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ICAR-Directorate of Coldwater Fisheries Research

Bhimtal-263 136, Nainital, Uttarakhand, India

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ICAR-DIRECTORATE OF COLDWATER FISHERIES RESEARCH

Bhimtal - 263 136, Nainital
Uttarakhand, India

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PREFACE

Coldwater fisheries have immense prospects in creating livelihood opportunities to the rurals dwelling in Indian uplands. The need of holistic and sustainable utilization of the coldwater fishery resources and their development and advancement has always been driving us to work for the sector. ICAR-Directorate of Coldwater Fisheries Research (ICAR-DCFR), Bhimtal has been continuously providing practical inputs through imparting quality research and services for sustainable coldwater fisheries production, management, conservation and eco-tourism to realise and to ensure the potentials of livelihood opportunities among upland populations.

During the year 2019, ICAR-DCFR has made sincere efforts under its mandated and prioritized responsibilities towards scientific management of fishery resources, safeguard of coldwater fisheries and promotion of hill aquaculture for enhancing farmer's income through research innovations, technological improvements, training and capacity building, extension activities, fostering partnership and linkages as well as farmer oriented approaches.

Trailing our commitments and obligations, Directorate has been working towards resource assessment and advancement such as GIS based site suitability maps comprising of aquatic resources, drainage network, land use land cover, digital elevation model, slope etc. of three districts of Arunachal Pradesh viz., Anjaw, Shi Yomi and Kamle were digitized and mapped potential fisheries development. Fish and plankton composition analysis of Kameng drainage of Arunachal Pradesh were also done.

The progressive advancements in hill aquaculture includes captive maturation and multiple breeding and seed rearing of golden mahseer through photo-thermal manipulations & sex segregations; development of breeding and rearing protocols of chocolate mahseer, *Neolissochilus hexagonolepis* under controlled conditions; successful induced breeding of *Garra annandalei*, *G. lamta* and *Schisutra beavani*; induction of triploidy in rainbow trout; formulation of GnRH synthetic peptide and its successful preliminary field test in two geographical locations as well as replacement of fish meal by 25-50% in trout feed with rice distillers dried grains (RDDG) and bacterial meal has been achieved. The validation for development and commercialisation of rainbow trout starter feed has been completed. The rainbow trout feed formulated and validated by DCFR at present will be marketed by Grow wel Ltd., Andhra Pradesh in a collaborative venture. Under the national project on innovations in climate resilient agriculture (NICRA), the first coldwater fish specific pilot-scale in-house designed RAS unit in the country has been established at ICAR-DCFR head quarters, Bhimtal and successfully completed one production cycle. Further, the possibility of inducing long-term physiological changes in rainbow trout through early life thermal programming has been investigated.

The issues and challenges of coldwater fish diseases are proactively being addressed by putting sincere efforts in disease surveillance of coldwater fish farms, identification of pathogens and development of management measures. Towards this end, protocol for tube based visual assay for detection and identification of *S. parasitica* using PNA (peptide nucleic acid) probe and gold nano-particle from genomic DNA has been optimized. A short novel anti-microbial peptide, named KK14 has been synthesized and evaluated its antimicrobial activities against various bacterial pathogens. Anti-fungal properties of *Thymus linearis* has been evaluated against *Saprolegnia parasitica*. The modern techniques of molecular biology and

biotechnology are imperative to address the issues related to aquaculture and species development more precisely. The Directorate has made significant advancements such as a comprehensive transcriptomic dataset for *Tor putitora* of both sexes to study the molecular mechanisms underlying sex determination and to unravel the molecular differences between males and females. The genome editing work in the Directorate has been initiated in common carp and a CRISPR target sequence was identified for myostatin gene and three sg RNA templates for this gene was generated.

The Directorate also organized various training programmes, field demonstrations, farmer advisories and exhibitions to disseminate scientific knowledge on various aspects of coldwater fisheries and aquaculture to farmers, fisheries officers and other concerned stakeholders. Under tribal sub-plan activity, rainbow trout farming is being promoted as a remunerative livelihood option and the Directorate is providing infrastructure and critical inputs to adopted tribal farmers and several programmes were organized at Uttarakhand, Meghalaya and Nagaland to establish trout, mahseer and carp farming.

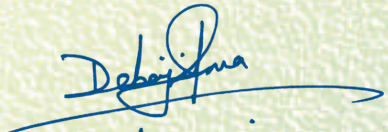
Under NEH activity, trout hatchery and trout raceways were established and made operational at Dzuleke, Kohima besides development of mahseer captive breeding facilities in the state of Nagaland. Further, workshop on "Trout farming in Nagaland: Prospects for doubling farmers income" was jointly organized by ICAR-DCFR, Bhimtal and Department of Fisheries & Aquatic Resources, Govt. of Nagaland at Dzuleke village, Kohima on 13th May, 2019. Initiatives have been taken in Arunachal Pradesh to make the existing trout hatchery functional at Shergaon. Similar initiatives have also been taken to re-establish the mahseer hatchery at Roing. The Directorate has also successfully implemented the newly instituted Govt. of India programme called Scheduled Caste Sub-Plan (SCSP). Under SCSP, programmes were organized at Champawat and Pauri Garhwal districts of Uttarakhand, Kamrup, Morigaon, Goalpara districts in Assam and critical farm inputs such as fish seeds, fish feeds, prophylactic chemicals, netting materials were distributed to 500 SC fish farmers.

The Directorate also strengthened linkages with other ICAR research institutes, fisheries departments of hill states, agricultural universities, KVKs, non-governmental organisations and central agencies such as National Fisheries Development Board and Department of Biotechnology for promoting research, extension and capacity building.

As per directives received from the Government of India and SMD from time to time, focus was also given on programmes such as Swachch Bharat Abhiyan, Mera Gaon Mera Gaurav, live telecast of Pradhan Mantri Kisan Samman Nidhi and Skill India Programme, Vigilance Awareness Week and implemented the programmes in its true spirit. The other important events of the year such as Republic Day, World Environment Day, National Fish Farmers Day, International Yoga Day, Independence Day, DCFR Foundation Day, Constitution Day, Hindi Pakhwada, Vigilance Awareness Week, and World Antibiotic Awareness Week were celebrated in spirit and zeal.

The cordial support, guidance, inspirations and encouragements received from Dr. T. Mohapatra Secretary, DARE & Director General, ICAR were commendable. The support, motivation and guidance received from Dr. J.K. Jena, Deputy Director General (Fisheries Science), ICAR, New Delhi is recorded with sincere thanks and gratitude. The valuable suggestions received from Dr. Pravin Putra, ADG (M.Fy.), ICAR, New Delhi along with other scientists from SMD are highly acknowledged.

I sincerely thank and appreciate the contributions of all the scientists and staff members of the Directorate for the successful progress made during the year. I also thank the editorial committee for putting their meticulous efforts in compiling, editing and bringing out the Annual Report 2019 on time.



(Debajit Sarma)
Director

CONTENTS

Executive Summary

1

The ICAR-Directorate of Coldwater Fisheries Research, Bhimtal has been working dedicatedly towards development of coldwater fisheries sector in the country through basic, strategic and applied research, extension activities, active surveillance, resource assessment and promotion of hill aquaculture in all the Himalayan states. Directorate has made advancements in generating GIS based site suitability maps, protocols for captive breeding and rearing of different coldwater fish species for diversification of hill aquaculture, development of efficient and cost effective feeds. The institute has also worked for enhancement of natural fish stocks through ranching particularly mahseer and some of the program focussed on fish species important from conservation point and ornamental purposes. DCFR also works on promoting eco-tourism and fish sanctuaries in various places. The institute has given technical support to many farmers of hill states to implement scientific/innovative farming practices to realise higher income/profit. DCFR has also conducted many skill development training programmes for developing human resources, and time to time on-farm demonstrations, consultancies, farm advisory have been given for establishment of hatcheries, fish ponds to farmers and fishery departments. Directorate has made linkages through MoUs with Universities, state fishery departments and other institutions for academic and collaborative research of students in master and Ph. D. level. The research accomplishments of the institute in the year 2019 are summarized as follows:

Resource assessment and management

- Analysis of the species composition in the Kameng drainage of Arunachal Pradesh showed the existence of three group of high commercial important fish species viz., mahseer, snow trout and exotic trout.
- In snow fed tributaries of Arunachal Pradesh, *Schizothorax* species, *S. richardsonii, S. plagiostomus* and *S. progastus* with average body length of 14.64 ± 2.36 cm, 17.32 ± 4.89 cm and 16.44 ± 1.02 cm respectively were found.
- Thirty species of phytoplankton under 24 families, 19 orders and 6 classes were identified from the different sampling stations in snow fed tributaries of Arunachal Pradesh.
- Aquatic resources, drainage network, land use land cover, digital elevation model, slope and potential fisheries development suitability sites in three districts of Arunachal Pradesh viz., Anjaw, Shi Yomi and Kamle were digitized and mapped using SOI toposheets, ground truthing and spatial data.
- In Anjaw and Shi Yomi districts, majority of the upland lakes accounting 63% and 68% respectively of the total are situated at an altitude ranging between 4000-5000 m MSL.

Aquaculture oriented research and development

- In conducive environment, 70-75% females of chocolate mahseer spawned in both gravel water and clear water tanks. Around 7000 eggs were produced, and the larvae are reared in mahseer hatchery.
- In standardized optimum conditions using circular biofilter tanks, golden mahseer brooders showed spontaneous spawnings and stripping of eggs can even be done without injecting any hormone.
- With successful protocol of sex segregation in golden mahseer, multiple breeding were done through the months of June to November and a total of 46200 eggs was striped from just 12 females in three tanks.
- An injectable solution of GnRH synthetic

peptide containing a dopamine inhibitor was formulated which is comparatively less viscous and does not cause blackening at the site of injection. Preliminary efficacy test of the formulation at field level in two different geographical locations (Assam and West Bengal) showed fertilization and hatching rate of 95% and 98% respectively.

- In a study, it was found that *Schizothorax progastus* and *Schizothorax plagiostomus* showed better adaptation and growth than *Schizothorax richardsonii* in low temperature during winter season and a survival rate of more than 90% was recorded.
- Approximately, two hundred first generation *Garra gotyla* fishes have been successfully developed and are reared for further studies on embryonic development, breeding protocol and seed production.
- The potential of rice distillers dried grains (RDDG), a distillery industry by-product was investigated to partially replace fish meal in rainbow trout diets and it was found that RDDG can be used to replace 25-50% fish meal in trout feed without significantly affecting growth, feed use and fish welfare.
- Similarly, the potential of single-cell protein meal (SCP) derived from methanotrophic bacteria was investigated to partially or completely replace fish meal in trout feeds and found that 12.5% of SCP can be included in rainbow trout feeds to replace 25% of fish meal.
- Spawning in *Garra annandalei*, *G. lamta* and *Schisutra beavani* was induced and around 2000 eggs of *G. lamta* and 600 eggs of *G. annandalei* were spawned per 10 g fish after 8-10 h of injection at 21±0.5°C. Fecundity of *Schisutra beavani* per 4-5 g female was observed to be 2000-2500.
- The first coldwater fish specific pilot-scale RAS unit in the country has been established at ICAR-DCFR, Bhimtal. The facility was designed in-house comprising all the primary constituent units of a RAS system.
- Findings in thermal programming experiment suggest the possibility of inducing long-term physiological changes in rainbow trout through early life thermal programming.
- Triploidy induction (98%) was achieved in rainbow trout with appropriate pressure shock and accurate zygote age. Passive integrated transponder (PIT) tagging was also done to study growth in triploid rainbow trout.

Molecular genetics and biotechnological contribution

- A comprehensive transcriptomic dataset for *Tor putitora* by sequencing the gonads and brain of both sexes using the Illumina Hiseq 2500 system was generated to study the molecular mechanisms underlying sex determination and unravel the molecular differences between male and female fishes. This has led to identification of numerous differentially expressed genes (DEGs) involved in sex differentiation, gonadal development and gametogenesis.
- For genome editing in common carp, a CRISPR target sequence was identified for myostatin gene and three sg RNA templates for this gene was generated by PCR using high fidelity DNA polymerase with a target specific forward primer and common tail primer.
- Partial sequence of immune genes such as IFN-γ, interleukin-1β, interleukin-10, TNF-α4 and complement component 3 from golden mahseer has been submitted to NCBI GenBank.

Disease surveillance and health management

- Protocol for PNA-mediated inhibition of PCR amplification of ITS region through arrest of primer elongation has been optimised for identification of *Saprolegnia parasitica*.
- Protocol for tube based visual assay for detection and identification of *S. parasitica* using PNA (peptide nucleic acid) probe and gold nanoparticle from genomic DNA has been optimized.
- PHMB coated silver nanoparticles (AgNPs-PHMB) was found to inhibit germination and colonization of *Saprolegnia* spores under *in-vitro* conditions as indicated by the absence

of advanced growth of the early developing *Saprolegnia* mycelia on hempseeds and 100% inhibition of radial growth.

- Ethanol extract of *Thymus linearis* exhibited inhibitory activity at a minimum concentration of 0.32 mg/ml against *Saprolegnia parasitica* and the presence of ethyl (9z, 12z)-9, 12-octadecadienoate, palmitic acid, ethyl palmitate, ethyl (9z, 12z)-9, 12-octadecadienoate, phytol as major constituents in the extract was confirmed by Gas chromatography-Mass spectrometry (GC-MS).
- *Aeromonas* species isolated from fish farms of Himachal Pradesh showed high antimicrobial resistance against cephalothin, ampicillin/sulbactam, cefoxitin, cefotaxime and trimethoprim/sulfamethoxazole.
- *Escherichia coli* isolated from fish farms of Himachal Pradesh showed high antimicrobial resistance against ampicillin, cefoxitin and cefotaxime.
- *Staphylococcus* species isolated from fish farms of Himachal Pradesh showed high antimicrobial resistance against penicillin G, cefoxitin, oxacillin, erythromycin and trimethoprim-sulfamethoxazole.
- Total 37 trout and carp farm/hatcheries located in the district of Kullu, Mandi in Himachal Pradesh and Chamoli, Champawat and Udhamsingh Nagar in Uttarakhand were covered under active disease surveillance.
- A short novel AMP, named KK14 has been synthesized in the laboratory and evaluated its antimicrobial activities against various bacterial pathogens including antibiotic resistant bacteria. It showed MIC (minimum inhibitory concentration) value ranging from 0.9 to 62.5 µM and MBC (minimum bactericidal concentration) range from 1 to 110 µM.

Important events, extension activities, trainings and other developments

- Republic Day of our nation was celebrated with flag hoisting ceremony by all the scientists and staffs of the Directorate on 26th January 2019.
- Live telecast the inaugural program of *Pradhan Mantri Kisan Samman Nidhi* was organised by ICAR-DCFR for 100 farmers, staff members of the Directorate and public representatives of Bhimtal and nearby villages on 24th February 2019.
- Research Advisory Committee (RAC) of ICAR-DCFR was held at the Directorate, Bhimtal under the chairmanship of Dr. M. Sinha on 28-29th March 2019.
- One day workshop on "Trout farming in Nagaland: Prospects for doubling farmers income" was jointly organized by ICAR-DCFR, Bhimtal and Department of Fisheries & Aquatic Resources, Govt. of Nagaland at Dzuleke village, Kohima district, Nagaland on 13th May, 2019.
- Institute Research Committee (IRC) was held at ICAR-DCFR, Bhimtal under the Chairmanship of Dr. D. Sarma, Director and coordination of Dr. N.N. Pandey, Principal Scientist cum I/c PME ICAR-DCFR on 27-28th May 2019.
- One day workshop on "Development of hill fish farming for upliftment of rural economy in Uttarakhand" was organized at Nail village, Almora district, Uttarakhand in collaboration with the ICICI Foundation on 30th May 2019.
- National Fish Farmer's Day was celebrated as an interactive scientist cum farmers meet with the theme "Fish farming in upland regions" at Mudiyani village, Champawat on 10th July 2019.
- Independence day of our nation was celebrated with flag hoisting ceremony attended by all the scientist and staffs of the Directorate at Bhimtal premises as well as at Champawat field centre on 15th August 2019.
- Hindi Saptah was organized at Bhimtal by conducting various competitions such as essay writing, word knowledge, hindi to english translation, hindi skill, computer oriented hindi typing among the staff of the Directorate during 14-20th September 2019.
- Quinquennial Review Team (QRT) reviewed and evaluated the progress of work done by ICAR-Directorate of Coldwater Fisheries

Research, Bhimtal for the period of April 2013 to March 2018 during September 2019.

- National symposium on "Coldwater fisheries development in India: innovative approaches and way forward for enhancing hill farmers income" was organized by ICAR-DCFR on the occasion of the Annual Foundation Day at Bhimtal during 24-25th September 2019.
- Vigilance Awareness programme on "Integrity: a way of life" was organized at EFF, Champawat on 28th October 2019.
- An awareness programme on antimicrobial resistance (AMR) was organized at Government School, Bidhora, Sitarganj Road, Khatima, Udhamsingh Nagar, Uttarakhand, India by ICAR-DCFR to mark the 'World Antibiotic Awareness Week' during 18-24th November 2019.
- On constitution day, an awareness campaign on our constitution was organized at ICAR-DCFR, Bhimtal and EFF, Champawat on 26th November 2019
- Swachha Bharat Abhiyan under Swachh Bharat Mission was conducted at ICAR-DCFR, Bhimtal and EFF, Champawat on 19th July 2019, 1st October 2019, 2nd October 2019 and 21st December 2019.
- SCSP programmes were organized at Champawat and Pauri Garhwal districts of Uttarakhand, Kamrup, Morigaon, Goalpara districts in Assam. Critical farm inputs in the form of fish seeds, fish feeds, prophylactic chemicals, netting materials were distributed to 500 SC fish farmers.
- TSP programmes were organized at Uttarakhand, Meghalaya and Nagaland to establish trout, mahseer and carp farming.
- NEH programmes were undertaken at Nagaland by establishing the first ever trout hatchery and raceways in the State. Initiatives have been taken in Arunachal Pradesh to make the existing trout hatchery functional at Shergaon. Similar initiatives have been taken to re-establish the mahseer hatchery at Roing.
- Exploratory surveys, farm advisories and consultancy were provided by the scientists to various stakeholders of the hill states of the country.

Introduction

2

2.1. Brief history

ICAR-Directorate of Coldwater Fisheries Research is the only national facility under Indian Council of Agricultural Research, Ministry of Agriculture & Farmers Welfare, Government of India dedicated to research investigation on capture and culture aspects of exotic and indigenous coldwater fish species. It was established as National Research Centre on Coldwater Fisheries (NRCCWF) on 24th September 1987 during the VII Five Year Plan to address the research and developmental needs of the coldwater fisheries sector. Since its inception, it has made significant contribution in the sector through scientific approach in assessment of coldwater fishery resources and by developing suitable breeding and rearing technologies to propagate important coldwater fish species in hills in spite of constraints in terms of manpower and infrastructure. Considering the greater potential of coldwater fisheries in different Himalayan states and the ever expanding activities of NRCCWF, the institute was upgraded to Directorate of Coldwater Fisheries Research (DCFR) during the eleventh five year plan.

At present, the Directorate is ISO certified (ISO 9001:2015) nodal research centre focussed on endemic as well as exotic coldwater fishes. In the last 32 years, the Directorate has been working untiringly to address issues and challenges of coldwater fisheries through use of modern techniques and biotechnological tools, development of efficient and cost-effective feeds, regular disease surveillance, consultancy services, identification of pathogens and development of management measures. The Directorate has generated GIS maps of site suitability, ichthyofaunal distribution covering different Himalayan states. The institute has also put sincere efforts to create awareness of sustainable management of the aquatic resources and ornamental fish farming for employment generation. The institute has well-structured organization set up having scientific, administration and coordination, monitoring and evaluation, account and drawing and disbursing section.

2.2 Location

The headquarters of ICAR-DCFR is located at Bhimtal (29°19'52.647"N 79°33'18.083"E), at an altitude of 1470 m asl in the district of Nainital of Uttarakhand state. The nearest airport is at Pantnagar which is about 55 km from Bhimtal. The closest railway station is Kathgodam, around 22 km from Bhimtal and about 280 km from Delhi. Bhimtal can also be reached from Delhi via Haldwani by bus. DCFR has an experimental fish farm centre at Chirapani in Champawat district (29°17'55.537"N 80°6'8.915"E) of Uttarakhand, which is about 150 km from Bhimtal.

2.3 Vision

Coldwater fisheries and aquaculture to be an important economic activity in upland region for livelihood security and ecotourism

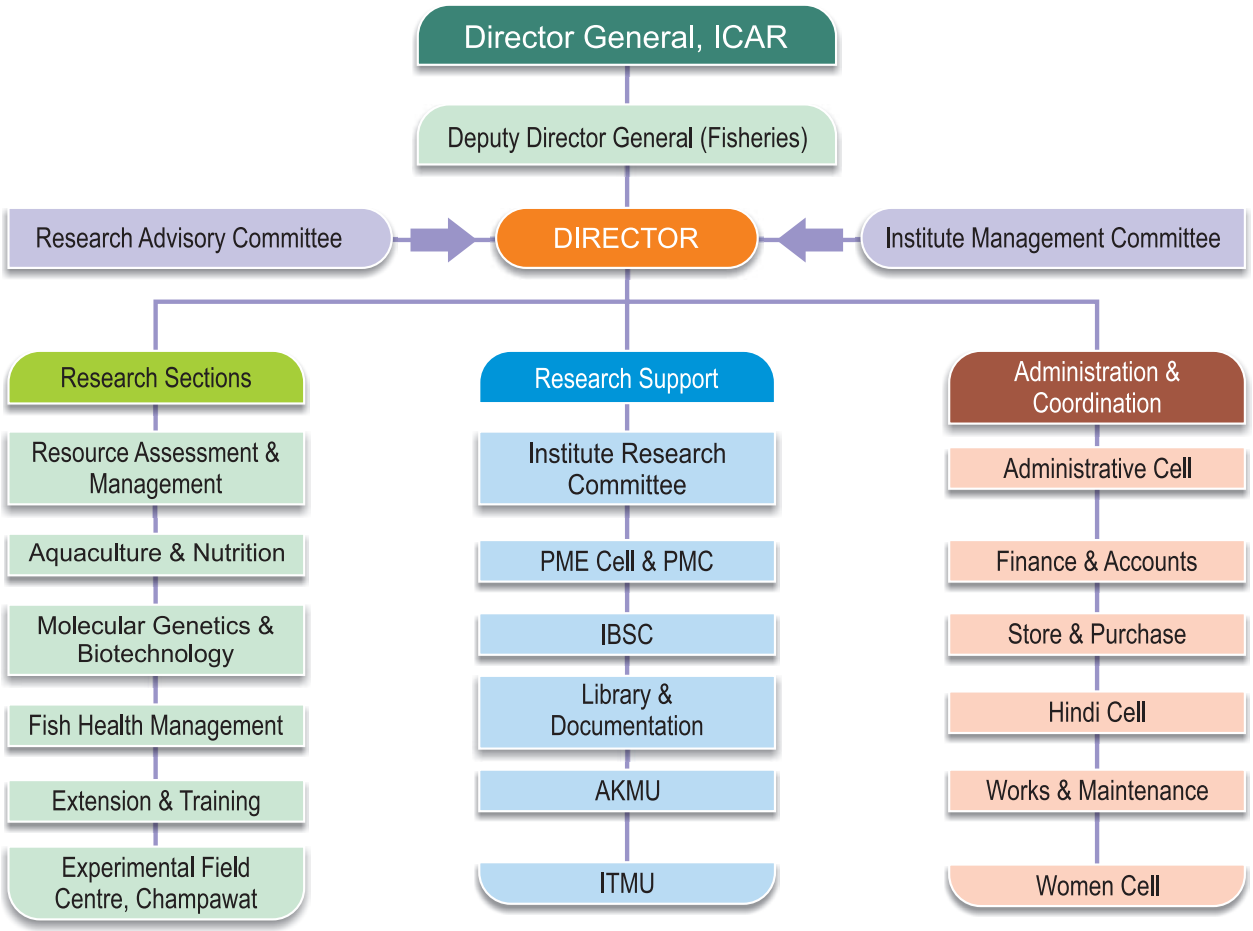
2.4 Mission

To become a Centre of excellence for assessing and managing coldwater fishery resources, development technologies and models of hill aquaculture and formulating strategies for holistic growth of the sector

2.5 Mandate

- To conduct basic, strategic and applied research in coldwater fisheries and aquaculture
- To act as repository of hill fisheries resources
- Human resource development through training, education and extension

2.6 Organizational set-up



2.7 Management

As per rules and bye laws of Indian Council of Agricultural Research, Research Advisory Committee (RAC) consisting of eminent scientist, experts, Director and one senior level scientist as member secretary review the research achievements in the institute. The committee also suggest research programmes based on national and global context in the thrust areas within the mandate of the institute. The RAC also guide in development of skills for presentation and efficient writing of reports, highlighting outputs and impact, commercialization, and innovative approaches for handling IPR and biosafety issues. Similarly, the Institute Management Committee (IMC) monitors the various administrative and financial aspects of the Directorate, under the chairmanship of the Director. A number of other internal committees such as Institute Research Committee (IRC), Project Monitoring and Evaluation Committee (PME) and Institute Joint Staff Council (IJSC) are also in place for smooth functioning and proper management of the institute.

2.8 Infrastructure

2.8.1 Building

The main office complex of ICAR-DCFR is located at Bhimtal. The facilities available at main complex are different laboratories, library, AKMU cell, wet laboratories, flow-through raceways, recirculatory aquaculture system, hatchery, museum and well maintained aquarium open for public, guest house, committee rooms and auditorium. A functional mahseer seed production unit is also available at a different site in Bhimtal. The Directorate has an experimental fish farm at Chhirapani, Champawat, Uttarakhand. The farm centre has trout hatchery, cemented nursery and grow-out raceways with water recirculation system, ponds, tanks for conducting experiments, laboratories, check dam, reservoir, meeting hall, guest house and staff quarters.

Main office building of ICAR-DCFR, Bhimtal

ICAR-DCFR premises at Bhimtal

Coldwater Fisheries Museum at ICAR-DCFR, Bhimtal

Coldwater Recirculating Aquaculture System at ICAR-DCFR, Bhimtal

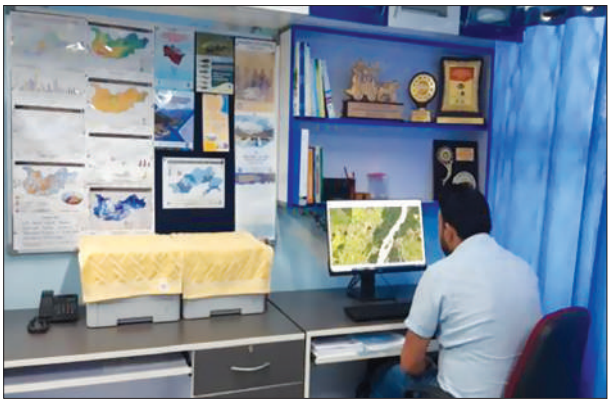
Himani aquarium at ICAR-DCFR, Bhimtal

Guest House of ICAR-DCFR, Bhimtal

Experimental Fish Farm of ICAR-DCFR at Champawat

2.8.2 Laboratory facilities

The Directorate has well equipped laboratories to support research on geo-informatics, environmental fish biology, nutrition, nutritional physiology, molecular genetics, molecular biochemistry, biotechnology, diagnostic virology, bacteriology and mycology. There is also wet laboratory facilities available in this institute which are well maintained used for conducting research experiments in coldwater fishes. A small feed mill installed in the main campus of the Directorate is functional to meet the basic requirement of fish feed in the experimental farm.



Laboratory facilities at ICAR-DCFR, Bhimtal

2.9 Support services

2.9.1 Prioritisation, Monitoring and Evaluation Cell

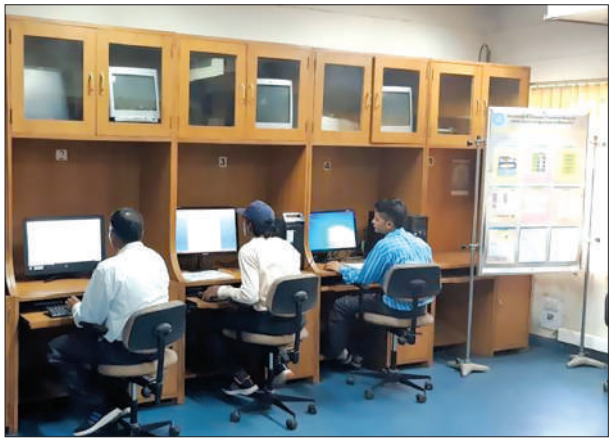
Prioritization Monitoring and Evaluation cell of the institute monitors the implementation and progress of research projects. The PME cell is responsible for maintaining the records of project reports through RPP system and for dealing with all the associated technical matters. The cell also keeps a record of publications, deputation and participation of scientists in seminars, symposia, workshop and conferences, training programmes attended as well as conducted. This cell also organizes the annual meeting of Institute Research Committee (IRC) and Research Advisory Committee (RAC) to evaluate the progress made in each research project and approve the work programme for the following

year. New research proposals are also approved by the IRC after thorough evaluation of the objectives, technical programme, practical utility, manpower and financial involvement.

2.9.2 Agriculture Knowledge Management Unit

Agricultural Knowledge Management Unit (AKMU) of this Directorate provides the facilities for scanning and printing and internet access (BSNL) to all scientists and other staff members. It also serves as network administrator and monitors the LAN connectivity of around 50 computers at this Directorate. In AKMU cell, desktop computer and internet facilities are also available for research scholars and students working under various project/programmes. Internet facilities at the experimental field centre, Champawat is provided through BSNL. Electronic mail and messaging solutions (mail server) are also maintained at this Directorate for secure communication via webmail.

The website of the Directorate (http://www.dcfr.res.in) has been modified as per Guidelines for Indian Government Website (GIGW) and certified for Standardization Test Quality Certification (STQC). The website is also being regularly updated as per the ICAR guidelines, under the AGROWEB project. The site presents information about the Directorate's manpower, mandate, research projects, major achievements, technology generated and consultancy services. Further, the conduct of training programmes, seminars, symposia, recruitments and tender notices are being notified in the website. The Directorate's website is also linked to the website of Indian Council of Agricultural Research (http://www.icar.org).



AKMU unit of ICAR-DCFR, Bhimtal

2.9.3 Library and Documentation Unit

The Directorate has a library and documentation unit which acts as a repository of literature and information. It is accessible to all the scientists, staff members, research scholars, students and other individuals from neighboring institutes interested in scientific literature on coldwater fisheries and allied subjects. All scientific books have been catalogued with barcoding. The library also provides the facility to access free online publications and articles of many international and national journals through www.cera.jccc.in. The library maintains active reprography services by producing departmental publications and supplying required photocopies to the scientists and research scholars. An inventory of e-journals comprising more than 35,000 soft copies of important fisheries research articles has been developed. The documentation section is entrusted with the responsibility of publishing scientific bulletins, brochures, pamphlets, annual report and newsletters. Publications like annual reports, technical bulletins and special publications published from time to time are mailed to about 250 organizations, institutions, fishery agencies for exchange and sharing of knowledge with other research organizations.

Library and Documentation unit at ICAR-DCFR, Bhimtal

2.9.4 Institute Technology Management Unit

The Institute Technology Management Unit has been constituted under the chairmanship of Director, for dealing with patents and other intellectual property rights developed at the Directorate. It is also responsible for safe transfer of technologies and for providing information about ICAR guidelines on IPR issues. Training and guidance are provided for concerned scientists with respect to IPR issues. The ITMU cell observes World Intellectual Property day on 26th April every year by organizing a special workshop to create awareness of intellectual property rights.

2.10 Staff strength (as on 31.12.2019)

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	-	1
Scientific	30	24	6
Technical	14	12	2
Administrative	13	11	2
Supporting	11	10	1
Total	**69**	**57**	**12**

2.11 Financial statement for the year 2019-20

S. No.	Head	R.E 2018-19	Expenditure
	CAPITAL		
1	Works		
	Land	-	-
	Office Building	3225000	3224500
	Residential Building	-	-
2	Equipments	9600000	9461121
3	Information Technology	1400000	1364258
4	Library Books & Journals	1430000	1422776
5	Vehicle & Vessels	632000	613940
6	Furniture & Fixtures	100000	99400
I	**Total Capital expenditure**	**16387000**	**16185995**
II	**Establishment Charges**	67568000	67567053
III	**Pension**	200000	200000
	Travelling Allowance		
	Domestic TA/ Transfer TA	3500000	3478962
IV	**Total TA**	**3500000**	**3478962**
	Research & Operation Expenses		
	Research Expenses	9217000	9216360
	Operational Expenses	9058000	9057438

S. No.	Head	R.E 2018-19	Expenditure
V	**Total- Research &Operation Expenses**	**18275000**	**18273798**
	Administrative Expenses		
	Infrastructure	9571000	9570513
	Communication	88000	87413
	Repair & Maintenance		
	Equipments, Vehicle & Others	621000	620730
	Office Building	1673500	1673249
	Residential Building	-	-
	Minor Works	304000	303546
	Other (excluding TA) (instt.)	10740000	10739962
VI	**Total Administrative Expenses**	**22997500**	**22995413**
	Miscellaneous Expenses		
	HRD within India	314000	313751
	Other Items (Fellowship)	-	-
	Publicity & Exhibition	307000	306323
	Guest House Maintenance	200000	200000
	Other Miscellaneous	678500	678463
VII	**Total Misc. Expenses**	**1499500**	**1498537**
	NEH (Capital)	800000	800000
	NEH (Revenue)	800000	799521
Total NEH		**1600000**	**1599521**
	TSP (Capital)	1000000	1000000
	TSP (Revenue)	1900000	1725615
Total TSP		2900000	2725615
	SCSP (Capital)	1015000	926462
	SCSP (Revenue)	5078000	5077825
Total SCSP		**6093000**	**6004287**
Total Revenue (Grants in Aid Salaries + Grants in Aid General)		**121818000**	**121616724**
Total Revenue + Capital		**141020000**	**140529181**

3 Research Achievements

3.1 Resource assessment and management

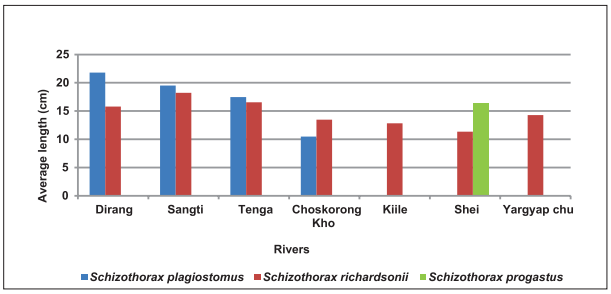
3.1.1 Assessment of population status, species diversity and habitat ecology of snow trout *Schizothorax* species in selected streams of Indian Himalayan region

Sampling area: Seven snow-fed tributaries of Arunachal Pradesh, viz, river Dirang *chu* (92°16'23"E, 27°22'30"N), river Sangti (92°37'22.4"E, 27°18'29.1"N), river Tenga (92°45'58"E, 27°18'15.7"N), river Choskorong Kho (92°27'32.8"E, 27°26'51.5"N), river Kiile (93°49'53"E, 27°33'18.2"N), river Shei (94°71'90"E, 27°99'08"N) and river Yargyap *chu* (94°09'49.3"E, 28°34'32.4"N) were explored during 2019 to analyze the catch composition of snow trout, abiotic and biotic components of their habitats, food and feeding habits and the reproductive biology.

