the Honourable Vice-Chairperson, Kerala State Planning Board, Dr. R. Ramakumar, Member, Kerala State Planning Board and Sri. S.S. Nagesh, Chief, Agriculture Division for their consistent guidance and suggestions in preparing the report. The drafting team put in commendable work in bringing together all the views and opinions of the members. I sincerely hope the recommendations in the report can lead to important changes in the public policy on the development of inland aquaculture in the State.

Dr. Riji John
Official Co-Chairperson

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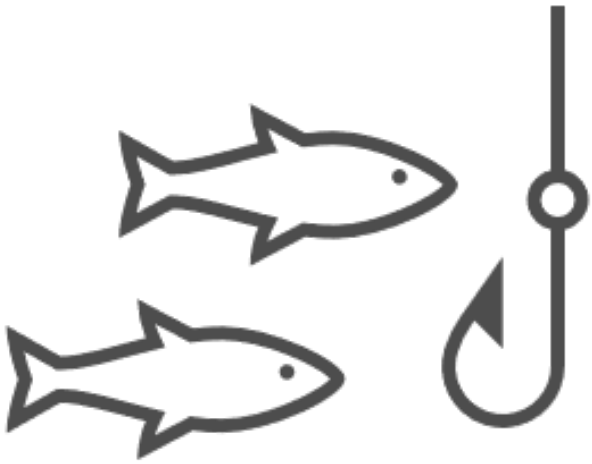
- Kerala faces a deficit of 2–2.5 lakh tonnes of fish, and aquaculture is seen as a sunrise sector in food security.
- During the 13th plan period, aquaculture, which was considered natural pond-based and seasonal, has become artificial tank-based and perennial with the use of bio floc technology, RAS, and culture in Padutha ponds.
- This document puts forward suggestions for the 14th FYP in inland capture fisheries, seed production, inland aquaculture development, aquaculture extension service, aquatic animal health management, reservoir fisheries, ornamental & recreational fisheries, and research.



HARVESTING THE POTENTIAL OF INLAND AQUACULTURE: TOWARDS A PLAN OF ACTION

EXECUTIVE SUMMARY

Kerala faces a deficit of 2–2.5 lakh tonnes of fish, which results in the inflow of fish from other states. In Kerala, the sector can contribute much more significantly to the fish basket, employability, livelihood enhancement, and protein security, especially nutritional security. Kerala has 8171 ha of freshwater ponds, 49718 ha freshwater fields, 2303 ha of brackish water ponds, and 5178 ha of brackish water fields which may be used for conventional farm-based aquaculture. The challenges ahead include climate change, frequent floods, and pollution etc., which necessitate scientific intervention to maintain a steady income for farmers and fishermen from this sector.

Review of 13th five year plan : The 13th Plan envisaged making Kerala self-sufficient in fish production by promoting open water fishing and aquaculture. The focus of the plan was on increasing seed production of important cultivable species of fish and shell fish, establishment of fish feed mills to ensure quality feed, and establishment of aquatic animal health labs. The aquaculture sector has achieved a growth rate of 20% during the last year. One of the major achievements to be noted during the plan period is that aquaculture, which was considered natural pond-based and seasonal, has become artificial tank-based and perennial with the use of bio floc technology, RAS, and culture in Padutha ponds. During the Plan period, fish stock enhancement programmes through the ranching of seed was extended to 28 reservoirs having an area of 17,853.85 ha. Fish seed production capacity in department-run hatcheries were enhanced from 200 lakh to 700 lakh. Presently, there are 18 fish hatcheries and 7 shrimp hatcheries under the state government. Live-feed units, monitoring, control, and surveillance systems, enhancement of fish stock in reservoirs, aerations units, extension activities, broodstock development programmes, water quality maintenance systems, feed mills, aquatic animal health management systems, mobile testing facilities, support services at different levels, demonstration units, fish farms, and aquariums have been set up. However, interventions in the ornamental fish culture segment have been largely inadequate and ineffective.

Approach for the 14th five year plan : Depending on the particular aspects of the aquaculture sector, different approaches have been formulated for each thrust area.

Inland capture fisheries - Increase fish production by protecting the natural stock through Fisheries Management Councils, conducting patrolling to prevent illegal fishing, enhancing fish stock through ranching, establishment of protected areas, restoration of damaged aquatic ecosystems, and mangrove afforestation. It should also include fishery resource mapping by applying remote sensing and geographical information system, assessment of fish catch, and buy back of licensed stake nets and Chinese nets.

Seed production - Establish new hatcheries and enhance seed production capacity of existing seed farms and hatcheries by creating additional infrastructure facilities. Additionally, backyard seed production units can be promoted under the private sector.

Inland Aquaculture Development - Aquaculture production to increase from 34,987 ton

to 70,000 ton during the 14th plan period by the diversification of species and aquaculture systems, adoption of innovative technologies, expanding aquaculture into new areas, and enhancing productivity. The aquaculture activities include: intensive fish farming viz., aquaculture in bio floc tank, cage, padutha, and RAS; one paddy–one fish/shrimp farming; farming of Carp, Nile tilapia, Pangasius, and indigenous fish in ponds; and farming of shrimp, crab, and mussel.

Aquaculture Extension Service - Aquaculture extension service to farmers includes IEC activities, capacity-building programmes, Matsya Karshaka Club, Matsyakrishi Sevana Kendram, Fish Farmers' Producer Organization, Matsya Karshaka Mitram, technology acquisition, demonstration farming, aquaculture awards, risk mitigation, and adoption of new technology & research. Setting up inland Matsyabhavans at strategic locations and engaging Fisheries Extension Officers, project co-ordinators, & aquaculture promoters for the promotion of aquaculture activity to be prioritised.

Aquatic Animal Health Management - It is proposed to establish a network of Mobile Aqua Laboratories for timely investigation, diagnosis, and adopting therapeutic measures. Mobile aqua laboratories will have facilities for conducting clinical examination of live/dead aquatic animals, sample fixing, water, and soil quality analysis. Aquatic animal health centres and mobile aqua laboratories may be used to determine water quality, aquatic animal health, AMR, and antibiotic residue as a part of passive surveillance programmes and for disease diagnosis, seed quality certification, medication, and disinfection of diseased sites as part of the active surveillance programme.

Reservoir Fisheries - In the case of smaller reservoirs, fish stock enhancement programmes would be sufficient, while medium and large reservoirs may be used for cage farming of fish. Fish stock enhancement programmes can be limited to the seeds of endemic carps, endemic catfishes, pearlspot, and mahseer in the case of reservoirs within wild life sanctuaries.

Ornamental & Recreational fisheries -. Ornamental fish rearing units, ornamental fish breeding units, brood banks, quarantine facility, disease diagnostic laboratory, and feed mills need to be developed. The expenses of the present four aquarium have to be met and new aquariums must be established in prominent tourist places. Promotional activities should be undertaken to popularize the keeping of ornamental fish in tanks as a hobby. Pearl oyster farming and tourism fisheries also offer considerable potential in Kerala's context.

Research - Focused research is essential to solve the problems that arise in the aquaculture sector, and these can be undertaken in collaboration with KUFOS.

The fund requirement for the implementation of various programmes for the implementation of above activities is Rs. 793 crore.

1. INTRODUCTION

Despite being a key component in ensuring global food security, marine capture fisheries have almost plateaued off owing to widespread mechanization and motorization coupled with illegal, unregulated, and unreported fishing. Hence, sustainability experts consider aquaculture as a sunrise sector, especially in the context of the projected world population of 9.9 billion by 2050. Fish is a food with high nutritional value, while the carbon footprint associated with its production is comparatively lower. The stagnancy in the captive production sector is a reminder to refocus energy and investments to this sector. Food and Agriculture Organization (FAO) therefore suggests the resilient local development approach for addressing food security and alleviating poverty by making the best use of what is locally available. The disruption caused by the pandemic in agriculture and other sectors allied with food production has made it critical to provide credible and timely information to the different players engaged in these sectors.

Kerala faces a deficit of 2–2.5 lakh tonnes of fish, which results in the inflow of fish from other states. However, this supply tends to be contaminated with preservatives and other chemicals, leading to considerable health issues. In this scenario, the inland fisheries sector in the state has been adopting scientific management approaches for improving the sector. However, the technologies applied in improving the pace of growth of the sector must be in tune with sustainability requirements. The challenges ahead include climate change, frequent floods, and pollution, which necessitate scientific intervention to maintain a steady income for farmers and fishermen from this sector.

This is the background against which Kerala's planning process pertaining to the inland fisheries sector is set. All stakeholders are represented in the discussions that are focused on the three pillars of sustainability that include economic, social, and environmental perspectives. The panel of experts was unanimous in their opinion that the inland fisheries sector of the state has considerable untapped potential. Owing to the availability of water and diversity of species in Kerala, the sector can contribute much more significantly to the fish basket, employability, livelihood enhancement, and protein security, especially nutritional security in terms of the availability of essential fatty acids, essential amino acids, vitamins, and minerals. It is estimated that Kerala has 8171 ha of freshwater ponds, 49718 ha freshwater fields, 2303 ha of brackish water ponds, and 5178 ha of brackish water fields which may be used for conventional farm-based aquaculture.

Non-conventional production systems with improved production levels offer great scope for further enriching the sector and ensuring better economic turnover. Such technologies exemplified by bio-floc aquaculture, aquaponics, cage aquaculture, pen aquaculture, integrated multitrophic aquaculture (IMTA), etc., are expected to create more employment opportunities for marginalised and underprivileged communities, particularly for women and young people. Fish and shrimp culture projects with varying levels of intensification can also be implemented as a means of alternate income for Gulf returnees and entrepreneurs. Augmented fish production will lead to enhanced per capita fish availability to the

public, which would eventually improve the health indices of the community. Likewise, ornamental fish culture and associated business activities offer immense potential for better employability and income security of the stakeholders.

In order to protect the ecological integrity of inland water bodies, anthropogenic incursions must be considered carefully. Water pollution, silting, aquatic weed infestations, illegal construction, invasive species, disease, loss of biodiversity, and climate change pose serious threats to inland waters. It is to be noted that the natural rhythm of regular tidal fluctuations has been disrupted unexpectedly, leading to crop loss and financial crises. Long-term planning including the raising of primary dykes all along the coastal and backwater stretches of the State, and establishing suitable water regulation structures is necessary to address these issues. Also, the extent of public water bodies show an overall decreasing trend which needs to be seriously addressed with stricter rules and regulations. Hence, it is absolutely necessary for the state to plan the progress of the sector ahead and formulate a new plan, keeping in view the achievements and setbacks of the previous plan period for addressing the challenges of the present and future, as well. Scientific adoption of technologies and successful models from other states, countries, and regions will also help enrich the sector and empower stakeholder communities.

2. REVIEW OF THIRTEENTH FIVE YEAR PLAN

Kerala, with its abundant water resources, has always played a key role in India's fish production. Even though major chunk of this production is from marine capture fisheries, considering the rich biodiversity of our inland waterbodies, the sustainable exploitation of these resources offers much promise. Hence, the 13th five-year plan focused on the conservation of these resources as well as their sustainable utilization through stock enhancement and aquaculture activities. Enhancing sustainable fish production from inland water bodies without affecting the species diversity and abundance is always a challenging task and needs scientific management and intervention. Therefore, activities focused on the conservation and management of these resources while increasing fish production through aquaculture and other support service programs were implemented as part of 13th five-year plan. Ranching was undertaken in rivers and lakes for stock enhancement and fishing management. Aquaculture production has been improved by adopting better management practices. The state has also been trying to formulate an appropriate leasing policy for facilitating aquaculture operations. A fish health management programme has been put in place by giving importance to disease diagnosis, management, and control, certification and quarantine measures, and best management practices of farms. The 13th Plan envisaged making Kerala self-sufficient in fish production by promoting open water fishing and aquaculture. The focus of the plan was on increasing seed production of important cultivable species of fish and shellfish, establishment of fish feed mills to ensure quality feed, and establishment of aquatic animal health labs. The outlay of the umbrella scheme 'Inland fisheries and Aquaculture' during the 13th plan period was Rs.417.14 crores, the details of which are given in Table 1 and 2.

Table 1: Outlay for inland fisheries and aquaculture

Particulars	Amount allotted in 13th Five-year plan (in Lakh Rs)					
	2017-18	2018-19	2019-20	2020-21	Total	2021-22 (as on 31-10-21)
Budget outlay	4888.00	7640.00	10905.00	9269.00	32602.00	9212.00
Expenditure	4501.52	4626.64	5607.00	8824.42	23489.32	3505.59
%	92.09	60.55	51.41	95.20	72.04	38.47

Table 2. Component wise expenditure details

SL. No	Scheme Name	2017-18		2018-19		2019-20		2020-21				2021-22 (as on 31/10/2021)	
		Outlay	Expenditure	Outlay	Expenditure	Outlay	Expenditure	Outlay	Expenditure	Cumulative for Expenditure	Cumulative for Expenditure	Outlay	Expenditure
1	Fish Seed Farms, Nurseies and Hatcheries-XXXIIII-2405-00-101-87	800	778.73818	800	547.63445	800	619.82	700	688.62	3100	2634.813	900	311.971
2	Conservand Management of Fish Resources-XXXIII-2405-00-101-62	350	330.58036	390	335.39584	835	372.84	500	451.22	2075	1490.036	500	146.116
3	Aqua Culture Development XXXIIII-2405-00-101-54	1838	1837.72633	4000	2622.32277	7420	4374.93	6119	6090.55	19377	14925.53	6262	2778.068
4	Establishment of Matsyabhavans In Inland Areas-XXXIIII-2405-00-101-53	0	0	650	0	150	0	150	9.09	950	9.09	100	0
5	Aquatic Animal Health Surveillance & Management XXXIIII-2405-00-101-52	0	0	0	0	0	0	100	98.87	100	98.87	100	0.609
6	Reservior Fisheries develop-ment-XXXIIII-2405-00-101-51	0	0	0	0	0	0	200	113.72	200	113.72	150	33.077
7	Fish Seed Farms, Nurseries and Hatcheries-XXXIIII-4405-00-101-95	900	1138.7	1000	879.85231	1000	182.36	900	883.96	3800	3084.872	700	201
8	Aqua Culture Development -XXXIIII-4405-00-101-90	1000	415.78	800	228.49277	700	57.05	500	431.07	3000	1132.939	400	34.746
	Total	4888	4501.52487	7640	4626.64022	10905	5607	9269	8824.42	32602	23489.32	9112	3505.587

Aquaculture production

One of the targets of 13th plan period was to double aquaculture production by expanding aquaculture into new areas and also by enhancing productivity from the existing area by the optimum utilization of water bodies, use of good quality seed and nutritionally balanced feed, implementation of disease prevention measures, and adoption of innovative technologies. The state witnessed a considerable growth in aquaculture during the plan period by increasing the productivity of culture systems through innovative technologies, and popularising new fish species, especially genetically improved varieties and locally preferred species. In previous years, aquaculture mainly focused on three groups, namely, carps, shrimps, and mussel. Presently, the species spectrum has been diversified through the introduction of murrels, tilapia, basa, pearl spot, milkfish, mullets, seabass, pompano, and mud crab. Farmers were made aware of the importance of maintaining good water quality and need for using good quality seed and feed.

Under the Janakeeya Matsya Krishi and Subhiksha Keralam projects, innovative farming techniques like cage aquaculture, recirculatory aquaculture system (RAS), bio floc aquaculture, semi-intensive/intensive farming of fishes & shrimps, etc., were implemented for doubling aquaculture productivity. These innovative farming practices were mainly implemented under blue revolution and Pradhan Mantri Matsya Sampada Yojana (PMMSY). As a result, the aquaculture sector has achieved a growth rate of 20% during the last year. One of the major achievements to be noted during the plan period is that aquaculture, which was considered natural pond-based and seasonal, has become artificial tank-based and perennial with the use of bio floc technology, RAS, and culture in Padutha ponds. The details of the present level of aquaculture productivity in comparison with the national average with respect to conventional aquaculture practices are given in Table 3.

Table 3: Present level of aquaculture productivity

SL. No	Description	Present Level	National Avarge
1	Fresh water ponds-low input system	2.24 t/ha	2.00-3.00 t/ha
2	Fresh water ponds-medium input system	5.02 t/ha	4.00-8.00 t/ha
3	Fresh water ponds-high input system	17.41 t/ha	10.00-15.00 t/ha
4	Fresh water paddy fields	458.68 kg/ha	500.00 kg/ha
5	Brackish water ponds-low input system	758.72 kg/ha	2.00-3.00 t/ha
6	Brackish water paddy fields	367.50 kg/ha	500.00 kg/ha

The details of the present level of aquaculture productivity and that of the possible level with respect to innovative aquaculture practices are given in Table 4.

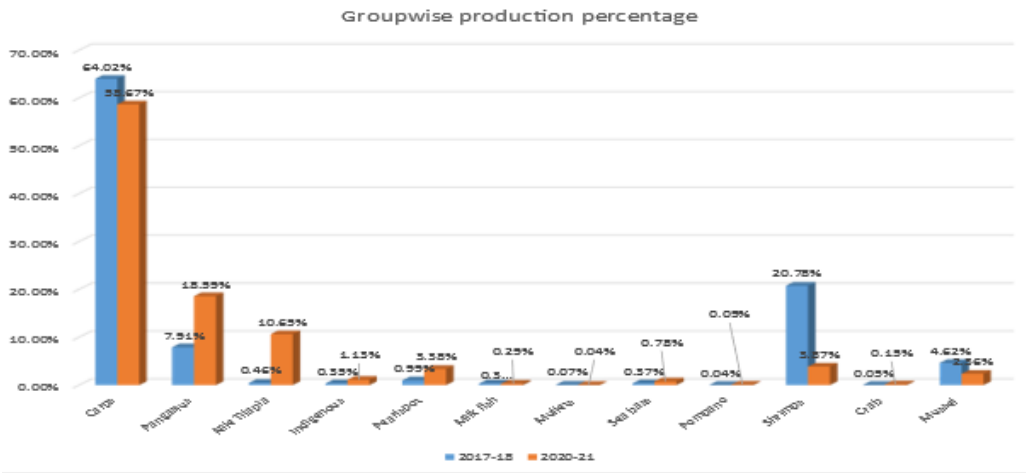
Table 4: Aquaculture productivity with innovative practices

No.	Description	Present level	Possible level
1	Cage Aquaculture (Brackish water)	11.00 kg/m^3	15-20 kg/m3
2	Cage Aquaculture (Fresh water)	16.94 kg/m^3	30-40 kg/m3
3	RAS & Aquaponics	26.91 kg/m^3	30-40 kg/m3
4	Padutha ponds	6.20 kg/m^3	8-10 kg/m3
5	Mussel farming	4.43 kg/m	8-10 kg/m
6	Bio floc Aquaculture (Tilapia)	18.39 kg/m^3	20-25 kg/m3

During the plan period, the contribution of carps, shrimps, and mussels towards the total production has shown a declining trend. On the other hand, production of tilapia, pangasius, and pearl spot shows an increasing trend

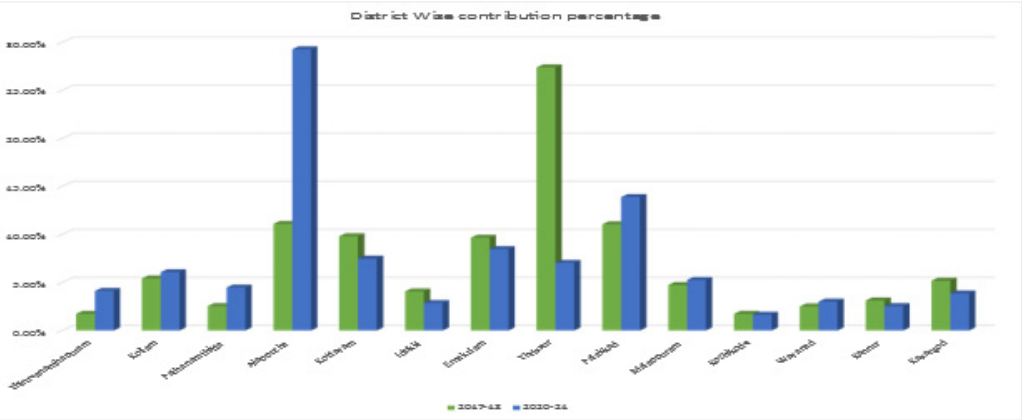
While considering the district-level fish production, the drop in production in Thrissur district was significant owing to the collapse of the aquaculture production system due to the floods in 2018 and 2019. Most fish farmers have left the sector due to heavy financial

Fig 1. Groupwise production percentage for 2017-18 & 2020-21



loss and lack of proper risk mitigation measures by the Government. In contrast to this, there was significant enhancement of aquaculture production in Alappuzha due to the concentrated efforts taken by the government in the wetlands of Kuttanad.

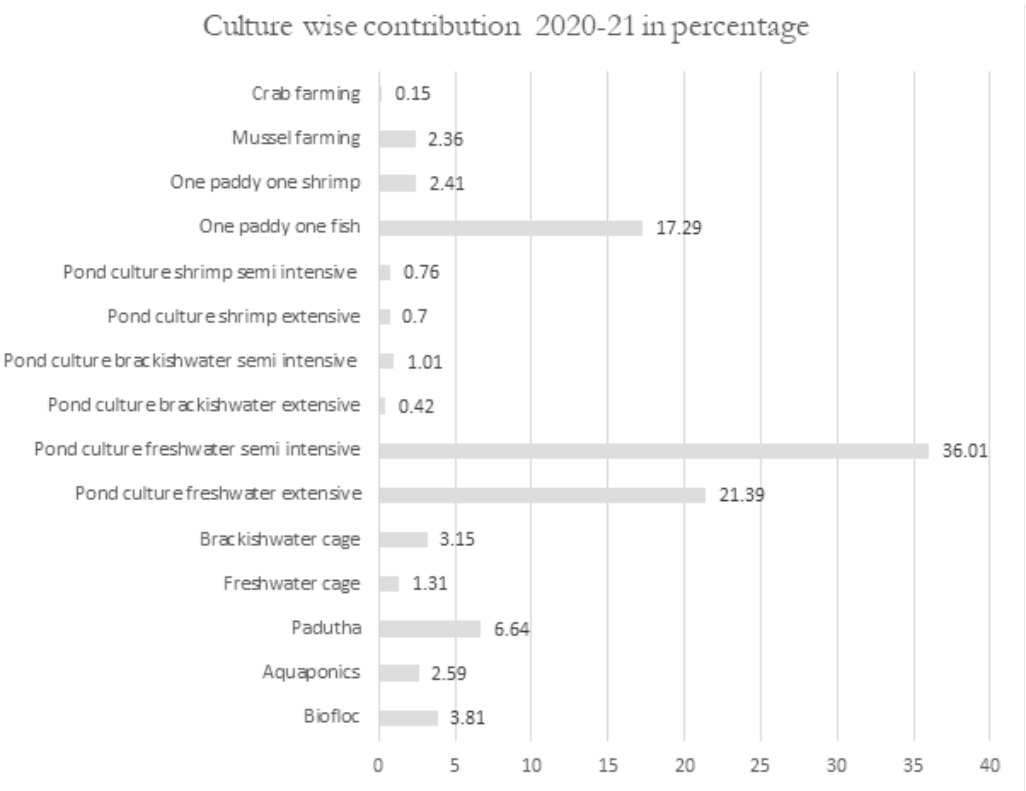
Fig 2. District wise production percentage for 2017-18 & 2020-21



Semi-intensive, pond-based culture continues to be the top contributor, although the contribution from innovative practices such as bio floc aquaculture, aquaponics, and cage aquaculture, has become significant in recent years

Through the introduction of innovative farming practices, use of aeration, probiotics, and biosecurity measures, the typical average production of one tonne per hectare has increased

Fig-3 Contribution of different culture activities



to one tonne per two cents area. Despite the floods and the pandemic, aquaculture production increased from 24,198 tonnes in 2017-18 to 34,987 tonnes in 2020-21. There are approximately 85,000 farmers presently engaged in aquaculture presently. The expected aquaculture production for the year 2021-22 is approximately 40,000 tonnes.