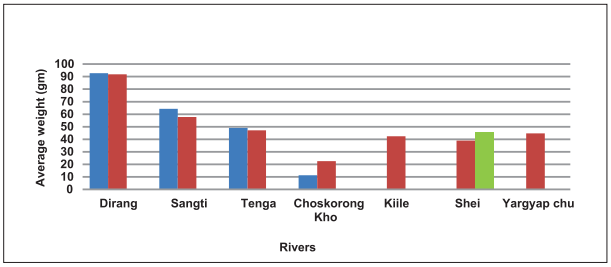
Location of sampling stations at Kameng drainage

Sampling for assessment of abiotic and biotic variables at a sampling station in Yargyap chu drainage

Snow trout composition: The average length of *S. richardsonii* was recorded as 14.64 ± 2.36 cm with an average catch size of 49.33 ± 21.52 kg in weight during the investigation in the different sampling sites of Arunachal Pradesh. In case of *S. plagiostomus*, the recorded average length was 17.32 ± 4.89 cm with an average catch size of 54.36 ± 33.92 kg in weight. *S. progastus* recorded an average length of 16.44 ± 1.02 cm and an average weight of 45.63 ± 14.34 kg. The maximum length of the fish recorded in these snow fed tributaries of Arunachal Pradesh was 52.5 cm weighing 1.20 kg.



Average length (cm) of snow trout from different sampling stations



Average weight (g) of snow trout from different sampling stations

Referring to the Kameng drainage in particular, the species of *S. plagiostomus* was dominating in the sampling points over the river Dirang *chu* and its tributaries (Table). The species of *S. richardsonii* was found dominating in river Tenga and its tributaries. Both the rivers further merge to form the Kameng drainage in the southern part of the district.

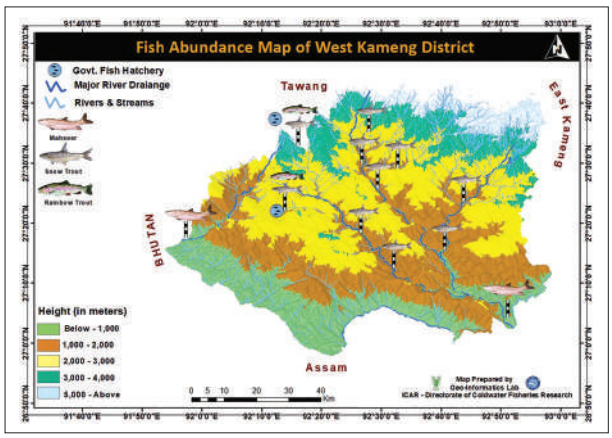
Length-weight relationship ($W=aL^b$) and relative condition factor (K_n) of fishes at sampling stations: In almost all the samples, the value of

Table: Percentage composition of fish species in different sampling stations in Kameng drainage

Fish species	Sangti	Dirang	Munna Camp	Tenga	Rupa	Shergaon
S. richardsonii	16%	24%	33%	53%	77%	81%
S. plagiostomus	79%	71%	63%	44%	18%	15%
Others	5%	5%	4%	3%	5%	4%

'b' is near to '3' indicating an isometric growth in fishes except in *S. richardsonii* at Tenga which shows negative allometric growth. An overall fitness for fish species is assumed when K_n values are equal or close to 1 indicating good health of snow trout in the environment.

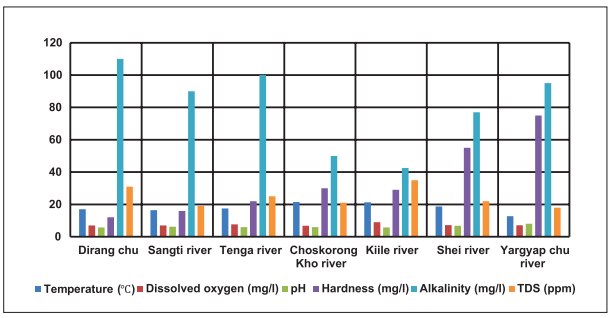
Species composition: Analysis of the species composition in the Kameng drainage showed the existence of three group of fish species of high commercial importance viz., mahseer, snow trout and exotic trout in the West Kameng drainage of Arunachal Pradesh. The fish species with economic importance in Kameng drainage in terms of food value was comprised of 53%, followed with 16% fishes having both food and ornamental value and 11% with food and sport value. The International Union for Conservation of Nature's Red List of Threatened Species showed 81% of the fish groups are under Least Concern category which is a good indicator for a healthy water body.



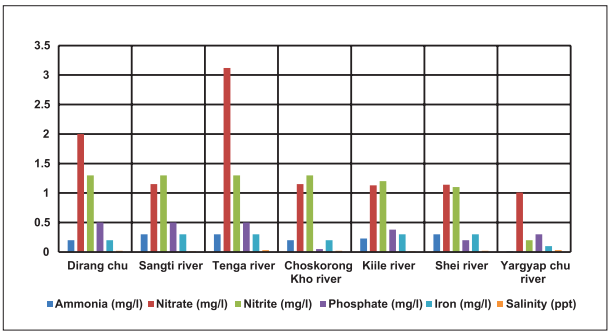
Map showing the abundance pattern of commercially important fish species

Snow trout fishing methods: The important fishing methods to catch snow trout in Arunachal Pradesh are the (i) Noose and line with a range of catch per unit effort (CPUE) of 1.8-2.2 kg/h/gear; (ii) Cast nets (0.5-5.2 kg/h/gear); (iii) Fishing trap (kholeya) with CPUE of 2.0-15.0 kg/day; (iv) Diversion of river water (neuta) to land the fishes on a perforated bamboo passage (0.5-4.2 kg/day); (v) Fishing trap (*Hoap*) with CPUE of 2-4 kg/day/gear; (vi) Fish aggregating structures (*Lipums*) yielding an average catch of 2.5-12.0 kg per *Lipum*.

Abiotic and biotic variables of water: The abiotic variables of water in all the sampling sites remained within the optimum level concluding good health of the water body and conducive for the abundance of the snow trout.



Graphical representation of physico-chemical parameters of water at sampling stations



Graphical representation of nutrient variables of water at sampling stations

The biotic variable analysis of the water bodies included the plankton analysis and altogether 30 species of phytoplankton were identified under 24 families, 19 orders and 6 classes from the different sampling stations. The minimum plankton density was recorded in the month of July (rainy season) accounting 75-150 cells/L and the maximum was recorded in the month of January (winter season) accounting 2625-3375 cells/L from the drainages.

Food and feeding habits: The relative gut content (RGL) value between 2.5-3.5 indicated

that the group of snow trout fishes were mostly herbivorous in nature.

Reproductive biology of snow trout: Field observations on the different stages of the reproductive organs reveal that the percentage of matured specimens was mostly recorded during May to August indicating the proximity of spawning period. The matured ovaries in females are yellowish in colour with reddish tinge and cover nearly the entire length of body cavity. On the other hand, the mature testes in males become very thick, creamy white in colour with oily surface, lobed and extend to 2/3rd of the body cavity. A slight pressure on the belly releases milt from the genital papilla. The fecundity of snow trout was found very low as compared to the carps. The histological aspects of the reproductive biology of the snow trout is in progress under the study.

3.1.2 GIS based digital data base on coldwater fishery resources of Arunachal Pradesh in North East Himalayan (NEH) region

Three districts of Arunachal Pradesh viz., Anjaw, Shi Yomi and Kamle were investigated and the aquatic resources, drainage network, land use land cover, digital elevation model, slope and potential fisheries development suitability sites were digitized and mapped using SOI toposheets, ground truthing and spatial data.

Digitised mapping of aquatic resources: Aquatic resources in the form of major river drainages, their connecting channels and streams, upland wetlands were digitized and mapped. The combined length of river network and wetland area is reflected in Table below. The majority of the upland lakes accounting 63% and 68% of the total are situated at an altitude ranging between 4000-5000 m MSL in Anjaw and Shi Yomi districts respectively.

Table: Details of river network and upland lakes of the selected districts

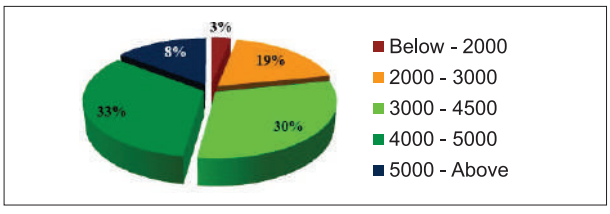
Resources	Districts		
	Anjaw	Shi Yomi	Kamle
River network in length (No./km)	4225/4671.45	1254/2456.37	932/1835.25
Wetland area (No./ha)	554/2484.36	62/240.71	-

Development of Land Use Land Cover (LULC) maps: Eight categories of LULC were classified for the three districts and the area of coverage in each category is mentioned in Table below. Forest covers the maximum land cover accounting 69.97%, 75.03% and 89.06% of the total area in the districts of Anjaw, Shi Yomi and Kamle respectively. Snow area is occupied only in Anjaw and Shi Yomi districts covering 20.23% and 17.09% of their total area. Shifting cultivation is a prominent feature in Arunachal Pradesh and is practised in 1.01%, 0.56% and 0.58% area in the three distrcits.

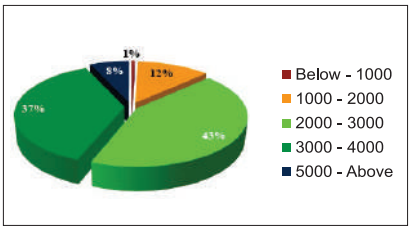
Table: Confusion matrix of the LULC classes

S. No.	LULC classes	Districts (Area in sq.km)		
		Anjaw	Shi Yomi	Kamle
1.	Agricultural land	19.13	4.08	3.95
2.	Built up	6.02	4.10	3.27
3.	Forest	4084.73	2136.56	1668.74
4.	Grassland & Grazing land	19.57	0.46	0.75
5.	Wastelands	456.47	189.11	30.73
6.	Water bodies	11.91	10.93	155.33
7.	Shifting Cultivation	59.24	15.83	0.58
8.	Snow / Glacier area	1181.13	486.55	-

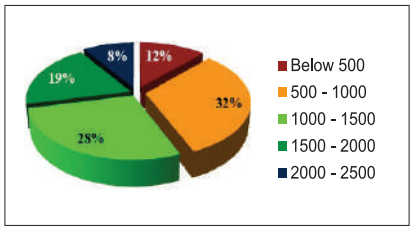
Digital Elevation Model (DEM) and Slope: The DEM examination infers that the elevation class ranging from 4000-5000 m and 3000-4000 m in Anjaw district encompasses 33.81% and 30.36% of the total geographic area, whereas the elevation class between 2000-3000 m and 3000-4000 m in Shi Yomi district comprises 42.88% and 37.31% respectively. Similarly, the elevation class between 500-1000 m and 1000-1500 m in Kamle district encompasses 31.63% and 27.62% respectively. Furthermore, the slope class 0-20 degree in green colour comprising 12.91%, 22.96% and 25.12% of the total geographic area has better probability in considering potential sites for undertaking fisheries developmental activities as compared to slope class 20-30 degree and the slope class 30 degree and above of the region.



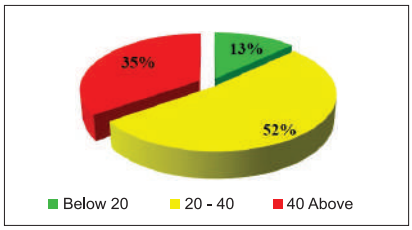
Percentage wise elevation classes of Anjaw district



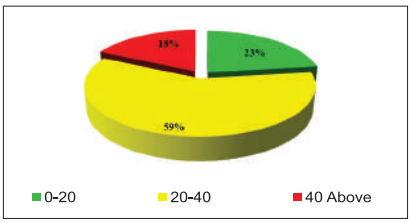
Percentage wise elevation classes of Shi Yomi district



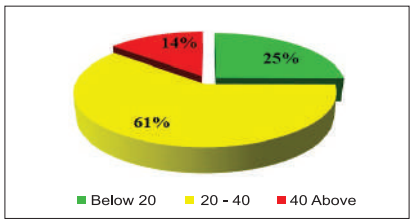
Percentage wise elevation classes of Kamle district



Slope classes of Anjaw district

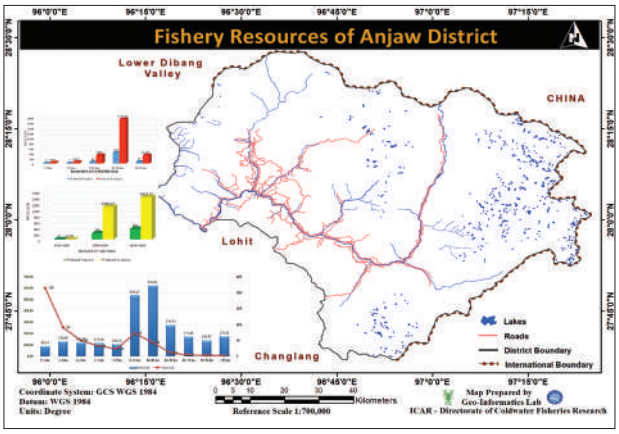


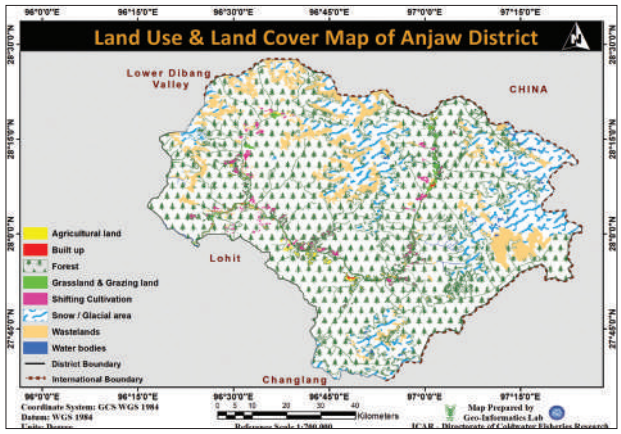
Slope classes of Shi Yomi district

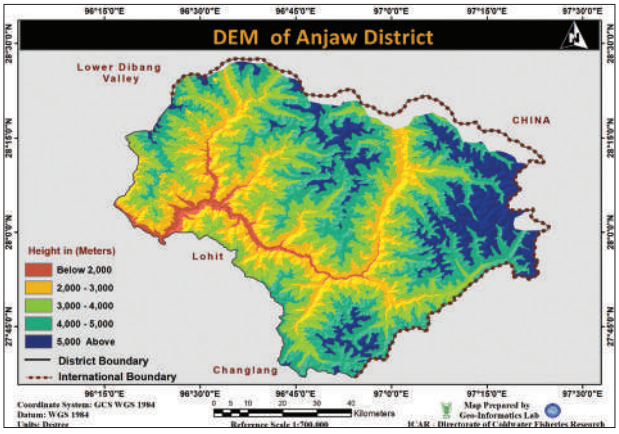


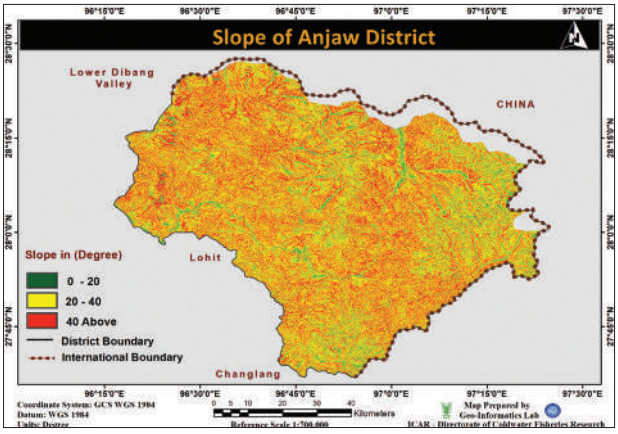
Slope classes of Kamle district

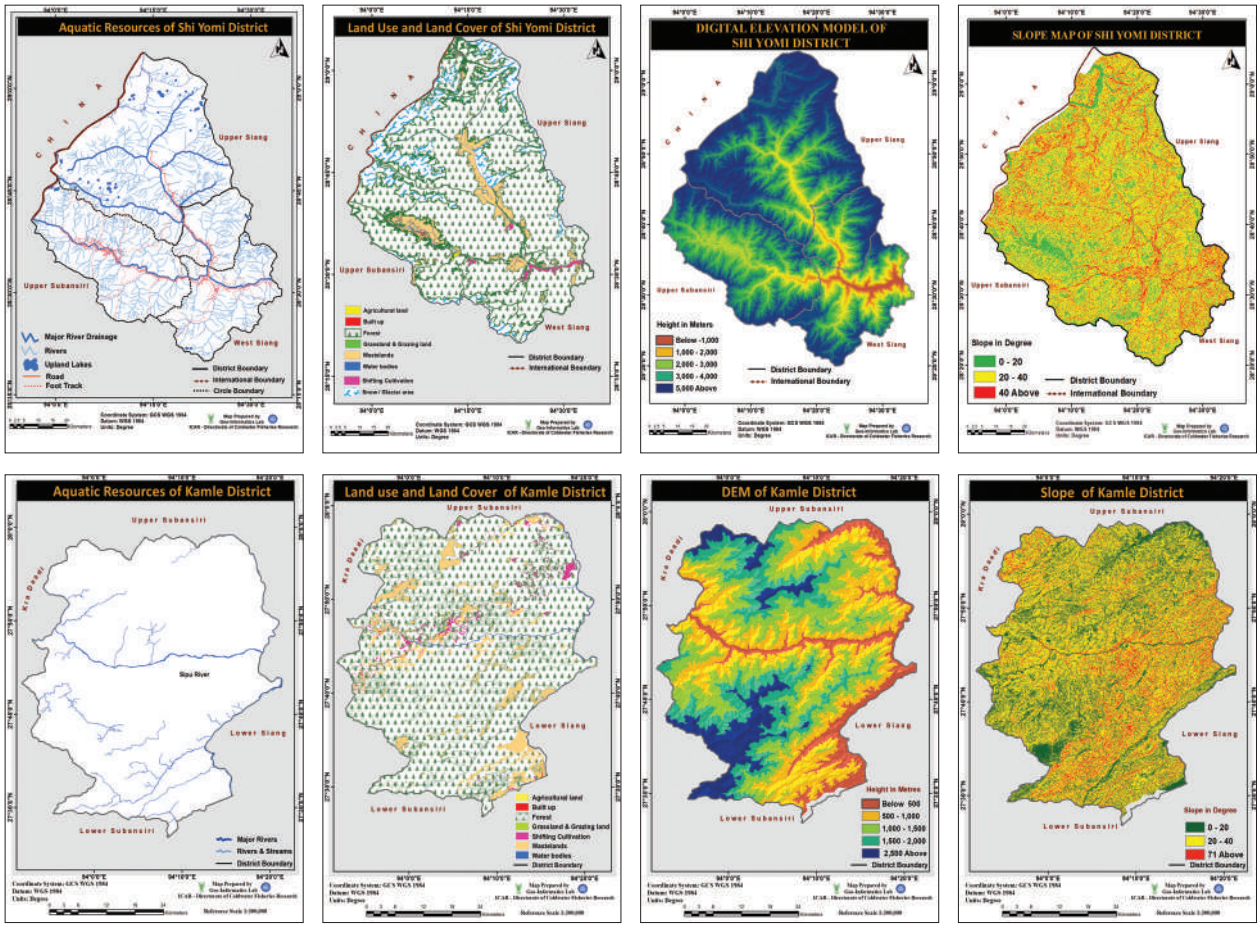
Mapping of potential fisheries suitability sites: Since the districts of the state are at a higher elevation with hilly terrains and little human habitation, it is presumed that the water of the region is pollution free and of the optimum quality as desired for coldwater aquaculture operations. The other feature classes which were taken as input criteria to designate the probable potential areas for fish farming were the drainage network, road connectivity, slope of the region (0-20 degree), digital elevation model and land use land cover (agricultural land and wasteland). Based on these criteria, the selected input feature classes were superimposed in the GIS environment and high potential areas conducive for fish farming were identified. The development of potential fisheries suitability areas are under progress of work where the pair-wise comparison method developed by Saaty (1977) in the context of AHP is used to develop a set of relative weights for each parameter. Preferences for fisheries development with respect to the evaluation criteria were incorporated into the decision model for the relative importance of each criterion. The preferences are typically defined as a value assigned to an evaluation criterion that indicates its importance relatively to other criteria under consideration.







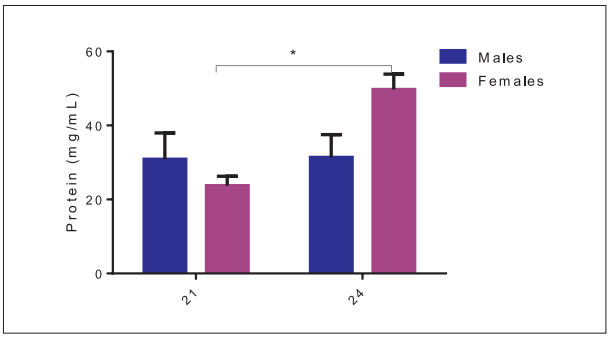


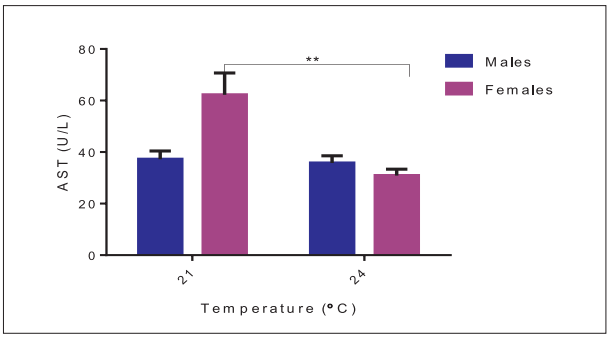


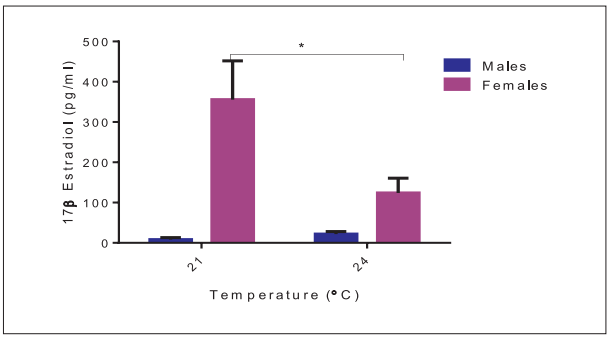
3.2 Aquaculture oriented research and development

3.2.1 Scaling up the seed production of chocolate mahseer in captivity

Two experimental trials were conducted to unravel the important environmental factors; temperature, water depth and substrate responsible for the trigger of volitional spawning of chocolate mahseer in captivity. In experiment I, broodstock rearing was carried out in 1:1 ratio in two different temperatures 21 and 24°C with substrate (GW) and without substrate (CW) in tanks of size 2m x 1m x 0.5m (LxWxH) and a tank of size 1.2m x 1m x 1m (LxWxH) at 24°C in which spawning was already observed (GWD). Broodstock were fed with prepared feed of 40% protein, 10% lipid and occasionally with goat liver. Each fish was anesthetized with clove oil @ 50 µl/L prior to blood collection and blood was collected through caudal puncture by using a sterile 5 ml syringe rinsed with freshly prepared 2.7% EDTA and transferred into EDTA coated tubes. A portion of blood was used for hematological parameters analysis, and rest was centrifuged for plasma separation. Plasma metabolites such as plasma glucose, protein, LDH, AST and steroids 17β-estradiol, and 11-ketotestosterone were quantified. Substrate has no significant effect on hematological variables and plasma metabolites (P>0.05) for both of the reared temperatures. The plasma metabolites (protein, AST) and steroid (17β-estradiol) level suggested the lower temperature of 21°C could facilitate the ovarian maturation compared to 24°C. Natural spawning was not observed in any of the treatments during the experimental period from March to July, 2019. Experiment II was conducted by facilitating the brood fish with optimum temperature (obtained from experiment I), depth, and substrate. After transferring the brood stock of experiment I to the conducive environment, instant spawning was observed in 70-75% females from both gravel water and clear water tanks. Spawning behaviour of the chocolate mahseer fish was recorded. Around 7000 eggs were produced, and the larvae were reared in mahseer hatchery.







Plasma protein (mg/mL), AST (U/L), and 17β Estradiol (pg/ml) level of *N. hexagonolepis* reared in two different temperatures. *= <0.05, **= P<0.01

3.2.2 Optimizing reproductive and spawning performance of golden mahseer for upscaling its seed production in captivity

For optimizing reproductive and spawning performance of golden mahseer in captivity, adult golden mahseers which were reared in pond captive conditions were collected and further maintained in captivity. Fabricated six FRP tank were installed with bed biofilters for the experimentations. Adult mahseer (4 males and 4 females in each tank were distributed in 6 biofilter tanks (3 circular and 3 rectangular) of each 1000 L capacity. The optimum photoperiod of 12 h light and 12 h dark and temperature of 25°C as standardized in our previous experiments were maintained throughout the experimental period. The water temperature was maintained using 1000W thermostatic water heaters. Fishes were fed *ad libitum* with regular broodstock diet twice daily. Water quality parameters such as temperature, DO, pH, nitrite, ammonia, free CO_2, hardness etc were monitored regularly.

After four months of rearing in the standardized optimum conditions, we observed four spontaneous spawnings in the circular biofilter tanks over a period of two months. But the egg retrieval was very poor. To address the egg retrieval constraint, firstly, we tried 1 mm mesh muslin cloth over the gravel bed with and without ovatide injection to the brooders. But unfortunately, we did not observe any spawning. Secondly, we carried out experiments of segregation of males and females i.e. we injected the females with ovatide @ 0.5 ml/kg and kept the males and females separately and then stripped. Surprisingly, we could strip the eggs. The stripping of eggs now is being done even without injecting any hormone to the brooders. With this successful protocol of sex segregation in golden mahseer, multiple breeding were done through the months of June to November (5 batches) and striped a total of 46200 eggs from

Golden mahseer brooders under photothermal manipulation

Stripping of captive matured golden mahseer brooder

Fertilized eggs of golden mahseer matured in captivity

Fry of captive bred golden mahseer

three tanks (800 L capacity with just 12 females). We observed fertilization rate of 82-86%, hatching rate of 75 -80% and 78-83% survival rate (till 3 months after hatching). The comparative study of wild and captive bred fry in terms of growth, thermal tolerance, egg hardening and other morphometric indices were done.

On the other hand, an in-house GnRH peptide was designed based on sGnRH sequence but kept structurally different from currently available commercial GnRH analogs to improve its stability and efficacy. The GnRH peptide was synthesized by Fmoc-chemistry in molecular biochemistry laboratory, ICAR-DCFR, Bhimtal and characterized by mass spectrometry. Using this peptide and a dopamine inhibitor, an injectable solution was formulated which is comparatively less viscous and does not cause blackening at the site of injection. The efficacy of the formulation was tried once in golden mahseer but could not get encouraging results. However, efficacy test of the same formulation conducted in IMC at field level in two different geographical locations (Assam and West Bengal) gave promising results. The fertilization and hatching rate was found to be 95% and 98% respectively.

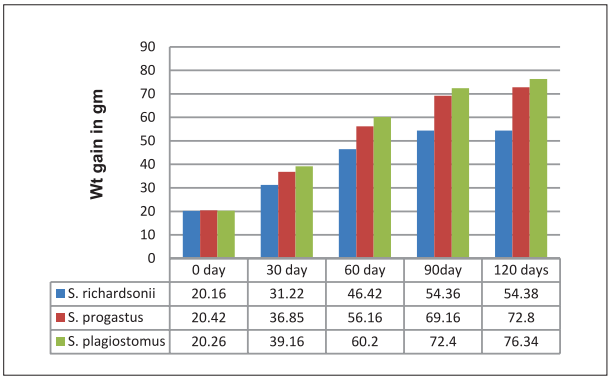
3.2.3 Growth potential and breeding performance of *S. progastus* and *S. plagiostomus*

Adult male and female fishes of 2-3 years age group were collected by netting and trapping from Sirodi stream located at Bhowali, district Nainital, Uttarakhand and Alaknanda stream. Brooders were collected by cast netting during morning hours. The fishes were transported in live condition to DCFR, model fish hatchery Bhimtal, Uttarakhand. The fishes were disinfected with 1.0 ppm $KMnO_4$ solution and stocked in acclimatization pond and were later shifted to FRP tanks. *S. progastus* was identified having pointed snout and no suctorial lips, whereas *Schizothorax plagiostomus* having a blunt snout and suctorial lips and different shape of labial fold. Brood stock of both the species was maintained in captive condition, observed general biology, gonadosomatic index (GSI) and breeding behaviour, bred *S. plagiostomus* in captive condition and evaluate the growth of fingerlings.

Brood fish was maintained in FRP tank and fed with 35% protein diet at 3% of body weight. Both the species were observed for gonadosomatic index (GSI). GSI of both species for both the sexes were done during the period of January to December. The GSI values of *S. plagiostomus* were ranging from 2.62% to 13.42% in females with the peak during the month of September (13.42%) and in March (12.86%) and minimum in the month of May (2.62%) and October (4.80%). The similar trend was observed in *S. progastus* brooders and GSI values were found in the range of 2.80% to 12.24% with maximum GSI in the month of September and March. The GSI values in males were observed in the range of 2.62% to 6.78% in both the species. Both the species showed similar pattern of gonadal maturity and two breeding seasons with round the year maturation in males. However, higher values of GSI during September showed reproductive superiority over spring season. Brooders showed maturity at the age of 3 years, however brooders

of the age of 4-5 years (size- 200-450 g) performed better breeding. Sexual dimorphism was observed having presence of nuptial organs and size of the basal sheath scale. Mature fish changed in colour during the breeding time. Mature males develop tubercles on either side of the snout, faint yellow colour of the body, and reddish colour of fins. *S. plagiostomus* was easier to breed than *S. progastus* at water temperature 15-20°C. Dry stripping method was applied for spawning. Females were checked twice a week during the spawning season. Eggs of two females were fertilized with milt from three males by stirring them gently with avian feather. Fresh water is added and eggs are washed 3/4 times till they are clean, swollen and kept in trays with water flow rate of 3-4 LPM for 10000 eggs. The eggs were sticky, orange in colour for both species having the size of fertilised eggs in the range of 3.2-3.8 mm in case of *S. plagiostomus,* while 2.9-3.6 mm in case of *S. progastus.* Hatching takes place within 11-18 days at water temperature of 18-21°C. The average number of egg laying in this group ranges as 14,000-18,000 per kg body weight in case of *S. plagiostomus,* while 18,000-20,000 per kg body weight in case of *S. progastus.* It was observed that the fully ripe eggs, which were orange in colour started degeneration within 2-5 days, if not extruded in time. The over-ripe eggs turned dull orange in colour. Fertilisation rate was observed in the range of 80% with slightly less in case of *S. plagiostomus.* The hatching rate was higher (>80%) during September than during March (<56%) and September/October is the best time for spawning to the both species. The size of hatchlings varied from 3.8-9.7 mg and survival was about 58%. The development from one day hatchling to free swimming stage varied inversely with water temperature, which was observed 8 days at 20-21°C and 17 days at 10-14°C (160-170 degree days) and the survival rate was also higher (>86%) at 20-21°C and lower (54%) at 14°C. Over all recovery of fry from fertilised eggs was observed in the range of 46% with slightly lower side (44%) in case of *S. progastus.* Starter trout feed having 45% protein was used to rear the fry.

Field experiment was conducted with stocking of yearlings of both the species and compared with the growth of *S. richardsonii* at the stocking density of 40 fish/m^3 for 120 days in FRP tanks. Stock was fed with 35% protein diet at 5% body weight and both the species showed better growth (53-64%) over the *S. richardsonii* with net weight gain in the range of 34.22-56.08 g. *S. plagiostomus* also showed slightly higher growth (7%) than the *S. progastus.* However growth of all species was almost negligible during December, when temperature was 11-14°C. Though low temperature adversely affected the growth, tested species *S. progastus* and *S. plagiostomus* showed better adaptation than *S. richardsonii* against low temperature during winter season. The recorded FCR was in the range of 3.82-3.46, which showed slow growth of the tested species. Observed survival was recorded >90% for all tested species.