Aquaculture extension

Various IEC activities were done under aquaculture development programs for encouraging aquaculture in the state and also for creating awareness. Fourteen brochures and three video documentaries on better aquaculture practices, bio floc aquaculture system, and farming of Basa in Padutha were created and published. A unified "Package of aquaculture practices" was published as part of the IEC activities. Since the success in aquaculture ultimately depends on aquatic animal health management, a book on "Standard Operating Procedures on Aquatic Animal Health Management" was also published in order to avoid unscientific disease management practices. In order to motivate farmers, aquaculture awards have also been instituted. Training of farmers, technical officers, and stakeholders have played an integral part in popularising aquaculture. They were trained on innovative aquaculture practices as well as best management practices. Both residential and online trainings were organized by the department during the last plan period.

An important extension mechanism adopted during the 13th five-year plan was the

engagement of project co-ordinators and aquaculture promoters. A batch of 100 project coordinators served as extension agents to promote the application of technology for the development of diversified aquaculture systems. Further, 560 aquaculture promoters appointed on temporary basis; however, it has been noted that the performance of half of them are not up to expectations. Aquaculture promoters are the LSGI level contact points for the farmers. For the smooth implementation of projects at the field level and to provide better technical support to farmers, the service of technically qualified project coordinators is found to be more advisable.

Conservation and management of inland fish resources

In order to increase fish landings and sustain the productivity of aquatic ecosystems in inland capture fisheries, there was a need to restore the depleted indigenous fish wealth of the state. Therefore, measures have been taken to protect the natural fish stock through Fisheries Management Councils (FMCs) and enhance the fish stock through seed ranching and establishment of protected areas for fish and clams in Ashtamudi and Vembanad lakes. Afforestation has been done by planting saplings of the native mangrove species in the coastal boundary of lakes. Inland patrolling was conducted to prevent illegal fishing and to ensure the enforcement of the Kerala Inland Fisheries and Aquaculture Act.

Stock enhancement in rivers and lakes

There are 44 rivers having an area of 85,000 ha and so many interconnected backwaters having an area of 46129 ha in the State. The 13th plan focussed on the conservation of natural fishery resources and stock enhancement through fish seed ranching programmes and management of fishing activities in these rivers and lakes. Fisheries Management Councils (FMC) form the grass root-level entity for the management of fisheries resources with a participatory approach. Use of small meshed nets was regulated in the strict sense to avoid the capture of the released young ones. Awareness programmes and focus group discussions (FGD) were carried out among inland water fishermen, in order to enhance their responsiveness to fishery resource conservation, prevention of juvenile fishery, use of specific fishing gear, protection of natural fishing grounds, etc. A total of 1096.70 lakh seeds were ranched in various rivers and lakes from 2017-18 to 2020-21. During 2021-22 370 lakh seeds would be ranched via the stock enhancement programme. Details of the ranching of seeds are given in Table 5.

Table 5. Details of Seed Ranching

Sl No	Name of species	2017-18 (in lakh)	2018-19 (in lakh)	2019-20 (in lakh)	2020-21 (in lakh)	Target (in lakh)	2021-22 till date (in lakh)
1	Carp	141.2	158.2	160.6	138	212	212
2	Shrimp	74.3	99.6	67.5	120	120	26
3	Milk fish/ Grey mullet	8.3	7.8	3.9	0.50	10	6.50
4	Freshwater prawn	0	0	0	20	20	5
5	Others	2.8	2.2	1.976	10	20	0

It is observed that, for approximately 150 lakh carp seeds that were ranched yearly, the annual yield obtained was 2300–3900 kg which indicates a survival rate of only 15–26%. The reduction in the survival rate may be attributed to the small size (4 cm) of the seed used for ranching, which might have been lost due to predation in the open waters. It may therefore be required to ranch large sized seeds for better stock enhancement. There is a gradual enhancement of production in rivers and backwaters which reflects the scientific interventions in the sector during 13th plan period. The river and backwater production figure for the last five years are given in Table 6.

Table 6. Production from rivers and backwaters (in tonnes)

Year	River	Backwater
2016-17	18679	137862
2017-18	19621	141981
2018-19	20436	143646
2019-20	22497	154043
2020-21	24636	160703

Eventhough 234 prawn filtration fields are continuing as such, the annual production has decreased to 292.69 kg/ha. It is seen that bulk of the catch is contributed by the stake net which reflects the unequal distribution of common wealth and points out the need to restrict its use in the future. There are 334 free net landing points. The contribution of stake nets, Chinese net, filtration fields, and free net in the production is given in Table 7

Table 7. Contribution of chinese net, filtration fields and free net

Nets	Units	Total quantity	Unit production
Stake net	6253 no.	33683 mt	5386.69 kg/no.
Chinese net	1631 no.	3908 mt	2396.08 kg/no.
Filtration field	12983 ha	380 mt	292.69 kg/ha
Free net	17118 no.	19456 mt	1136.58 kg/no.

Monitoring, Control & Surveillance (MCS)

There are five patrolling stations at Kollam, Alappuzha, Kottayam, Ernakulam, and Thrissur for effective MCS for the conservation of natural fish resources. Patrolling is conducted to ensure the enforcement of Kerala Inland Fisheries and Aquaculture Act. Illegal fishing methods and implements are removed as part of this exercise whereby natural fish stocks are protected from over exploitation. The details of patrolling conducted are given in Table 8.

Table 8. Patrolling for unauthorized fishing

Sl No	Item	2017-18	2018-19	2019-20	2020-21	2021-22 (as on 31/10/21)
1	No. of patrolling conducted	397	613	563	591	373
2	No. of impounding	64	95	353	194	202
3	No. of unauthorized nets removed	295	369	603	359	25

MCS has been less intense after 2019-20 due to Covid-19 and the subsequent lockdown. It must be strengthened in the coming years for effective implementation of the Kerala Inland Fisheries and Aquaculture Act.

Protected Areas

Aquatic pollution can affect the breeding pattern of fish, especially pearlspot, in inland waters. In order to prevent this, fish protected areas have been envisaged and established as part of Vembanad and Ashtamudi lake conservation. Each such two-hectare area is demarcated in natural waters, where suitable substrates are provided for the breeding of fish and the area is closed for any fishing activities. It was done by the active participation of Fishermen Development and welfare co-operative societies/inland fishermen groups. There are twenty fish protected areas in Vembanad and five in Ashtamudi lake.

As a consequence of human incursions, geomorphological changes, and construction of barrages, clam resources are on a decline that can affect not only the total production, but also the livelihood of clam pickers. Hence, suitable two-hectare sites have been identified in the Vembanad and Ashtamudi lakes and established as clam protected areas. These areas were stocked with baby clam and allowed to breed at least once by banning clam fishing in the demarcated area. There are 17 black clam protected areas in Vembanad lake and two yellow clam protected area in Ashtamudi lake.

Reservoir fisheries

During the Plan period, fish stock enhancement programmes through the ranching of seed was extended to 28 reservoirs having an area of 17,853.85 ha. As a part of reservoir fisheries development programme, 231.58 lakh Indian major carp seeds were stocked in 26 reservoirs outside wild life sanctuary area and 4.3 lakh endemic catfish, endemic carp, pearlspot, and mahseer seeds were stocked in Peechi and Vazhani reservoirs inside the wild life sanctuary area. The details are given as Annexure-1. There has been a gradual

enhancement of reservoir production in the last five years, which reflects the positive results of interventions already done.

Table 9 Reservoir production

Year	2016-17	2017-18	2018-19	2019-20	2020-21
Production in tonnes	3113	3281	3434	3803	4169

Cage fish farming has been undertaken in the reservoirs of Malampuzha, Pazhassi, Banasurasagar, Karapuzha, Peruvannamuzhi, and Kakki reservoirs. Harvesting of fish from these cages have been started partially.

Seed production

Availability of adequate quality fish seed to meet the increasing demand for fish farming and stock enhancement programme is one of the major constraints in the aquaculture sector. During the 13th plan period, the fish seed requirement was estimated to be 12 crores and hence, the objective was to enhance the seed production capacity to achieve the estimated target. In order to achieve this, additional facilities for seed production were created in the existing four carp seed production centres at Polachira, Meenkara, Kallanode, and Chulliyar. Seven new fish seed production centres were established at Neyyar, Kulathupuzha, West Kallada, Peechi, Bhoothathankettu, Thalipuzha, and Karapuzha. Besides, four seed production units at Pannivelichira, Pallom, Walayar, and Ullanam were renovated. Thus, the fish seed production capacity in department-run hatcheries were enhanced from 200 lakh to 700 lakh.

GIFT seed production centre was established at Neyyar and Pannivelichira, and Pompano fish seed hatchery was established at Azheekode in Thrissur. Sanction has also been given for establishing tilapia hatcheries of 100 lakh capacity at Kulathupuzha in Kollam and 25 lakh capacity at Malampuzha, carp hatchery of 100 lakh capacity at Bhoothankettu in Ernakulam, Scampi hatchery of 50 lakh capacity in Alappuzha, and mussel hatchery at Puthyangadi in Kannur, but they have not been commissioned yet. The slow pace of construction, particularly by KSCADC and HED, has caused the state to fall short of the target of 12 crore fish seed production during the 13th plan period. It is expected that construction work will be finished within two years. Details are given as Annexure- 2. Presently, there are 18 fish hatcheries and 7 shrimp hatcheries under the State Government. It is seen that by strengthening of hatcheries and farms, fish seed production has been increasing over the past years. The details of production are given in Figure 4

Fig. 4. Quantity of fish seed produced over the last six years

Table 10 Details of the fish and shrimp seed produced

Year	Fish (no. in lakh)	Shrimp (no. in lakh)
2017-18	243.18	1005.33
2018-19	373.90	807.70
2019-20	493.62	929.23
2020-21	545.85	956.60

In order to enhance the survival rate, feeding with live feed organism is essential. Hence, steps were taken to specially maintain the pure stock culture of the desired phytoplankton and zooplankton in the indoor laboratory for the continuous production of live feed organisms. The details of live feed units established are given in Table 11.

Table 11 Details of live feed units

Sl. No.	Name of hatchery/ Seed farm	AS Amount (In lakh)	Present status
1.	Neyyar	25.00	Work progressing
2.	Thevally	19.70	Completed
3.	Polachira	24.69	Completed
4.	Peechi	18.99	Completed
5.	Azheekode	49.10	Work progressing
6.	Malampuzha	15.68	Completed

Aeration helps in the breakdown of ammonia into less toxic nitrogenous compounds, which helps in maintaining the water quality and ultimately, the health of the seed. For enhancing production through better survival rate, aeration works have been sanctioned for the seed farm/hatchery at Meenkara, Walayar, Malampuzha, Polachira, Ullanam, Kallanode,

Pannivelichira, and Pallom.

Broodstock development programmes aim to develop improved strains of suitable species, which can help in augmenting fish production. The process involves the collection of broodstock with specific characteristics such as good growth and disease resistance, which are bred selectively after establishing a base population in order to obtain improved strains. Steps have been taken for the production of genetically improved pearlspot, which can be expected by the end of the next five-year plan period. Later, these improved varieties would be tested at multiple locations in farms. Genetically improved varieties like GIFT, Jayanthi rohu, amur carp, and catla are sourced and maintained at various locations. The broodstock development programmes were undertaken in the 13th five-year plan are given in Table 12.

Table 12 Status of hatcheries and seed farms at various locations

SL No.	Hatchery/ Seed farm	AS Amount (in lakh)	Present status
1	Kulathupuzha	24.50	Progressing
2	Pannivelichira	24.00	Completed
3	Irattu	24.00	Completed
4	Edathua	168.80	Progressing
5	Kallanode	5.00	Progressing
6	Ayiramtheng	58.00	Progressing
7	Pallom		Progressing
8	Malampuzha		Progressing

CCTV systems were installed in hatcheries in order to increase the security of farms and hatcheries, to prevent poaching of seeds and broodfishes, to monitor the technical and managerial activities and workers, and to monitor visitors and trespassers. Details are given in Table 13.

Table 13 Hatcheries and seed farms provided with CCTV

Sl No.	Hatchery/ Seed farm	Present status
1.	Kulathupuzha	Work progressing
2.	Meenkara	Completed
3.	Polachira	Completed
4.	Peechi	Completed
5.	Malampuzha	Completed
6.	Edathua	Completed
7.	Pallom	Completed

Details of installation of water filtration systems in the hatcheries are given in Table 14. An automated water quality information system was installed at Peechi hatchery for monitoring

and controlling the water quality in tanks. The system functions well in the hatchery, aids in managing water quality, and ultimately increases the survival rate.