	0 day	30 day	60 day	90day	120 days
S. richardsonii	20.16	31.22	46.42	54.36	54.38
S. progastus	20.42	36.85	56.16	69.16	72.8
S. plagiostomus	20.26	39.16	60.2	72.4	76.34

Comparative growth of three species in coldwater condition during 120 days field trial

Mature brooder of *Schizothorax progastus* and *Schizothorax plagiostomus*

3.2.4 Embryonic development, breeding and seed production of Sucker head, *Garra gotyla*

Garra gotyla, commonly known as sucker head fish belongs to family Cyprinidae. It has a broad geographical distribution along the Himalayas, Chota-Nagpur plateau, the Vindhya-Satpura mountains of the Indian peninsula; Pakistan, Bangladesh and upper Burma. It has second highest food value in Uttrarakhand and considered as a potential ornamental coldwater indigenous species. Apparently, it is considered as a vulnerable species in West Bengal and Northeastern states. However,

as per IUCN Red list (2012), this fish has been categorized as least concern. This species has export value with the trade name of 'Stone fish or gotyla' having high price in global market. This is well known for its excellent algae cleaning abilities and therefore it can be proficiently used as a coldwater aquarium cleaner fish candidate in coldwater aquarium, where the temperature is generally low (10-23°C).

Brooders were maintained at 19-22°C water temperature. Captive reared fish were regularly monitored for maturity confirmation by slight pressing at the abdomen and other biological traits. Females of mean body weight 35 g and mean length 14 cm and males of mean body weight 52.22 g and mean length 18 cm were used for induced breeding. Synthetic hormone (Ovatide) was administered sub-dermally at the rate of 0.2 ml for male and 0.4 ml for female, only to trigger. Latency period was 8 h. Fertilized ova measured 0.8-1.0 mm in diameter and fertilization rate was 75-80% at 22-24°C. Fertilized eggs were slightly whitish and transparent in colour whereas the unfertilized eggs were whitish in colour, opaque, non-sticky, small in size. Sampling of fertilized eggs has been taken for observation of fecundity and work is under progress. The hatching rate was 90-95% and survival rate up to fry was more than 90%.

The larvae were allowed to grow in periphyton based rearing tanks as well as in glass aquarium for validation of ornamental potential of the fish. The fishes kept in rearing tanks were fed on planktons and periphyton whereas fishes kept in glass aquarium were initially fed on available supplementary diet. In 12 month, the average length and weight of *Garra gotyla* was 7.05 cm. and 3.7 g respectively. Physicochemical parameters, temperature (14.8-20.6°C), DO (4.5-9.0 mg/l), pH (7- 8.5), alkalinity (40-140 mg/l), TDS (50-80 mg/l), nitrate (5-12 mg/l), CO_2 (5-15 ppm) and calcium hardness (35-100 ppm) of rearing tank were observed regularly. Under this project, approximately 200 numbers of first generation *Garra* fishes have been successfully developed and presently are under observation.

Gut content analysis to assess food and feeding habits of *Garra gotyla* showed that this species is bottom grazing, plankty- herbivorous fish. Gut contents revealed that *Garra gotyla* consume algae belonging to Chlorophyceae (*Volvox* sp., *Oedogonium* sp., *Spirogyra* sp., *Ulothrix* sp. and *Chlorella* sp.), Bacillariophyceae (*Tabellaria* sp., *Fragillaria* sp., *Pinnularia* sp., *Cymbella* sp., *Synedra* sp. and *Navicula* sp., Myxophyceae (*Oscillatoria* sp.). Major food item present in gut of *Garra gotyla* was *Bacillariophyceae*, *Fragilaria* and *Cymbella* along with decayed organic matter, leaves, mud and sand. They have longer and coiled intestine which increased absorbing surface area.

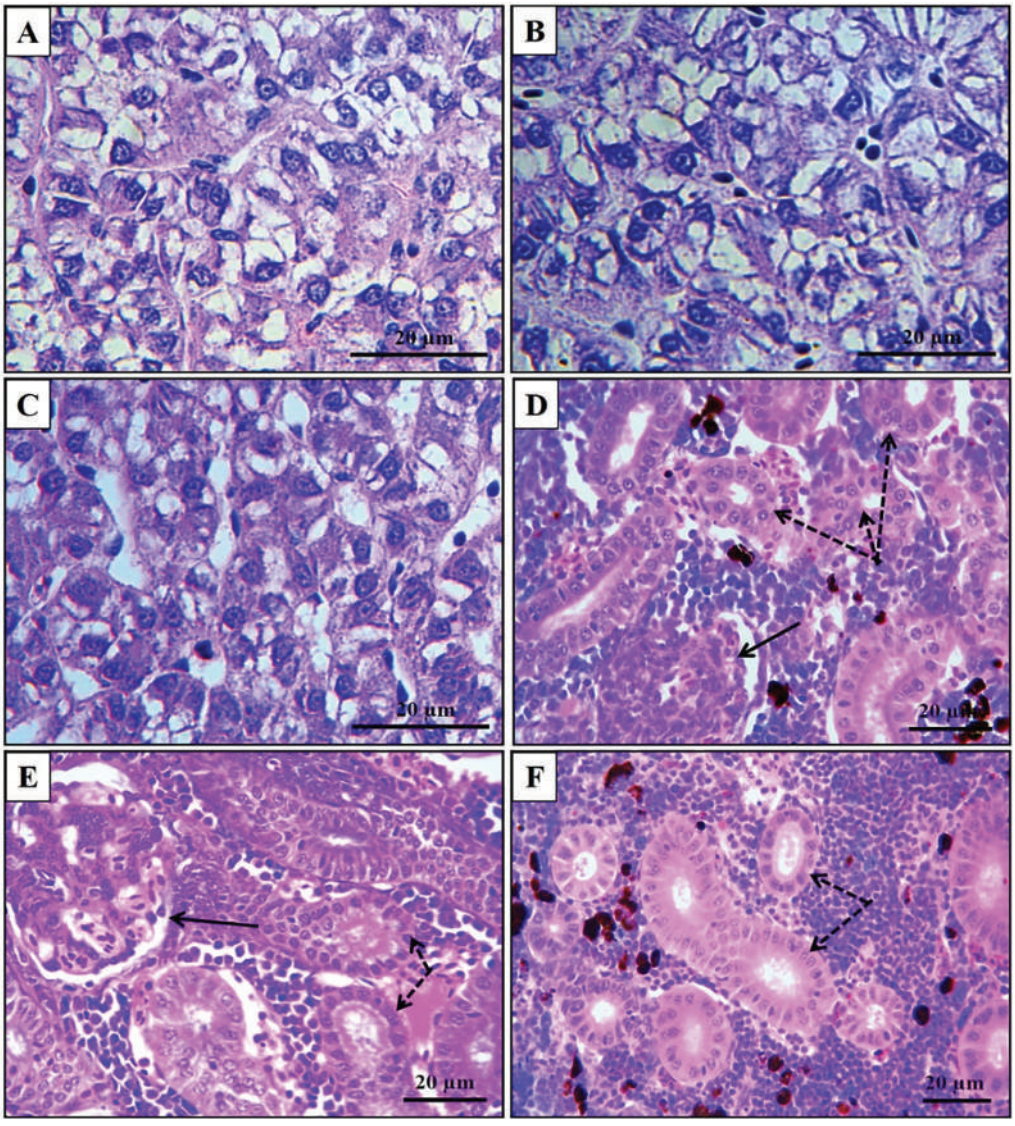
Brooder and breeding operation of *Garra gotyla*

Larval rearing and growth observation

Sampling of *Garra* and gut analysis

3.2.5 Development and validation of cost effective feed formulation for rainbow trout based on commercial scale industrial by-products

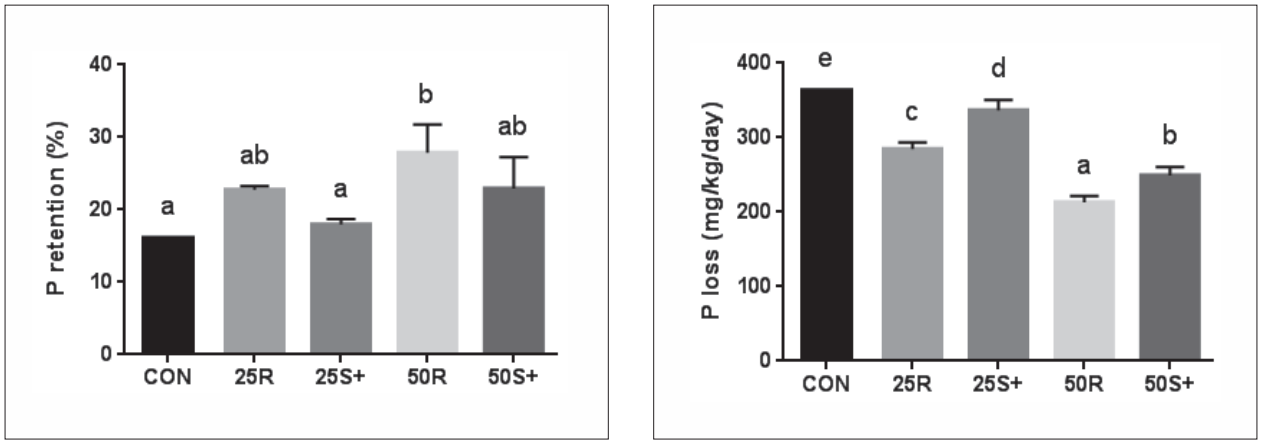
Feeding trial to ascertain the optimum dietary inclusion level of RDDG: In the first study, we investigated the potential of rice distillers dried grains (RDDG, a distillery industry by-product) to partially replace fish meal in rainbow trout test diets, with or without limiting nutrient (lysine, methionine and phosphorus) supplementation. Five experimental diets were fed to triplicate groups of rainbow trout juveniles (30 g initial body weight) for a period of 12 weeks. This feeding trial was



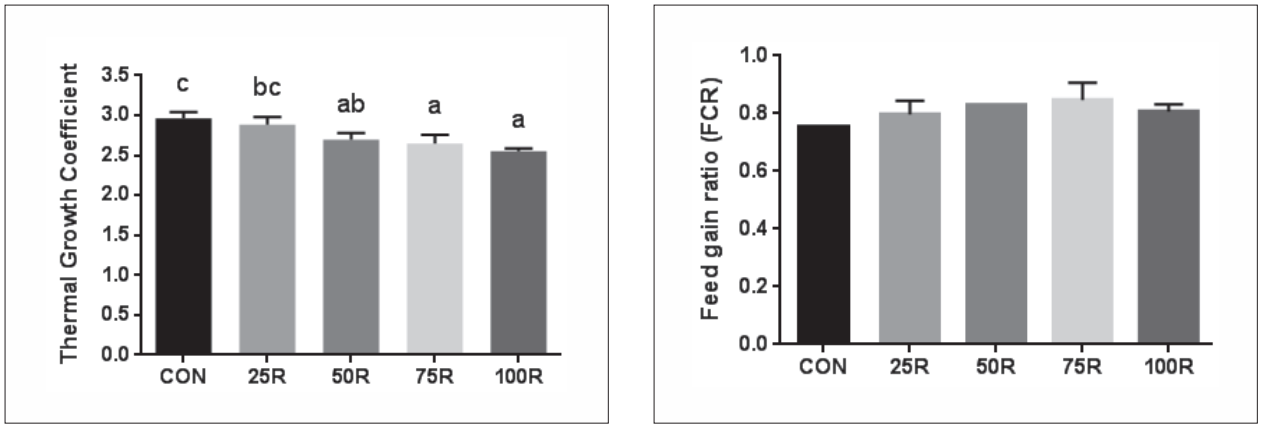
Histological image of liver (A-C) and kidney (D-F) from the RDDG dietary groups

conducted in an experimental RAS system, where water temperature was maintained at 18 ± 2°C. At the end of the trial, growth, feed utilisation, whole body composition and nutrient retention/loss were estimated. Partial replacement of fish meal (25 and 50%) with RDDG and limiting nutrient supplementation had no significant effect on feed intake (19.7-20.7 g/Kg/day), final mean body weight (179-200 g), weight gain percentage (502-578%), specific growth rate (2.1-2.3), thermal growth coefficient (1.7-1.8), feed conversion ratio (~1.1), feed efficiency (~0.9) and protein efficiency ratio (1.9-2.1). Biochemical analyses indicated that there was no significant difference in whole body content of moisture, protein, ash and phosphorus; but lipid content was found to decrease with higher level of RDDG inclusion. Correspondingly, lipid retention and gain estimates were also lower with higher inclusion level of RDDG; whereas, no such significant difference was evident for protein retention and nitrogen gain estimates. On the other hand, phosphorus retention/gain was found to increase with dietary RDDG inclusion, with concurrent reduction in phosphorus loss. Whole body amino acid profile did not indicate any substantial shifts due to fish meal replacement with RDDG. Histological investigations of liver, kidney and gastrointestinal tract did not show any abnormalities due to RDDG inclusion. Analyses of digestive enzyme activities and plasma metabolite levels were also done. Overall, we found that RDDG can be used to replace 25-50% FM in trout feed without significantly affecting growth, feed use and fish welfare.

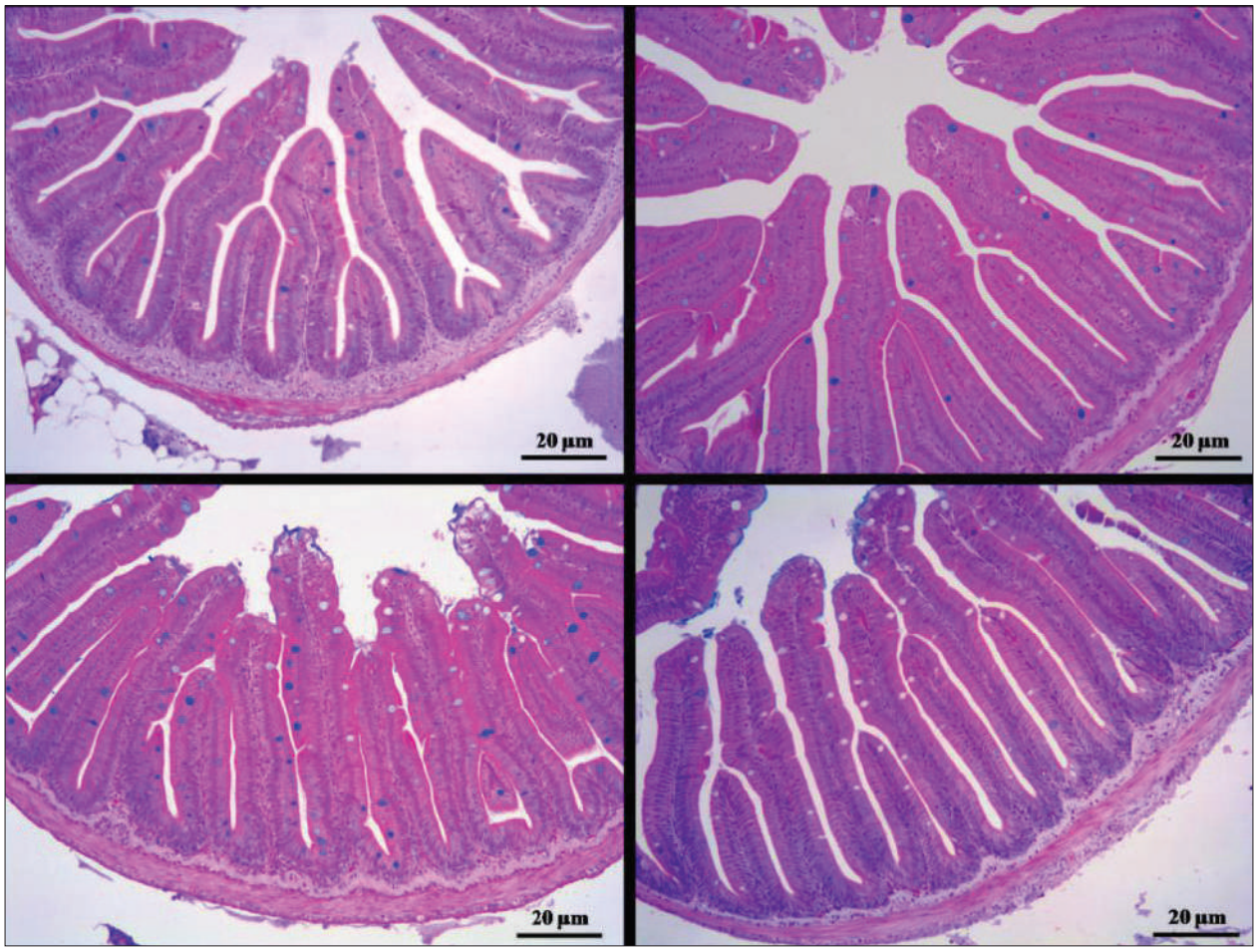
Feeding trial to ascertain the optimum dietary inclusion level of single cell protein meal: In the second study, we investigated the potential of single-cell protein meal (SCP) derived from methanotrophic bacteria to partially or completely replace fish meal in trout feeds. For this purpose, we conducted a nine-week feeding trial with five isonitrogenous (50.2 ± 0.7%) and isocaloric (21 ± 0.2 MJ/kg) experimental diets, where 0, 12.5, 25, 37.5 and 48% of SCP was included to replace 0, 25, 50, 75 and 100% fish meal, respectively. Each diet was fed to triplicate groups of rainbow trout juveniles (21.7 ± 0.2), to visual satiation twice a day. Given its high nutritional value (65-70% protein, 8-9% lipid and relatively good amino acid profile), at the end of the feeding trial, the growth and feed utilisation response was fairly high (i.e., thermal growth coefficient was 2.55 and feed efficiency was 1.23) even in the group where fish meal was completely (100%) replaced with the bacterial protein. Likewise, histological observations showed that there were no adverse changes in the gastro-intestinal tract, liver and kidney of rainbow trout, when fed diets with different levels of this bacterial protein. Nevertheless, comparisons between the dietary treatments revealed that there was a significant reduction in feed intake (from 1.79 to 1.45 g/fish/day) and correspondingly growth, when the bacterial protein was used to replace more than 25% fish meal. Feed gain ratio, feed efficiency and protein efficiency ratio were however not significantly different between the dietary groups. Measurement of the apparent digestibility coefficients (ADC) of the different diets showed that digestibility of dry matter and



Phosphorus retention and loss estimates in the RDDG dietary groups



Growth response and feed utilisation in the SCP dietary groups



Histological observation of the intestinal tract from the SCP dietary groups

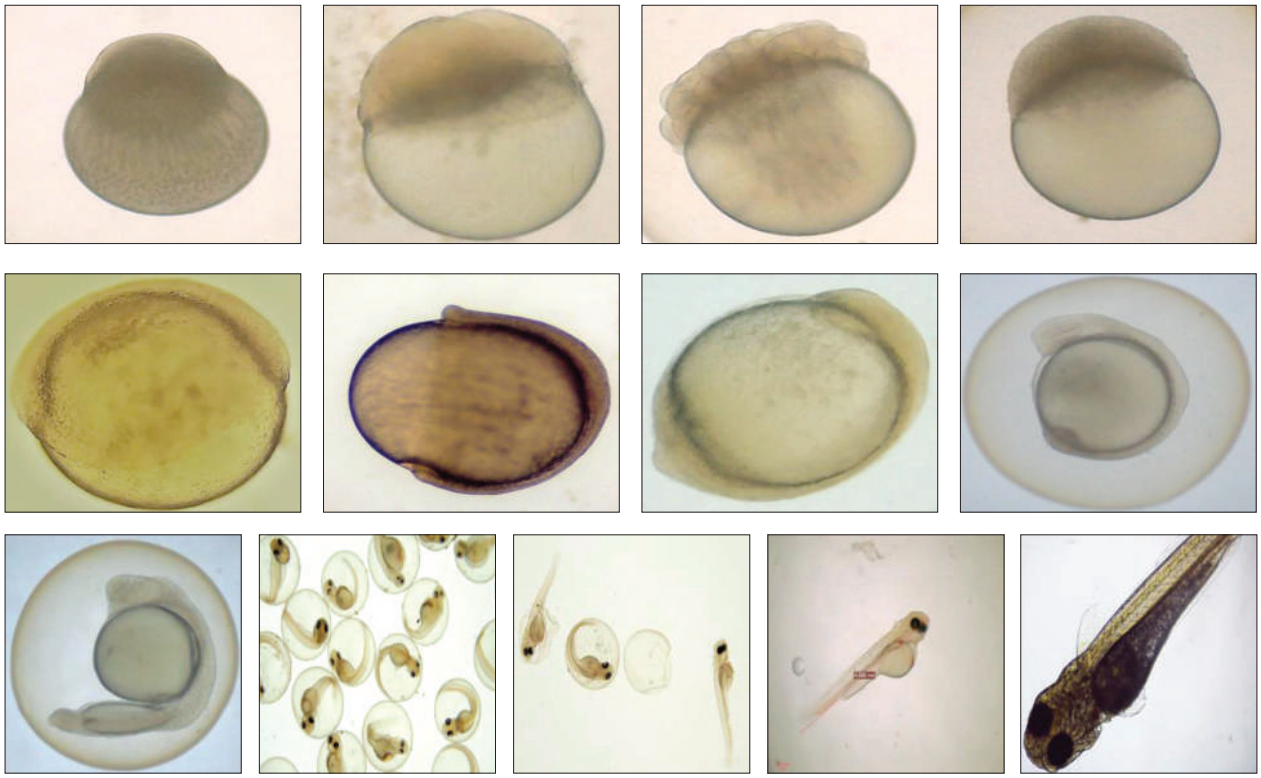
of protein was significantly reduced at the 100% FM substitution level; while lipid digestibility and leucine aminopeptidase activity decreased beyond 25% FM replacement itself. At higher levels of fish meal substitution with the bacterial meal, we observed considerable changes in condition factor, whole body protein content and tissue indices. Protein and lipid retention were not significantly different between the dietary treatments. However, phosphorous retention was found to substantially increase with increasing inclusion levels of the bacterial meal, with corresponding decrease in phosphorous loss, and this has clear environmental significance. Overall, the study demonstrated that 12.5% of SCP can be included in rainbow trout feeds to replace 25% of fish meal.

3.2.6 Network project on Ornamental fish breeding and culture (NPOFBC): ICAR-DCFR component:- Development of breeding protocol and larval rearing technique of the selected indigenous hill stream ornamental loaches, suckers and hill trouts

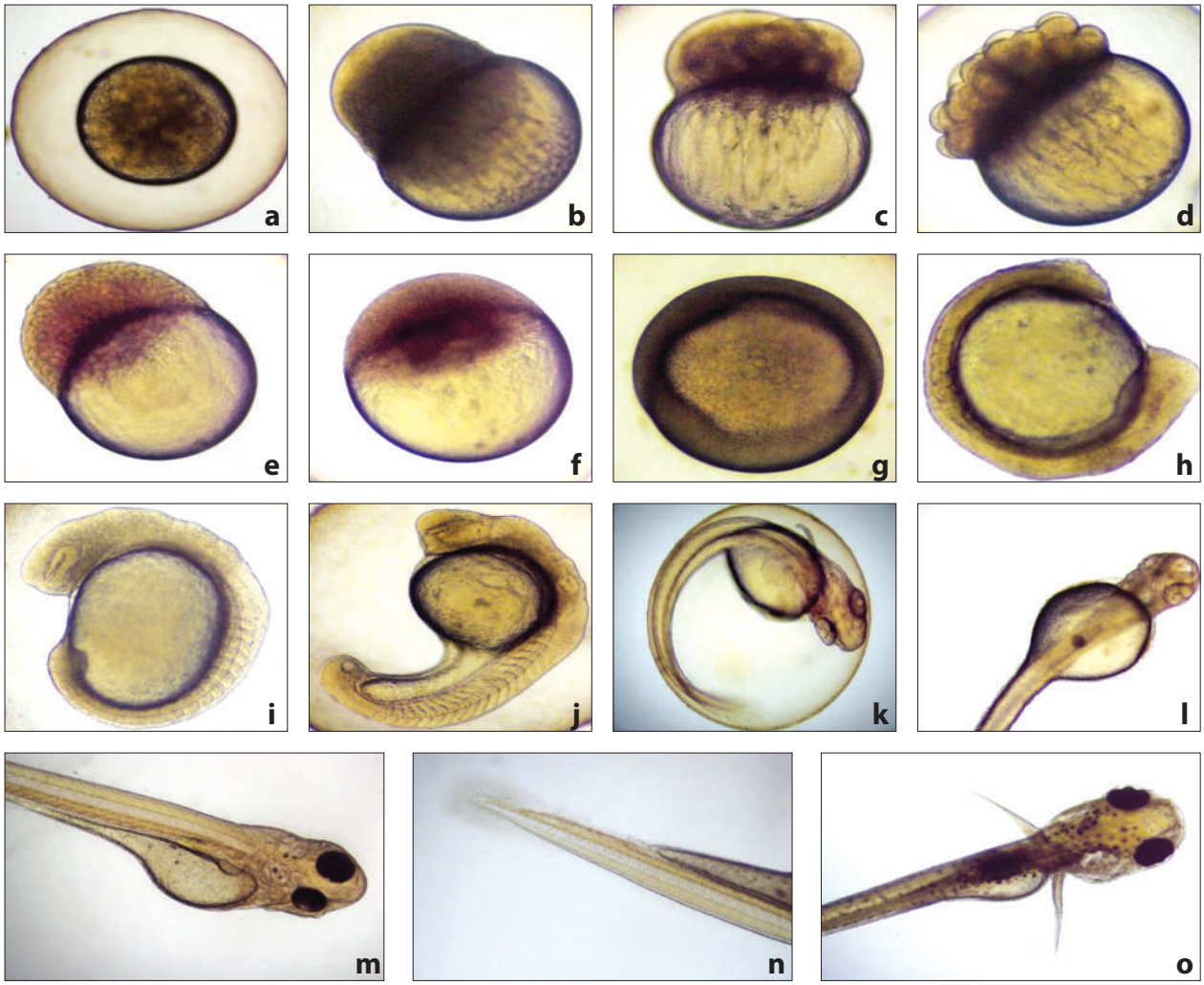
Captive maturation, spawning and larval rearing of *Garra annandalei and G. lamta*: Induced spawning of *Garra annandalei*, and *G. lamta* was achieved in the month of June and July 2019 by intramuscular ovatide administration to both females and males. Around 2000 eggs of *G. lamta* and 600 eggs of *G. annandalei* were spawned per 10 g fish after 8-10 h of injection at 21±0.5°C. Eggs were incubated in aquarium tanks and periodically photographed for the embryonic developmental study. Hatched larvae were fed with green water for 10 days followed by egg custard and prepared feed. Around 140 no. fry of both *Garra* species are now being maintained.

Seasonal sampling of *Barilius vagra* for the assessment of reproductive indices: Bimonthly sampling of *Barilius vagra* was carried out in the month of September, November, January, and March from Ladhia river, Chalthi, Champawat. Biological indices such as length, weight, VSI, GSI was collected and analyzed. Gonad samples were collected and preserved in Bouin's fluid for histology study. Blood was collected by caudal puncture; a portion of blood was kept in 4°C for hematological assay. Plasma was separated and stored in -20°C for further analysis.

Captive maturation and breeding trial of *Schistura beavani*: *Schisutra beavani* was collected from Assam, North Eastern India, and during month of April, 2019. Induced spawning trial was conducted with 0.01 ml and 0.02 ml ovatide to 4 pairs male and female in August 2019. Eggs were transparent and scattered on the bottom of aquarium tank. Fecundity per 4-5 g female was observed to be 2000-2500 no. Fertilization rate was 90-95% but embryonic development was arrested from gastrulation onwards.



Embryonic development of *Garra annandalei;* a. 1 cell, b. 4 cell, c. 32 cell, d. oblong stage, e. 70% epiboly, f. shield stage, g. bud stage, h. 5 somite, i. muscular movement, j. pre hatch, k. hatching, l. 0 DPH, m. 2 DPH



Embryonic development of *Garra lamta;* a. fertilized egg, b. 1 cell, c. 4 cell, d. 32 cell, e. high stage, f. dome stage, g. shield stage, h. 5 somite, i. 13 somite, j. pharyngeal phase, k. prehatch, l. 0 DPH, m. 1 DPH, n. 1 DPH, o. 4 DPH

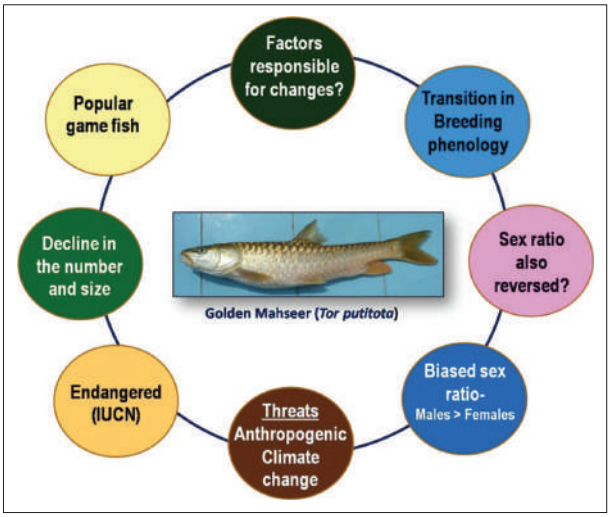
3.3 Molecular Genetics and Biotechnology

3.3.1 Transcriptome based sex specific marker discovery in golden mahseer (*Tor putitora*)

Golden mahseer *(Tor putitora)* is a preferred game fish, has regional table delicacy and considered as India's national heritage. In the last decade, skewed sex ratios have been reported in various populations of golden mahseer. However, the molecular mechanisms governing this process remain a mystery. In order to study the molecular mechanisms underlying sex determination and unravel the molecular differences between male and female fishes, we generated a comprehensive transcriptomic dataset for *Tor putitora* by sequencing the gonads and brain of both sexes using the Illumina Hiseq 2500 system. RNA-seq yielded 1497.3 million clean reads, which were mapped and assembled, then used to characterize differential gene expression. Furthermore, changes in the transcriptome occurring as a function of both development and sexual differentiation were extensively profiled. The comparative analysis of ovaries and testes revealed numerous differentially expressed genes (DEGs) known to be involved in sex differentiation, gonadal development and gametogenesis. In addition, we have also identified several important pathways enriched in male and female gonads. The highly reliable transcriptome assembly developed in our study will be useful for future genomic and genetic studies of golden mahseer and related species. In addition, the present study also provides an archive for further studies on sex differentiation and gonadal maturation mechanisms in golden mahseer.

3.3.2 Gender specific transcriptomic response to environmental stress in golden mahseer (*Tor putitora*)

The Himalayan golden mahseer (*Tor putitora*) is an endangered species and its population is declining sharply due to various natural and anthropogenic reasons. Further skewed or differential sex ratio, in which males are mostly predominant than females in natural environment poses new threat to the sustenance of the species. It is also well known that the global climate change poses many threats to biodiversity and altering the physical, chemical, and biological characteristics of freshwater habitats including freshwater and diadromous fishes. Recent studies on temperature and precipitation indicated that the rate of warming in Himalayas is three times greater than global average. Therefore, Himalayan region is highly vulnerable to climate warming. Fishes being ectotherms are metabolically sensitive to environmental temperature. They are likely to respond to the challenges associated with global climate change in many ways depending upon the effects of new environmental inputs on essential physiological processes. The skewed sex ratio in mahseer may be a response to the environmental warming. Since, temperature plays an important role in sex determination and identified as an important factor in determining sex ratios in many other species of fishes, amphibians, and reptiles. Examining these sex differences at a molecular level is important in understanding structural, behavioural, and cellular differences between sexes. Studies of transcriptome level responses to environmental change offer an opportunity to understand the underlying genetic basis for adaptation. Identifying genes of adaptive significance in a changing environment, particularly increasing temperatures is essentially required for devising appropriate management response for the sustenance of the species.



In the present investigations, the golden mahseer were collected from hatchery stock and acclimatized at 25˚C for a period of three months in the wet lab facility of DCFR prior to the start of the temperature trials. During the acclimatization period fishes were fed on the artificial diets *ab libitum*. The water quality was maintained with adequate aeration to avoid any stress or mortality. A total of 40 individuals were selected randomly for control and treatment group (n= 20 per group). All individuals were sexually differentiated and of known age. The experiment was set up in a 90 L tank with proper aeration. The temperature of the control group was maintained at 25±0.5˚C, while temperature in the treatment group was increased by 1˚C daily over a period of 9 days till the temperature reached to a target of 34˚C. The temperature stress was given for a period of around six weeks. Upon completion of the experiment a total of 18 specimens each from control and treatment groups were sacrificed after proper anesthetization and different tissue samples were collected. In the first phase of transcriptome profiling, gonads and brain tissues were selected. Total RNA was individually extracted using Trizol method. The concentration and purity were measured using NanoDrop® 2000 (Thermo Fisher Scientific, Wilmington, USA), and its integrity was visualized using agarose gel electrophoresis (1.2% MOPS/formaldehyde agarose gels). The quality of total RNA was further analysed using 2100 Bioanalyzer (Agilent Technologies, Santa Clara, USA), with an acceptable RNA integrity (RIN) value of 8. The RNA samples from both the groups collected separately in equal concentration for library preparation. A total of 12 libraries for each tissue (Control: $n_{♂}$= 3; $n_{♀}$=3; treatment: $n_{♂}$= 3; $n_{♀}$=3; total = 12) have been prepared. Thus a total of 24 paired-end RNA-Seq libraries (12 each for gonad and brain) were constructed using TruSeq® RNA Sample Preparation Kit (Illumina, San Diego, USA), according to the manufacturer's instructions. The paired-end RNA-Seq libraries were sequenced on Hi-Seq 2000 (Illumina, San Diego, USA) for

generating 2 × 150 bp sequencing reads. The NGS data is under process for various downstream analyses.

3.3.3 Genome editing in common carp, *Cyprinus carpio* using CRISPR/Cas system

Common carp, *Cyprinus carpio* male (6 nos) and female (7 nos) brooders were collected from private farm and maintained in wet laboratory and outdoor raceways of ICAR-DCFR, Bhimtal for the production of fertilized embryo for microinjection. In addition to this 6 number of zebrafish, *Danio rerio* was also procured and maintained for experimental purpose under this project. First the myostatin gene (MSTN) of common carp of approximately 1000 bp was amplified (figure 1) by using PCR primers, and after sequencing and BLAST search the sequence was submitted to GenBank of NCBI (GenBank number MN419323). Using online CRISPR Design tool (figure 2), a CRISPR target sequence was identified for MSTN gene and three sg RNA templates (figure 3) for this gene was generated by PCR using commercially available high fidelity DNA polymerase with a target specific forward primer and common tail primer. The sg RNA was generated by *in vitro* transcription of the sg RNA PCR template using T7 transcription kit and purification of the RNA was also carried out. *In vitro* evaluation of sgRNA efficacy was tested using sgRNA screening system for cleaved and uncleaved fragments (figure 4).