Table 14 Hatcheries provided with water filtration systems

Sl No.	Hatchery/ Seed farm	AS Amount (in lakh)	Present status
1.	Polachira	5.00	Completed
2.	Meenkara	5.02	Work in progress
3.	Kulathupuzha	31.00	Retendered
4.	Neendakara	3.50	Progressing
5.	Pallom	4.91	Completed
6.	Malampuzha	8.75	Completed

Establishment of feed mill

It was estimated that 58,000 tonnes of feed were required in the state , which has to be completely imported from other states. Besides, the protein requirement of fish varies from species to species. Carnivorous fishes require 45% protein while herbivores require only 30% protein in their diet. Hence, there was a requirement for species-specific feed. For ensuring the supply of species-specific feed and regulating price, steps for establishing a feed mill at Thalai and Azheekal were taken through ADAK. Thalai feed mill has a capacity of 0.5 tonne/hour and an amount of Rs. 298 lakh was sanctioned for its construction. Azheekal feed mill with a capacity of 1 tonne/hour had a budget of Rs. 583 lakh on 25.11.2016. However, the work at Azheekal is yet to begin and the progress is slow at Thalai.

Aquatic animal health management

Outbreaks of fish diseases pose a severe threat and hamper fish production. Surveillance, timely intervention, prevention, containment, and routine monitoring are major strategies which are very essential for the control and management of epidemics and prevention of financial loss. A state fish seed centre was established at Thevally in Kollam district for ensuring the quality of fish seed and undertaking registration of fish seed farms and hatcheries.

The 13th plan emphasized that Kerala should have a good fish health management programme by ensuring farm hygiene and sound management practices including disease diagnosis and control as well as certification and quarantine. State-level and district-level 'fish disease surveillance and management teams have been functioning to achieve the above. A State Aquatic Animal Health centre is being established through ADAK at Thevara (Ernakulam) for control of fish diseases. In addition to this, action has been taken for setting up regional centres at Odayam, Pannevelichira, Pallom, Azheekode, Malampuzha, Kozhikode, Unniyal, and Thalipuzha. Civil works have been completed for all labs and the procurement of equipment is progressing. Training of staff is to be completed with the assistance of KUFOS, CIFT, and CMFRI.

An effective surveillance programme is essential for ensuring early detection and quick response to control further outbreak of diseases. Regular testing and measures to control the outbreak can help in dealing with diseases effectively. Various activities were planned as part of this programme including seed quality testing, disease diagnosis, antibiotic residue testing, surveillance for the prevalence of AMR, and disinfection of diseased sites. The details of test conducted are given in Table15.

Table 15 Investigations carried out on health management

Year	Seed quality testing		Disease investigation and Diagnosis		Antibiotic residue testing	
	Target	Achievement	Target	Achievement	Target	Achievement
2020-21	260	115	120	61	50	14
2021-22	1000	45	240	30	100	19

Apart from this, a mobile Aqualab with testing facilities has already been procured at Ernakulam and steps have been taken for procuring the second mobile Aqualab for Kollam district.

Support services

Matsyakrishi Sevana Kendram

The concept of MSK includes two components, namely, consultancy service with mini lab and aquaculture input shop. The purpose of MKS was to act as an intermediary extension mechanism for farmers, by providing quality professional guidance. A total of five units has been proposed but only one has been established so far.

Matsya Karshaka Mitram

Skilled labour force is an essential requirement for imparting certain aquaculture activities. This concept aims to create such a specialized and skilled labour force in aquaculture sector. A total of 42 units has been established so far.

Matsyakrishi Saksharatha

Matsya Krishi Saksharatha (MKS) programme aims to attract more investors into the sector. Under this program, it was proposed to establish small RAS units integrated with vegetables in the terrace of the 250 households to instil confidence among farmers to invest in larger units in the future. A total of 500 units has been provided so far under this scheme during the year 2019-20.

Matsya Karshaka Club

Matsya karshaka club is an informal grama panchayath-level organization for aqua-farmers that acts as a common platform to identify and manage local problems in the field. There are 654 Matsya karshaka clubs in the state with 57 clubs having their own building. It was proposed to revive and ensure functioning of at least 400 clubs and to upgrade 100 among them as model clubs in the coming years. The model club should have the necessary infrastructure such as own building, display board, water testing kits, facilities for fish harvest and live fish marketing, data base on potential aqua culture, documentation etc.

The model clubs will be given financial assistance for securing the above basic infrastructure facilities.

Establishment of Matsyabhavan in inland areas

The shortage of technical support, guidance, and monitoring is a factor which inhibits the expansion of inland fisheries, especially aquaculture. Hence, the establishment of Inland Matsyabhavans at strategic locations was taken up at 16 locations for solving the problem to a great extent. Government sanction is being awaited for the establishment of 33 more matsyabhavans.

Demonstration units

Holistic information on scientific farming is a must to convince the farmers about the lucrative aquafarming practices followed all over the world, thus encouraging more farmers to take up the concept. Hence, demonstration farming has been undertaken in various farms under the department and its agencies. The details are given below

1. Demonstration unit of Bio floc Aquaculture System for tilapia in all districts except Idukki to create working model for departmental staff and farmers – Completed
2. Demonstration unit of Bio floc Aquaculture System for vannamei at Neendakara and Azheekode for creating working model – Progressing.
3. Demonstration unit for RAS at Ayiramtheng - Completed
4. Demonstration unit for cage farming of marine/brackish water finfishes at Ayiramtheng and Eranoli farm – Completed
5. Demonstration unit at Govt. fish farm for cage farming of brackish water fishes at, Edakochi and Kadappuram – Completed
6. Demonstration unit for Innovative Aquaculture Practices at Ayiramthengu – Progressing
7. Demonstration unit for Tiger shrimp farming (Zero water exchange) at Ayiramtheng and Eranoli farm – Completed
8. Demonstration unit for farming of Mud crab in pond integrated with mangroves in Govt Fish farm, Ayiramtheng – Completed

Government fish farms

There are six farms under ADAK and three under Matsyafed that concentrate on demonstration farming and providing practical training to functionaries and farmers. Fish production details of the farms under ADAK is given in Table16.

Table 16 Fish production details of the farms under ADAK

Year	Production (in tonnes)					
	Ayiramtheng	Edakochi	Njarakkal	Poyya	Kadappuram	Eranjoli
2017-18	11.4	0	3.03	22.9	0.11	1.88
2018-19	4.56	6.88	4.57	10.29	0.25	1.37
2019-20	2.75	14.72	2.74	9.4	1.27	0.86
2020-21	6.53	11.01	6.29	7.91	2.42	0.83

The status of infrastructure work during the last plan period is given below:
1. Infrastructure Development of Govt Fish farm, Ayiramtheng – Progressing
2. Infrastructure Development of Demonstration farm at Kadappuram – Progressing
3. Infrastructure Development of Demonstration farm at Njarakkal – Progressing
4. Infrastructure Development of model shrimp farm, Poyya – Progressing
5. Infrastructure Development of Eranholi farm of ADAK – Progressing

Aquariums

Presently there are four aquariums in the state. Those at Neyyar and Odayam is operated by ADAK and the others are directly operated by the department of fisheries. The details of visitors during the period are given in Table 17.

Table 17. Details of aquarium visitors

Year	No. of Visitors			
	Malampuzha	Karappuzha	Neyyar	Odayam
2017-18	302745	25518	74766	43875
2018-19	237046	15357	64915	33118
2019-20	216321	17841	62868	36456
2020-21	101190	3,727	11185	7509
2021-22 (till 31-10-2021)	19908	4813	2889	2444

Ornamental fisheries

India's share to the global ornamental fish trade is as low as 0.4% and hence, the country is rightly projected as a 'sleeping giant' because of the untapped potential resources. Indian ornamental fish trade mostly depends on freshwater fish (90%) with negligible contribution from marine fishes. In India, the sector is highly unorganized with about 200 species and its colour variants being produced, collected, and traded internationally. The strategy for production as well as marketing of each species differ depending on the diverse nature. Government interventions to promote the industry have not been fruitful as there was no customized approach for diverse species and treated the same as a singular product or commodity.

During 2017 – 2020, India exported ornamental fishes to 36 countries and more than half of it them were for the Chinese market. Markets for Indian ornamental fish have never been consistent, and their destinations have changed frequently. The most important indigenous varieties exported are Sahyadria denisonii, Botia lohacata, Botia striata, Carinotetraodon travancoricus, and Channa sp.

In order to have a substantial global presence in the field India needs to have a quantum shift from its current cons to "Competitor Oriented Strategy". It is necessary to develop breeding protocols for all the high value indigenous species in the export market. At the same time, it is also necessary to mass produce good quality exotic species at a price cheaper than Southeast Asian Countries.

The contribution of Kerala to international trade in ornamental fish is almost negligible, except for the wild-caught varieties collected from the streams, rivers and backwaters. The lack of awareness on the potential ornamental fishes available in the state, underdeveloped handling system including the domestic and overseas airline network, lack of proper breeding technologies, inadequate extension functionality, less government support, and poor market information system are the major reasons for the poor growth rate and performance in this sector. Demand for different indigenous ornamental fishes change from year to year. Therefore, the potential varieties for breeding and culture are to be selected only after careful market analysis, so that the global demand and price levels can be maintained sustainably.

3. APPROACH FOR THE FOURTEENTH FIVE YEAR PLAN

"Sustainable development of fisheries for nutritional security & economic growth of the state and for socio-economic upliftment of fishermen community".

Inland capture fisheries

One of the main priorities in the 14th five-year plan, is to enhance inland capture fish production from 1.89 lakh to 2.2 lakh tonnes through sustainable management and effective surveillance. This can be achieved by ensuring fair price for fish, protecting traditional livelihood, and creating new opportunities for inland fisherfolk.

Effective Monitoring, Control & Surveillance (MCS)

Capturing undersized fishes and brooders during their natural breeding season is detrimental to the sustainability of fish production. Even as awareness efforts against small-mesh nets have been largely futile, MCS can be an effective tool in the management of this inland fishery. Regular patrolling and imposition of penalties for any violation of Inland Fisheries & Aquaculture Act can restrain people from illegal fishing practices. This requires the increased use of resources and strengthening of manpower and technology. Currently, there are patrolling units in only five districts (Kollam, Alappuzha, Kottayam, Ernakulam and Thrissur). There should be at least one patrolling unit in all the districts for ensuring effective MCS.

Regulation of fixed nets

Experts opine that, unlicensed fixed nets like stake nets and Chinese dip nets that trap undersized fishes and brooders need to be uninstalled and fish catch during the high tide needs to be stopped. The tendency to use small mesh sizes also needs to be prohibited. Fishes must be allowed to breed at least once in their lifetime so that essential stock is maintained in the natural waters without causing recruitment overfishing.

Over capitalization of fishing efforts is also a serious concern. Table 7 indicates that out of the total inland capture fisheries, 58% was caught by stake nets and Chinese dip nets, resulting in the concentration of income and depriving benefits to the majority of inland fishermen. Removal of illegal nets can promote the availability of fishes to a large majority of inland fishermen, thus improving their socio-economic status.

Illegal reduction in mesh size results in the capture of undersized fish, which is mostly wasted. Hence, the committee is of the view that fixed nets – even licensed nets - should not be allowed to operate in natural water bodies. A buy-back scheme is proposed for licensed stake net and Chinese nets. In the case of fishermen who do not wish to sell their nets, a onetime assistance may be given to correct the mesh size of the net to the permitted size. In most cases only cod end replacement is required.

Protected area

Heavy siltation, dredging operations, construction works, and pollution have resulted in the destruction of natural breeding grounds of fish and shellfish. The deterioration of the ecosystem has resulted in the disruption of the food web, which in turn affects the species

diversity and availability. Because of heavy siltation and construction works, areas that had a water depth of 3–6 m has become very shallow. This has affected water flow and tidal influences. All these have contributed to a grave reduction in the seed availability of commercially important species of fish and shellfish. The indiscriminate capture of brooders has led to recruitment overfishing, especially that of pearlspot. Production from the brackish water fields has reduced to one-third compared to the production in the 1960's. Therefore, the committee is of view that construction works that harm the ecosystem should not be allowed. Temporary bunds used for bridge construction should be removed as soon as possible. The breeding grounds of the fish may be demarcated with the co- operation of the local fishermen. Prohibiting fishing in these regions can invariably lead to more recruitment, thereby increasing the production. This is especially important in the case of indigenous fishes like Etroplus suratensis.

The construction of Thanneermukkam bund has resulted in changes in the water quality parameters and reduced the availability of clams, thus affecting the livelihood of fishermen who depend on it. So, there should be clam protected areas also, where clams, especially Paphia malabarica and Villorita cyprinoides, are allowed to breed and recruit to fishery production. Suitable areas have to be identified with the help of the scientific community, local fishermen, and co-operatives so that a collective effort may be ensured for the protection of such breeding grounds.

Stock enhancement

Ranching is an effective method for replenishing the depleted stock of commercially important species.

Most brackish water fishes migrate to areas of higher salinity for spawning. There are freshwater species that migrate to estuarine areas to spawn. These breeding migrations are vital for their existence and to increase fishery recruitment. However, the unscientific construction of roads, dams, and bridges, have impeded water flow, thus obstructing breeding migrations. Siltation has also resulted in decreasing the width and depth of these water channels. As a result, brooders perish without the opportunity to spawn. Therefore, it is necessary to replenish the natural stock of these fishes by stock enhancement and other scientific management measures. Stock enhancement of rivers and brackish water resources should be undertaken by ranching, preferably with seeds of commercially important indigenous fishes of the lower trophic level, after they grow to at least 10 cm size in separated areas like 'kaithodu' in adjoining canals. Use of bigger seed can increase survival rates.

Participatory management & awareness creation

The management of waterbodies and fishing operations should be done through Fisheries Management Councils (FMCs) in association with LSGI's. There should be awareness creation to make each fisherman responsible for increasing the catch. These communities can contribute much to waterbody management as they are well-acquainted with the local conditions. All activities related to the conservation of inland waterbodies can be monitored by this participatory approach.

Mangrove afforestation

Tropical mangroves provide a wide range of ecosystem services such as nutrient cycling, flood and erosion control, etc. They also offer a safe breeding and nursery ground to a wide variety of fish and shellfish. Kerala once supported approximately 700 km² of mangroves, which has dwindled due to variety of reasons. Mangrove afforestation along the periphery of brackish water fields must be undertaken to provide better protection of these areas from unusual tidal surges, floods, and pollution.

Restoration of damaged aquatic ecosystem

Fish kill due to pollution of water by pesticides, industrial waste, plastic waste etc. has become a common phenomenon in Kerala Release of untreated hospital discharge and domestic sewage lead to the rapid increase in antimicrobial resistance (AMR). The introduction of temporary bunds along the road/bridge construction sites has damaged aquatic ecosystems in many places. Such areas need to be restored. The possibility of constructing culverts on roads across streams may be explored so that the migration of fishes is not affected. There should be periodical dredging so as to clear and widen channels and canals before the seasonal breeding migration of commercially important fish. Regulatory bodies should implement rules and regulations regarding discharge of effluents/solid wastes including plastic into the water bodies. Modern surveillance technologies such as use of drones and web-enabled cameras should be considered to prevent violations.

Analysis of fish catch data and study of other indices

Data collection and creation of a reliable database is essential for realistic planning and projections. Data should be collected based on the random sampling method from landing centres and inland water bodies for estimating the production from capture fisheries. Data collection should be made by enumerators specifically assigned for this task with specified qualifications. To refine management plans, accurate data on fish catch and species availability are essential, which may be facilitated by developing a system for fish catch assessment in inland capture fisheries. The development of an app for obtaining the quantity of fish caught at landing centres and at harvest in each farm unit (big and small) functioning within each LSGI is to be ensured for better accuracy in inland production statistics.

Control of invasive species

Regular monitoring, assessment, and eradication measures of invasive species such as Clarias gariepinus and Mytella strigata must be undertaken. Transboundary movement of alien species should be strictly regulated according to international, national, and state legislations. The state should become a member of the international organizations and programmes involved in monitoring and control of invasive alien species.

Inland aquaculture

It is estimated that the state has an aquaculture production potential of 1.3 lakh tonnes based on a survey conducted by the fisheries department during 2020-21 (Annexure-3). Aquaculture production may be enhanced by adding more species into the basket of the aquaculture system and by adopting latest technologies and extending aquaculture into new

areas. A production of 70,000 tonnes may be easily achieved during 14th plan period. Low availability and poor quality of seed, disease prevalence, high risk due to climate change, lack of credit support without collateral security, limited research activities on prevailing issues, shortage of technical manpower, lack of scientific skill among major stakeholders, and lack of proper extension support are the major constraints in the aquaculture sector. There was a considerable hike in aquaculture production in the year 20-21 (34,991 tonnes) compared to the previous years, mainly because of the adoption of innovative practices such as cage aquaculture, bio floc aquaculture, and RAS.

Carp-centric aquaculture has limitations in the state due to poor consumer acceptance and hence, focus should be given to preferred species. The freshwater aquaculture sector can focus on murrel, basa, and tilapia. Likewise, pearl spot, milk fish, vannamei shrimp, edible oyster, and mud crab are to be encouraged in the brackish water sector. In the case of shallow ponds, farming of air-breathing fishes can be encouraged.

The potential for cage farming in quarries and backwaters must be fully utilized. Public freshwater ponds may be utilized for cage farming to increase the production per unit area. Cage culture of pompano and seabass, pen culture in shallow areas, and mussel and edible oyster farming may be promoted. The asymmetrical growth pattern of fishes in cages needs to be addressed. Possibility of seaweed culture via tissue culture seeds may be given importance.

There should be special emphasis for the filtration fields of Pokkali as well as Kaipadu lands, which have been underutilized due to several reasons. An integrated study for the revival of the ecosystem and optimum utilization of the agriculture-aquaculture potential is required. The conflicts of interest between farmers and fishermen are a regular problem that needs to be addressed. The 'kettukalakkal' has to be postponed at least to the 30th of April so that the shrimp reach a marketable size and fetches a decent price. There are frequent occurrences of unexpected tidal surges since 2018, which causes flooding. The height of peripheral dykes have to be increased based on the tidal parameters in each area and strengthened by planting mangroves. Mangrove infestation & joint ownership of larger fields are the other problems. Previously farmed areas that have recently been inhabited by mangroves should be brought back to farming. At the same time, measures must be taken for encouraging the revival of tiger shrimp and white shrimp culture. Crop rotation with alternate culture of fin fish and shellfish should be followed to ensure ecological sustainability.

Campaigns should be strengthened to ensure that all the fields in the Kuttanad and Kole lands are utilized for fish culture during gaps in paddy cultivation, through padashekarams or co-operative society. The problems in this sector include conflicts between agricultural labours and farmers and lack of advanced seed for one-paddy-one-fish cultivation. Paddy fields may be better utilized by doing nursery rearing in Padutha ponds near fields during the paddy cultivation season and releasing bigger fingerlings into the fields after the paddy harvest. If possible, a demand-based production plan has to be made for paddy fields to facilitate aquaculture. In most cases, aquaculture fetches more profit than agriculture and

farmers are more interested in fish culture. This shift is also prompted by the risk of loss in agriculture. Studies can be conducted jointly by KUFOS and KAU to identify areas that are not suitable for agriculture so that it can be used for aquaculture. LSGI level committees may be formed consisting of presidents of respective grama panchayath, agricultural officers, fisheries extension officer, and presidents of primary cooperative society.

Integrated agri/horti/flori culture has to be promoted along the bunds for aquaculture farms. Integrated livestock and poultry farming, and cultivation of medicinal plants may also be explored.

The prevailing practice of giving 40% grant to new farmers for infrastructure development and meeting operational costs need to be continued in the 14th five-year plan also, but in the case of natural ponds, it should be restricted to 0.1 ha and above. For successful subsequent crops, a grant of 20% of the feed cost based on biomass as declared by the farmer and authenticated by the concerned officer, should be considered as production incentive. Besides, seed should be provided free of cost for entire aquaculture activities and its nursery rearing in the farm should be made mandatory.

The extent of water bodies available for aquaculture has to be physically verified and the data has to be superimposed on GIS data to get a clear picture. This enables the efficient management and use of natural water bodies in Kerala for fishing and other allied activities. Aquaculture zones may be established with its own seed and feed production. There should also be a defined leasing policy for water bodies. Aquaculture operations are to be carried out in project mode, prepared at the LSGI level. The LSGI's should have the correct data regarding areas suitable for cultivation, so that it will be easy for the farmers to get the land on lease. Public ponds which not currently used for fish culture should be cleared and cleaned and fish culture should be initiated with the participation of youth clubs/ neighbourhood groups/Kudumbasree, etc.

In remote areas, unavailability of electric power is one of the major constraints that affect productivity. Renewable sources of energy shall also be made available in such remote farms. In order to encourage aqua farmers to shift to renewable sources of energy, attractive financial assistance should be provided, such as electricity charges towards the operation of marginal aquaculture farms should be provided. There should be proper risk mitigation policy that includes crop insurance as in agriculture, and also ensure that department schemes reach all interested farmers.

Protein content and source of fish feed plays a crucial role in fish growth. It is recommended to have a monitoring system including biochemical tests to ensure the supply of good quality fish feed. Feed mills should be established in the public sector to regulate price.

It is noted that only about 50% of the retail price of fish reaches the farmers, owing to exploitation by middlemen. Increase in fish production should be accompanied by improved marketing strategies. E-commerce and the use of technology platforms for effective networking and marketing of the produce will encourage farmers and entrepreneurs. Branding of products, eco-labelling, and certification will help farmers realize better

value and capture the domestic market, but also ensure that more farmers adopt good management. Better market linkages, storage facility, and value addition enterprises must be encouraged for ensuring fair price of the fish to the producer. There should be inter-institutional co-operation for the procurement and marketing of fish. The marketing has to be improved by:

a) Establishing a network of live fish marketing outlets/kiosks and/or chilled storages.
b) Marketing the produce by collaborating with Matsyafed must be given focus to avoid middlemen.
c) Including fish in the noon meal program of school children.
d) Enhancing fish-consumption habits of the people through proper campaigning.
e) Increasing the popularity of fish produced by organic farming in the state.

Reservoir fisheries

The State has 47 reservoirs having an area of 34,000 ha, which includes 37 small reservoirs (<1000 ha), 9 medium reservoirs (1000−5000 ha) and 1 major reservoir (>5000 ha).

Fish stock available in the reservoirs has diminished drastically due to obstructions imposed by the dam against the breeding activities of fish like endemic carps, indigenous catfishes, and mahseer, resulting in the domination by exotic species such as tilapia. In order to facilitate the breeding activities of these fishes, fish ladders, also known as a fishway, fish pass, or fish steps, can be constructed around artificial barriers (such as dams) for ensuring the passage of fishes. Most fishways enable fish to pass around barriers by swimming and leaping up a series of relatively low steps (hence the term ladder) into the waters on the other side. The velocity of water falling over the steps has to be great enough to attract the fish to the ladder, but it cannot be so great that it washes fish back downstream or exhausts them to the point of inability to continue their journey upriver.

Stock enhancement, preferably using endemic species, is another key factor to improve fish production in the upstream of the dam. It has both conservatory and developmental importance. Harvesting can be permitted for nearby tribes or other residents using a large-meshed gill net with the help of coracles, so that the fish production will be sustainable. There are 23 reservoirs having an area of 8563.61 ha suitable for a stock enhancement programme, which has a potential of producing 4281 mt.

The feasibility of cage aquaculture in reservoirs may also be explored. Cage farming is ideal for utilizing the resources in the most judicious and optimum manner to generate the most efficient output, including employment and income generation. In comparison with open reservoir fishing, cage culture effectively multiplies the production from a given water area. A water volume of 96 cubic meter can potentially produce 2−3 tonnes of fish in 10−12 months while the normal catch in reservoirs is around 80−140 kg/ha. At the same time, it can generate around 200−250 man-days of employment to fishers compared to a mere 4−5 days of fishing (assuming a daily catch of 5 kg/person). There are 10 reservoirs with an area of 20,275 ha in Kerala, where 8200 cage units may be installed, offering a production of 16,400 tonnes. However, this should be through a slow process over a period of the next 10 years, so that any environmental hinderances can be addressed effectively. Suitable

locations for the cages can be identified within the reservoirs and selected fishers, farmers, entrepreneurs, co-operatives, and SHGs may be encouraged to set up cage aquaculture systems in these reservoirs.