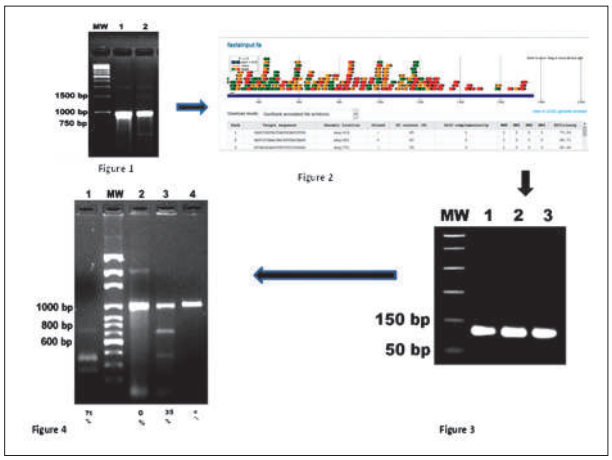
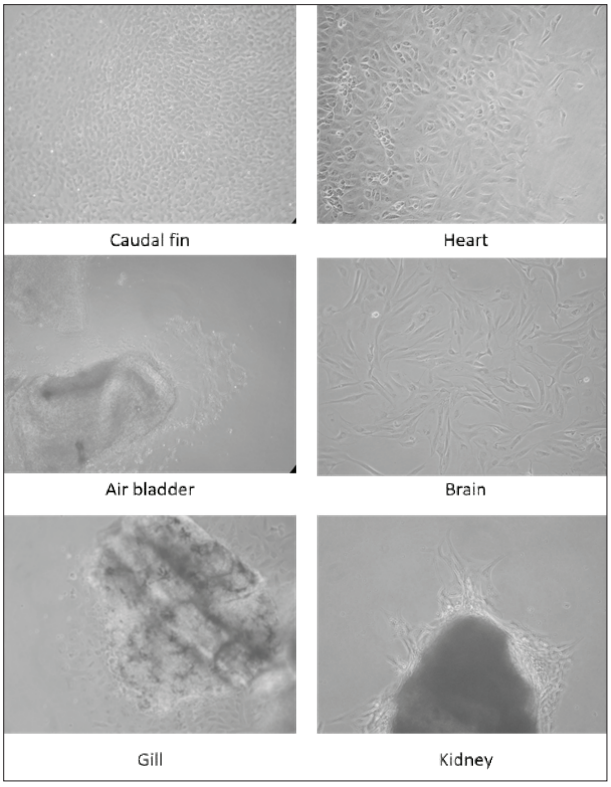


Figure 1: MSTN gene of approximately 1000 bp was PCR amplified from fin tissue of common carp. Figure 2: Design of three sg RNA primers for MSTN gene using online tool. Figure 3: PCR amplified template of sg RNA for MSTN gene of common carp Figure 4: In vitro cleavage assay for testing the efficacy of sgRNA and Cas9 RNPs. Lane 3 shows effective cleavage with 35% efficiency. Lane 1 is positive control and lane 2 and 3 is control without RNPs.

3.3.4 Development of cell lines from different organs of rainbow trout

Fish cells can be of immense use in studying fish viruses and parasites besides gene editing and toxicological research. However, there are only a handful of cell lines developed in India from Coldwater fish species like TTCF and SRCF. The important cell lines from salmonids include CHSE-214, RTgill-W1, and RTS11 a monocyte / macrophage-like cell line from rainbow trout spleen and RTG-2. Therefore, there is still a scope for developing novel cell lines from rainbow trout. The indigenously developed cell lines from rainbow trout can be of immense use in disease diagnosis besides other biotechnological applications. With the intensification of rainbow trout farming in the country, a serious threat of viral diseases persists. In the event of viral disease, the virus need to be characterised for which it has to be isolated. This can best be achieved in receptive cells of the host for which tissue specific cell lines can be of great help.

To begin with, the procedure for setting up of explant culture from rainbow trout caudal fin was first standardized. Radiation of cells with epithelial morphology was observed from the explants which could be grown to form a monolayer. This procedure was repeated to test the reproducibility of protocol



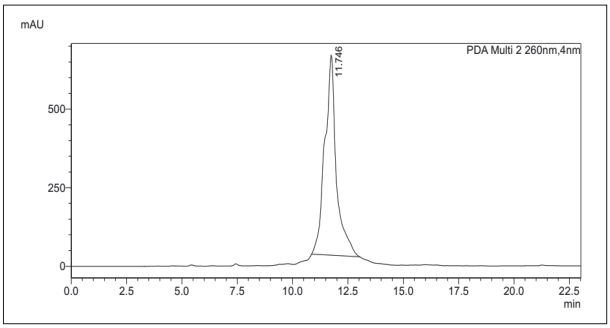
developed. Further, the procedure was adopted to set explant culture from gills, eye stalk, brain, heart, liver, kidney, spleen, muscles and air bladder. Cells could be observed radiating from caudal fin, gills, heart, brain, kidney, and air bladder. The cells from heart and brain were viable although their growth has been very slow. However, cells from other explants were dead after first or the second passage. So far, live cells from brain and heart are being maintained at fourth passage in the laboratory.

3.4 Disease surveillance and health management

3.4.1 Development of rapid assays for detection & identification of *Saprolegnia* species

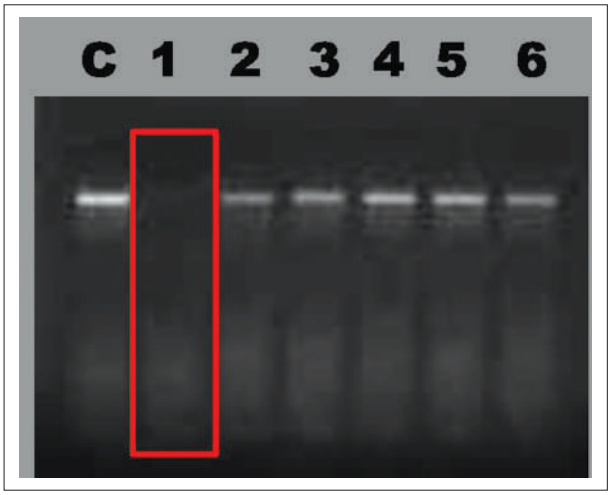
Synthesis and purification of PNA probe: A PNA probe specific for *Saprolegnia parasitica* was designed. The properties of the probe were, Tm - 68.4 °C, base count - 16, GC content -43.8%, and molecular weight - 4455.24. The probe was synthesized in the laboratory using F-moc chemistry. The probe was then purified by semi preparative HPLC and the retention time was found to be 11.746 min.

PCR clamping: Protocol for PNA-mediated clamping PCR through arrest of primer elongation was optimised. PNA can bind to complementary template DNA but cannot serve as primers and are not recognized by DNA polymerases during PCR. Therefore PNA probe when bound to template with perfectly matched sequence hinders the polymerase readthrough preventing primer elongation and inhibits amplification. Clamping efficiency of the PNA was evaluated using genomic DNA from *Saprolegnia parasitica*. The PNA was found to specifically inhibit the PCR amplification of ITS region in *S.parasitica* but not in other species.

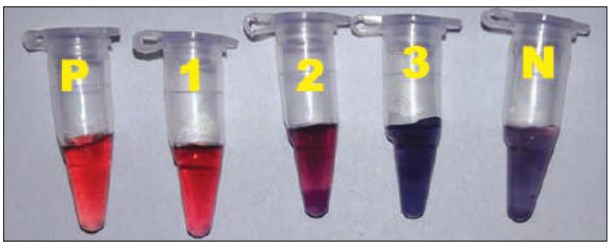


HPLC Chromatogram of the PNA probe

Visual assay: Protocol for tube based visual assay for detection and species identification of *S. parasitica* using PNA probe and gold nanoparticle from genomic DNA was optimized. Typically, free PNA induces agglomeration in AuNPs and leads to a color change from red to blue. PNA hybridize with complementary DNA target and a charged molecular complex is formed which retains the stability of colloidal AuNP solutions. In absence of complementary DNA target, free PNA aggregates AuNP resulting in colour change. There was no change in colour in the assay with genomic DNA of *S. parasitica* but the colour turned to purple/ blue in case of other *Saprolegnia* species. Based on colour changes, the assay could differentiate *S. parasitica* from other *Saprolegnia* species. The assay could detect upto 10 ng of genomic DNA in a 20 µl reaction.



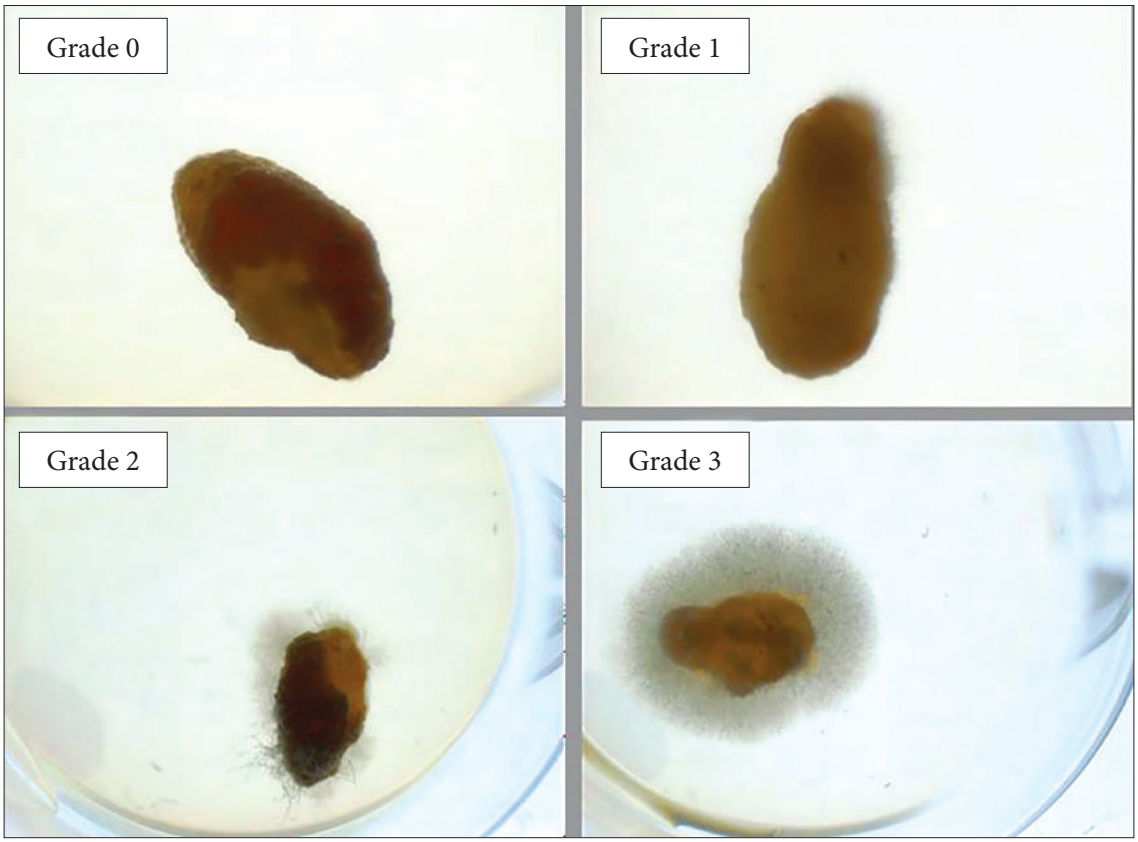
Inhibition of PCR amplification of ITS region in *S. parasitica* (1, marked red). C: Control without PNA. 2, 3, 4, 5, 6- With different concentrations of PNA.



Visual assay differentiating *S .parasitica* (1) from other *Saprolegnia* species (2&3). P: Positive control, N: Negative control

3.4.2 Evaluation of antimicrobial activities of nano & polymer-based formulation against Saprolegniasis

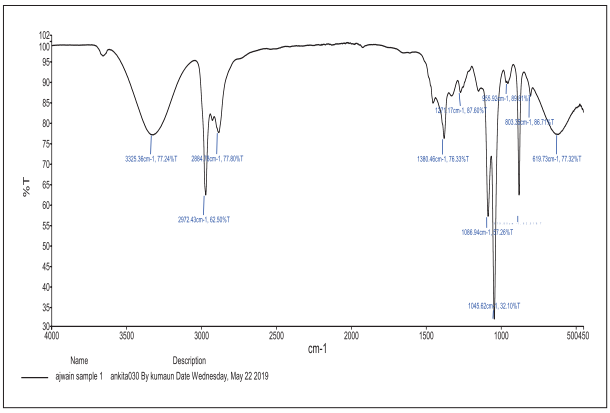
Anti-oomycetes activity of PHMB coated silver nanoparticles (AgNPs-PHMB): Mycelium growth inhibition assay, spore germination inhibition and colonization tests were performed. Under *in-vitro* conditions, the germination and colonization of *Saprolegnia* spores were inhibited with AgNPs-PHMB. The early developing *Saprolegnia* mycelia on hempseeds did not show advanced growth and 100% radial growth inhibition was recorded. The evaluation of cytotoxicity of AgNPs-PHMB is under way.



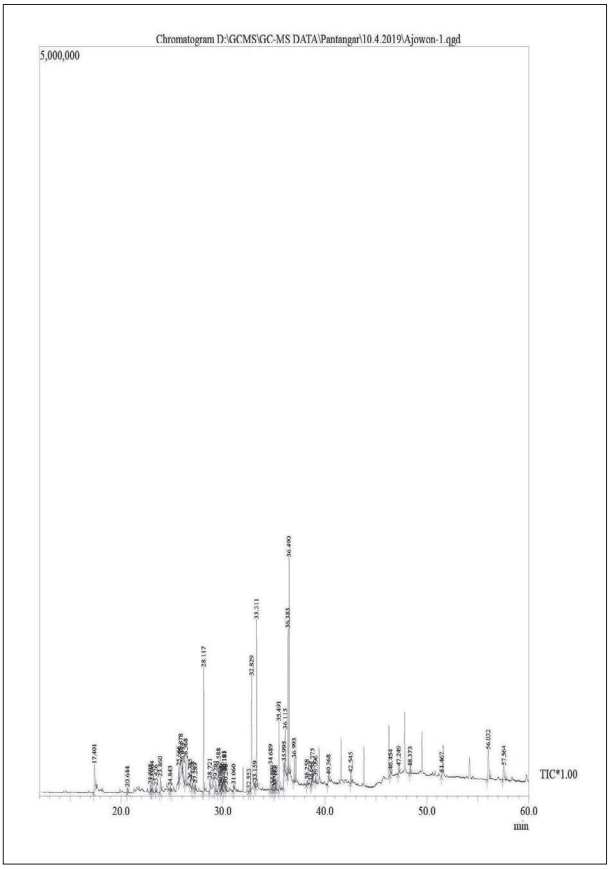
Spore germination inhibition and colonization test of AgNPs-PHMB at different concentrations. Grade 0: No germination, no growing mycilia on the hempseed, Grade 1: Germinating spores, no growing mycelia on the hempseed, Grade 2: Germinating spores, very few growing mycelia on the hempseed, Grade 3: Germinating spores, profuse growing mycelia on the hempseed.

3.4.3 Evaluation of available anti-fungal agents and herbs for their efficacy against oomycetes infection in farmed rainbow trout

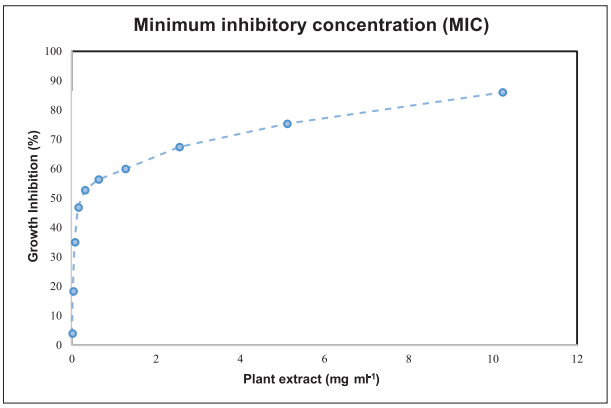
The efficacy of seven plant extracts has been tested for its efficacy as phytotherapy remedy alternative to teratogenic synthetic compounds against *Saprolegnia* species infection in rainbow trout. The study on the potential anti-oomycetes activity of *Thymus linearis* leaf extract and phytochemical compounds by FTIR analysis, Gas chromatography-Mass spectrometry (GC-MS) was conducted. During this study, the protocols for GC-MS and FTIR analysis were optimised and molecular docking of identified bioactive compounds was performed with target proteins of *Saprolegnia parasitica*. The FTIR analysis of ethanol leaf extracts of *Thymus linearis* confirmed the presence of alkyne, aldehyde, aromatic amine, aliphatic ether, anhydride, alkene, 1,2,4 trisubstituted, 1,4-disubstituted and halo compound, which show major peak. The FTIR gives strong instance peak obtained at leaf extract 3325.36 cm^{-1} which the presence of alkyne (C-H stretching). The ethanol extract of *T. linearis* exhibited an inhibitory activity at a minimum concentration of 0.32 mg/ml against *Saprolegnia parasitica.* A total of 24 constituents were identified from GC-



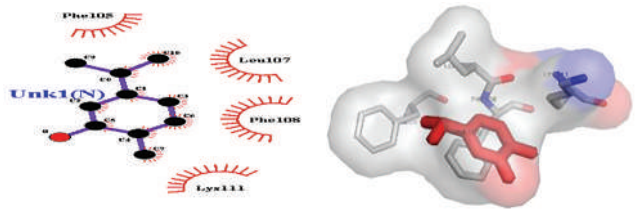
FTIR Spectrum analysis of *Thymus linearis* leaf extract



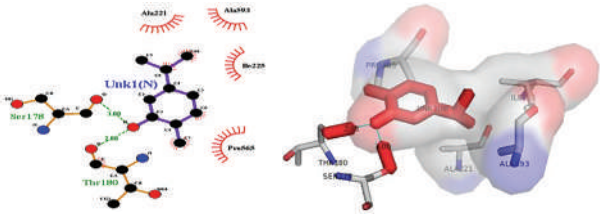
Gas chromatogram profiling of *Thymus linearis* plant extract



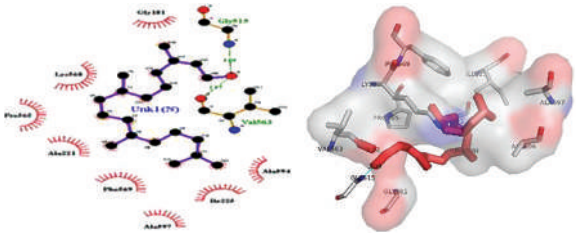
Minimum inhibitory concentration (MIC) of *Thymus linearis* leaf extract against *Saprolegnia parasitica*



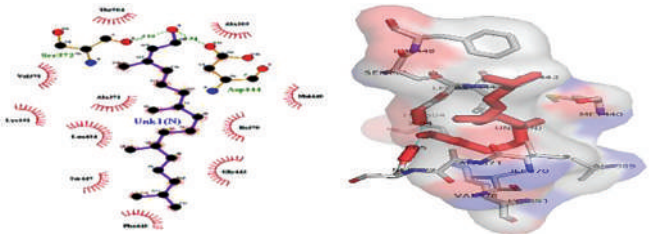
Interaction of Host targeting protein-1 with carvacrol



Interaction of plasma membrane ATPase with phytol



Interaction of plasma membrane ATPase with phytol



Interaction of TKL protein kinase with phytol

Molecular docking of carvacrol and phytol with *S. parasitica* functional and virulent proteins

MS, representing about 74.80 % of the whole plant extract. The major constituents in the extracts were ethyl (9z, 12z)-9, 12-octadecadienoate (14.41%), palmitic acid (11.95%), ethyl palmitate (9.89%), ethyl (9z, 12z)-9, 12-octadecadienoate (8.17%), phytol (5.03%), etc. Molecular docking was also performed for phytol and carvacrol for obtaining the binding mode predictions with target proteins of *S. parasitica*. Phytol and carvacrol were identified to have potential targets to interact with plasma membrane ATPase, host targeting protein-1 and TKL protein kinase and V-type protein ATPase. Molecular interaction of phytol was stronger to V-type protein ATPase. *T. linearis* extract along

with its compounds especially phytol could be explored as phyto-additives for treating oomycetes disease. Investigation of acute toxicity and behaviour changes on *Oncorhynchus mykiss* (rainbow trout) fry in response to ethanolic extract of *Myrica esculerata* was also conducted. *In vivo* experimental study with the herbal bioactive compounds as phyto-additives against *Saprolegnia* species is in progress.

3.4.4 Network programme on antimicrobial resistance (AMR) in fishes under INFAAR

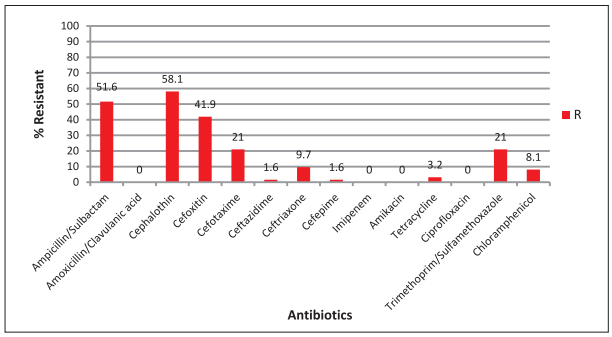
Overall scenario of antimicrobial sensitive, intermediate and resistance profile of *Aeromonas* group, *Escherichia coli* & *Staphylococcus* group isolated from fish farms in state Himachal Pradesh:

Aeromonas sp: The antimicrobial resistance of *Aeromonas* spp. (n=62) isolated from 67 gill tissues of 67 fish samples; rainbow trout (29), common carp (32), rohu (1), catla (2), mrigal (2) and grass carp (1) from 67 fish farms in district Bilaspur and Kullu-Mandi in Himachal Pradesh was performed against 14 antibiotics by disk diffusion method as per CLSI guidelines. The results recorded that highest antimicrobial resistance was observed against cephalothin (58.1%), followed by ampicillin/sulbactam (51.6%), cefoxitin (41.9%), cefotaxime (21%) and trimethoprim/sulfamethoxazole (21%). Low antibiotic resistance among *Aeromonas* spp was recorded against ceftazidime, ceftriaxone,

Antibiotic sensitivity assay for *Aeromonas* sp. (n=62)

Antibiotics		No.	% R	% I	% S
Penicillins And Beta-Lactam Inhibitor Combinations					
Ampicillin/ Sulbactam (SAM 10 /10 µg)		62	51.6	16.1	32.3
Amoxicillin/Clavulanic acid (AMC 20/10 µg)		62	--	1.6	98.4
Cephems					
First generation cephalosporin	Cephalothin (CEP 30 µg)	62	58.1	3.2	38.7
Second generation cephalosporin	Cefoxitin (FOX 30 µg)	62	41.9	1.6	56.5
Third generation cephalosporin	Cefotaxime (CTX 30 µg)	62	21	27.4	51.6
	Ceftazidime (CAZ 30 µg)	62	1.6	4.8	93.5
	Ceftriaxone (CRO 30 µg)	62	9.7	11.3	79
Fourth generation cephalosporin	Cefepime (FEP 30 µg)	62	1.6	19.4	79
Carbapenems					
Imipenem (IPM 10 µg)		62	--	12.9	87.1
Aminoglycosides					
Amikacin (AMK 30 µg)		62	--	12.9	87.1
Tetracyclines					
Tetracycline (TCY 30 µg)		62	3.2	4.8	91.9
Quinolones					
Ciprofloxacin (CIP 5 µg)		62	--	6.5	93.5
Folate pathway inhibitors					
Trimethoprim/ Sulfamethoxazole (SXT 1.25/23.75 µg)		62	21	3.2	75.8
Phenicols					
Chloramphenicol (CHL 30 µg)		62	8.1	8.1	83.9

R: Resistance; I: Intermediate; S: Sensitive



Antibiotic resistance pattern of *Aeromonas* sp. (n=62) isolated from Bilaspur and Kullu-Mandi in Himachal Pradesh

cefepime, tetracycline, and chloramphenicol, whereas percentage of isolates showing intermediate resistance to cefotaxime, cefepime and ampicillin/sulbactam were 27.4, 19.4 and 16.1 respectively. 98.4% of the isolates were susceptible to amoxicillin/clavulanic acid, followed by ceftazidime (93.5%) and ciprofloxacin (93.5%).

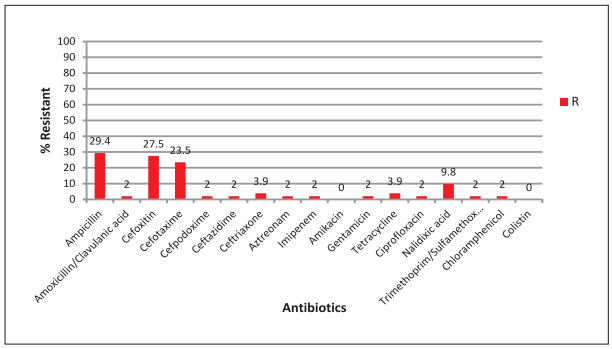
Escherichia coli: Intestine tissues from 67 fish samples; rainbow trout (29), common carp (32), rohu (1), catla (2), mrigal (2) and grass carp (1)) were collected from 67 fish farms in district Bilaspur and Kullu-Mandi in Himachal Pradesh and processed aseptically for isolation and purification of *Escherichia coli*. Antimicrobial resistance pattern among isolates of *E. coli* (n=51) was determined against 17 antibiotics by disk diffusion method as per CLSI guidelines. The results recorded that highest antimicrobial resistance was observed against ampicillin (29.4%), followed by cefoxitin (27.5%) and cefotaxime (23.5%). Low antibiotic resistance in *E. coli* isolates was recorded against amoxicillin/clavulanic acid, cefpodoxime, ceftazidime, ceftriaxone, aztreonam, imipenem, gentamicin, tetracycline, ciprofloxacin, nalidixic acid, trimethoprim - sulfamethoxazole and

Antibiotic sensitivity assay for *E. coli* (n=51)

Antibiotics		No.	% R	% I	% S
Penicillins And Beta-Lactam Inhibitor Combinations					
Ampicillin (AMP 10 µg)		51	29.4	21.6	49
Amoxicillin/Clavulanic acid (AMC 20/10 µg)		51	2	2	96.1
Cephems					
Second generation cephalosporin	Cefoxitin (FOX 30 µg)	51	27.5	9.8	62.7
Third generation cephalosporins	Cefotaxime (CTX 5 µg)	51	23.5	31.4	45.1
	Cefpodoxime (CPD 10 µg)	51	2	5.9	92.2
	Ceftazidime (CAZ 30 µg)	51	2	17.6	80.4
	Ceftriaxone (CRO 30 µg)	51	3.9	5.9	90.2
Monobactam					
Aztreonam (ATM 30 µg)		51	2	--	98
Carbapenems					
Imipenem (IPM 10 µg)		51	2	13.7	84.3
Aminoglycosides					
Amikacin (AMK 30 µg)		51	--	15.7	84.3
Gentamicin (GEN 10 µg)		51	2	--	98
Tetracyclines					
Tetracycline (TCY 30 µg)		51	3.9	3.9	92.2
Quinolones					
Ciprofloxacin (CIP 5 µg)		51	2	3.9	94.1
Nalidixic acid (NAL 30 µg)		51	9.8	7.8	82.4
Folate pathway inhibitors					

Antibiotics	No.	% R	% I	% S
Trimethoprim/ Sulfamethoxazole (SXT 1.25/23.75 µg)	51	2	--	98
Phenicols				
Chloramphenicol (CHL 30 µg)	51	2	7.8	90.2
Polymixin				
Colistin (COL 10 µg)	51	--	--	100

R: Resistance; I: Intermediate; S: Sensitive



Antibiotic resistance pattern of *E. coli* (n=51) isolated from Bilaspur and Kullu-Mandi in Himachal Pradesh

chloramphenicol, whereas 31.4% of isolates had shown intermediate response to cefotaxime, followed by ampicillin (21.6%) and ceftazidime (17.6%). All the isolates of *Escherichia coli* were susceptible to colistin (100%), followed by aztreonam (98%), gentamicin (98%), trimethoprim-sulfamethoxazole (98%), and amoxicillin/clavulanic acid (96.1%).

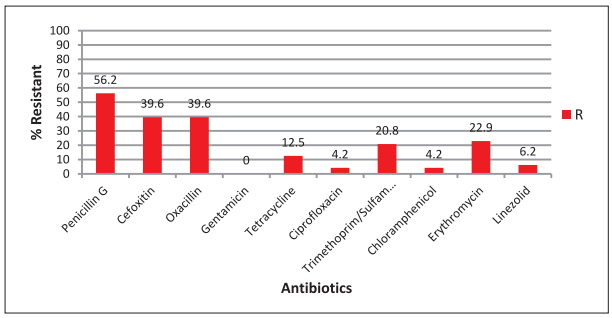
Staphylococcus sp: Gill tissues from 67 fish samples; rainbow trout (29), common carp (32), rohu (1), catla (2), mrigal (2) and grass carp (1)) were collected from 67 fish farms in district Bilaspur and Kullu-Mandi in Himachal Pradesh and processed aseptically for isolation and purification of *Staphylococcus* sp. (n=48). Antimicrobial resistance pattern among the isolates of *Staphylococcus* sp. (n=48) was determined against 10 antibiotics by disk diffusion method as per CLSI guidelines. The results showed that the highest antimicrobial resistance was observed against penicillin G (56.2%), followed by cefoxitin (39.6%) and oxacillin (39.6%), erythromycin (22.9%) and trimethoprim-sulfamethoxazole (20.8%). Low antibiotic resistance among *Staphylococcus* sp. was recorded against tetracycline (12.5%), ciprofloxacin (4.2%), chloramphenicol (4.2%)

Antibiotic sensitivity assay for *Staphylococcus* sp. (n=48)

Antibiotics	No.	% R	% I	% S
Penicillinase-labile penicillins				
Penicillin G (PEN 10 units)	48	56.2	--	43.8
Penicillinase-stable penicillins				
Cefoxitin (FOX 30 µg)	48	39.6	--	60.4
Oxacillin (OXA 1 µg)	48	39.6	12.5	47.9
Aminoglycosides				
Gentamicin (GEN 10 µg)	48	--	4.2	95.8
Tetracyclines				
Tetracycline (TCY 30 µg)	48	12.5	4.2	83.3
Quinolones				
Ciprofloxacin (CIP 5 µg)	48	4.2	16.7	79.2
Folate pathway inhibitors				
Trimethoprim/ Sulfamethoxazole (SXT 1.25/23.75 µg)	48	20.8	--	79.2
Phenicols				
Chloramphenicol (CHL 30 µg)	48	4.2	2.1	93.8

Antibiotics	No.	% R	% I	% S
Macrolide				
Erythromycin (ERY 15 µg)	48	22.9	12.5	64.6
Oxazolidinones				
Linezolid (LNZ 30 µg)	48	6.2	--	93.8

R: Resistance; I: Intermediate; S: Sensitive



Antibiotic resistance pattern of *Staphylococcus* spp. (n=48) isolated from Bilaspur and Kullu-Mandi in Himachal Pradesh

and linezolid (6.2%). The percentages of isolates showing intermediate resistance to the antibiotics were ciprofloxacin (16.7%), oxacillin (12.5%) and erythromycin (12.5%). The percentages of isolates showing susceptibility to the antibiotics were gentamicin (95.8%), chloramphenicol (93.8%) and linezolid (93.8%).

3.5 Externally funded projects

3.5.1 NSPAAD-Surveillance of coldwater fish diseases in Himachal Pradesh and Uttarakhand (NFDB funded multi-institutional project)

Periodic disease surveillance in trout and carp farms and hatcheries was carried out in selected districts of Himachal Pradesh and Uttarakhand. During the period total 37 numbers of trout and carp farm/hatcheries located in the district of Kullu, Mandi in Himachal Pradesh and Chamoli, Champawat and Udhamsingh Nagar in Uttarakhand were covered under active disease surveillance. Sampling of the rainbow trout brooders, stripped eggs and trout larvae was made to find out the reason behind non fertility in rainbow trout eggs at Barot, Hamani, Patlikuhl and Bathar. Total 382 fish tissue samples of kidney, spleen, liver, skin, intestine, brain and gills were collected and as per the standard protocol, 140 pooled samples were screened for VHSV, IPNV, and IHNV, bacterial, fungal and parasitic infections. Disease outbreak in fry and brooders of rainbow trout at Dhamwari trout hatchery in Shimla District of Himachal Pradesh, parasitic infestation in golden mahseer hatchery and *Labeo* spp in cages at Bhimtal in Nainital District were covered under passive disease surveillance. RT-PCR was conducted using the gene specific primer of VHSV (Viral hemorrhagic septicemia virus), IPNV (infectious pancreatic necrosis) and IHNV (infectious hematopoietic necrosis virus) along with the positive controls. ITS-1 and ITS-4 primers for fungal and 16S rRNA for bacterial identification were used. At Dhamawari trout hatchery, about 200-300 fry /day rainbow trout and brown trout fry in size range 25.66 ± 2.34 mm & 187.11 ±14.17 mg were found dying at water temperature range of 9.6-10.4^{0}C. Emaciation, blackening or body coloration, whirling movement, hemorrhagic anterior abdomen, settling of infected fry in the bottom of tank, exophthalmia with blackening of eye, whitish small nodule like structure over the head in moribund specimens, whitish trailing faecal pseudo cast in few infected fry were the clinical features observed with mass mortality of >60%. Economic loss due to this severe infection was quantified and was in a range of about Rs 3.5 - 4.0 lakh. OTC treatment did not provide significant reduction in mortality. Although, RT PCR results indicated IPN like presence in few samples, however, this could not be confirmed in CPE. Severe degeneration in pancreatic tissue surrounding the intestine was observed in moribund trout fry. Apparently healthy looking brooders and 1+ & 2+ year old juvenile's mortality also showed blackening of body, lethargic movement, yellowish fluid from the body cavity, empty alimentary canal with whitish mucus, swollen kidney with swelling in genital opening in infected specimens. So far all the samples were found (-ve) for IPNV, IHSV and VHSV in RT-PCR study. Total seventy bacteria were isolated and purified for their identification as a representative

bacterial colony. In preliminary screening, 30 bacterial isolates were subjected for biochemical and molecular identification (16S rRNA). The identified bacteria were from 9 different genera and 14 different species. *Aeromonas salmonicida sub* sp. *salmonicida, Aeromonas salmonicida sub* sp. *achromogenes, Providencia rettgeri, Aeromonas hydrophila, Aeromonas bestiarum, Citrobacter freundii, Providencia alcalifaciens, Pseudomonas putida, Hafnia alvei, Enterococcus faecalis, Enterococcus hirae, Acinetobacter* sp., *Myroides odoratus, Pseudomonas fluorescens, Pseudomonas rhizosphaerae and Stenotrophomonas* species were the bacterial isolates characterized. However, the challenge studies of above bacterial strains did not produce any disease. *Saprolegina parasitica* was a common fungus isolated from moribund specimens. Skeletal deformity in rainbow trout at early stages of development in Himachal Pradesh and Uttarakhand was reported. Morphometric and molecular characterization of *Argulus siamensis* (Wilson) from endangered golden masheer (*Tor putitora*) was performed with successful control measures. Severe myxosporidean outbreak in cage reared *Labeo* species was reported first time.