Seed production

Infrastructure development

Despite the considerable increase in fish seed production during the last 5 years, the gap between production and demand for good quality fish seeds remains considerable. In order to obtain self-sufficiency in seed production, it is necessary to establish new hatcheries and increase the capacity of existing ones. Sanction for establishing hatcheries at the department level is accorded for brackish water fishes at Azheekode, carps at Bhuthathankettu, mussel at Puthiyangadi, tilapia at Kulathupuzha and Malampuzha, and indigenous fishes at Peechi, and this should be completed urgently within the first year of the next plan. New hatcheries for seabass at Odayam, basa at Pallom, tilapia at Kallanode, Parazhi, Ullanam & Polachira, vannamei at Ponnani & Azheekode, carp at Idukki & Edathuwa, and murrel at Neyyar must be considered in the 14th five-year plan period and completed the same by not later than 2025, to meet the demand for fish seeds. Details of expected seed requirement and production is given in Table 18. Participatory seed production in the backyard is possible for pearlspot and murrel, and it may be promoted by the transfer of appropriate technology and by providing financial and market linkages. Considering the huge investment required for establishing new hatcheries, it is important to ensure the involvement of the private sector in seed production particularly for tilapia, basa, seabass and vannamei shrimp.

Table 18. Expected seed requirement and production (in lakh)

Sl. No	Item	Seed requirement by 2025	Existing production capacity (Govt.)	Expected production by 2025 (Govt.)	Expected production (Private)
1	Tiger shrimp, White shrimp	3100	1150	1395	1700
2	Vannamei shrimp	4800	-	1000	3800
3	Pearl spot	150	50	75	75
4	Pompano, Seabass, Cobia	30	10	20	10
5	Milk fish, Grey mullet	200	-	-	200
6	Mud crab	10	-	10	
7	Carp	1200	700	1200	
8	GIFT	1100	100	700	400
9	Pangasius	200	-	-	200
10	Murrels	300	-	-	300
11	Others	200	25	100	100

Technical improvement

One of the major limiting factors in fish seed production is the low availability of good quality, balanced, and nutrient-rich feed. This can be overcome to a great extent by providing live feed organisms to the young ones. Hence, it is highly essential to initiate live feed culture in all hatcheries. Aeration facility, state-of-the-art water quality management, flood protection, and use of renewable energy sources must all be ensured to ensure the survival rate of seeds.

Genetic improvement of the stock can be achieved by using fresh stock of the brooders every year. Annual replacement of brooders should be done to prevent 'inbreeding depression' and ensuring genetic improvement of the stock. Technology-based year-round seed production of carps and commercialization of seed production for indigenous fishes need to be explored. R&D for the commercialization of technology for indigenous fishes, health management interventions to enhance the survival rate, ISO certification for seed quality improvement, etc. should also be implemented.

There should be a central quarantine facility for brooders and other exotic fish which could be used for small scale hatcheries and government-certified quarantine facility may be allotted for large scale hatchery operations.

Ornamental & recreational fisheries

The existing brooders and fish varieties of exotic ornamental fishes are not of sufficient quality to improve domestic production at present. Steps should be taken to import quality brood stock and introduce new varieties in the ornamental fish trade to enhance production and compete in the international market with South East Asian countries. A list of fishes that could be imported from other countries as been issued by the DAHDF, Government of India. Steps should be taken to review this list of species to include new species which are in demand in the current international market. While the import of invasive species should be prevented, inter-state trade of exotic and indigenous ornamental species within India should be unrestricted. Registration and licensing of ornamental fish seed farms and hatcheries should be streamlined.

Separate quarantine/trans-shipment facilities need to be established for the import and export of ornamental fishes. For import of ornamental fish, elaborate facilities for proper quarantine and adherence to necessary protocols must be ensured. A mandatory quarantine facility should be established, preferably near Cochin International Airport Ltd. (CIAL). The AQC for ornamental fishes must be separate from food fish to prevent accidental pathogen transfer between the consignments. Temperature-controlled pre-shipment holding and repackaging facilities may be established in all the airports.

Institutions like KUFOS must focus on developing standardised breeding and rearing protocols for potential indigenous species, as well as on technology transfer to entrepreneurs. Hands-on training, skill development, and capacity building programmes for stakeholders have to be carried out separately for each species.

Industry-sponsored advertisements and programmes, trade shows, etc. should be conducted

regularly to popularise ornamental fish keeping. Well-maintained aquaria may be exhibited in government offices, schools, colleges, hospitals, and other public spaces to improve the visibility. Technology-assisted marketing of ornamental fishes by the development of an e-platform for e-trading and e-marketing is necessary to increase connectivity between buyers and sellers and also for ease in transactions.

Ornamental fish-keeping requires much equipment other than the fish itself; activities related to the construction of aquarium tank, gadgets and devices such as aerators, pumps, skimmers, filters, aqua-scaping, feed production, water quality management, healthcare monitoring, sale of therapeutics etc., also have to be promoted. Saplings of aquarium plants, particularly those available in plenty in local water bodies, have to be distributed to the farmers for mass production. Micro propagation can also be resorted to, for producing bulk volume in a short period.

Kerala's ornamental fish trade is worth Rs. 1750 lakh annually, with our contribution being Rs. 500 lakh. Steps should be taken for the additional production of ornamental fishes worth Rs. 2800 lakh by encouraging the establishment of production units under PMMSY. Specialised infrastructure required for different species must also be considered. Rearing of certain species of egg layers like sword tail, platy, and mollies can be carried-out by establishing backyard freshwater ornamental fish rearing units. The species like guppy, discus, and fighter can be reared successfully by establishing medium-scale ornamental fish breeding units. In order to increase production, integrated ornamental fish unit (breeding and rearing for fresh water fish and marine) with laboratory facility as well as live feed production units are necessary with the production of one lakh fry per year, and entrepreneurs must be given sufficient training. A brood bank for exotic fishes and another for indigenous fishes must be established for ensuring continuous supply of brood fish. Abstract of the requirement is given in Table 19.

Table 19. Number of ornamental fish rearing unit

Sl. No.	Name of activity	No. of units
1	Backyard freshwater ornamental fish rearing units	500
2	Medium scale freshwater ornamental fish rearing unit	100
3	Integrated ornamental fish unit (breeding and rearing for freshwater fish)	20
4	Integrated ornamental fish unit (breeding and rearing for marine fish)	5
5	Freshwater ornamental fish brood bank	2

In order to maintain the quality standards of fish for effective domestic and international trade, it is imperative to establish a state-of-the-art diagnostic laboratory for the detection of infections and pathogens present in fish stock for import and export, as well as for mandatory random sampling of imported consignments. As food and feeding habits are different for each fish species and also for the different age

groups, appropriate feed needs to be prepared in the required quantity. A feed mill with adequate production quantity has to be established to cater to the ornamental fish sector.

The expenses of the present four aquariums have to be met in the current plan period as we;;. Visibility of the sector should be improved by establishing new aquariums. Farming both freshwater and marine pearl oysters should be promoted through fishermen groups as a measure for livelihood support. Existing farms under ADAK can be linked with tourism activities including boating, angling, and seafood cafeterias.

Aquatic animal health management

Increased aquaculture production, as envisaged in the 14th five-year plan, requires the state to be prepared to tackle frequent outbreaks of diseases. For this, a well-managed machinery with strong linkages between the state fisheries department, KUFOS and farmers is are essential. Effective disease monitoring, surveillance, and reporting are the first steps towards the prevention of disease spread, particularly of new and emerging diseases. For implementation of this network, a State lab at Thevara and eight regional labs at Odayam (Varkala), Pannivelichira (Kozhencheri), Pallom (Kottayam), Azheekode (Kodungallore), Malampuzha, Unniyal (Tirur), Westhill (Kozhikode), and Thalipuzha (Wayanad) were sanctioned in the 13th five-year plan. These will become functional shortly. Besides, 14 mobile Aquaclinics should be established under the fisheries department.

A hub-and-spoke model, with the referral lab at KUFOS working as the central hub for the regional labs, can result in better co-ordination of all the activities. The referral lab for aquatic animal disease diagnosis and quality control being established by KUFOS under PMMSY will serve as the nerve centre of aquatic animal health management in the State. The disease diagnosis lab at the regional centre of KUFOS at Payyannur will cater to the needs of Kannur and Kasargode districts. A state-of-art mobile Aquaclinic operated by KUFOS (procured under PMMSY) enables sample collection from the farmers' fields and has facilities for the primary investigation of diseases and advisory services to the stakeholder at farm premises itself. The State Referral Lab at KUFOS will have facilities for analysing antibiotic and pesticide residues, and heavy metal contamination in fish and fishery products. Detailed clinical investigation and disease diagnosis will also be possible at the referral lab. The regional labs will be equipped with facilities for the microbiological analysis and PCR testing of samples, in addition to the routine analysis of soil and water quality parameters. PCR testing to screen for Aphanomyces invadans in fish, TiLV in tilapia, and WSSV, IHHNV, MBV, HPV, and EHP in shrimp will be continued in all these centres. Facilities for analysing the quality of feed will also be available. The farms in which positive or infected samples are observed should be thoroughly disinfected, ensuring that the water in these farms is not discharged to open water bodies/canals.

Personnel in these disease diagnosis centres should be technically qualified as per the SoP of the Govt. of Kerala and trained in the different levels of aquatic animal disease diagnosis. Training of lab personnel can be arranged at ICAR-CIFT, ICAR-CMFRI, and KUFOS and it must be ensured that only such trained staff are deputed in the labs.

Intensification of aquaculture may also lead to the increased use of antibiotics. Being

partners in Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) of the state, the fisheries department and KUFOS are committed to ensuring the judicious use of antibiotics. Awareness programmes for farmers and surveillance for the prevalence of AMR for E. coli, Staphylococcus spp., and Klebsiella spp. in aquaculture farms, which is currently carried out by KUFOS with funding from the State Fisheries Department can be continued in the 14th five-year plan. Screening for antibiotic residue including chloramphenicol, tetracyclines, and quinolones in fish/shrimp should be carried out.

However, in certain situations, use of antibiotics as per the SoP may be indispensable. Therefore, it is necessary to work out the withdrawal period and maximum residual limit (MRL) for recommended antibiotics for each culture species. Also, alternate strategies including the development of probiotics, phage therapy, and other biocontrol methods should be given priority in research activities.

Aquaculture research

Aquatic environment

Ecosystem-based Fisheries Management (EBFM) strategy has been developed for the optimum utilization of the different inland ecosystems of Kerala. This includes measures to utilize swampy/derelict water bodies for fisheries development. In order to ensure sustainable mussel farming, cage culture, or pen culture, the carrying capacity of the water body has to be determined scientifically. The number of cages, pens, or rafts that can be installed in a water body has to be restricted based on this. A systematic study of the extent of invasion and damages caused by alien species in our water bodies should be conducted. Proper mitigation measures should be developed and advocated.

Seed production

Focus of the research should be on the standardization of commercial seed production of indigenous species of fish such as Wallago attu which have good market value. Indigenous fishes can also be ranched to enhance stocks with a view to improving the livelihood of the tribal population who have the right to fish in these waters.

Species diversification

Lack of diversification in the cultured variety of fishes is a major lacuna faced by the state. For instance, fishes cultured in freshwater are mostly restricted to carps, and research on culture technologies for commercially valuable indigenous fishes should be explored.

Fish nutrition

Species-specific and stage-specific feed based on the nutrient and physiological requirements of each species has to be developed. Microencapsulated feeds also need to be developed, which can provide balanced feed without leaching.

Aquatic animal health

Research on alternate strategies including development of environment friendly and safe therapeutic measures, and studies on withdrawal period and MRL for all the major cultured species should be initiated. Cost-effective rapid detection kits for the most serious diseases of fish and shrimp that have significant economic impact will facilitate timely decisions.