Besides regular visits to farmer's ponds, mobile advisories, six numbers of awareness, interaction and demonstrations on coldwater fish health management and farming were conducted at village Sunkiya, Harish Tal, and Alchaunain Nainital, Barigana and in Chamoli and Bathar in Kullu involving total about 210 fish farmers. One day training cum awareness programme for the fish farmers on the topic Coldwater Fish Farming, Health Management and Food Safety was conducted at Village Sunkiya**.** Participants shared their experience with each other on general practices of feeding, disease treatment, management practices etc. During the programme the farmers raised their concern regarding the prevalence of tail and fin rot, lower growth rate of stocked fishes, surfacing in summer months, and water scarcity during the culture. These problems were addressed by team members. Total 78 farmers of Sunkiya, Parbada, Mazara, Budhi bana, Galla, Nathuwakhan villages of Dhari Block, Nainital participated in the programe. Another interaction meeting with officials of Uttarakhand State Fisheries Department personal was undertaken at Bairagna trout farm to discuss regarding incubation and rearing of imported Denmark eyed ova and larvae. Standard acclimatization and rearing procedures for the imported Denmark eyed ova at the Bairagna trout firm was prepared. Similar demonstations and interactions meet were conduted during the period.

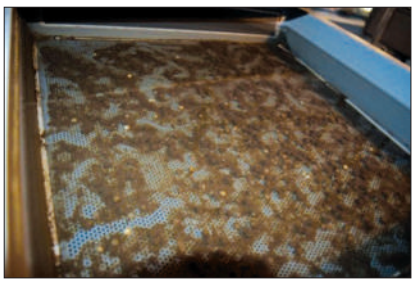
Mortality of rainbow trout juveniles at Dhamawari (HP)

Haemorrhagic genital opening in female trout brooder at Hamni (HP)

Sampling of a carp farm in US Nagar (UK)

Training cum Awareness at village Sunkiya (UK)

Sampling of imported Denmark trout fry at Bairangana



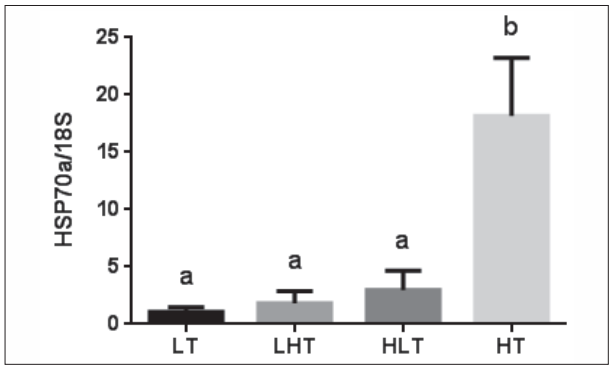
Silt laden fertilized eggs at Bathar (HP)

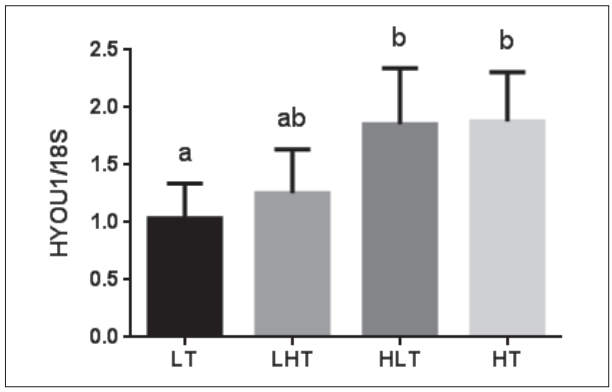
3.5.2 Development of climate resilient rainbow trout and innovative trout farming strategies to mitigate climatic stressors (NICRA)

Establishment of re-circulating aquaculture facility for rainbow trout: Under NICRA project, the first coldwater fish specific pilot-scale RAS unit in the country was commissioned on 24th September 2019 at Bhimtal. This facility was designed in-house comprising all the primary constituent units of a RAS system. For fish rearing and experimental production trials, there are 4 large and 18 small FRP tanks with dual drain and provision for oxygenation. Swirl separators and radial flow settlers are used in the first stage of filtration for solid waste removal and rotary drum filter is used in the second stage for removing suspended particles. Following that, two moving bed biofilters with bacterial culture media and air diffusers are provided for the biological filtration process (ammonia bioconversion). The filtered water is temporarily held in water sump and continuously recirculated using a high-power water pump. An ultraviolet filter is also provided in the RAS loop to eliminate pathogenic microorganisms. Approximately, this unit has a maximum production capacity of 1-1.5 tonnes of rainbow trout, with 40-50 kg/m^3 productivity. As compared to a conventional flow-through raceway of similar water volume, the expected fish production and productivity will be two to three-fold higher, with concurrent decrease in the volume of water used for unit fish production by more than 100 times, at half the culture duration. At present, the optimization of the operational factors of this pilot-scale RAS unit is in progress.

Coldwater recirculating aquaculture facility at ICAR-DCFR, Bhimtal

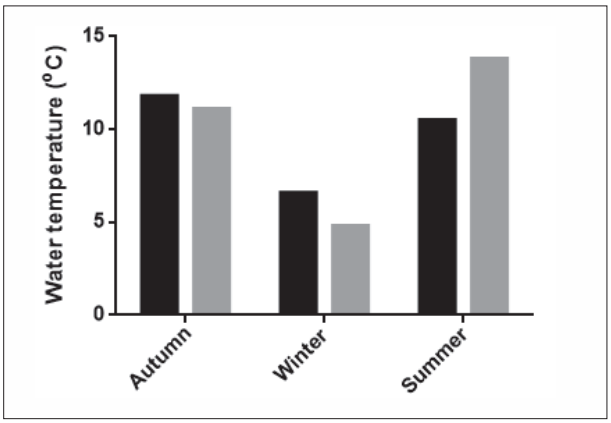
Thermal programming during early life of rainbow trout: We carried out a thermal programming experiment in rainbow trout to ascertain the appropriate development window in which thermal stimulus should be given to the fish for eliciting a positive physiological response to high temperature exposure. For this, eyed ova of rainbow trout from the same genetic lineage were incubated at two different temperatures, low (LT, 10 ± 1°C) and high (HT, 18 ± 1°C). Post-hatching, half of the LT sac fry was transferred to 18°C (LHT) and half of HT sac fry was transferred to 15°C (HLT) and reared in the respective temperature until 45 dph. At 45 dph, randomly selected individuals from all the four treatments were examined for their thermal tolerance limits and other performance indices. LHT group was found to exhibit higher upper thermal tolerance (CTmax: + 1.5 to 3°C), weight gain and condition factor as compared to the other groups. Further, morphometric features as examined by Truss analysis were found to be substantially influenced by temperature in the initial phase, with decreasing significance later on. Transcriptional analysis of biomarkers from the heat shock protein and other stress response pathways indicated significant changes in target gene mRNA levels (*hsp*70, *hsp*90, *hsc*70, *serpinh*1, *hyou*1 and *gr*1) due to early life thermal stimulus. After a latent phase for 75 days and subsequent high temperature challenge (23 ± 1°C) for one month, we did not find persistent positive effects of early life thermal stimulus in the thermal tolerance and metabolic rate of LHT group as compared to LT group. However, blood oxygen carrying capacity was significantly higher in LHT group. This observation suggests the possibility of inducing long-term physiological changes in rainbow trout through early life thermal programming. For further validation of the transcriptional regulation pattern of these markers, we have conducted a time-kinetic analysis of the response of these molecular biomarkers post-exposure to a higher environmental temperature. The analysis is in progress.

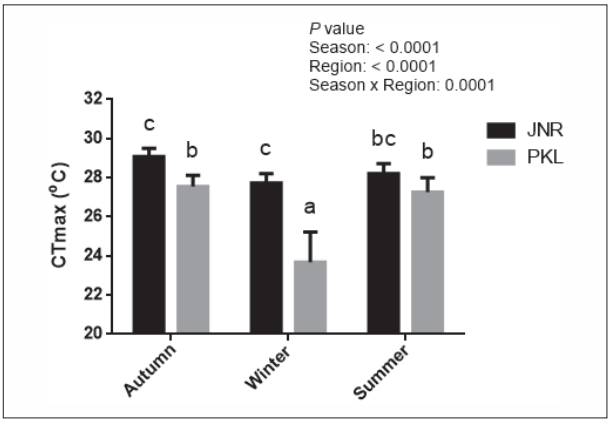




Field data collection and in situ investigation on thermal tolerance: Field observation of seasonal changes in important abiotic water quality indices were carried out in twelve private rainbow trout farms in two distinct micro-climatic zones in Kullu and Mandi districts of Himachal Pradesh. As of now, baseline information of periodic water quality changes is available for the twelve farms for a two year period. Moreover, water quality analysis kits were distributed to the associated trout farmers and field demonstration of water quality analysis procedures was done in each farm. Parallel to this, we also carried out an *in situ* investigation of the seasonal changes in thermal tolerance capacity of rainbow trout from the two different micro-climatic zones. The magnitude of seasonal fluctuations in water temperature was found to be strong determinant of the fish's upper thermal tolerance, with significant interaction between microclimatic condition and season. Whereas, mRNA levels of stress biomarkers in different tissues indicated a significant up-regulation during winter in Kullu region. This clearly indicates that the physiological response of the fish varies with the prevalent micro-climatic conditions.

In situ study of thermal tolerance limit in trout farms





3.5.3 Triploid rainbow trout (*Oncorhynchus mykiss*) production for aquaculture enhancement and ecological risk management

This project was conceived for achieving a viable methodology to produce triploid rainbow trout efficiently, by standardizing mechanical treatment protocol for the post-fertilized trout eggs. Due to extra genetic material, triploids remain more heterozygous and results in better growth. Experiment was conducted at four sites of different altitudes viz. Jogindernagar in Himachal Pradesh (1220 m), State trout farm Uttarey in Sikkim (2012 m) and Experimental fish farm, Champawat, Uttarakhand (1610 m) and state trout farm, Talwadi, Uttarakhand (1800 m). The 'time window' (a frame of zygote age, heat shock regime and shock duration) period was found very narrow. For the confirmation of ploidy level, karyotyping of fry and measuring nucleus and cell size of erythrocytes was applied. TRC Aqua Pressure Vessel was used for the triploidy induction in fish. Breeding operation was conducted for triploidy induction at different 3 levels of pressure i.e 9000, 9500 and 10000 psi for different 3 levels of exposure time i.e 3, 5 and 7 min during December to March. Spawning was conducted at 9 to 14°C. Eggs were incubated and larvae were reared in ova house. Water quality parameters were recorded during entire experimental operation. 98% triploidy induction was achieved with appropriate pressure shock and accurate zygote age. In triploids, three sets of chromosomes (88-90) were observed in chromosome plates. Erythrocytes measurement (µm) reflects comparatively larger cell size and larger nucleus in triploids over the diploids. During egg incubation, hatching rate (68%) was comparatively less than the diploids (76%). In larval rearing, triploids showed 22.4% better growth over diploids, however survival was less (72%) in triplods with 6.2% deformed fry. Tagging of the specimen was done by PIT tagging unit (BioMerk), for growth study of triploid rainbow trout.

Triploidy induction by pressure shock at Himachal Pradesh and Sikkim

Triploid egg incubation and blood sampling for erythrocyte measurement

Rudimentary gonads and better growth in rainbow trout

Passive integrated transponder (PIT) Tagging

3.5.4 Immunomodulation in golden mahseer (*Tor putitora*) broodstock under captive conditions

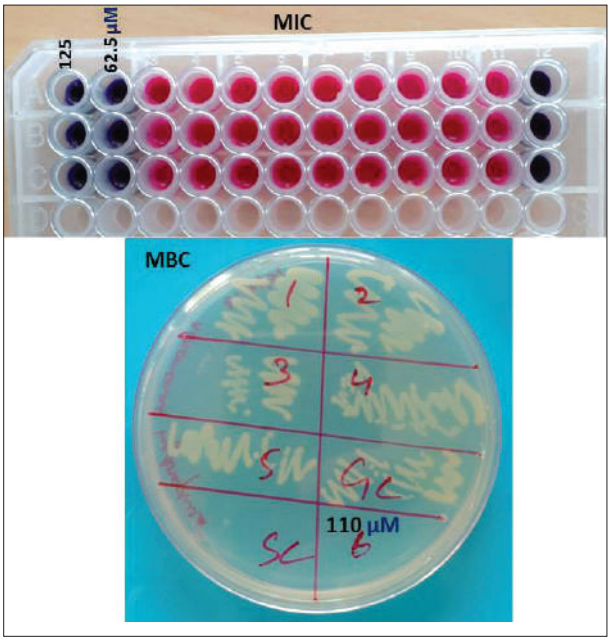
Use of immunostimulants as dietary supplements has been proven to be one of the potential methods to boost the innate immunity of broodstock in aquaculture. To develop high health brooders of golden mahseer in captive conditions, the present DBT project is aimed to evaluate dietary β-glucan in enhancing immunity of *T. putitora* broodstocks through well designed experiment and analysis of physio-biochemical, reproductive indices and immune gene characterisation and expressions.

For characterisation of targeted immune genes such as IFN-γ, interleukin-1β, interleukin-10, TNF-α4 and complement component 3, few golden mahseer juveniles were sacrificed and tissue samples such as spleen, kidney and liver were collected aseptically. Total RNA was isolated and first strand cDNA synthesis was carried out. Based on NCBI-BLAST analysis of conserved regions, forward and reverse primers were designed for the target genes. Amplification of these target immune genes was done after optimising the RT-PCR conditions. Cloning of all the above genes was performed using Zero blunt vector. Colony PCR was performed to screen the transformed bacterial cells for the desirable recombinant plasmids by picking atleast 5 colonies for each gene insert (from the master plate) and PCR product was run on 1% agarose gel. The isolated and purified plasmid DNA was sent for sequencing in order to obtain the partial sequence for all the above mentioned immune genes. After analysis the partial sequences for the immune genes were submitted to NCBI GenBank.

S. No	Gene Name	Gene Symbol	Size (in bp)	Accession Number
1	IFN gamma 1	ifng1	407	MN193584
2	Interleukin 1β	il1b	550	MN193586
3	Tumor Necrosis Factor alpha	tnfa	653	MN193587
4	Complement component 3	c3	4770	MN531579
5	Interleukin 10	il10	663	MN193585

3.5.5 Bio-engineered synthetic antimicrobial peptides as alternative to antibiotics for use in aquaculture

Seven novel short AMPs have been designed using bioinformatics tools. Out of these, one peptide named KK14 has been synthesized in the laboratory and evaluated its antimicrobial activities against various bacterial pathogens including antibiotic resistant bacteria. The peptide showed MIC (Minimum inhibitory concentration) value ranging from 0.9 to 62.5 µM and MBC (minimum bactericidal concentration) range from 1 to 110 µM. The peptide showed 14.9% helical structure in bacterial mimetic environment (25 mM SDS) as observed in CD spectroscopy. To study the interaction between the peptide and the bacterial membrane mimetic and hydrophobic environment (90% TFE), fluorescent spectroscopy was carried out. It was observed that there was interaction of the peptide with the bacterial membrane mimetic and hydrophobic environment as revealed by the blue shift of the spectrum i.e shifting of λ max.



MIC (Minimum Inhibitory Concentration) and MBC (Minimum Bactericidal Concentration) of KK14 against *Aeromonas hydrophila*

Successful Innovative Technologies

4

4.1 Rainbow trout farming in re-circulating aquaculture system: Towards sustainable fish production in Indian uplands

Rainbow trout farming has been a promising and remunerating livelihood opportunity in Indian uplands due to the abundance of cold fresh water sources. Nevertheless, with changes in the demographic pattern and competition for resources, huge amount of water required in conventional flow-through raceway system (FTRS) of trout farming which makes the activity unsustainable in the long-term. To illustrate, to maintain 1000 kg of trout at a stocking density of 25 kg/m^3 in an FTRS, a water flow rate of 600 L/min is required. As such, 50-200 m^3 of water (depending on the different methods of calculation) is required to produce one kg of rainbow trout in FTRS, which is apparently not sustainable with diminishing water resources and limits rainbow trout farming activities to only specific region of Indian uplands. Therefore, it is time to adopt climate-resilient and intensive farming practices, which involves maximum utilization (reuse) of available land and water resources, to facilitate the blue revolution fish production targets by 2030. It is important to note that scientific advances in Recirculating Aquaculture Systems (RAS) have reduced the water requirement in trout culture by several folds (less than 1 m^3 of water per kg fish production), with stocking densities as high as 100 kg/m^3. Comparison of the environmental impact of FTRS and RAS suggests that RAS reduces water dependency by 93%, eutrophication potential by 26-38%, and improves feed conversion ratio by 27%. Even the bottom side of high energy requirement in RAS (16 kWh per kg fish) can be overcome by strategically reducing energy usage to a significant extent by optimizing water re-circulation and oxygenation requirements. Besides, clean energy sources (e.g., solar energy which is adequately available in hilly regions) and biogas produced from fish waste sludge can be utilized to make RAS based rainbow trout farming more sustainable. Further, by controlling water temperature in RAS, it is possible to reduce crop duration to 5-6 months (as compared to the 12-14 months cycle in FTRS) and augment production per unit time. In this regard, ICAR-Directorate of Coldwater Fisheries Research, Bhimtal has initiated a study for the feasibility of RAS for rainbow trout in the Indian context. ICAR-DCFR designed and installed a RAS, consisting of four 7 m^3 large culture

A rainbow trout Recirculating Aquaculture System (RAS) at ICAR-DCFR, Bhimtal

Haul of rainbow trout harvested from RAS of ICAR-DCFR, Bhimtal

tanks for grow-out production and eighteen (0.5 m^3 each) juvenile rearing and experimental tanks with available rearing volume of 33 m^3. The system consists of radial flow separators and mesh screen drum filter to remove settable and suspended solids and two moving-bed biological filters to remove ammonia and nitrite, and a UV filter for disinfection. The water is re-circulated with the help of water pumps continuously. With the current pilot-scale RAS set up, it is possible to produce 1.2 tonnes of trout per crop cycle (2.4 tonnes per year, at the stocking density 40 kg per m^3). The production can be increased to ~5.0 tonnes per year with the help of pure oxygen for oxygenation and addition of CO_2 stripper and protein skimmer to system. In the trial, ~ 250kg of rainbow trout were harvested and sold from two of the grow-out tanks, and observation indicates that growth rates are much faster in RAS compared to FTRS (100 g to 800 g in four months) due to controlled water parameters. Currently, we are testing the system for complete production cycles and economic feasibility of the RAS system for rainbow trout farming in the Indian scenario. RAS system can significantly contribute to increase in trout production due to the fact that the RAS farming practices can be done from nearly anywhere in the Indian upland region with limited water availability and lower land footprints which otherwise impossible with current farming practices in flow through raceways. Moreover, ICAR-DCFR is also working on development of affordable and economically viable prototypes for small scale RAS trout production systems which can be operated by small scale farmers.

4.2 Formulation, validation and commercialization of rainbow trout starter feed

ICAR-Directorate of Coldwater Fisheries Research formulated rainbow trout starter feed based on different protein sources and tested their performance efficacy through a series of feeding experiments at Bhimtal and Champawat, 2016 onwards. Based on various response criteria such as growth, feed use, survival, size homogeneity, morphometric-histological indices and molecular biomarkers related to growth and metabolism, the best performing feed formulation was arrived at. Further investigation on the feed preparation method (extrusion versus pelleting) revealed the advantage of using extruded starter in terms of pellet physical properties, fish survival and water quality changes in the rearing set-up. Subsequent to this, meticulous internal validation, for field demonstration and potential commercialization, ICAR-DCFR partnered with Growel Feeds Pvt. Ltd., Andhra Pradesh to produce 2500 kg of nutritionally and physically superior extruded starter 1 (0.4-0.6 mm crumble) and starter 2 (0.8 mm slow sinking pellet) feeds having 50% crude protein and 15% crude fat. Downstream, with the support of State Fisheries Departments and private farmers, ICAR-DCFR conducted on-farm validation and demonstration at 8 test sites covering all the major trout producing states (Himachal Pradesh, Jammu & Kashmir, Sikkim and Uttarakhand). In all the test sites, under different environmental conditions, the performance of ICAR-DCFR starter feed was found to be consistent and very good in terms of feed acceptance, use, growth, survival and size homogeneity. Specifically, on a comparative scale, this feed outperformed the existing trout starter feeds by 50-90% difference in weight gain. Survival was greater than 90% in all the test sites. Feed conversion ratio was found to range from 0.8 to 1.15, with substantially less feed wastage. Importantly, the duration of nursery rearing (from first feeding to 2 g size) was reduced from 75-90 days to 45-60 days. Overall, through this on-farm demonstration-validation trials, it was proven that a nutritionally and production-wise superior starter feed can remarkably enhance growth, feed utilisation efficiency, survival, fitness traits and size homogeneity in trout nurseries, while substantially reducing culture duration, disease incidence, malformations and feed wastage. Based on conservative estimates, using this starter feed, ICAR-DCFR has contributed to the production of more

than 0.5 million healthy trout fingerlings across the country. Prospectively, this roughly translates to 125 tonne of trout production (considering 75% survival from stock-size to pan-size) with a combined value of 62.5 million rupees (at Rs. 500 per kg). Based on the technological sophistication required to produce this feed, ICAR-DCFR and M/s Growel Feeds are in the final stages of officially partnering in the commercial production and marketing of this rainbow trout starter feed all across the country.

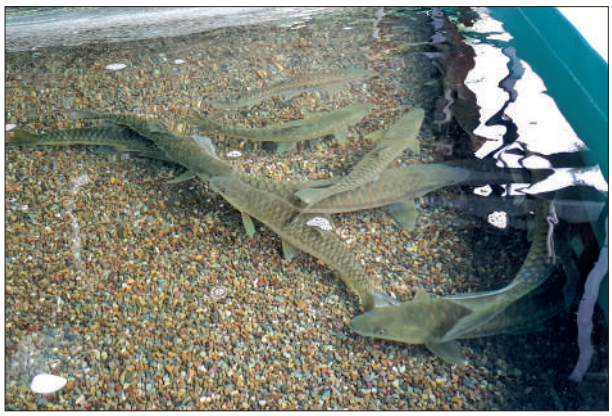
4.3 Captive maturation and multiple breeding of endangered Golden mahseer (*Tor putitora*)

Golden mahseer (*Tor putitora),* is a prime fish species not only in Indian Himalaya but in Himalayan sub-continent due to its socio-economic, ecological, recreational, heritage, cultural and food values. Apart from aquaculture prospects, it has got huge potential in fish based eco-tourism by means of angling, fish watching, sport fishing etc. for generating livelihood opportunities of local communities. However, due to various inherent and anthropogenic factors like environmental degradation, habitat fragmentation viz., hydroelectric and irrigation projects and indiscriminate fishing, its population in natural water bodies/habitat had declined sharply over time. Consequently it has been declared as endangered species and listed in IUCN Red List of Threatened Species. Therefore, it has become a subject of great concern for the success of its breeding and seed production.

Until recently, the breeding and seed production of golden mahseer was being done using wild gravid brooders collected from natural water bodies for seed production which is a non-sustainable practice. This dependence on wild brooders is because golden mahseer females fail to complete ovarian development and maturation in captive conditions due to endocrine dysfunctions.

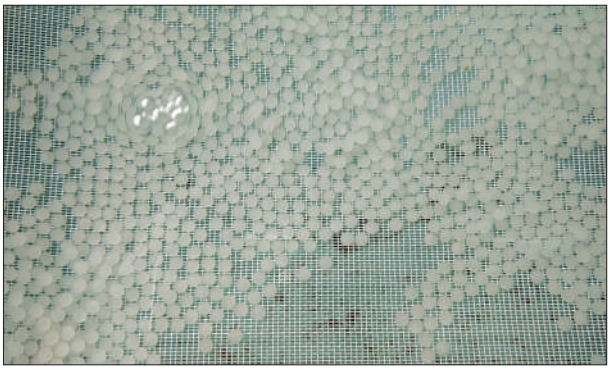
Therefore, to address this issue on priority basis, ICAR-Directorate of Coldwater Fisheries Research, Bhimtal embarked upon conducting series of experiments such as reproductive hormonal profiling of wild and captive brooders to decode the degree of endocrine dysfunctions, photoperiod and temperature manipulations to induct maturity, broodstock diet intervention, interventions on spawning substratum and biofilteration system to induce maturity in captive conditions. Besides experiments on sex segregation methods have successfully achieved year round multiple breeding of endangered golden mahseer. Hence, this technology of captive maturity and multiple breeding of golden mahseer through photothermal manipulations have resulted in producing a substantial number of fry of golden mahseer round the year on sustainable basis.

Further, the technology is being validated which otherwise has been a major bottleneck for large scale rehabilitation efforts to conserve this esteemed species.

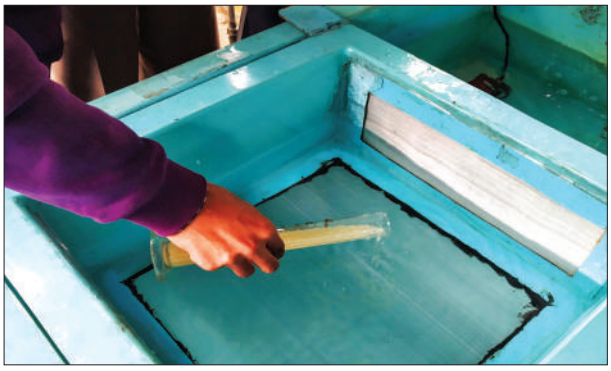


Golden mahseer brooders under maturation system

Captive matured golden mahseer female brooder



Fertilized eggs of golden mahseer matured in captivity



Incubation of fertilized eggs

Advanced fry of captive bred golden mahseer

Captive maturation hatchery system

List of Research Projects

5

5.1 Institutional projects

Project Code	Project Title	Investigators	Year of Start	Year of Completion
A. Resource assessment and management				
CF-6	Ecosystem assessment and mapping of aquatic resources in Indian Himalayan regions	**D. Sarma** (Coordinator)		
	Sub-project 4: Assessment of population status, species diversity and habitat ecology of snow trout *Schizothorax* species in selected streams of Indian Himalayan region	**D. Baruah** D. Sarma P. Sharma K. Kunal P.A. Ganie	2016	2020
	Sub-project 5: GIS based digital data base on coldwater fishery resources of Arunachal Pradesh in North East Himalayan (NEH) region	**D. Baruah** K. Kunal P.A. Ganie	2018	2021
B. Aquaculture oriented research and development				
AQ-16	Captive management of Golden mahseer in perspective to aquaculture and conservation	**D. Sarma** (Coordinator)		
	Sub-project 4: Scaling up the seed production of chocolate mahseer in captivity	**P. Dash** D. Sarma R.S. Tandel	2018	2021
	Sub-project 5: Optimizing reproductive and spawning performance of golden mahseer for upscaling its seed production in captivity	**M.S. Akhtar** D. Thakuria Ciji, A. Rajesh, M.	2018	2021
AQ-19	Domestication, biology and breeding of selected species for species diversification in mid-hill aquaculture	**N.N. Pandey** (Coordinator)		
	Sub-project 4: Growth potential and breeding performance of *S. progastus* and *S. plagiostomus*	**N.N. Pandey** R.S. Patiyal R. Singh	2018	2021
	Sub-project 5: Embryonic development, breeding and seed production of Sucker head, *Garra gotyla*	**R.S. Patiyal** N.N. Pandey	2018	2021
AQ-21	Development and validation of novel feed formulations for rainbow trout (*Oncorhynchus mykiss*) based on commercial-scale industrial by-products	**B.S. Kamalam** Rajesh, M. N.N. Pandey Ciji, A. P. Sharma	2018	2021

Project Code	Project Title	Investigators	Year of Start	Year of Completion
NPOFBC	Network project on Ornamental fish breeding and culture (NPOFBC): ICAR- DCFR component: -Development of breeding protocol and larval rearing technique of the selected indigenous hill stream ornamental loaches, suckers and hill trouts	**P. Dash** D. Sarma A.K. Giri	2018	2023
C. Molecular genetics and biotechnology				
AQ-18b	Transcriptome based sex specific marker discovery in golden mahseer (*Tor putitora*)	**Siva, C.** S. Ali P. Sharma Rajesh, M.	2017	2021
AQ-18c	Gender specific transcriptomic response to environmental stress in golden mahseer (*Tor putitora*)	**S. Ali** Siva, C. P. Sharma	2018	2021
AQ22	Genome editing in common carp, *Cyprinus carpio* using CRISPR/Cas system	**N. Shahi** D. Sarma S.K. Mallik	2019	2022
AQ23	Development of cell lines from different organs of rainbow trout	**Amit Pande** D. Thakuria	2019	2022
D. Disease surveillance and health management				
AQ-20	Development of diagnostic & therapeutic measures for rainbow trout pathogens	**D. Sarma** (Coordinator)		
	Sub-project 1: Development of rapid assays for detection & identification of *Saprolegnia* species	**K.V. Chanu** D. Thakuria R.S. Tandel	2017	2020
	Sub-project 2: Evaluation of antimicrobial activities of nano & polymer-based formulation against Saprolegniasis	**D. Thakuria** K.V. Chanu R.S. Tandel	2017	2020
	Sub-project 3: Evaluation of available anti-fungal agents and herbs for their efficacy against oomycetes infection in farmed rainbow trout	**R.S. Tandel** R.A.H. Bhat S.K. Mallik P. Dash	2017	2020
AMR	Network programme on antimicrobial resistance (AMR) in fishes under INFAAR	**S.K. Mallik** N. Shahi	2018	2021
5.2 Externally funded projects				
DBT-6	Molecular and Genetic Characterization of selected important ornamental Fishes of North East India	**Siva, C.**	2017	2020
NSPAAD	National surveillance programme for aquatic animal disease-Surveillance of coldwater fish diseases in Himachal Pradesh and Uttarakhand (NFDB funded multi-institutional project)	**S. Chandra** S.K. Mallik R.S. Tandel R.A.H. Bhat	2014	2020

Project Code	Project Title	Investigators	Year of Start	Year of Completion
AINP-Fish Health	All India Network Project on Fish Health- AINP-FH	**S.K. Mallik** N. Shahi R.S. Tandel	2015	2020
NICRA	Development of climate resilient rainbow trout and innovative trout farming strategies to mitigate climatic stressors	**D. Sarma** R.S. Patiyal D. Baruah B.S. Kamalam Rajesh, M. P. Sharma R.S. Tandel S.K. Mallik M.S. Akhtar N. Shahi Ciji, A., A.K. Giri Siva, C. R.S. Haldar	2017	2020
DBT-7	Triploid rainbow trout (*Oncorhynchus mykiss*) production for aquaculture enhancement and ecological risk management	**N.N. Pandey** B.S. Kamalam R. Singh	2017	2020
DBT-8	Immunomodulation in golden mahseer (*Tor putitora*) broodstock under captive conditions	**M.S. Akhtar** Ciji, A. Rajesh, M.	2018	2021
DBT-9	Bio-engineered synthetic antimicrobial peptides as alternative to antibiotics for use in aquaculture	**D. Thakuria** A. Pande K.V. Chanu	2019	2022
NMSHE	National Mission for sustaining the Himalayan ecosystems (NMHSE-Taskforce 6 for Himalayan Agriculture)	**N.N. Pandey/ D.Sarma** S. Ali R.S. Patiyal Rajesh, M. B.S. Kamalam A.K.Giri	2015	2020
Extramural	Development of anti-infective synthetic peptide against *Lactococcus garviae* & other pathogenic bacteria isolated from rainbow trout, *Oncorhynchus mykiss*	**S.K. Mallik** N. Shahi	2018	2020

6 Events and Meetings

6.1 Celebration of Republic day

The Republic Day on 26th January 2019 of our nation was celebrated with flag hoisting ceremony attended by all the scientist and staff of the Directorate. Dr. Debajit Sarma, Director unfurled the national flag on the Republic Day and addressed the gathering to work in harmony. Shri K.C. Pandey, ADG Coast Guard was invited as the Chief Guest of the programme. Scientists and staff of the Directorate also expressed their views on the occasion. Likewise, the Republic day was also celebrated with flag hoisting ceremony at Experimental Fish Farm, Champawat. Mr. Kishor Kunal, Scientist & OIC hoisted the national flag on this occasion and wished all the staff happy republic day and a bright year ahead.

The Director addressing the gathering on the Republic Day

Celebration of Republic day at EFF, Champawat

6.2 Mann ki baat

ICAR-DCFR organized to webcast the inaugural program of *Pradhan Mantri Kisan Samman Nidhi* on 24th February 2019 in the Auditorium. 100 farmers, staff members of the Directorate and public representatives of Bhimtal and nearby villages participated in the live telecast programme.

Live Telecast of Mann Ki Baat addressed by the Hon'ble Prime Minister of India to the farmers at ICAR-DCFR

6.3 Regional Advisory Committee meeting

The Research Advisory Committee (RAC) of ICAR-DCFR was held on 28-29th March 2019 at the Directorate, Bhimtal under the chairmanship of Dr. M. Sinha, former Director, ICAR-CIFRI, Barrackpore. The meeting was attended by esteemed members Dr. S.C. Mukherjee, Dr. A.K. Sahoo and Dr. H.C.S. Bisht. Dr. D. Sarma, Director, ICAR-DCFR gave a brief account of the on-going research

programmes, new initiatives and significant achievements during April 2018 to March 2019 and apprised the RAC on the recent development of infrastructure and facilities created at the Directorate. Dr. N.N. Pandey, Principal Scientist and Member Secretary presented the action plan and progress on committed activities under approved SFCs. Based on the presentations made by the scientists, detailed review and discussion on the research outputs under different projects of ICAR-DCFR were made. RAC recommended to explore aquatic resources in high altitudinal regimes, action taken initiatives for commercialization of trout farming, development of breeding technology for different coldwater fish species and technical support to the state fisheries departments in doubling farmers' income. RAC appreciated the overall progress made by the institute and congratulated Director and scientists of ICAR-DCFR for their commendable work.

Apprising the RAC members on the developmental activities of the Directorate

Release of *Himjyoti* during the RAC meeting

6.4 Workshop on trout farming at Nagaland

One day workshop on "Trout farming in Nagaland: Prospects for doubling farmers income" was jointly organized by ICAR-DCFR, Bhimtal and Department of Fisheries & Aquatic Resources, Govt. of Nagaland at Dzuleke village, Kohima district, Nagaland on 13th May, 2019. Dr. Debajit Sarma, Director, ICAR-DCFR briefed on the objectives of the workshop to promote high valued trout farming in Nagaland and disseminating technical knowhow to achieve better productivity and augmenting livelihood security in the region. Dr. R.S. Haldar, ACTO coordinated the workshop under NEH activity. On the occasion a unit of trout hatchery and three numbers trout raceways established under the NEH activity of ICAR-DCFR was inaugurated in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland. Altogether, 100 participants including farmers from the villages Dzuluke, Khonoma, Mezama, Phesama, Jakhama, Kigwema, Mima and officer, scientists, faculty members, students, guests print and visual media personnel attended the programme. The programme was chaired by Shri Senti Ao (IAS), Commissioner & Secretary, Department of Fisheries & Aquatic Resources, Govt. of Nagaland as Chief Guest. The programme also witnessed the gracious presence of Prof. R. C. Nayak, Pro Vice Chancelor, Nagaland University; Mr. Vitsiepielie, Village Chairperson, Dzuleke village; Shri Rongsennungba, Additional Director; Mr. Lotimenba, Joint Director; Mr. Neitho-o Kuotsu, Dy. Director; Shri Ketusielie Angami, Dy. Director.

Interaction with the farmers during the workshop on "Trout Farming in Nagaland: A Prospect for Doubling Farmers Income" at Dzuleke, Nagaland

6.5 Institute Research Committee (IRC) meeting

ICAR-DCFR Scientists' Meet was held during 27-28th May, 2019 as Institute Research Committee (IRC) meeting under the Chairmanship of Dr. D. Sarma, Director and coordination of Dr. N.N. Pandey, Principal Scientist cum I/c PME. The Director welcomed all the scientists and briefed on the research gap in coldwater fisheries sector. Scientists of the institute presented the progress of the ongoing institutional research programmes. Discussion was also made on NEH, TSP, SCSP and farm activities at Experimental Fish Farm, Champawat. Project wise critical comments, suggestions and thorough discussions on each of the presentations were made during the meet.

6.6 Workshop with ICICI foundation

One day workshop on "Development of hill fish farming for upliftment of rural economy in Uttarakhand" was organized in collaboration with the ICICI Foundation on 30th May 2019 at Nail village, Almora district, Uttarakhand. The programme was attended by several local farmers of the region. Mr. Saurabh Singh, President, ICICI Foundation, Mumbai and Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal graced the occasion. Critical farm inputs in the form of live fish seed were distributed to the selected farmers of the area alongwith water testing kits for periodical testing of important water quality parameters of fish ponds. Fish sampling of farmer's pond was also done periodically to observe the growth performances of the fish stocks. The programmes were coordinated by Dr. R.S. Haldar, ACTO of this Directorate.

Distribution of fish seed to the farmers

Distribution of water testing kits to the farmers

Release of fish seed in farmers pond at Nail village, Almora

Distribution of participation certificate to the farmers

6.7 National Fish Farmer's day

National Fish Farmer's Day was celebrated on 10th July 2019 at Mudiyani village, Champawat by organizing an interactive scientist cum farmers meet with the theme "Fish farming in upland regions". The participants were from the villages Mudiyani, Chaekuni Bora, Pawet, Chekuni, Raakri Phulaara, Dasiya, Kanda, Semalata and Runani and they were briefed on the importance of celebrating the National Fish Farmers' Day. The farmers were later trained on methodologies of suitable site selection for aquaculture, breeding and seed production protocols of common carp and rainbow trout and their farming potential in Indian uplands. Issues and queries raised by the farmers on carp feed, disease mitigation and water quality management were answered. At the end of the programme, the fish farmers were provided with 1000 numbers of farm raised improved strains of common carp fingerlings each. The programme was coordinated by the scientists, technical and supporting staff of Experimental fish farm, Champawat.

6.8 Swachha bharat abhiyan

Swachha Bharat Abhiyan was conducted on 19th July 2019, 1st October 2019, 2nd October 2019 and 21st December 2019 at EFF, Champawat. Extensive cleaning was carried out in and around the Experimental fish farm campus during the campaign. Public places like temples and others were also cleaned during the event. Similar activities were also taken at ICAR-DCFR, Bhimtal under Swachha Bharat Abhiyan.

6.9 Celebration of Independence day

Independence Day was celebrated on 15th August 2019 at ICAR-DCFR, Bhimtal and EEF, Champawat. Dr. D. Sarma, Director and Mr. Kishor Kunal, Scientist & OIC hoisted the national flag on this occasion and witnessed by all the staff members. Scientists and staff of the Directorate also expressed their pride for being the part of such a glorious nation and paid homage to the freedom fighters on this occasion.

Flag hoisting on the Independence day by the Director at ICAR-DCFR, Bhimtal

Flag hoisting on the Independence day by Officer-in-charge at EFF, Champawat

6.10 National symposium

National symposium on "Coldwater fisheries development in India: innovative approaches and way forward for enhancing hill farmers income" was organized by ICAR-DCFR on the occasion of the Annual Foundation Day at Bhimtal during 24-25th September 2019. Altogether, 250 participants comprising the fish farmers, entrepreneurs, students, academicians, researchers, fisheries officers, administrative officers from various parts of the country participated in the programme. Dr. J.K. Jena, DDG (Fisheries), ICAR, New Delhi was the Chief Guest of the programme. Several former Directors of ICAR-DCFR, ICAR-CIFRI, ICAR-CIFA, Director of Fisheries, Govt. of Himachal Pradesh were present on the occasion as Guest of Honour.

Presentation on research & development activities of ICAR-DCFR by the Director

Participants during the National Symposium

6.11 Hindi saptah samaroh

Hindi Saptah was organized at Bhimtal during 14-20th September 2019 by conducting various competitions such as essay writing, word knowledge, Hindi to English translation, Hindi skill, computer oriented Hindi typing among the staff of the Directorate. Prizes were distributed to the winners on the Annual Foundation Day of ICAR-DCFR on 24th September 2018. The I/c Hindi Cell Shri Amit Joshi coordinated the programmes. Further, Dr. R.S. Patiyal, Principal Scientist coordinated competitions on different subjects during Hindi Phakhwada from 1-16th September, 2019 as the Chairman of Hindi Pakhwada.

Participation of ICAR-DCFR staffs in hindi writing competetions

6.12 ICAR-DCFR Foundation Day

ICAR-DCFR celebrated the 32nd Annual Foundation Day on 24th September 2019 at its premises with great enthusiasm. Dr. J. K. Jena, Deputy Director General, ICAR, New Delhi graced the occasion as Chief Guest and appreciated the contributions of ICAR-DCFR for significant coldwater fisheries and aquaculture research in the country. Dr. D. Sarma, Director, ICAR-DCFR, welcomed the dignitaries and updated on the ongoing activities and achievements made by the Directorate in the coldwater sector of the country. 150 delegates including 50 eminent scientists and former Directors of ICAR fisheries institute across the country participated in the foundation day celebrations. Several publications of the Directorate were also released on the ocassion. Coldwater Fisheries Society of India (CFSI), C/o ICAR-DCFR awarded eminent scientists and researchers with CFSI Gold Medal, CFSI Fellowship, CFSI Life Time Achievement Award, CFSI Special Recognition Award, CFSI Photo Contest Award for their significant contributions to coldwater fisheries research and development.

Release of publication during the Foundation Day of ICAR-DCFR

Dignitaries and Participants on the ICAR-DCFR Foundation Day

6.13 Inauguration of the ICAR-DCFR Museum

ICAR-DCFR has established a fish museum to collect, preserve, interpret and display of fish specimens and fish based objects of artistic, cultural and scientific significance for the purpose of education, knowledge sharing and amusement for the public. The museum is presently having more than 70 freshwater fish species found in the colder regimes of Indian Himalayan Region. Fishing gears in the form of bamboo made traps, spears, angling gears and accessories are in display. A photo gallery representing the contribution of eminent scientists of the Directorate can also be seen in the museum. The museum was inaugurated on the occasion of annual foundation day of ICAR-DCFR, Bhimtal on

Inauguration of the ICAR-DCFR museum on the Annual Foundation Day

24th September 2019 by Dr. J.K. Jena, DDG Fisheries, ICAR and in the gracious presence of Prof. W. Vishwanath, former Vice-Chancellor, Manipur University and Dr. V.V. Sugunan, former Director, ICAR-CIFRI.

6.14 Inauguration of re-circulating aquaculture system (RAS) for rainbow trout

The first coldwater fish specific pilot-scale RAS unit in the country was commissioned on 24th September 2019 at Bhimtal under NICRA project. This facility was designed in-house comprising all the primary constituent units of a RAS system. For fish rearing and experimental production trials, there are 4 large and 18 small FRP tanks with dual drain and provision for oxygenation. Approximately, this unit has a maximum production capacity of 1-1.5 tonnes of rainbow trout, with 40-50 kg/m^3 productivity. As compared to a conventional flow-through raceway of similar water volume, the expected fish production and productivity will be two to three-fold higher, with concurrent decrease in the volume of water used for unit fish production by more than 100 times, at half the culture duration.

At present, the optimization of the operational factors of this pilot-scale RAS unit is in progress. The RAS unit was inaugurated on the annual foundation day of ICAR-DCFR by Dr. J.K. Jena, DDG Fisheries, ICAR and in the gracious presence of Dr. Dilip Kumar, former Director, ICAR-CIFE and Dr. K.K. Vass, former Director, ICAR-CIFRI.

6.15 Vigilance awareness programme

Vigilance Awareness programme on "Integrity: a way of life" was organized on 28th October 2019 at ICAR-DCFR, Bhimtal and EFF, Champawat whence the staff of the farm took a pledge to work for integrity among the fellow Indians. Dr. R. S. Patiyal, Principal Scientist organized a debate on 'Imaandari ek Jeevan shaili' to mark the vigilance week programme on 30th October , 2019 at ICAR-DCFR, Bhimtal. Mr. Kishor Kunal, Scientist & OIC appraised the farm staff on value of highest standards of honesty and probity in all walks of life. A debate competition on "Honesty: a way of life" was also organized for the staff of EFF, Champawat.

6.16 World antibiotic awareness week

An awareness programme was organized on antimicrobial resistance (AMR) at Government School, Bidhora, Sitarganj Road, Khatima, Udhamsingh Nagar, Uttarakhand, India by ICAR-DCFR to mark the 'World Antibiotic Awareness Week' during 18-24th November 2019. The programme was attended by 35 farmers and local residents. All the participants were made aware on the issues of antimicrobial resistance, and their role as determinant in spreading through fish-food chain and causing potential risks on animal and human health. After an interactive session, an AMR pledge was taken together with the participants. The

Distribution of FAO study materials to explain participants on potential health risk posed by AMR

Pledge taking ceremony on constitution day at EFF Champawat

Fish farmers and villagers of Bidhora village, during World Antibiotic Awareness Week

programme was coordinated by Mr. S.K. Mallik, Scientist cum Project investigator and Dr Neetu Shahi, Scientist cum Co-Project investigator, ICAR-FAO Network Project on Antimicrobial Resistance in Fisheries. Later fish samples were also collected from farmers' field for laboratory analysis.

6.17 Constitution day

An awareness campaign was organized on 26th November 2019 at ICAR-DCFR, Bhimtal and EFF, Champawat whereon the staff read the preamble and took oath to work in interest of nation and abide by the constitution.

Oath taking ceremony at ICAR-DCFR, Bhimtal

6.18 Celebration of swachhta pakhwada

The Swachhta Pakhwada under Swachh Bharat Mission was observed during 16-31st December, 2019 at Experimental Fish Farm, Champawat by the staff members, students and contractual staff. During the pakhwada, regular cleaning of campus and surrounding was taken up, awareness programme on cleanliness and proper waste disposal was organized at nearby villages, office premises and adjoining areas of the office. On various occasions during the pakhwada Mr. Kishor Kunal, Scientist and OIC addressed the villagers and explained the importance of cleanliness in day to day life and the mission of the Government of India. Similar activities were taken at ICAR-DCFR, Bhimtal campus

Swachhta Abhiyan at ICAR-DCFR campus

Swachhta Abhiyan at a nearby village Mudiyani, Champawat

6.19 Quinquennial Review Team (QRT) meeting

The Secretary, DARE and Director General, Indian Council of Agricultural Research constituted Quinquennial Review Team (QRT) to review the work done by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal and to evaluate the progress of research work for the period of April 2013 to March 2018 under the Chairmanship of Dr. Dilip Kumar, Former Director & Vice Chancellor, ICAR-CIFE, Mumbai. The QRT team comprising Dr. J.R. Dhanze, Dr. S.D. Gupta, Dr. Madan Mohan and Dr. Atul Borgohain visited at different work places and discussed with scientists of ICAR-DCFR and farmers, stakeholders and state departmental personnel of State Sikkim and Arunachal Pradesh.

Interaction of QRT members with office staff of EFF, Champawat

Discussion with the ICAR-DCFR scientists by QRT members

Witnessing the work progress of ICAR-DCFR wet labs

Visit of QRT members to a trout farm at Sikkim

6.20 ICAR Inter Institutional Sports Meet - 2019

ICAR-DCFR actively participated in the ICAR Inter Institutional Sports Meet - 2019 (North Zone) at Indian Institute of Technology, Kanpur. The sports meet was hosted by ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh during 12-14th December, 2019.

ICAR-DCFR sports contingents

A volley ball match in progress

7 Extension Activities, Consultancy and Services

7.1 Mera Gaon Mera Gaurav (MGMG)

Name of ICAR Institute/SAU: ICAR-Directorate of Coldwater Fisheries Research, Anusandhan Bhawan, Industrial Area, Bhimtal-263136, Distt.-Nainital (Uttarakhand).

Details of Nodal Officer:

Name of Nodal Officer	Designation of Nodal Officer	Contact details (Phone No., email Id etc.)
Dr. R. S. Haldar	Asstt. Chief Technical Officer	8126435135, 9412981357 (WhatsApp), haldardcfr@gmail.com rs.haldar@icar.gov.in

Institute/SAU summary under MGMG:

No. of Teams formed	No. of Scientists	No. of Villages adopted	No. of Blocks covered	No. of Districts covered	Bench Mark Survey conducted (No. of villages)
06	17	26	12	10	06

Summary of activities organized under MGMG by Institute/SAU:

S. No.	Name of activity	No. of activities conducted	No. of farmers participated/ benefitted
1.	Visit to village by teams	104	680
2.	Interface meeting/ *Goshthies*	26	647
3.	Trainings conducted	28	842
4.	Mobile based advisories	82	202
5.	Literature support provided	25	964
6.	Awareness created	27	987
7.	Linkages developed with other agencies	10	286

Summary of other activities organized under MGMG by Institute/SAU:

S. No.	Name of activity	Quantity/No.	Area (ha)/ number of units (no.)	No. of farmers benefitted
1.	No. of demonstrations laid out	40	40	308
2.	Input support provided like seed, planting material, fertilizers, etc.			
	i. Seeds (q)	32,000	-	28
	ii. Planting material (No.)	-	-	-
	iii. Fertilizers (q)	-	-	-
	iv. Any other (pl specify)	Azolla	12	22

Details of MGMG Team and status of benchmark survey of selected villages:

Team	Name of team coordinator	Name of scientists with discipline	Name villages adopted	No. of villages
1.	Dr. Debajit Sarma, Director (Acting)	Dr. S.K.Mallik, Scientist Dr. M.S.Akhtar, Scientist Dr. Dimpal Thakuria, Scientist Dr. Prakash Sarma, Scientist	Umsining, Pynhurslla, Laithrong, Myrang	04
2.	Dr. N.N. Pandey Principal Scientist	Dr. Amit Pande, National Fellow Dr. S. Ali, Scientist Dr. Siva C, Scientist Dr. R.S.Haldar, ACTO Sh. Santosh Kumar, STO	Todera, Dudhauli, Jyurkafun, Manan, Nail	05
3.	Dr. S. Chandra Principal Scientist	Sh. R.S.Tandel, Scientist Dr. Kh. Victoria Chanu, Scientist Smt. Pragyan Dash, Scientist	Alchaunna, Hari Nagar, Barijala, Baheri Gaon, Boherakun	05
4.	Dr. R. S. Patiyal Principal Scientist	Dr. Ciji Alexander, Scientist Dr. B.S. Kamalam J., Scientist Dr. Rajesh, M., Scientist	Salmatta, Sarmoli	02
5.	Dr. D. Baruah, Sr. Scientist	Dr. Neetu Shahai, Scientist Sh. Adil Raja Bhat, Scientist	Chug, Hari, Changpa, Donglok	04
6.	Dr. R. Singh Scientist	Dr. Kishor Kunal, Scientist Sh. Parvaiz A. Ganie, Scientist	Kathad, Chekuni Bora, Moradi, Mudyani Dodhpokhara, Khunari	06

List of villages adopted under MGMG by the Institute/SAU:

State	Name of district	Name of block	Name of villages	No. of villages
Uttarakhand	Nainital	Bhimtal	Hari Nagar, Baheri Gaon, Barijala, Bohrakun, Alchaunna	05
	Almora	Dwarahat, Hawalbagh, Salt	Jyurkafun, Todera, Dudhauli, Manan, Nail	05
	U.S. Nagar	Sitarganj	Salmatta	01
	Pithoragarh	Munsiyari	Sarmoli	01
	Champawat	Champawat	Kathad, Chekuni Bora, Moradi, Mudyani, Dodhpokhara, Khunari	06
Arunachal Pradesh	West Kameng, Lower Subansiri	Dirang, Ziro	Chug, Hari, Donglok, Changpa	04
Meghalaya	Ri-bhoi, East Khasi Hills, West Khasi Hills	Umsining, Phyhurslla, Laithrong, Myrang	Umsining, Pynhurslla, Laithrong, Myrang	04

Details of demonstration conducted under MGMG by the Institute/SAU:

S. No.	Title of demonstrations	No. of demonstration	Area covered under demonstration (ha)/ number of units, etc.)	No. of farmers benefitted
1.	Preparation of fish stocking tank, stocking of fish seed and pond management	4	4 units	4
2.	Breeding and seed rearing of common carp	4	4 units	4
3.	Breeding and seed production of mahseer	2	2 units	2
4.	Health management in carp farming	3	3 units	3
5.	Integrated fish farming	8	8 units	8
6.	Soil and water quality management in integrated fish farming	4	4 units	4
7.	Transportation of rainbow trout	1	1 unit	1
8.	Rainbow trout farming	4	4 units	4
9.	Health management in rainbow trout farming	2	2 units	2
10.	Feed formulation and feeding	2	2 units	2
11.	Ornamental Fish Farming	6	6 units	6

Details of Input support provided under MGMG by the Institute/SAU:

S. No.	Type of Input Support Provided (Seed, planting material, technology, fertilizers, etc.)	Quantity (Kg/ No.)	Area (ha)	No. of farmers benefitted
1.	Fish seed	32,000 FL	40 unit	40
2.	Fish feed	800 kg	40 units	40

Details of trainings conducted under MGMG by the Institute/SAU:

S. No.	Topic of training	Duration of training (No. of days)	No. of farmers participated in training
1.	Best management practices for culture and breeding of coldwater fishes	1 day	17
2.	Awareness cum training programme on trout farming	1 day	20
3.	Awareness cum training programme on carp farming	1 day	22
4.	Awareness cum training programme on ornamental fish farming	1 day	24
5.	Awareness cum training programme on mahseer farming	1 day	15
6.	Coldwater Fisheries and aquaculture practices in Indian Himalayan Region	1 day	20
7.	Integrated fish farming	1 day	23
8.	Training on value addition	1 day	15
9.	Coldwater Fisheries and aquaculture practices in Indian upland	1 day	21
10.	Integrated fish farming	1 day	22

Details of literature support provided under MGMG by the Institute/SAU:

S. No.	Title of literature (Scientific cultivation of broccoli/ Improved varieties of wheat, etc.)	Type of literature (Folder/pamphlet/ leaflet/package of practice, etc.)	No. of famers benefitted
1.	Good management practices for trout and carp farming in mid hills, ICAR-DCFR Pamphlet No. 33	Pamphlet	42
2.	Parvatiya chhetron kei pramukh palan yaog matshya prajatiyon kei prajanan avam beej utpadan takneekiyia, ICAR-DCFR Bulletin No. 28	Bulletin	46
3.	Rainbow trout ki aakh aur muh kei Beemari, ICAR-DCFR Pamphlet	Pamphlet	39
4.	Rainbow trout ke fry aur anguliyaoki safed daag ki bimari, ICAR-DCFR Pamphlet No. 34	Pamphlet	35
5.	White spot disease in coldwater fish, ICAR-DCFR Pamphlet No. 32	Pamphlet	37
6.	Field observations on common health disorders of farmed rainbow trout, ICAR-DCFR Bulletin No. 30	Bulletin	35
7.	Parvatiya chhetron mein matshya samvardhan, ICAR-DCFR Pamphlet No. 37	Pamphlet	43
8.	Sunheri mahseer, *Tor putitora* ka prajanan ebam hatchery provandhan, ICAR-DCFR Bulletin	Bulletin	32
9.	Sheetjaliya machhlion mein rog nidan ebam upchar, ICAR-DCFR Bulletin No. 22	Bulletin	46
10.	Enhancement of livehood security through aquaculture, ICAR-DCFR leaflet	Leaflet	52
11.	Parvatiya chhetron mein matshya palan, ICAR-DCFR leaflet	Leaflet	50
12.	Polyculture of exotic carp in mid hills, ICAR-DCFR leaflet	Leaflet	48
13.	Culture and breeding of rainbow trout in midhills, ICAR-DCFR leaflet	Leaflet	41

Details of linkages created under MGMG by the Institute/SAU:

S. No.	Name of department/ organization/agency etc.	Type of linkage/purpose of creating linkage (for training/ for selection of villages/ for credit, etc.)
1.	Department of Fisheries, Govt. of Uttarakhand, Bhimtal, Nainital	Training/ for selection of villages
2.	Krishi Vigyan Kendra, Jeolikot, Nainital	Training/ for selection of villages
3.	ICAR- Central Institute of Temperate Horticulture, Mukteswar, Nainital	Training/ for selection of villages
4.	ICAR-Vivekanand Parvatiya Krishi Anusandhan Sansthan, Almora	Training/ for selection of villages
5.	Krishi Vigyan Kendra, West Kameng, Dirang	Training/ for selection of villages
6.	Krishi Vigyan Kendra, Subansiri	Training/ for selection of villages
7.	ICAR-Indian Institute of Soil & Water Conservation, Dehradun	Training/ for selection of villages
8.	ICAR-Indian Veterinary Research Institute, Mukteswar	Training/ for selection of villages
9.	ICICI Foundation, New Delhi	Training / Transfer of Technology

Details of awareness created under MGMG by the Institute/SAU:

S. No.	Subject matter of awareness (*Swachhata*/ Crop insurance/ climate change, etc.)	No. of farmers benefited
1.	Coldwater Fish Farming	42
2.	Fish farming in mid hills	45
3.	Awareness on Fish health management	42
4.	Soil and water health	39
5.	Integrated fish farming in Mid hill region	48
6.	Ornamental fish farming	52
7.	Fish feed preparation	50
8.	Fish pond management during winter months	41
9.	Fish farming in tarai region	56
10.	Fish farming in Hills	55
11.	Culture of rainbow trout in upper hills	44
12.	Awareness on value addition of fish	48
13.	Seed production of mahseer	31
14.	Awareness on pond managements	49
15.	Awareness on cleanliness of surroundings area of fish ponds etc.	45

Details of problem diagnosed under MGMG by the Institute/SAU:

S. No.	Name of village	General problem	Agricultural problem
1.	Hari Nagar, Bohrakun, Barijala,	Quality seed	Stocking of small size fish seed resulting low survival and slow growth
2.	Nail, Chekuni Bora, Jyur Kafun,	Slow growth	Lower water temperature and algal bloom during summer months
3.	Hari	Fish disease	Bacterial and fungal infections in fingerlings
4.	Chug, Donglok	Quality seed/Slow growth	Lower water temperature and mix unwanted seed stocking

Details of any other activity organised under MGMG by the Institute/SAU:

S. No.	Name of activity	No. of farmers benefited
1.	Hygiene and cleanliness in work place	210
2.	Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) Yojana	180

Details of any Success story under MGMG by the Institute/SAU:

S. No.	Title of story
1.	Integrated Fish-cum-horticulture using polytanks: A climate resilient practice in mid hill region




Glimpses of MGMG programme

7.2 Consultancy Services

7.2.1 Captive breeding of mahseer

Successful breeding and seed production of the golden mahseer and chocolate mahseer was carried out under captivity at Suteplenden (Longkong) village, Mokokchung district, Nagaland in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland. 3000 fingerlings were produced and are reared in the earthen ponds for their further development as brood stock.

7.2.2 Hatching of rainbow trout ova

5000 number of rainbow trout eyed ova was procured for the first time by the Department of Fisheries & Aquatic Resources, Govt. of Nagaland from the Department of Fisheries, Govt. of Jammu & Kashmir during February, 2019 for stocking at the newly constructed trout hatchery at Dzuleke village, Kohima, Nagaland under the technical and financial supports of ICAR-DCFR, Bhimtal. Dr. R. S. Haldar, ACTO and Nodal Officer, NEH activity coordinated the programme.

7.2.3 Rearing of rainbow trout brooders

Three numbers of trout raceways were established for the first time to rear quality brooders of rainbow trout at Dzuleke village, Kohima district, Nagaland with necessary technical and financial support from the Directorate in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland. 3000 numbers of advanced fry of rainbow trout were stocked in the raceways for further rearing as brooder. Dr. R.S. Haldar, ACTO and Nodal Officer, NEH activity coordinated the programme.

7.2.4 Development of trout farming in Arunachal Pradesh

Technical and financial support has been provided to the Department of Fisheries, Govt. of Arunachal Pradesh to renovate the existing facilities of trout hatchery for breeding and seed production of trout at Regional Trout Farm, Shergaon in relation to further expansion of trout farming in the state on scientific lines. Dr. R.S. Haldar, ACTO and Nodal Officer, NEH activity coordinated the programme.

7.2.5 ICAR-DCFR prepared trout feed disseminated

ICAR-DCFR prepared starter feed of rainbow trout has been provided to Regional Trout Farm, Shergaon, West Kameng district in Arunachal Pradesh and better growth and survival of the rainbow trout fry at the farm was achieved.

Similarly 200 kg of ICAR-DCFR prepared grow-out feed of rainbow trout has been provided to the Department of Fisheries & Aquatic Resources, Government of Nagaland for rainbow trout stocks being reared in raceways at Dzuleke village, Kohima district for better growth and survival of the species.

7.2.6 Consultancy on rainbow trout hatchery operation at Munnar, Kerala

Based on the memorandum of understanding signed with Kannan Devan Hills Plantations Company Pvt. Ltd., Munnar, Kerala, in 2018, the Directorate continues to provide scientific and technical guidance to improve the rainbow trout hatchery operation at Rajamallay tea estate. Firstly, the feeding practice was shifted from minced slaughterhouse waste to proper extruded feed pellets of appropriate nutritional quality, resulting into remarkable increase in the average body mass (from ≤ 500 g to ≥ 1500 g) and condition factor of the brood fishes. ICAR-DCFR formulated and validated starter feed for use during nursery rearing were also provided. Secondly, hands on training and workshop was organized by ICAR-DCFR scientists Mr. A.K. Giri and Mr. Siva, C. on rainbow trout breeding and hatchery management for the hatchery employees and concerned managers of the estate during 6-8th February 2019. Subsequently, to address observations and concerns of poor maturation, jaw malformation and mortality in brooders, Dr. Biju Sam Kamalam, Scientist visited the KDHP hatchery during 1-3rd September 2019, inspected the brooder condition, collected jaw swabs for bacterial pathogen profiling, demonstrated water quality monitoring methods and discussed in detail about the constraints and possibility of infrastructure upgradation with the senior estate management and hatchery employees. Proper farm environment record was initiated by weekly monitoring and recording of water quality changes in the farm. Screening for bacterial pathogens was done by Mr. S.K. Mallik, Scientist and it was observed that obligate bacterial pathogens were not present. Bacteria belonging to the genus *Pantoea* sp., *Pseudomonas* sp., *Mixta* sp., *Enterococcus* sp., *Staphylococcus* sp. and *Curtobacterium* sp. were isolated from the jaw swabs. Exchange of reports and planning for the next breeding season and stock conservation is in progress. Overall, this activity was coordinated by Dr. Biju Sam Kamalam, Dr. Rajesh, M and Dr. Debajit Sarma of ICAR-DCFR.

Brooder holding unit at Rajamallay, Munnar

Demonstration of rainbow trout breeding procedure

7.2.7 Advisory for backyard fish farming at Kutani, Bhimtal

Farm advisory, feed inputs and scientific guidance was provided to Mr. Alok Naskar, a farmer-entrepreneur from Bhimtal for backyard farming of Chinese carps and ornamental fish breeding-rearing. From 80 m^3 pond area, 90 kg of grass carp and 40 kg of common carp was harvested in 2019, after two and half year culture period, with gross earnings of approximately Rs. 30,000.00. In parallel,

the natural breeding and rearing of gold fish and koi carp was facilitated and successfully carried out by the farmer, with annual earnings of approximately Rs. 60,000.00 through the sale of ornamental fishes. This farm advisory activity was carried out by Dr. Biju Sam Kamalam, Dr. Rajesh, M. and Dr. R.S. Haldar.

Backyard fish ponds of Mr. Alok Naskar, Bhimtal

Periodic netting of fish to monitor fish growth

7.2.8 Technical interventions in tanks

Technical interventions was made by stocking of 2500 numbers of cage reared one year old yearlings in 28 fish farmers tanks located in Nainital district along with other regular technical advices in farm management. The programme was need based and was undertaken with a view to increase the growth and production of small hill fish farmers. The adopted fish tanks showing significant improvement in terms of survival and growth.

7.2.9 Collaborative work in PPP mode with ICICI Foundation

ICAR-DCFR has undertaken collaborative work in PPP mode with ICICI Foundation for upliftment of rural livelihood security of hill fish farmers in different villages of Nainital and Almora districts of Uttarakhand. Under this programme to begin with 10 fish farmers have been selected and initially two days training was given to the farmers to knowhow of the scientific hill fish farming. Furthermore, polythene lining, fish seed, fish feed etc. were provided to the selected farmers as critical inputs to start up fish farms.

7.2.10 Technical support for trout fisheries development at Menchukha valley

ICAR-DCFR provided technical support to Department of Fisheries, Govt. of Arunachal Pradesh by conducting extensive field surveys during 13-14th February 2019 and 23-25th November 2019 in the Menchukha region for selecting potential sites suitable for trout farming in concrete raceways and in establishing a unit of ova house for trout seed production. A team of scientists namely Dr. Deepjyoti Baruah alongwith Mr. P.A. Ganie and Young Professional Mr. Ravindra Posti visited the Menchukha valley of newly declared Shi Yomi district of Arunachal Pradesh situated along the Indo-China border. The local villagers, entrepreneurs, administrators and fishery officers of Menchukha region were interacted and later accompanied to potential farm lands with adequate supply of water qualitatively and quantitatively. The water quality of the streams and river Yargyap chu and its adjoining snow-fed streams were analyzed, trout fish samples were examined and GIS points were taken to mark the possibility in selecting suitable sites for establishment of trout raceways and marking of trout protected zones for conservation. A road map on GIS platform and ground survey was prepared for policy framework and its implementation for trout fisheries development at GIS laboratory, coordinated by Dr. Deepjyoti Baruah, Sr. Scientist.

7.2.11 Consultancy services to MP Fisheries Federation, Bhopal

Consultancy services to MP Fisheries Federation, Bhopal was provided by Dr. Debajit Sarma, Director and Dr. M. S. Akhtar, Scientist on 7th October, 2019 and discussed with the Managing Director and other officers of the Federation to finalize a joint programme for the conservation and

development of *Tor* fisheries in Narmada river. The existing farm facilities for the development of *Tor tor* brood bank were evaluated and suggestions were given to upscale the facilities before start of the joint programme. The final proposal has been made for submission to NFDB for funding.

7.3 Exploratory surveys, field visits, farm advisories

- Exploratory survey to river Siang at Pasighat and Aalo of Arunachal Pradesh to analyse water quality parameters and fish composition. The survey was jointly conducted by ICAR-DCFR team of Dr. Deepjyoti Baruah, Sr. Scientist; Mr. P.A. Ganie, Scientist, Mr. Ravindra Posti, YP-II in association with fishery officers of Department of Fisheries, Govt. of Arunachal Pradesh during February 2019.
- Exploration of river Yargyap chu at Menchukha valley, Shi Yomi district, Arunachal Pradesh to study catch size composition of brown trout. Furthermore, a stretch of the river was selected for declaration of "Protected Zone" for brown trout propagation. The survey was jointly conducted by ICAR-DCFR team comprising of Dr. Deepjyoti Baruah, Sr. Scientist; Mr. P.A. Ganie, Scientist; Mr. Ravindra Posti, YP-II in association with District Fishery Development Officer Mr. Kenbom Chisi and other fishery officers of Department of Fisheries, Govt. of Arunachal Pradesh during February 2019.
- Farm advisory on "Renovation of Carp fish ponds" was conducted on 3rd May, 2019 at Kotwali Campus, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh, Mr. Ravinder Kumar and Mr. Hansa Datt conducted and coordinated the program.