Aquaculture extension

Advances in big data and AI should be adopted for feed and water quality management. This, in turn, can help in developing prediction models for disease prevention. Sudden/ unusual changes in water quality/feed intake pattern can serve as early warning signals that could help farmers take adequate precautionary measures. It will also help optimize the feed given, thereby minimizing the wastage of feed and reducing organic load. A user-friendly mobile application may be developed that can be used by the farmers at the field level to detect the change in environment and behaviour of cultured organisms

Aquaculture extension service

Extension support

The main lacunae in the promotion of aquaculture activities in the state is the shortage of technical manpower and lack of proper guidance and monitoring. The present staff strength of the department is grossly inadequate and unable to meet the requirements of the inland sector.

In order to accelerate the process of decentralization and to provide service at the field level, 158 Matsyabhavans have to be established at strategic locations in each development block and municipal corporation. Instead of more aquaculture promoters, 300 project coordinators may be engaged at the field level who are qualified to give technical advice, so that one official can provide assistance and technical support to farmers from 3–5 panchayaths.

Promoting fish as health food through campaigns in mass media, social media, and educational campaigns in schools must be taken up. Inclusion of fish in daily diet, particularly among pregnant women and adolescent girls, is to be promoted

Capacity building programme

Training programmes form the core of aquaculture activities. Confidence-building and technical training for farmers should be imparted with the help of KUFOS and other central institutes. Training can be in both online and offline mode. Residential training programmes and hands-on training may also be included wherever necessary.

Technology acquisition & Demonstration farming

Aquaculture is a highly dynamic sector. Hence, it is necessary to introduce new technologies in the sector for updating farmers to new conditions in the field. Holistic information on scientific farming practices is a must to convince farmers about lucrative aqua farming practices followed all over the world, thus encouraging more farmers to take up the concept. Many countries have already achieved success in aquaculture extensive utilization of water resources. For example, many fishes like murrels that fetch high price in the Kerala market are cultured in Vietnam. Similarly, basa farming in Vietnam has conquered the world market with its high-quality meat and intensive production systems. Demonstration farms are to be established to convey the latest technologies to farmers in order to achieve world class standards. Technical collaboration with Vietnam, Thailand, U.S.A etc., can be explored as part of the 14th five-year plan in the following areas:

- Seed production technology of murrels
- Seed production technology, processing, and value addition of basa
- Intensive culture of vannamei shrimp in RAS
- Seed production technology and farming of edible oyster in trays

Matsyakrishi Sevana Kendram (MSK)

Matsyakrishi Sevana Kendrams can provide aquaculture inputs to farmers under one umbrella and aid in the effective extension delivery through consultancy services at pre-fixed rate. It will be established, owned and operated by an entrepreneur. There should be facilities for primary analysis of water quality, disease diagnosis, and sample preparation for detailed investigation. There should be one MSK in each development block and municipal corporation.

Fish Farmers' Producer Organization (FFPO)

Even as the aquaculture sector expands, the exploitation of farmers on various aspects like market, technology, seed, and feeds etc. is rampant. To combat this, district-level Fish Farmers' Producer Organizations have to be formed at the district level per State Co-operative Societies Act under a state-level apex federation for reducing atrocities towards farmer's societies. New co-operative unions can empower fish farmers in obtaining good quality seed and feed and play a key role in marketing, thereby eliminating intermediaries. The FFPO can enhance bargaining power by achieving economies of scale, enhancing productivity, building capacity of fish farmers, developing entrepreneurial skills, and developing vibrant and sustainable income-oriented value chain products. FFPO can also own MSKs, seed production units, and live fish marketing units. They can arrange weekly clinics and monthly farmers' meets.

This necessitates an amendment of the Kerala Co-Operative Societies Rule 1969. At present, Co-op societies Rule 15(5) (1) provides for the setting up of an apex institution; Kerala State Co-operative Federation for Fisheries Development (Matsyafed). It is the apex institution of primary societies, and it engages in fisherman welfare co-operatives. However, an apex institution for the development of aquaculture is necessary to exclude intermediaries. So, a provision in should be created in Rule 15 (5) (1) for setting up a separate apex body for aquaculture societies, and at the same time, an amendment for Rule 15(5) (3) should also be made for the organization of primary societies at the district level.

Matsya Karshaka Mitram (MKM)

Matsya Karshaka Mitram envisages a specialized work force of 10–20 youths in the aquaculture sector who can provide assistance in the form of labour in all steps from pre-stocking to harvest. It can be formed in all LSGIs where potential exists and is linked with FFPO.

Risk mitigation

Climate change and global warming have resulted in frequent adverse events leading to crop losses. Hence, risk mitigation and providing crop insurance for farmers undertaking aquaculture is important.

Aquaculture award

For popularising aquaculture and motivating farmers, it is necessary to provide encouragement in the form of awards every year, and should hence be taken up in this plan period also.

4. PROGRAMMES SUGGESTED

Inland capture fisheries

It is proposed to increase fish production through inland capture fisheries by protecting the natural stock through Fisheries Management Councils, conducting patrolling to prevent illegal fishing, enhancing fish stock through ranching, establishment of protected area, restoration of damaged aquatic ecosystems, and mangrove afforestation. It should also include fishery resource mapping by applying remote sensing and geographical information system, assessment of fish catch, and buy back of licensed stake nets and Chinese nets.

Seed production

One of the main constraints for aquaculture in the state is the lack of good quality fish seed in adequate quantity. It is envisaged to establish new hatcheries and enhance seed production capacity of existing seed farms and hatcheries by creating additional infrastructure facilities. Additionally, backyard seed production units can be promoted under the private sector.

Inland aquaculture development

It is targeted for enhancing aquaculture production from 34,987 ton to 70,000 ton during the 14th plan period by the diversification of species and aquaculture systems, adoption of innovative technologies, expanding aquaculture into new areas, and enhancing productivity. Proposed annual physical targets for different aquaculture practices have been given as Annexure-4. The aquaculture activities include:

- Intensive fish farming viz., aquaculture in bio floc tank, cage, padutha, and RAS;
- One paddy–one fish/shrimp farming;
- Farming of Carp, Nile tilapia, Pangasius and indigenous fish in ponds
- Farming of shrimp, crab, and mussel.

Aquaculture extension service

The shortage of a proper aquaculture extension service for providing the necessary technical guidance and monitoring is a factor that inhibits the expansion of aquaculture. The aquaculture extension service to farmers includes IEC activities, capacity-building programmes, Matsya Karshaka Club, Matsyakrishi Sevana Kendram, Fish Farmer's Producer Organization, Matsya Karshaka Mitram, technology acquisition, demonstration farming, aquaculture awards, risk mitigation, and adoption of new technology & research. Setting up inland Matsyabhavans at strategic locations and engaging Fisheries Extension Officers, project co-ordinators, & aquaculture promoters for the promotion of aquaculture activity to be prioritised.

Aquatic animal health management

As the outbreak of diseases pose severe threats to aquaculture, aquatic animal health surveillance and management systems are essential for early-stage disease detection, which may reduce the mortality rate and further spread. It is proposed to establish a network of Mobile Aqua Laboratories for timely investigation, diagnosis, and adopting therapeutic measures. Mobile aqua laboratories will have facilities for conducting clinical examination of live/dead aquatic animals, sample fixing, water, and soil quality analysis. Aquatic animal

health centres and mobile aqua laboratories may be used to determine water quality, aquatic animal health, AMR, and antibiotic residue as a part of passive surveillance programmes and for disease diagnosis, seed quality certification, medication, and disinfection of diseased sites as part of the active surveillance programme.

Reservoir fisheries

Reservoirs offer considerable potential for improving fish production. In the case of smaller reservoirs, fish stock enhancement programmes would be sufficient, while medium and large reservoirs may be used for cage farming of fish. Fish stock enhancement programmes can be limited to the seeds of endemic carps, endemic catfishes, pearlspot, and mahseer in the case of reservoirs within wild life sanctuaries.

Ornamental & recreational fisheries

There is potential to transform the state into a hub of the ornamental fish trade. Availability of indigenous ornamental varieties and the favourable entrepreneurship culture are Kerala's unique advantages. Ornamental fish rearing units, ornamental fish breeding units, brood banks, quarantine facility, disease diagnostic laboratory, and feed mills need to be developed. The expenses of the present four aquarium have to be met and new aquariums must be established in prominent tourist places. Promotional activities should be undertaken to popularize the keeping of ornamental fish in tanks as a hobby. Pearl oyster farming and tourism fisheries also offer considerable potential in Kerala's context.

Research

Focused research is essential to solve the problems that arise in the aquaculture sector, and these can be undertaken in collaboration with KUFOS.

The fund requirement for the implementation of various programmes for the implementation of above activities is Rs. 793 crore and the details are given in Table 20. The expected physical output is given in **Table 21.**

Table 20. Fund requirement for 14th plan (Rs. in lakh)

No.	Components	2022-23	2023-24	2024-25	2025-26	2026-27	Total
1	Inland capture fisheries	500	500	500	500	500	2500
2	Inland aquaculture development	6700	7500	8300	9000	9800	41300
3	Reservoir Fisheries	200	200	200	200	200	1000
4	Seed production- Operation	500	550	600	650	700	3000
	Seed production- Infrastructure development	3000	3000	3000	3000	3000	15000
5	Aquaculture Extension Service	1900	1900	1900	1900	1900	9500
6	Aquatic Animal Health Management	200	250	300	350	400	1500
7	Ornamental & recreational fisheries	300	350	400	450	500	2000
8	Research	700	700	700	700	700	3500
	Total	14000	14950	15900	16750	17700	79300

Table 21. Details of Physical target

No.	Components	2022-23	2023-24	2024-25	2025-26	2026-27
1	District patrolling units (no.)	14	14	14	14	14
2	Fish protected area	5	5	5	5	5
3	Clam protected area	4	4	4	4	4
4	Stock enhancement (no. in lakh)	400	400	400	400	400
5	Fish seed production (no. in lakh)	800	1000	1200	1500	1800
6	Shrimp seed production (no. in lakh)	1200	1200	2200	2200	2200
7	Aquaculture production (in tonnes)	50,000	60,000	70,000	80,000	90,000
8	FFPO, MSK	30	60	90	120	158
9	Aquaculture Extension Service Units	100	158	158	158	158
10	Seed quality test	1000	1000	1000	1000	1000
11	Antibiotic residue test	100	100	100	100	100
12	Reservoir Fisheries Development	5	10	16	22	28
13	Ornamental fish production (no. in lakh)	800	1300	1800	2300	2800

ANNEXURE 1

Sl No.	Name of Reservoir	Area (ha)	Species
1	Mangalam	393	Carps (IMC)
2	Pothundy	363	Carps (IMC)
3	Chulliyar	159	Carps (IMC)
4	Meenkara	259	Carps (IMC)
5	Walayar	259	Carps (IMC)
6	Malampuzha	2313	Carps (IMC)
7	Kanjirampuzha	512	Carps (IMC)
8	Karappuzha	1660	Carps (IMC)
9	Banasurasagar	1277	Carps (IMC)
10	Peruvannamuzhy	1050	Carps (IMC)
11	Pazhassi	648	Carps (IMC)
12	Maniyar	110	Carps (IMC)
13	Pampa	200.6	Carps (IMC)
14	Ponmudi	278	Carps (IMC)
15	Neriamanagalam	413	Carps (IMC)
16	Munnar head dam	250	Carps (IMC)
17	Mattupetty	323.75	Carps (IMC)
18	Anayirangal	485.5	Carps (IMC)
19	Kallar	220	Carps (IMC)
20	Malankara	120	Carps (IMC)
21	Irattayar	200	Carps (IMC)
22	Kakki	1751	Carps (IMC)
23	Neyyar	1500	Carps (IMC)
24	Idukki	6160	Carps (IMC)
25	Bhoothatankettu	608	Carps (IMC)
26	Thenmala	2590	Carps (IMC)
27	Peechi	1263.00	Pulchellus, Pearlspot
28	Vazhani	255.00	Yellow catfish
	Total	17853.85	