Sampling of water quality parameters of river Siang for GIS interpolation maps

Sampling of size catch of brown trout at river Yargyap chu

- Field day on "Pond preparation and seed stocking" was organized on 4th May, 2019 at VIP residential area, Chhatar, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh, Mr. Ravinder Kumar and Mr. Hansa Datt conducted and coordinated the program.
- Field day on "Fish and plankton collection for assessing biodiversity of river Ladhiya" was organized on 18th May, 2019 at river Ladhiya, Chalthi, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh and Mrs. Pragyan Dash conducted and coordinated the program.
- Field visit to Government Trout Fish Farm, Dhamwari, Shimla District, Himachal Pradesh by Dr. R.S. Haldar with Dr. Amit Pande (ICAR National Fellow) on 1st June, 2019 and collected fish diseased samples under the disease surveillance programme.
- Field visit to Bagi village to conduct a baseline survey at the confluence of river Ganga

Release of ornamental fishes in garden pool

Fish germplasm collection at river Ladhiya

Exploratory visit to Harish Tal by scientist and interaction with local residents

and Nayar to determine the possibilities of promotion of mahseer angling for recreation and generating avenues for local Scheduled Caste population. The programme was jointly conducted by ICAR-DCFR team comprised of Dr. Deepjyoti Baruah, Sr. Scientist; Mr. Ravindra Posti, YP-II in association with Mr. Abhishek Mishra, Sr. Fishery Inspector of Department of Fisheries, Govt. of Uttarakhand during 16-17th June 2019.

- Exploratory visit was undertaken by Dr. Suresh Chandra, Principal Scientist and Shri S K Mallik, Scientist on 6th July, 2019 to an unexplored remote lake of Harish Tal situated in Okhalkanda block of Nainital District at an altitude of 4315 feet above sea level. The local residents around the lake were interacted and their issues were noted. Water samples were also collected for laboratory analysis. The potentiality of harnessing the lake for fisheries development and generating avenues was assessed by the visiting scientist.

Collection of data from SC trout growers of Chamoli district under SCSP

- Awareness programme on "Polyculture of carps in midhills and its prospects" was conducted on 9th July, 2019 at Village Mudiyani, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh, Mr. Ravinder Kumar, Mr. Hansa Datt and Mr. T M Sharma conducted and coordinated the program.
- Field visit was conducted by Dr. R.S. Haldar, ACTO to Mr. Jagat Ram, the only trout grower at Ramgarh area, Nainital District on 10th July, 2019 to monitor the growth pattern of rainbow trout reared in two raceways. The water quality was also analysed and advisory was given to him regarding the best management practices for trout farming.
- Farm Advisory on "Soil and water quality analysis" was conducted on 11th October, 2019 at Salli village, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh and Mr. Ravinder Kumar conducted and coordinated the program.
- Field day on "Balanced fertilizer and manure application in carp ponds at mid-hills" was organized on 25th October, 2019 at Chaukuni Bora village, Champawat. Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, Dr. Raghvendra Singh and Mr. Hansa Datt conducted and coordinated the program.
- Exploratory visit was conducted by a team of scientist, Mrs. Pragyan Dash, Mr. Ritesh Tandel, Mr. Kishor Kunal and Dr. Raghvendra Singh to Chalthi and Ladhia river at Champawat with an aim to collect live ornamental fishes for germ

plasm conservation, and carrying out seasonal sampling for *Barilius vagra* fish. Several varities of ornamental fishes viz. *Schistura* sp., *Glyptothorax* sp., *Barilius* sp., Macrognathus sp., Garra sp., dark mahseer and snow trout were collected during 2019 and maintained at Experimental Fish Farm and Aquarium unit of Bhimtal.

- Field adaptation trial was conducted for rainbow trout at Ramgarh, Uttarakhand and regular farm advisory and inputs were given to farmer Mr. Jagath Singh by Rajesh M and Biju Sam Kamalam, Scientists of ICAR-DCFR.
- Provided technical advices on coldwater fish farming and health management by Dr. Suresh Chandra, Principal Scientist to 350 fish farmers, entrepreneurs, students through mobile calling, WhatsApp and SMSs.

Trout farm of Mr. Jagath Singh at Ramgarh

- Field day was organized by Dr. S. Chandra, Principal Scientist by visiting Alchauna village, Uttarakhand on 12th September 2019 by demonstrating on techniques of fish pond manuring, stocking, feeding and health and hygiene maintenance during culture period.
- Field visit by Dr. S. Chandra, Principal Scientist to the trout hatcheries of Himachal Pradesh to address the problem of non-fertility in rainbow trout eggs followed with submission of a report with effective measures.
- Field visit by Dr. S. Chandra, Principal Scientist at Kosi Katarmal to provide necessary advices in developing a new fish pond.
- Farm advisory by Dr. S. Chandra, Principal Scientist to ICAR-IVRI on developing a fish hatchery.
- On-field awareness programme held on AMR in Udhamsingh Nagar district, Uttarakhand on 15th October, 2019 by ICAR-DCFR, Bhimtal, Nainital, Uttarakhand. The programme was coordinated by Mr. S K Mallik, Scientist & Project investigator and Dr. Neetu Shahi, Scientist & Co-Project investigator, ICAR-FAO Network Project on Antimicrobial Resistance in Fisheries.
- Technical support was provided by ICAR-DCFR in transporting improved variety of rainbow trout eyed ova imported from Denmark to Bairangana trout hatchery, Chamoli, Uttarakhand. A team of scientist including Dr. Suresh Chandra and Mr. Siva, C visited the Bairangana hatchery during 11-17th November, 2020 and briefed the hatchery managers and operators of the Department of Fisheries, Govt. of Uttarakhand on the healthy hatchery management and larval rearing practices.
- Exploratory survey was conducted in Roing area by Dr. Deepjyoti Baruah, Sr. Scientist alongwith Mr. P.A. Ganie, Scientist and Mr. Ravindra Posti, YP-II and Dr. R.S. Haldar, ACTO in two separate occasions in the month of February 2019 and November 2019 respectively with an objective to promote mahseer farming in the State. The survey was done alongwith Mr. Nabam Tania, District Fisheries Development Officer; Ms. Kime Janu, Fisheries Inspector and Ms. Neriyong Jamoh, Fisheries Inspector, Block Office, Lower Dibang Valley District, Roing Arunachal Pradesh. Several Government and private fish farms, recreational lakes and

tanks were visited to aware the stakeholders in developing mahseer fishery for their benefit, economic upliftment and livelihood security.

- Field survey was conducted to villages Dorgeeling, Lhallung of Menchukha valley, Shi Yomi district of Arunachal Pradesh by Dr. Deepjyoti Baruah, Sr. Scientist alongwith Mr. J. Taba, Director of Fisheries and other Deputy Directors, Assistant Directors and District Fishery Development Officers of Department of Fisheries, Govt. of Arunachal Pradesh to select suitable sites for establishment of rainbow trout raceways and ova house. The visit was conducted during November 2019.

Advisory to the fishery officers on mahseer hatchery operational practices

Discussion on water facilties with the fishery officers of Lower Dibang valley

- Exploratory survey was conducted by Dr. R.S. Haldar in Hosangabad district of Madhya Pradesh for collection of live fish seed of *Tor tor* from river Narmada in collaboration with Madhya Pradesh Fisheries Federation, Govt. of Madhya Pradesh during the 1st week of December 2019. Later, 250 numbers of *Tor tor* fry of 20-25mm in size were collected from the river and were stocked in the nursery tank of Madhya Pradesh Fisheries Federation Fish Seed Farm, Powarkheda, Hoshangabad for further rearing to conserve and propagate the fish.

Water sample analysis at Menchukha valley for rainbow trout farming

Field visit to Bagi village at the confluence of river Ganga and Nayar for mahseer angling

- Field visit was conducted to trout hatcheries at Bairangana and Talwari of Chamoli district, Uttarakhand during 16-19th December 2019 with an objective to select Scheduled Caste trout growers for implementation of SCSP activities in collaboration with Department of Fisheries, Govt. of Uttarakhand. The visit was coordinated by Dr. Deepjyoti Baruah, Sr. Scientist and Mr. Ravindra Posti, YP-II alongwith Mr. Jagdamba Kumar and Mr. Kanak Shah, Fisheries Officers.
- Exploratory survey to river Dirang, Sangti, Tenga and Choskhorong kho in West Kameng district of Arunachal Pradesh by Dr. Deepjyoti Baruah, Sr. Scientist; Mr. K. Kunal, Scientist; Mr. P.A. Ganie, Scientist during 2019 to investigate on the snow trout composition and to analyse other biological details. Abiotic and biotic components of water was studied seasonally for each drainage.
- Field visit to Joginder nagar, Kullu and Patlikuhl, Himachal Pradesh by Dr. M. S. Akhtar and Dr. Ciji Alexander for rainbow trout sample collection and ecophysiological studies under the NICRA project during 3-9th June, 2019.

7.4 Participation in exhibitions

Succession of seminar, symposia, workshop, conference and kisan mela were participated to display and exhibit the research and developmental activities of the Directorate. Various stakeholders viz., scientists, farmers, students, academicians, entrepreneurs from different regions, localities and institutes were benefited. The details of the programmes participated by ICAR-DCFR are mentioned in the Table below:

Name of the programme	Organizer	Duration	Place/venue
Goral Mahotsav	Nagarpalika Parishad, Champawat	10-15th June 2019	Champawat
International Conference Asia Pacific Aquaculture (APA-2019)	World Aquaculture Society (WAS), Asian Pacific Chapter in association with Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU)	19-21st June, 2019	Chennai Trade Centre, Chennai, Tamil Nadu
Kisan Mela and Gosthi on Jal Shakti Abhiyan -2019	Krishi Vigyan Kendra, Jeolikote, Nainital (Uttarakhand)	3rd September, 2019	ICAR-DCFR, Bhimtal
National Symposium on Coldwater Fisheries Development in India: Innovative Approaches and Way Forward for Enhancing Hill Farmers Income	ICAR-DCFR, Bhimtal in collaboration with Coldwater Fisheries Society of India	24-25th September, 2019	ICAR-DCFR, Bhimtal
106th Pantnagar Kisan Mela & Agro-Industrial Exhibition	Govind Ballav Pant University of Agriculture & Technology, Pantnagar	27-30th September, 2019	GBPUAT, Pantnagar
Kisan Mela	ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora	15th November, 2019	ICAR-VPKAS Experimental Farm, Hawalbagh
4th PAF National Congress on Increasing Aquaculture Production in India through Synergistic Approach Between Multinational Industries, Domestic Enterpreneurs and Aquaculturists	ICAR-Central Institute of Freshwater Aquaculture in collaboration with Association of Aquaculturists (AoA) and Pillay Aquaculture Foundation (PAF)	15-17th November, 2019	ICAR-CIFA, Bhubaneswar
International Conference "AQUABE 2019 - Aquatic resources and blue economy"	Kerala University of Fisheries & Ocean Studies, Kochi	28-30th November, 2019	Cochin, Kerala
Conference on One Health & Ecosystem Services (OHES-2019)	ICAR-National Bureau of Fish Genetic Resources and Academy of Environmental Biology in collaboration with Aquatic Biodiversity Conservation Society (ABCS), India	29-30th November, 2019	ICAR-NBFGR, Lucknow
Conference on Ecosystem Health & Fisheries of Indian Inland Waters: Multiple Stressors, Management & Conservation	Inland Fisheries Society of India (IFSI), Barrackpore in collaboration with College of Fisheries, GBPUAT, Pantnagar; Aquatic Ecosystem Health & Management Society, Canada; ICAR-CIFRI, Barrackpore and Professional Fisheries Graduates Forum (PFGF)	17-19th February, 2020	GBPUAT, Pantnagar

Dr. J.K. Jena, DDG (Fy. Sc.), ICAR during APA-2019

Exhibition and sale of fish processed products Goral Mahotsav, Champawat

Dr. K.K.Vass, Former Director, ICAR-CIFRI & ICAR-DCFR with dignitaries during National Symposium at Bhimtal

7.5 Visitors

7.5.1 Farmer visits

- A group of 18 fish farmers along with two Veterinary Officers from the Department of Animal Resources Development, Govt. of West Bengal, Krishnagar, Nadia district, West Bengal visited ICAR-DCFR, Bhimtal during 19-20th July, 2019 under ATMA scheme for their exposure on coldwater aquaculture. They interacted with scientists and discussed their problems and remedies also.

Shri Ram Singh Kera, Hon'ble MLA, Bhimtal during Jal Shakti Abhiyan-2019

Students visit to stall during "AQUABE 2019 " at Kochi

Interaction with progressive fish farmers from Krishnagar, West Bengal during their exposure visit

7.5.2 Students visits

International Students

- A group of 16 French students (DEFIAA Consortium, French Ministry for Food, Agriculture and Forestry) along with three Faculty members from G. B. Pant University of Agricultural Science & Technology, Pantnagar, Uttarakhand visited ICAR-DCFR, Bhimtal during 12-13th August, 2019 and interacted with scientists.
- A group of 16 students (08 boys & 08 girls) of B.Sc. (Fisheries) 7th Semester along with two Faculty members from the Agriculture and Forestry University, Deptt. of Animal Science, Veterinary Science and Fisheries, Rampur, Chitwan, Nepal visited ICAR-DCFR, Bhimtal during 10th December, 2019 and interacted with scientists.

Indian Students

- A group of 12 students of Govt. Senior Secondary School Salli, Champawat visited EFF, Champawat on 5th February, 2020.
- A group of 28 students of Govt. Higher Secondary School, Phungar, Champawat visited EFF, Champawat on 14th February, 2020.
- A group of 57 students of Govt. Inter College, Dayartoli, Champawat visited EFF, Champawat on 15th February, 2020.
- A group of 113 students of GIC, Chaumel, Champawat visited EFF, Champawat on 17th February, 2020.
- A group of 100 students of GIC, Pullhindola, Champawat visited EFF, Champawat on 17th February, 2020.
- A group of 45 students of GIC, Manch, Champawat visited EFF, Champawat on 18th February, 2020.
- A group of 10 students of Govt. Inter College, Digalichaur, Champawat visited EFF, Champawat on 18th February, 2020.
- A group of 140 students of Govt. Girls Inter College, Champawat visited EFF, Champawat on 18th February, 2020.
- A group of 09 (01 boys + 08 girls) Post graduate students (IV Semester, M.Sc. Zoology, Fish & Fisheries Science specialization) from Department of Zoology, D.S.B. Campus, Kumaun University, Nainital, Uttarakhand visited ICAR-DCFR, Bhimtal on April 05, 2019 and interacted with scientists.
- A group of 10 (04 boys + 07 girls) Post graduate students (IV Semester, M.Sc. Zoology, Fisheries Science & Aquaculture specialization) along with one Ph. D. girl student and two faculty members from Department of Zoology, Aligarh Muslim University, Aligarh-202002, Uttar Pradesh visited ICAR-DCFR, Bhimtal on 16th April, 2019 and interacted with scientists.
- A group of 31 (07 boys + 24 girls) Post graduate students (IV Semester, M.Sc. Zoology, Fish & Fisheries Science specialization) along with two faculty members from Deptt. of Zoology, Kumaun University, Almora Campus, Uttarakhand visited ICAR-DCFR, Bhimtal on 19th April, 2019 and interacted with scientists.
- A group of 59 Third year B.Sc. (Ag) students (33 boys + 26 girls) along with two faculty members from RMD College of Agriculture & Research Station, Indira Gandhi Krishi Vishwavidyalaya, Ambikapur, Surguja, Chhatishgarh visited ICAR-DCFR, Bhimtal during 3rd May, 2019 and interacted with scientists.
- A group of 26 B.F.Sc. 3rd Year students (12 boys +14 girls) along with two faculty and one staff member from College of Fishery Sciences, Sri Venkateswara Veterinary University, Muthukur-524 344, SPSR Nellore district, Andhra Pradesh visited ICAR-DCFR, Bhimtal during 6-8th July, 2019 and interacted with scientists.
- A group of 65 students of Class IX along with three faculty members from Woodbridge School, Sattal Road, Dob Lewshal, Bhowali, Nainital district, Uttarakhand visited ICAR-DCFR, Bhimtal on 31st July, 2019 and interacted with scientists.

- A group of 44 B.Sc. (Ag) students along with two faculty members from Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi, Jharkhand visited ICAR-DCFR, Bhimtal during 20-21st August, 2019 and interacted with scientists.
- A group of 33 students of B.Sc. Zoology (Hons.) First year & Second year with two faculty members from Department of Zoology, Hindu College, University of Delhi, Delhi visited ICAR-DCFR, Bhimtal on 29th November, 2019 and interacted with scientists.
- A group of 11 Officers from Department of Land Reforms, Govt. of Nagaland visited ICAR-DCFR, Bhimtal during 1st October, 2019 and interacted with scientists.
- A group of 25 students (15 boys + 10 girls) of B.Sc. Zoology First year & Third year with two faculty members from Department of Applied Science, Invertis University, Bareilly, Uttar Pradesh visited ICAR-DCFR, Bhimtal on 3rd October, 2019 and interacted with scientists.
- A group of 55 B.V.Sc & A.H. Final Year students (40 boys + 15 girls) along with two faculty members from College of Veterinary Science, Maharashtra Animal and Fishery Post Graduate Institute of Veterinary Education and Research (PGIVER), Agra Road, Jamdoli, Jaipur, Rajasthan visited ICAR-DCFR, Bhimtal during 18th October, 2019 and interacted with scientists.
- A group of Second year & Third year B.Sc. (Zoology) students along with two faculty members from Department of Zoology, SGTB Khalsa College, North Campus, University of Delhi visited ICAR-DCFR, Bhimtal on October 21th, 2019 and interacted with scientists.
- A group of 39 students (15 boys + 24 girls) of B.F.Sc. Third year along with two faculty members from College of Fisheries, Babasaheb Sawant Konkan Krishi Vidyapith, Shirgaon, Ratnagiri, Maharashtra visited ICAR-DCFR, Bhimtal during November 27th, 2019 and interacted with scientists.
- A group of 116 Primary section students along with four faculty members from Mallikarjun School, Bohrakun, Bhimtal, Nainital district, Uttarakhand visited ICAR-DCFR, Bhimtal on November 14th, 2019 and interacted with scientists.
- A group of 45 students of class VIII along with two faculty members from Azim Premji School, Word No. 3, Dineshpur, Udham Singh Nagar, Uttarakhand visited ICAR-DCFR, Bhimtal on 29th November, 2019 and interacted with scientists.
- A group of 12 students (06 boys + 06 girls) of B.F.Sc. 4th year along with two faculty members from College of Fisheries, Guru Angad Dev Veterinary and Animal Science University (GADVASU), Ludhiana, Punjab visited ICAR-DCFR, Bhimtal during 11-14th December, 2019 and interacted with scientists.
- A group of Third year B.Sc. (Zoology) students along with two faculty members from Department of Zoology, Hooghly Women's College (Affiliated to Burdwan University), Hooghly, West Bengal visited ICAR-DCFR, Bhimtal on 17th December, 2019 and interacted with scientists.
- A group of 80 students of Class IX and Class XI along with two faculty members from Govt. Inter College, Padampuri, Nainital district, Uttarakhand visited ICAR-DCFR, Bhimtal on 20th December, 2019 and interacted with scientists.
- A group of 29 students (15 boys + 14 girls) of B.F.Sc. 3rd year along with two faculty members from College of Fisheries, Chhattisgarh Kamdhenu Vishwavidyalaya, Kawardha, Kabirdham, Chhattisgarh visited ICAR-DCFR, Bhimtal on 30th December, 2019 and interacted with scientists.
- A group of students of Maneshwar Public School, Lohaghat visited Experimental Fish Farm, Champawat on 20th December, 2019.

Visit of French students

Interaction of French students with scientists

Visit of students from Nepal to ICAR-DCFR

Visit of officers from Nagaland

Visit of B.Sc. (Zoology) students from Hooghly Women's College, West Bengal

Visit of Class IX and Class XI students from Govt. Inter College, Padampuri, Uttarakhand

Visit of In-service trainees from ICAR-CIFE, Kolkata Centre

7.6 Preparation of Documentary Film

ICAR-DCFR produced a documentary Film on "DCFR profile and its role" in association with the ICAR approved firm M/s. Nepathya Communications, New Delhi. The documentary film illustrates the comprehensive history of the Directorate, the existing facilities at Bhimtal and Experimental Fish Farm, Champawat; the functioning of various laboratories; operation of coldwater fish hatcheries; aquarium and the outreach and extension programmes undertaken across the country.

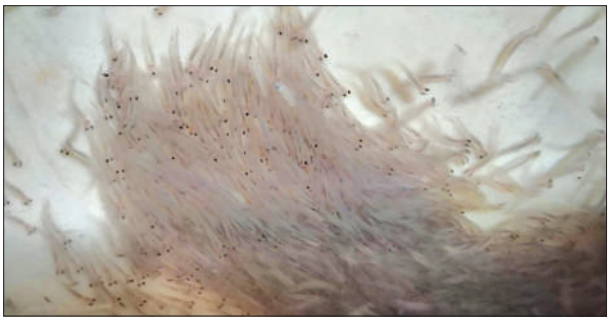
Coldwater Fish Breeding and Farm Production

8

8.1 Breeding and seed production of golden mahseer, *Tor putitora* (Hamilton, 1822)

Breeding and seed production from wild-caught golden mahseer, *Tor putitora* was successfully carried out at mahseer hatchery complex of ICAR-DCFR, Bhimtal during July to September, 2019. About 25000 nos. of eggs were stripped out from the matured female brooders collected from Bhimtal lake, which were then fertilized with milt by the stripping of mature males. The fertilization and hatching rates were 85-90% and 90-92% respectively. The incubation period was 88-96 hrs at water temperature 21.6 - 23.4^{0}C. The water flow was maintained @ 1-2 Lit./min and @ 3-4 Lit./min during incubation and rearing of fry respectively. Total 20000 nos. of golden mahseer fry were produced. On the other hand, multiple breedings and seed production of golden mahseer matured in captive conditions through photothermal manipulations were also done through the months of June to November (5 batches) and striped a total of 46200 eggs from just 3 small maturation tanks. Fertilization rate of 82-86 %, hatching rate of 75 -80 % and 78-83 % survival rate (till 3 months after hatching) was achieved. The nursery rearing was done in the flow through hatchery. Five thousand numbers of fry were sold to Dept. of Fisheries, Pauri, Uttarakhand and generated a revenue of Rs. 50,000.00 Around 5000 numbers of eggs and fry were used for different research purpose of the Directorate. The remaining fries were stocked into the nursery pond of the Mahseer Hatchery Complex of the Directorate to raise them into yearlings/ juveniles. The entire activities were coordinated by Dr. M. S. Akhtar.

Captive matured golden mahseer fertilized eggs keeping for incubation



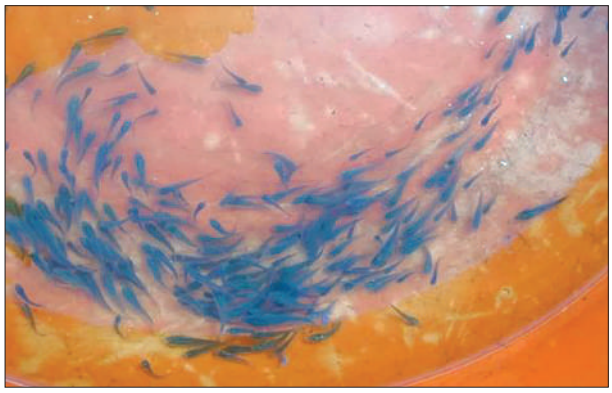
Larvae produced from captive matured golden mahseer

8.2 Breeding of improved strains of common carp

Hungarian strains of common carp 'Ropsha scaly' and 'Felsosomogy mirror carp' are very important candidate fish in mid Himalayan region and widely practiced in polyculture cement tanks/ ponds owing to hill geomorphological features and lower thermal regime. These species were found more suitable for hill farming due to their fast growth and wide temperature tolerance (5-32°C). The species spawn twice during a year, i.e. March-May and July-August. Breeding and seed production of improved strains of common carp was carried out at Experimental Fish Farm, Champawat following old conventional hapa breeding method without hormone administration. Egg were collected using plastic twines extracted from unused plastic sacks. About 150-200g of twines were used per kg of female for collection of eggs. Sex ratio was kept 1.0-1.5:1.0 (Male:Female) by weight. Fertilized eggs were adhesive, pale yellowish in colour and have diameter ranging from 1.4-2.5 mm. Recorded

fecundity was about 0.5-1.0 lakh eggs/kg body weight. Hatching takes place after 80-110 hrs post fertilization and yolk absorption takes place within 72-96 hrs at 18-22°C. The survival percentage of egg to spawn and spawn to fry was found 45-50% and 30-35%, respectively. One hundred eighty seven numbers of female brooders of size range 234 g to 412 g were deployed for breeding and about 4.05 lakhs fry (15dph) were produced. The whole breeding program was coordinated by Mr. Kishor Kunal, Mr. P.A.Ganie and Dr. Raghvendra Singh.

Breeding hapas for seed production of common carps



Farm raised young ones of common carp

8.3 Seed production and rearing of rainbow trout

Breeding, seed production and culture of rainbow trout has been an important activity at the Experimental Fish Farm. The farm rears more than 600 adult rainbow trout in raceway systems. 49000 numbers of fertilised eggs of size ranging from 4.1-4.7 mm with yellow-orange colour were produced from a total of 15 numbers of female (wt. range: 1880- 3678 g) and 38 males (wt. range: 1720-3121 g). Recorded fertilization rate, incubation period,

Stripping of female brooders

Farm raised trout fingerlings

hatching rate, yolk sac absorption time and survival rate was 91-94%, 56-65 days, 84 %, 17-22 days and 78% respectively. Around 20000 numbers of swim-up fry were produced during the breeding cycle. The activities of seed production and rearing of rainbow trout were coordinated by Mr. Kishor Kunal, Mr. Parvaiz Ahmad Ganie, and Dr. Raghvendra Singh.

8.4 Marketing and distribution of farm raised fish seeds

Experimental Fish Farm raised rainbow trout weighing 100-200g on average were sold to different fish farmers, government and private agencies generating a revenue of Rs. 6600.00 (Rupees six thousand six hundred only). Also, more than 17000 nos. of common carp fingerlings raised at the farm were sold and distributed to different fish farmers,

Fish seed sale and distribution to farmers from EFF, Champawat

government and private agencies generating a revenue to the tune of Rs. 22185.00 (Rupees twenty two thousand one hundred eighty five only). Furthermore, the seed of ornamental fishes reared at farm were also distributed to fish growers of the region in different farmer oriented programmes.

8.5 The Himani aquarium

The Himani aquarium unit of ICAR-DCFR is maintaining indigenous ornamental fishes including mahseers viz., *Tor putitora*, *Neolissochilus hexagonolepis, Naziritor chelynoides*; hill trouts viz., *Barilius bendelensis, Barilius vagra*; loaches viz., *Schistura beavani, Schistura obliquofascia, Botia dario, Botia kubotai, Botia almorhae*; algae eaters viz., *Garra annandalei, G. lamta, G. gotyla,* and *G. birostris.* Several exotic fish varieties viz., *Carassius auratus, Astronotus ocellatus, Scarus psittacus, Cyprinus carpio*, *Osphronemus gourami, Poecilia reticulata* are also maintained.

8.6 Cage culture of exotic carps at Bhimtal lake

Grass carp fry of 15-20 mg were stocked in cages at Bhimtal lake by ICAR-DCFR with a stocking density of 500 pieces (set 1), 750 pieces (set 2) and 1000 pieces (set 3) per sq. m area. Regular cleaning, feeding with pelleted feed, water quality monitoring was accomplished with an objective to study the growth and survival of grass carp and silver carp fry in coldwater regimes having water temperature below 23°C. Water temperature, DO, pH, iron, alkalinity, calcium, nitrate and nitrite of the water of the experimental tanks ranged in between 18.8 to 23.9°C, 6.0 to 6.72 mg L^{-1}, 7.2 to 7.4, 0-0.3 mg L^{-1}, 60-70 mg L^{-1}, 55-70 mg L^{-1}, 10 to 40 mg L^{-1} and 10 to 25 mg L^{-1} respectively. Grass carp fry has grown to 9.2 ± 2.01g to 12.0 ± 4.52 g in set 1; 7.2 ± 1.3g to 7.3 ± 2.25g in set 2 and 3.13 ± 1.13g to 4.33 ± 0.82g in set 3 in a period of 8 months of culture. The silver carp stocked @100 per sq. m attained an average weight of 75.17 ± 5.098g with survival of 47-55%. Any occurrence of diseases in the caged fishes were mitigated with suitable remedies.

Cage culture at Bhimtal lake

Healthy grass carp fingerlings in cages

8.7 Fish sell at ICAR-DCFR, Bhimtal

ICAR-DCFR farm produced table-sized carps weighing 105.5kg were sold @ Rs. 120/kg during May-June, 2019 and generating a revenue of Rs. 12,660.00. Dr. N.N. Pandey, Dr. R.S. Patiyal and Mr. A.K. Giri coordinated the sale proceed as the committee members.

Tribal Sub Plan (TSP) Activities

9

The Directorate has undertaken various activities in the states Uttarakhand and Ladakh (Leh) and North East region as a means of livelihood security of rural tribal farmers during the reporting period. Critical inputs as well as trainings were imparted under TSP programme to promote hill aquaculture in high Himalayan region. The detailed activities under taken are listed hereunder.

9.1 Input distribution at Munsiyari, Uttarakhand

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal disseminated the culture techniques of rainbow trout farming among the farming clusters of Munsiyari, Pithoragarh district, Uttarakhand. Extension activities was conducted and inputs in the form of rainbow trout seed, feed and fishing nets were distributed to the farmers of remote tribal village- Sarmoli and Jaitee, Munsiyari, Pithoragarh for their livelihood development on 20th July 2019 in presence of Block Development Officer, Munsiyari.

Input distribution to the farmers of Munsiyari and trout seed stocking in presence of Block Development Officer, Munsiyari

Trout and ornamental fish culture in Munsiyari

9.2 Awareness cum Interaction meet at Dharchula

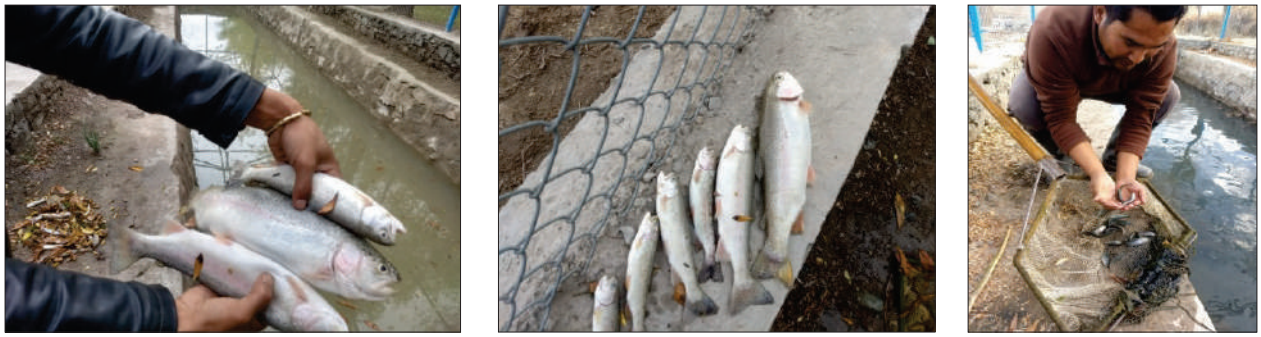
Awareness cum interaction meet was organised at Pangu village, Dharchula block, Pithoragarh district, Uttarakhand on 6-7th October 2019 which was participated by 27 fish farmers from nearby villages such as Ronto and Himkhola. The queries raised by the farmers were addressed on the spot by the experts and later the farmers were advised for attending such exposures by means of training and by keeping telephonic contacts. During the programme seeds of ornamental fishes, carp feeds, polythene lines, $KMnO_4$, fishing nets were distributed to farmers.

9.3 Distribution of critical inputs to farmers of Uttarakhand

- 4500 nos. of rainbow trout fry were stocked in 2nos. of farmer's raceways as well as distribution of rainbow trout feed at village-Sarmoli, Munsiyari, Pithoragarh district. Along with these, 100 nos. of ornamental fish seeds were distributed to 2 farmers of the area in the month of April 2019.
- Stocked 1500 nos. of rainbow trout fingerlings in raceways of 2 farmers, and distributed rainbow trout feed, hand nets, hapas and fishing nets to 3 farmers of village-Sarmoli, Munsiyari, Pithoragarh district in the month of July 2019.
- Distribution of carp and trout seed to 3 farmers, ornamental seed to 1 farmer, fish therapeutics to 4 farmers and polythene, fishing net to 4 farmers of Sarmoli and Jaitee village of Munsiyari, Pithoragarh during month of October 2019.
- 5000 numbers of ornamental seeds of koi carp and gold fish produced at ICAR-DCFR Bhimtal were distributed to progressive ornamental fish farmers.
- Carp seed, ornamental seed, fish therapeutics, polythene lines, fishing net, hand nets, bird net were distributed to 5 farmers of Munshiyari village, Pithoragarh in the month of December 2019.
- In the month of March 2020, training cum capacity building program was organized for 15 farmers followed with an exposure visit at Pantnagar for 10 farmers and distribution of 2000 carp seed to 5 farmers, 200 nos. ornamental seed to 1 farmer of villages Tharutisor and Amrupur, Nanakmatta, Udhamsingh nagar.