ANNEXURE 2

Sl No	Name of hatchery/ Seed farm	AS amount (in lakh)	Fund source	Present status
1.	GIFT Hatchery, Neyyar	500	RIDF	Sanctioned on 28/12/2016 and nearing completion
2.	Brackish water finfish hatchery, Odayam	900	RIDF	Sanctioned on 03/04/2017 but not started
3.	Neyyar, 3rd phase	746	State Plan	Sanctioned on 4/4/2018 and nearing completion
4.	Indegenous fish hatchery, Kulathu-puzha	500	State Plan	Sanctioned on 18/10/2016 and nearing completion
5.	Indoor hatchery, Neendakara	49.95	State Plan	Sanctioned on 21/1/2021 and work progressing
6.	West kallada, 2nd phase	450	State Plan	Sanctioned on 18/10/2016 and work progressing
7.	GIFT Hatchery, Pannivelichira	500.00	RIDF	Completed
8.	Indegenous fish hatchery, Irattu	500	State Plan	Sanctioned on 16/07/2015 and nearing completion
9.	Freshwater prawn hatchery, Valanja-vazhi,	176.20	State Plan	Sanctioned on 6/10/2020 - Work initiated
10.	Mussel hatchery, Puthiyangadi	500	State Plan	Sanctioned on 6/10/2020 - CRZ clearance to be obtained
11.	Bhoothathankettu Hatchery Phase II	1120	RIDF	Sanctioned on 5/2/2020 but tendering process to start
12.	BW finfish unit, Azheekode	860	RIDF	Work in progress
13.	Fish seed farm IV phase, Peechi	465	Plan	Work in progress
14.	Fish seed farm, Thalipuzha	160.50	Plan	Completed
15.	Fish seed farm Karappuzha	170	RIDF	Completed
	Total	7597.65		

ANNEXURE 3

No	Component	Target	Unit Production	Exp. production (mt)
1	Fresh water pond (Pvt)	6155 ha	4 t/ha	24620
2	Fresh water pond (Public)	2016 ha	0.8 t/ha	1612
3	Brackish water pond	2303 ha	4 t/ha	9212
4	Fresh water fields	49,718 ha	0.4 t/ha	19887
5	Brackish water fields	5,178 ha	0.8 t/ha	4142
6	Brackish water cage farming	6159 No.	0.8 t/ha	4927
7	Fresh water cage farming	1044 No.	1.6 t/ha	1670
8	RAS (50 Cum)	1200 No.	1.6 t/ha	1920
9	Bio floc Fish (20 Cum)	10692 No.	0.8 t/ha	8553
10	Bio floc Vannamei (160 Cum)	4000 No.	1.6 t/unit	6400
11	Farming in Padutha (100 Sm)	19918 No.	0.8 t/unit	15934
12	Mussel farming (100 m)	3000 No.	0.8 t/unit	2400
13	Edible oyster farming	36,000 No.	0.8 t/unit	28,800
TOTAL				130077

ANNEXURE 4

SL. No	Activity	Potential	Under taken during 2020-21	Progressing during 2020-21	Target for 22-23	Target for 23-24	Target for 24-25
1	Fw Ponds (pvt)	6155 ha	3800 ha	4305 ha	5205 ha	6155 ha	-
2	Fw ponds (Pub)	2016 ha	1292 ha	1516 ha	2016 ha	-	-
3	BW ponds	2303 ha	665 ha	767 ha	1512 ha	2000 ha	2303 ha
4	Fw fields	49718 ha	13706 ha	19850 ha	28850 ha	39000 ha	49718 ha
5	BW fields	5178 ha	2298 ha	455 ha	1455 ha	2500 ha	5178 ha

SL. No	Activity	Potential	Under taken during 2020-21	Progressing during 2020-21	Target for 22-23	Target for 23-24	Target for 24-25
1	BW Cage farming	6159	1842	2171	2725	4000	6159
2	FW Cage farming	1044	420	670	900	1044	-
3	RAS	1773	703	788	848	1000	1200
4	Biofloc GIFT	10692	3169	3812	5005	7000	10692
5	Biofloc Vannamei	20018	4	490	1000	2000	4000
6	Padutha	19918	5064	6110	8900	13000	19918
7	Mussel farming	3000	482	832	2853	3000	-

APPENDIX - I

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD

(Present: Sri. Teeka Ram Meena IAS)

Sub: - Formulation of Fourteenth Five Year Plan (2022-27) – Constitution of Working Group on Inland and Marine Fisheries – Revised Proceedings - reg.

Read: 1. Note No. 297/2021/PCD/SPB dated: 27/08/2021
2. Guidelines on Working Groups
3. This Office order of even number dated 08.09.2021

ORDER No:SPB/342/2021-Agri (3) Dated:14.09.2021

As part of the formulation of Fourteenth Five Year Plan, it has been decided to constitute various Working Groups under the priority sectors. Accordingly, the Working Group on **Inland and Marine Fisheries sector** is constituted. For the smooth functioning of the Sectoral Working Group (SWG), it is decided to split the Working Groups into Expert Sub Groups (ESG). Hence the Working Group is categorized into four Expert Sub Groups as indicated in the proceedings. The names of the members of the SWG are indicated under each ESG. The Working Group shall also take into consideration the guidelines read 2nd above in fulfilling the tasks outlined in the ToR for the Working Group.

1. SOCIAL SECURITY FOR FISH WORKERS: AN ASSESSMENT AND SUGGESTIONS FOR REFORM

Co - Chairperson

1. Dr John Kurien, Visiting Professor, Azim Premji University, Bengaluru

Members

1. Dr C. Ramachandran, Principal Scientist, Socio Economic Evaluation and Technology Transfer Division, CMFRI, Cochin
2. Dr Daisy Kappen, Professor, Director of Extension, KUFOS
3. Mr V. M. Shoukath, Kerala Karshaka Sangham, Kumomkulam, Manjeri, Malappuram
4. Dr A. Suresh, Principal Scientist, CIFT
5. Dr M. K. Anil, Principal Scientist, CMFRI, Vizhinjam
6. Ms Smitha R. Nair, Joint Director, Fisheries Department
7. Ms C. R. Sathyavathi, Additional Director of Fisheries (Retd.)
8. Mr P. P. Chitharanjan, Former Chairman, Matsyafed

9. Mr. Antony Kurishinkal, State Committee member, Kerala Swatantra Matsya Thozhilali Federation (KSMTF)
10. Mr. V. Vivekanandan, CEO, South Indian Federation of Fishermen Societies (SIFFS)
11. Mr Joseph Xavier Kalapurackal, General Secretary, All Kerala Fishing Boat Operators' Association.

Terms of Reference

1. To document and access the status of social security for fish workers in Kerala over the past decade.
2. To identify gaps in the existing system of social security for fish workers and suggest remedial measures.
3. To prepare a vision for social security for fish workers over the next decade taking into consideration the changing developmental needs and the growth of the fisheries sector.
4. To suggest measures to reduce the dependence of fish workers on private money lending.
5. To suggest necessary infrastructural and administrative changes required to improve the status of social security of fish workers.

2. INFRASTRUCTURAL CHALLENGES IN KERALA'S MARINE FISHERIES SECTOR

Co - Chairperson

1. Dr B. Manoj Kumar, Registrar, KUFOS
2. Dr Leela Edwin, Principal Scientist and HOD, CIFT

Members

1. Dr B. Santhosh, Principal Scientist, CMFRI
2. Dr M V Baiju, Senior Scientist, CIFT
3. Dr Madhu V R, Principal Scientist, CIFT
4. Dr Ashok Kumar, Principal Scientist, CIFT
5. Ms Smitha R. Nair, Joint Director, Fisheries Department
6. Ms S. Manju, Fisheries Extension Officer, Karunagappally
7. Mr Sivakumar, Manager, Chintha Publishers

Terms of Reference

1. To assess the major infrastructural development work undertaken in Kerala's marine fisheries sector in the last decade, including existing old harbours, landing structures, markets, vehicles and transport and machinery.

2. To assess the infrastructural requirements in Kerala's marine fisheries sector for the next ten years, including in harbours, landing structures, markets, vehicles transport and machinery.
3. To suggest a plan to improve and modernise the existing infrastructure facilities in marine fisheries in Kerala.
4. To suggest ways to better link infrastructure in marine fisheries with the livelihood of fish workers, reduction of costs in value chains, promotion of trade, addressing food safety concerns of domestic and international consumers, employment generation and creating business opportunities and investment avenues.

3. HARVESTING THE POTENTIAL OF INLAND AQUACULTURE: TOWARDS A PLAN OF ACTION

Co - Chairperson

1. Dr Riji John, Vice-Chancellor, KUFOS

Members

1. Dr Devika Pillai, Associate Professor, KUFOS
2. Dr.Dinesan Cheruvat,Additional Director of Fisheries ,Department of Fisheries
3. Dr K. Dinesh, Associate Professor, KUFOS
4. Mr Jothish, Chief Operating Officer, Citra Agro Peixe Private Limited
5. Mr Ignatius Mandro, Joint Director, Department of Fisheries
6. Dr M. P. Safeena, Assistant Professor in Microbiology, Department of Fish Processing Technology, KUFOS
7. Ms. C. K. Shiny, Deputy Director of Fisheries, Kannur
8. Mr. Purushothaman Payyannur, Kerala Karshaka Sangham, Asad Bhavan, Payyannur
9. Mr Santhosh Baby, Managing Partner, Aqualine Exports

Terms of Reference

1. To assess the growth and development of the inland fisheries sector in Kerala over the past decade and identify gaps in policy.
2. To prepare a vision for the next 10 years to harvest the potential of inland fisheries in Kerala (including capture and culture)
3. To assess the existing systems of input and service delivery in inland fisheries and suggest measures for improvement.
4. Suggest specific action plans for transforming the inland fisheries sector as a major engine of growth of the fisheries sector including the use of new fish types, better utilisation of

water resources, reforms in inputs and service delivery systems, infrastructure development and value chain upgradation.

4. FISH PROCESSING SECTOR IN KERALA: CONSTRAINTS TO GROWTH AND SUGGESTIONS FOR REFORM

Co - Chairperson

1. Dr C. N. Ravishankar, Director, ICAR-CIFT

Members

1. Mr Anil Kumar Rajendran, Business Head, Neelratna Aqua Farm Private Ltd, Cochi
2. Mr Lauret Sadanandan, General Manager, Amalgam Foods
3. Mr Alex K. Ninan, Managing Partner, M/s. Baby Marine International
4. Mr K. Sivakumar, Vice-President, Innovative Foods Limited
5. Ms. Jisphin Martin, Block Panchayat Member, Anjengo; Matsya Thozhilali Federation
6. Mr. Manoj T Varghese, Proprietor, Kings Marine Products, Kollam
7. Dr. George Ninan, Head, Fishery Engineering Division and Principal Scientist, Fish Processing, CIFT

Convener

Mr.S.S.Nagesh, Chief, Agriculture Division, State Planning Board

Co- Convener

Ms.Vidhya.K, Assistant Director, Agriculture Division, State Planning Board

Terms of Reference

1. To assess the growth and development of the fish processing sector in Kerala over the past decade and identify gaps in policy.
2. To document the potential for the growth of the fish processing sector in Kerala over the next decade and suggest an action plan considering the needs of domestic and export markets.
3. To ensure that the action plan appropriately gives importance to the scope for value addition to increase values per unit quantity and need for skill up gradation of the workforce.

Terms of Reference (General)

1. The non-official members (and invitees) of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GoI

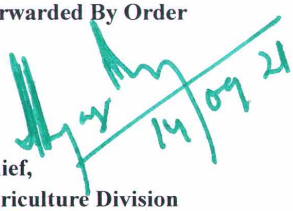
will be entitled to travelling allowances as per rules if reimbursement is not allowed from Departments.

2. The expenditure towards TA, DA and Honorarium will be met from the following Head of Account of the State Planning Board "3451-00-101-93"- Preparation of Plans and Conduct of Surveys and Studies.

The order read as reference 3 is modified to this extent

(Sd/-)
Member Secretary

Forwarded By Order



Chief,
Agriculture Division

To

The Members concerned

Copy to

PS to Vice Chairperson
PA to Member Secretary
CA to Member (Dr.Ramakumar.R)
Economic Advisor to VC
Chief, PCD,SPB
Sr. A.O, SPB
The Accountant General, Kerala
Finance Officer, SPB
Publication Officer, SPB
Sub Treasury, Vellayambalam
Accounts Section
File/Stock File