9.4 Demonstration on rainbow trout farming at Leh

ICAR-Directorate of Coldwater Fisheries Research (DCFR), Bhimtal has initiated demonstration of trout culture practises by forming clusters at Chushout Shamma village of Chushout, Leh. 3000 numbers of healthy seeds of rainbow trout was stocked in the village with continuous technical support from ICAR-DCFR. Critical inputs such as feed and seeds were provided in the month of December 2019. Field day was conducted to demonstrate the harvest of the farm produce. Success in trout farming was achieved by Mr. Juber with a sale of Rs.1.68 Lakh from his farm reared trout.



Market sized rainbow trout at farmers' field, Leh

9.5 Initiation of mahseer fisheries development in Northeast region

Establishment of a mahseer flow through hatchery is under progress for the socioeconomic development of tribal farmers in the state of Arunanchal Pradesh and Nagaland.

10 North East Hill (NEH) Activities

Research and Developmental activities have been carried out in the states of Northeast namely Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim and Nagaland under the NEH programme and the details of which are enlisted hereunder;

10.1 Promotion of rainbow trout farming in Nagaland

10.1.1 Establishment of trout hatchery at Nagaland

ICAR-DCFR, Bhimtal in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland established the first ever a trout hatchery at Dzuleke village, Kohima, Nagaland with an objective to produce quality seed of rainbow trout. The trout hatchery was inaugurated on 13th May, 2019 by Shri Senti Ao (IAS), Commissioner & Secretary, Deptt. of Fisheries & Aquatic Resources, Govt. of Nagaland in presence of Prof. R. C. Nayak, Pro Vice Chancelor, Nagaland University (A Central University); Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal; Mr. Kevisa Kense, Director, Deptt. of Fisheries & Aquatic Resources, Govt. of Nagaland; Shri Rongsennungba, Additional Director; Mr. Lotimenba, Joint Director; Mr. Neitho-o Kuotsu, Dy. Director; Shri Ketusielie Angami, Dy. Director; Mr. Wabang, Fy Demonstrator; Officials from Engineering Wing; Deptt. of Fisheries & Aquatic Resources, Govt. of Nagaland; Mr. Nava Gogoi, Chief Managing Director, Jasingfaa Aqua Tourism Centre; Dr. Pranay Pallav, Asstt. Professor, Nagaland University; Mr. Vitsiepielie, Village Chairperson, Dzuleke with Fisheries Departmental officers and fish farmers and local villagers from the village Dzuluke, Khonama, Mezama, Phesama, Jakhama, Kigwema, Mima etc. were present during the programme. ICAR-DCFR further supported in transporting 1.0 lakh rainbow trout eyed ova to the newly constructed trout hatchery at Dzuleke village, Kohima, Nagaland from Department of Fisheries, Government of Jammu and Kashmir on 14th February, 2019. The hatched over 3000 fingerlings is now being reared in the newly constructed three trout raceways after considering all the mortality rates since hatching. Dr. R. S. Haldar, ACTO and Nodal Officer, NEH activity coordinated the programme.

Inauguration of rainbow trout hatchery complex by Shri Senti Ao (IAS), Commissioner & Secretary, Deptt. of Fisheries & Aquatic Resources, Govt. of Nagaland

Briefing on the rearing of rainbow trout fry in FRP tanks to the dignitaries

Discussion on rainbow trout breeding and hatchery operation

The rainbow trout hatchery complex at Dzuleke, Nagaland

10.1.2 Establishment of trout brooder raceways at Nagaland

Three numbers of trout raceways were established to rear quality brooders of Rainbow trout at Dzuleke village, Kohima district by ICAR-DCFR, Bhimtal in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland. The trout raceways were inaugurated on 13th May, 2019 by Shri Senti Ao (IAS), Commissioner & Secretary, Deptt. of Fisheries & Aquatic Resources, Govt. of Nagaland in presence of Prof. R. C. Nayak, Pro Vice Chancelor, Nagaland University (A Central University); Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal; Shri Rongsennungba, Additional Director; Department of Fisheries & Aquatic Resources, Nagaland Govt. etc. After inauguration of the raceways the Hon'ble Secretary with the dignitaries released rainbow trout fingerlings (40 mm in size) in the raceways for further rearing. The rainbow trout attained a growth of about 250-300 mm in size and 350-500 g in weight after rearing of 10 months period. It is also mentioned that another three raceways is under construction near the area in Nagaland.

Functioning of rainbow trout raceways at Dzuleke, Nagaland

Stocking of rainbow trout advanced fry in trout raceways at Dzuleke, Nagaland by the dignitaries

Rearing of rainbow trout advanced fry in FRP tanks

Sizable growth of rainbow trout yearlings reared in trout raceways

10.2 Facilitating captive breeding of mahseer in Nagaland

ICAR-DCFR has established a mahseer hatchery at village Suteplenden (Longkong), Mokokchung district of Nagaland in collaboration with the Department of Fisheries & Aquatic Resources, Govt. of Nagaland under NEH activity. Successful breeding and seed production of pond reared golden mahseer as well as chocolate mahseer was carried out under captivity in the month of September, 2019 for the second time in the state in order to promote their aquaculture practices

and further conservation and rehabilitation of the state fish of Nagaland. Altogether, 2 pairs of golden mahseer and 4 pairs of chocolate mahseer were bred resulting into production of 3000 numbers of fertilized eggs of golden mahseer and 7000 numbers of chocolate mahseer. The hatching was done in the newly established mahseer hatchery in FRP tanks and later 3000 numbers of fingerlings were stocked in the earthen rearing ponds of the hatchery complex for further development as brood stock. The facility created is expected to help in the conservation and rehabilitation of the species through ranching in the natural water bodies as well as for the development of aquaculture program in the state. Dr. R. S. Haldar, ACTO and Nodal Officer, NEH activity coordinated the programme with the fisheries officers of Department of Fisheries & Aquatic Resources, Govt. of Nagaland.

Collection of Mahseer brooder at Suteplenden (Longkong), Mokokchung, Nagaland

Mahseer brooders netted out from the brood pond

Examination of mahseer brooders for stripping

Swim up fry of mahseer in FRP rearing troughs

10.3 Conservation initiatives of mahseer in Nagaland

1000 fingerlings of mahseer were stocked in Doyang reservoir, Nagaland for conservation and rehabilitation of the mahseer species on 5th December, 2019 as a part of National Hornbill Festival of the State. The fingerlings were produced by captive breeding of mahseer in the hatchery complex established at Suteplenden village (Longkong), Mokokchung district of Nagaland during September, 2018. The programme was coordinated by Dr. R.S. Haldar, ACTO and Nodal Officer, NEH activity of this Directorate.

Collection of mahseer yearlings from earthen rearing ponds

Release of hatchery reared mahseer fry in Doyang Reservoir, Nagaland

10.4 Strengthening of trout hatchery at Shergaon, Arunachal Pradesh

Technical and financial support has been provided to the Department of Fisheries, Govt. of Arunachal Pradesh for renovation and maintenance of trout hatchery facilities at Government Trout Farm, Shergaon, West Kameng district, Arunachal Pradesh. The hatchery is expected to produce quality seeds of rainbow and brown trout for horizontal expansion of trout farming in the state on a scientific manner. The programme was coordinated by Dr. R.S.Haldar, ACTO and Nodal Officer, NEH activity of this Directorate in coordination with the fisheries officers of Department of Fisheries, Govt. of Arunachal Pradesh.

The trout farm at Shergaon, West Kameng district, Arunachal Pradesh

Provision of FRP tanks, troughs and trays to Government trout farm at Shergaon

10.5 Provision of ICAR-DCFR formulated trout feed

ICAR-DCFR formulated starter feed of rainbow trout has been provided to Government Trout Farm, Shergaon, Arunachal Pradesh for better growth and survival of the rainbow trout fry at the farm. Similarly 200 kg of ICAR-DCFR prepared grow-out feed of rainbow trout has been provided to the Department of Fisheries & Aquatic Resources, Government of Nagaland for rainbow trout stocks at Dzuleke, Kohima district for better productivity per unit area. Both the programmes were coordinated by Dr. R.S. Haldar, ACTO and Nodal Officer, NEH activity of this Directorate.

10.6 Fish diversity studies in Northeast region

ICAR-DCFR has initiated in exploring and studying important coldwater fish diversity in the selected Himalayan drainage of Northeast region of the country. In this aspect, the Directorate has collaborated with the Department of Aquatic Environment Management, College of Fisheries, Assam Agricultural University, Raha, Assam under a NEH project on "Taxonomic identification and genetic characterization of mahseer population in North-eastern region of India" during 2019.

10.7 Field day-cum-awareness program on trout farming in Sikkim

A field day-cum-awareness program on "Trout Farming for Sustainable Livelihood of Hill farmers" was organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal on 17th August, 2019 at Upper Sribadam, West Sikkim. The programme was chaired by Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal and Mr. Sunil Pradhan, Director, Department of Fisheries, Govt. of Sikkim graced the occasion as Special Invitee. Dr. N.N. Pandey, Principal Scientist; Dr. Prakash Sharma, Scientist, ICAR-DCFR were present during the program to address the farmers. Mr. Lobsang Tamang, Assistant Director Fisheries, West Sikkim and other Officers and Staffs were there to make the event successful. During the inaugural address, Dr. Debajit Sarma, Director, ICAR-DCFR highlighted the scope of trout farming in the state and extended his help to the hill fish farmer for their livelihood security. Dr. N. N. Pandey, Principal Scientist, ICAR-DCFR

talked about the breeding, rearing and aquaculture practices of rainbow trout. Altogether, 60 trout growers from different nearby villages attended the program and actively participated in discussion regarding scope and constraints. During this program, Director of ICAR-DCFR distributed water testing gears and kits to the three progressive farmers, namely Mr. Samdup Bhutia, Mr. Pem Tshering Bhutia and Mr. A. B. Gurung of the area.

Scheduled Caste Sub Plan (SCSP)

11

The programmes conducted by ICAR-DCFR under Scheduled Caste Sub Plan (SCSP) component are mentioned below:

11.1 Farmers-Scientist interactive workshop cum kisan mela

Two days farmers-scientist interactive workshop cum Kisan mela was organized by ICAR-DCFR under Scheduled Caste Sub Plan (SCSP) component during 11-12th March 2019 at Experimental Fish Farm, Champawat, Uttarakhand. The inaugural session of the programme was chaired by Dr. K.K. Vass, former Director, ICAR-CIFRI & ICAR-DCFR in presence of Dr. Rak Narayan, CITF, Mr. Vijay Verma, Chairman Municipality, Mr. Brijmohan Singh, Dy. Commandant, ITBPF, Champawat, Nitin Sharma, SSB, Champawat, Dr. Debajit Sarma, Director, ICAR-DCFR and Mr. Kishor Kunal, Officer Incharge, EFF Champawat. The Mela was participated by more than 250 farmers belonging to Scheduled Caste community from the villages Modiyani, Banlekh, Pati, Lafra, Mulakot, Kharhi, Gadyura, Chilthia, Patan, Nursingdanda, Dakna and Amakdiya of the state Uttarakhand including women farmers and rural youth. Moreover, the programme was witnessed by a good number of researchers, academicians, bureaucrats from the region and the country. The farmers were trained on various aspects of fish farming practices which can be well adopted in hill regions for development of livelihood and income generation. Special attention was given to develop skills on fabrication and maintenance of aquarium for generating revenue and preparation of fish pickles for self-employment. Later, the farmers were given free of cost inputs in the form of fish nets, fish pickles & ingredients, aquarium preparation kits and fish seeds with an objective to encourage them to adopt and upscale fish farming as a true vocation for their livelihood. Five fish farmers of the region were awarded on the occasion for their constant hard work, passion and dedication in the field of fish farming. Certificate of participation was given to all the farmers at the end of the programme. All the dignitaries expressed their satisfaction for conducting such an important programme at Champawat for the upliftment of livelihood of the Scheduled caste population of the state. They explained on the various avenues in fisheries and aquaculture which can be undertaken in hilly regions of the country. The programme was coordinated by Mr. Kishor Kunal, Officer Incharge, EFF Champawat; Mr. Parvaiz A. Ganie, Scientist and oversee by Dr. Deepjyoti Baruah, Sr. Scientist & Nodal Officer, SCSP.

Distribution of critical inputs to the SC fish farmers

Training on preparation of fish pickles to SC womenfolk

Training on aquarium fabrication and ornamental fish keeping

Learning on trout rearing and hatchery operation

Exhibition for SC farmers on technical knowhow in coldwater fisheries

Women SC farmers on receive of participation certificates and free inputs for homemade fish pickles

11.2 Human resource development programme held at Gauhati University

Three days Human Resource Development Programme was held at Gauhati University, Guwahati, Assam during 27th February to 1st March 2019 on "Integrated Fish Farming for Doubling Fish Farmers Income of Scheduled Caste Community of Northeast Region". The programme was jointly organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Uttarakhand and Gauhati University, Guwahati, Assam. The objective of the programme was to promote aquaculture and fisheries among the Scheduled Caste population of Northeast region by disseminating technical knowhow to achieve better productivity by adopting fish farming as a true vocation for their livelihood security. Altogether, 200 farmers belonging to Scheduled Caste population from rural Kamrup, Goalpara, Nalbari, Morigaon and Darrang districts of Assam participated in the programme. The other participants included delegates from ICAR Institutes; College of Fisheries, Assam Agricultural University; Department of Fisheries, Govt. of Assam; Gauhati University; KVKs etc. Students, research scholars of Department of Zoology, Gauhati University were also present on the occasion. Welcoming the participants, Prof. Dandadhar Sarma, Gauhati University briefed on the schedule and activities to be pertained in the 3-days HRD programme at Gauhati University. Mr. Ritesh S. Tandel, Co-Nodal Officer of SCSP programme from ICAR-DCFR explained on the objectives of the SCSP programme and its importance in conducting the programme at Assam for the benefit of the SC community. Dr. P. K. Saikia, Professor & Head, Dept. of Zoology, Gauhati University expressed his satisfaction for an overwhelming response of the participants for attending the programme. Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal briefed on the mandates of the institute and spoke on the necessity to create awareness among the SC community in expansion of diversified aquaculture practices in different regions of Northeast region and in making the state self-sufficiency in fish seed production. The programme was chaired by the Hon'ble Vice-Chancellor Prof. Mridul Hazarika as Chief Guest.

He mentioned on the importance of adopting scientific farming practices by the under-privileged farming communities for achieving enhanced production of fish and crops in the region. Dr. K.K. Tamuli, Dean, College of Fisheries, Raha Dr. S.K. Das, Head of Division (Fisheries), ICAR RC, Umiam; Prof. Dr. R. Bhuyan, St. Anthony's College, Shillong were the guest of the programme and spoke on various developmental matters of coldwater fisheries by interacting with the farmers. In order to encourage the fish farmers, critical input in the form of quality fish seeds, fish feeds and medicines were distributed free of cost to the farmers for adopting better management practices in their culture tanks and ponds. A technical pamphlet on "Fish based eco-tourism as an avenue for supporting livelihood to scheduled caste population in northeast India" was also released on the occasion in the gracious presence of the delegates and participants. The programme had a successful session of interaction among the participants where many questions raised by farmers were solved and feedback was received. Certificates were distributed to the farmers for their participation. Vote of thanks was offered by Dr. Hrishikesh Chudhury and the programme was coordinated by Dr. Deepjyoti Baruah, Sr. Scientist & Nodal Officer, SCSP.

Distribution of critical inputs to the fish farmers

Interactive session with SC fish farmers and experts

11.3 Interactive workshop cum training programme in Assam

An interactive workshop cum training programme for development of scheduled caste population of Assam was jointly organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Nainital, Uttarakhand and Directorate of Extension Education, Assam Agricultural University, Khanapara, Guwahati, Assam on "Adopting recent advances in coldwater aquaculture practices" during 8-10th June 2019 at Uttar Dharamtul Gram Panchayat Office, Morigaon district, Assam. Altogether 200 participants from Borghat, Uttar Khula, Dharamtul, Matiporbat and Mantabori villages of Dharamtul region, participated in the programme. Scientists from ICAR-DCFR, Bhimtal; Faculty members of College of Fisheries Science, AAU, Raha; College of Veterinary Science, AAU, Khanapara, Guwahati; Directorate of Extension Education, AAU, Khanapara and representatives of Krishi Vigyan Kendra Morigaon and Kamrup districts, Assam witnessed the gathering. Dr. Atul Borgohain, Associate Director of Extension Education, AAU, Khanapara in his welcome address elaborated on the importance of the interactive meet in this remote area of the country. Dr. Debajit Sarma, Director, ICAR-DCFR highlighted on the recent advances being made in pursuance to promotion of fisheries in the coldwater sector of the country. Dr. Deepjyoti Baruah, Sr. Scientist and Nodal Officer of SCSP, ICAR-DCFR, Bhimtal briefed the participants on the objectives of the programme. The other dignitaries present on the occasion were Dr. K.K. Tamuli, Dean, College of Fisheries Science, AAU, Raha; Dr. (Prof.) K. Kalita, CVSc, AAU, Khanapara; and Programme Coodinator, KVK, Morigaon; Mr. Diganta Takbi, President, Uttar Dharamtul Gram Panchayat, Morigaon; and many panchayat leaders. They assured the participants to provide their best assistance in undertaking fish farming and development of integrated models of farming with fish, livestock and poultry for livelihood security and income generation. A farmers Extension Bulletin in Assamese language edited by Dr. Deepjyoti Baruah, Dr. Atul Borgohain and Dr. Debajit Sarma was also released during the inaugural programme. Free inputs in the form of improved Jayanti rohu, Amur common carp and fish feeds were distributed

to each of the participating fish farmers on the occasion. 10 progressive fish farmers of the region were encouraged with an Appreciation letter for promoting fish farming and increasing the pond productivity. The participants expressed their prodigious satisfaction on the programme and later received a certificate of participation from the invited guest. Field visit to the village fish farms at Dharamtul region by experts from ICAR-DCFR and Directorate of Extension Education, AAU were also conducted to interact with the fish farmers and to understand the ground reality and constraints in fish farming in the area.

Release of Farmers Extension Bulletin in Assamese

Distribution of improved strains of fish seeds to farmers

Distribution of fish feeds to farmers

Diagnostic visit at farmers field at Dharamtul region

11.4 Interactive meet cum training programme at Pauri, Garhwal region

An interactive meet cum training programme for development of scheduled caste population of Garhwal Region by adopting recent advances in coldwater aquaculture practices under Scheduled Caste Sub Plan (SCSP) was jointly organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Nainital, Uttarakhand and Department of Fisheries, Pauri, Govt. of Uttarakhand during 14-15th June 2019 at Vikash Bhawan District, Pauri Garhwal, Uttarakhand. Altogether 300 participants from different districts of Garhwal region namely Pauri, Uttarakashi, Rudraprayag, Chamoli, Tehri, Dehradun and Haridwar District participated in the programme. Scientists from ICAR-DCFR, Bhimtal; District Magistrate, Pauri, Garhwal; Chief Development Officer, Pauri, Garhwal; and officers from various line departments of Pauri, Garhwal; Campus Director HNBGU, Pauri; Director of Fisheries, Govt. of Uttarakhand and representatives of District Fishery In-charges of Garhwal Region, Uttarakhand witnessed the gathering. Welcoming the gathering, Dr. Debajit Sarma, Director, ICAR-DCFR elaborated on the importance of the interactive meet among the farmers and experts in these remote areas of the country for doubling the farmer's income by 2020. The programme was chaired by Shri Dhiraj Singh Garbyal District Magistrate, Pauri Garhwal who later in his speech stressed the farmers to take the advantage of having such a premier institute ICAR-DCFR in the state of Uttarakhand through receiving technical knowhow and expertise in aquaculture in the coldwater sector of the country. Dr. B.P. Madhwal, Director of Fisheries, Govt. of Uttarakhand highlighted on the recent advances being made and targets achieved by the state fisheries department in pursuance to promotion of fisheries in the coldwater sector by implementing the schemes and programmes logistically. Mr. Abhishek Mishra, District Fishery In charge, Pauri Garhwal and Dr. Deepjyoti Baruah, Nodal Officer, SCSP, ICAR-DCFR delivered presentations on scope and recent trends of recreational fisheries in the state and the country for earning revenue and improving livelihood; Dr. Suresh Chandra, Principal Scientist, ICAR-DCFR elaborated in his presentation on the aspects of trout farming and

seed production in the upland regions of the state. Dr.K.C Purohit, Campus Director HNBGU; Smti. Deepti Singh, the Chief Development Officer, Pauri Garhwal; Mr. Joshi, Deputy Director of Fisheries, Pauri Garhwal interacted with the participants on the overall developmental aspects in the Pauri region. A farmers Extension Bulletin was released during the inaugural programme. 20 progressive fish farmers of the region were encouraged with a Certificate of Appreciation for their concerting effort in expansion of fish farming in the remotest area of the country. The participants expressed their prodigious satisfaction on the programme and later received a certificate of participation from the invited guest. Field visit was conducted to Baggi village situated at the confluence point of river Ganga and Nayar at Pauri district by a team of experts from ICAR-DCFR and Department of Fisheries, Pauri. Farmers and angling guides of the village consisting of SC population were interacted to understand the probability of fish farming and angling in the area.

Shri Dhiraj Singh Garbyal, District Magistrate, Pauri Garhwal addressing the participants

Release of a Farmers Extension Bulletin during the programme

Encouraging women farmers group with Certificate of Appreciation

Field visit to Baggi village at Pauri for assessing the prospects of mahseer angling and hill fish farming

A gathering of 300 fish farmers of Garhwal region of Uttarakhand

Presentation on coldwater aquaculture practices to 300 fish farmers of Garhwal region of Uttarakhand

12 Training and Capacity Building

12.1 Capacity building on ornamental fish technician

Training programme of 200 hours in job role "Ornamental Fish Technician" for 20 farmers of Nainital district was organised from 3rd February 2019 to 10th March 2019 under skill development training programme of Agricultural Council of India. 7 women participated from nearby villages Songaon, Sangudi gaon, Pande gaon, Alchona and Bhimtal. The farmers were taught on various aspects of ornamental fish breeding and culture including pond construction, pond management, breeding and rearing of ornamental fishes, health management, feed and nutrition, aquarium fabrication and maintenance. Dr. R.S. Patiyal, Dr. N.N. Pandey and Dr. Suresh Chandra took part in 27 lecture sessions, 28 training and 2 exposure visits during the programme. An exposure visit was organised to College of Fisheries, Pantnagar to witness a Krishi Mela. On line assessment of the farmers was accomplished through theory, viva and practical examinations. The programme was inaugurated by Dr. D. Sarma, Director, ICAR-DCFR, Bhimtal and the training was coordinated by Dr. R.S. Patiyal, Principal Scientist cum certified trainer ASCI on Ornamental Fish Technician.

12.2 NFDB sponsored Training of Trainers (ToT) programme on minor carps

ICAR-DCFR organized ToT training programme on "Grow out technologies of indigenous coldwater minor carps" during 4-8th March, 2019 at Bhimtal.

12.3 In plant training programme

Two months In plant training for 10 Final Year B.F.Sc. Students of College of Fisheries Science & Research Centre, C.S.A. University of Ag. & Tech, Kanpur, Campus, Etawah-206001, Uttar Pradesh was organised from 17th July-16th September, 2019 at ICAR-DCFR, Bhimtal and EFF, Champawat. The students were exposed to various aspects of coldwater fisheries through a series of theoretical and practical sessions. The In plant training programme was coordinated by Dr. S. Chandra, Principal Scientist and Course Director at Bhimtal and Mr Kishor Kunal, Scientist & OIC, Mr. P. A. Ganie, Scientist and Dr Raghvendra Singh, Scientist at EFF, Champawat. The Scientists of ICAR-DCFR tarined the students in various aspects of aquaculture, fisheries resource management, application of GIS, ornamental fish rearing and breeding, eco-tourism, fish nutrition and physiology, fish genetics and biotechnology, fish pathology, histopathology etc.

In plant training programme at EFF, Champawat

12.4 Training of Trainers (ToT) programme on mahseer

National Fisheries Development Board (NFDB) sponsored Training of Trainers programme on "Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer" was organized at ICAR-DCFR during 5-9th August, 2019. 16 participants including officials from different State Fisheries Departments and Fish entrepreneurs from all over the country (6 states) participated in the training programme. The training was focussed on both theoretical and practical aspects of hatchery management, breeding and seed production practices of golden

Inaugural address by the Director, ICAR-DCFR

Explaining to trainees about mahseer brooders

mahseer and chocolate mahseer. A training manual entitled 'Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer which contained all aspects of mahseer breeding and hatchery management was given to each participant. Dr. M. S. Akhtar, Scientist (SS), Dr. Ciji Alexander, Scientist and Ms Pragyan Dash, Scientist coordinated the program. The training programme ended on 9th August, 2019 with the distribution of certificates to the participants. The

valedictory session was chaired by Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal where upon he congratulated all the participants for their successful completion of the training and requested them to join hands together for the conservation and rehabilitation of mahseer in the country.

12.5 Field training programme for students of ICAR-CIFE

One-week long field training was organized for the MFSc students of Fisheries Resource Management division of ICAR-CIFE, Mumbai during 11-17th September, 2019 at ICAR-DCFR, Bhimtal. The programme was coordinated by Dr. S. Chandra, Principal Scientist

12.6 Training cum awareness programme under NSPAAD project

ICAR-DCFR conducted NFDB funded one day training cum awareness programme on Coldwater Fish Farming, Health Management and Food Safety for 80 fish farmers of Sunkiya, Parbada, Mazara, Budhi bana, Galla, Nathuwakhan villages of Dhari block of Nainital District on 30th September, 2019 under the National Surveillance programme for Aquatic Animal Diseases (NSPAAD). Initiatives were taken under the programme to make aware the fish farmers on the techniques of coldwater fish farming, improved management practices for prevention and control, hygiene and on safe fish eating habits. Guidance on the commonly occurring diseases, their symptoms and preventive/control measures were given. Farmers shared their experience interacted with team members and raised their concern regarding the prevalence of fungal infection and slow growth of stocked fishes. Farmers were advised to use disinfects while handling the fishes and follow improved practices. The programme was coordinated by Dr. Suresh Chandra, PS & PI, NSPAAD and Dr. R.S. Patiyal, PS, DCFR, Bhimtal.

Participants during a mass awareness programme on fish health management at Sunkiya village

12.7 Training of Trainers (ToT) Programme on coldwater fish disease management

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal organised five days Training of Trainers (ToT) Program on "Coldwater Fish Disease Management" during 7-11th October, 2019 under the aegis of NFDB, Hyderabad. A total of 25 participants from various districts of Uttarakhand and Uttar Pradesh took part in the programme. Dr. S. Chandra, Principal Scientist cum programme coordinator explained on the aim and objectives of the training programme during the introductory session. The participants shared their experiences on fish farming practices and expressed their expectation from the training programme. The participants were trained and demonstrated on fish bacteriology, virology, parasitology, mycology, genetics and nutrition, water quality monitoring in various practical and theoretical sessions. Dr. Debajit Sarma, Director addressed the ToT delegates and congratulated them upon successful completion of the training programme. Dr. Amit Pande, Principal Scientist, Mr. S.K. Mallik, Mr. R.S. Tandel and Mr. Aadil Bhat, Scientist coordinated the five days programme.

12.8 On-field Awareness programme on AMR

In light to raise the awareness in INFAAR (Indian Network for Fisheries & Animals Antimicrobial Resistance), the fish farmers were interacted to aware on the present global antimicrobial resistance (AMR) issues under One-health concept while collecting the fish samples on-field for AMR study on 15th October 2019 at Udhamsingh Nagar district, Uttarakhand. Fish farmers were sensitized on injudicious use of antimicrobials in livestock including fishes and its direct implications on human health. In solution to antimicrobial resistance, it is emphasized on adapting good animal husbandry practices to reduce AMR, preventing the emergence of resistance by reducing selection pressure by appropriate control measures, replacement and reduction in the use of available antimicrobial agents to combat the development of AMR. Fish farmers were also made aware of the fact that there was a need for standardizing the dose of antimicrobials used in aquaculture to prevent antimicrobial resistance. Various informative products such as FAO leaflets, hand-outs, umbrella with AMR slogan and posters prepared in the laboratory were displayed on AMR during the programme to educate the farmers along with their family members. Queries related to the irrational use of antibiotics and the spread of antibiotic resistance asked by farmers were also answered. The programme has a positive impact over the fish farmers and it is realized that awareness programme on AMR needs to be conducted on-field during routine samplings by ICAR-DCFR involving fish farmers and their family members.

12.9 Training of Trainers programme (ToT) on rainbow trout

NFDB sponsored Training of Trainers programme for 25 participants on "Recent advances in culture and breeding of Rainbow Trout (*Onchorynchus mykiss*)" was conducted from 23-27th December 2019 at EFF, Champawat. The training programme was coordinated by Mr Kishor Kunal, Scientist & OIC, EFF, Champawat.

FAO leaflets, hand-outs, umbrella and posters on AMR displayed to the fish farmers

Young professionals of ICAR-DCFR explaining on the ongoing research work on AMR

NFDB sponsored ToT programme at EFF, Champawat

12.10 Field experience programme

Three months field experience learning cum training programme for 2 Diploma students Mr. Vignesh and Mr. S Gomathy Sankar from TNJFU, Nagapattinam was conducted at ICAR-DCFR, Bhimtal and Experimental Fish Farm, Champawat. The training programme was coordinated by Mr. Kishor Kunal, Scientist & OIC, Mr. P A Ganie, Scientist and Dr. Raghvendra Singh, Scientist.

12.11 Students guided

- Vandana Pandey of Kumaon University has completed her MSc (Microbiology) dissertation work on the topic "Bacterial and histopathological study on the farmed common carp, *Cyprinus carpio* suffering from skeletal deformity" under the guidance of Dr. Neetu Shahi.
- Siva C co-coordinated a one month summer training programme for Ms. Neha Suyal, B.Sc student of Uttaranchal University, Dehradun during 17th July, 2019 to 17th August, 2019.
- Siva C guided Ms. Renu Loyi, Ph.D scholar of Department of Zoology, Rajiv Gandhi University, Rono Hills, Itanagar on molecular biological experiments at ICAR-DCFR for a period of one month during April 2019.
- Anupam Pandey is pursuing his PhD from Kumaon University under the supervision of Dr. D. Sarma, Dr. B. S. Kamalam and Dr. M. S. Akhtar on the topic 'Molecular and phenotypic investigation of thermal adaptation in a coldwater fish, rainbow trout (*Oncorhynchus mykiss*).'
- Sivaramakrishnan, T. is pursuing his PhD from Tamil Nadu Dr. J. Jayalalitha Fisheries University under the co-supervision of Dr. B.S. Kamalam on the topic 'Elucidation of critical larval nutritional elements for the production of robust milkfish fry'.
- Ms. Babita from Department of Biotechnology, Kumaon University has completed her M.Sc dissertation on the topic 'Efficacy study of antioomycetes agents against Saprolegnia sp. isolated from snow trout: In vitro' under supervision of Mr. R.S. Tandel and Mr. Raja Aadil H Bhat.
- Ankita Bhandhari from Department of Biotechnology, Kumaon University has completed her M.Sc dissertation on the *topic* 'Investigation of acute toxicity and behaviour changes on *Oncorhynchus mykiss* rainbow trout fry in response to ethanolic extract of Myrica esculerata' under supervision of Mr. Raja Aadil H Bhat and Mr. R.S. Tandel.
- Priyanka H. Tripathi is pursuing her PhD from Kumaon University under the supervision of Dr. M. S. Akhtar and Dr. Ciji Alexander on the topic 'Molecular investigation of selected immune and reproductive genes in golden mahseer, *Tor putitora* during ontogeny and in response to dietary ß-glucan' under DBT project.

Linkages

13

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal has developed functional linkages with different National-level Organizations, Agricultural Universities, State Department of Fisheries, Financial Agencies, Registered Societies for promotion of R&D in collaborative programmes.

13.1 ICAR Institutes

- ICAR-National Bureau of Fish Genetic Resources, Lucknow
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-Central Institute of Fisheries Education, Mumbai
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Central Inland Fisheries Research Institute, Barrackpore
- ICAR-Central Inland Fisheries Research Institute, Regional Centre, Guwahati
- ICAR Research Complex for NEH Region, Barapani
- ICAR-Indian Institute of Soil and Water Conservation, Dehradun
- ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora
- ICAR-Indian Veterinary Research Institute, Izatnagar
- ICAR-Directorate of Foot and Mouth Disease, Mukteswar
- ICAR-Indian Agricultural Statistics Research Institute, New Delhi
- ICAR-Indian Agricultural Research Institute, New Delhi
- ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru
- ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur

13.2 Central Agencies/Departments

- National Fisheries Development Board
- Department of Biotechnology
- Department of Science & Technology
- Science and Engineering Research Board
- Indian Space Research Organization
- North Eastern Space Applications Centre, Shillong, Meghalaya
- Uttarakhand State Council for Science and Technology, Dehradun
- Survey of India, Dehradun, Uttarakhand
- State Agricultural Management & Extension Training Institute (SAMETI), Jammu
- Ministry of Environment, Forest & Climate Change
- Indian Council of Forest Research and Education
- Tehri Hydro Development Coorporation Ltd.
- Sashastra Seema Bal (SSB), Ministry of Home Affairs, Govt. of India, Champawat

13.3 State Agencies/Departments

- Department of Fisheries, Sikkim
- Department of Fisheries, Uttarakhand
- Department of Fisheries, Himachal Pradesh
- Department of Fisheries, Jammu & Kashmir
- Department of Fisheries, Arunachal Pradesh
- Department of Fisheries, Meghalaya

- Department of Fisheries, Mizoram
- Department of Fisheries, Nagaland
- Department of Fisheries, Tamil Nadu
- Uttarakhand Council for Biotechnology

13.4 Universities & Colleges

- GB Pant University of Agricultural Science & Technology, Pantnagar
- GB Pant Institute of Himalayan Environment and Development, Almora
- College of Fisheries, SKUAS&T, Jammu &Kashmir
- College of Fisheries, Assam Agricultural University, Raha
- College of Fisheries, Central Agricultural University, Lembucherra
- Tamil Nadu Fisheries University
- Kerala University of Fisheries & Oceanography
- CSKHP Agricultural University, Himachal Pradesh
- Kumaun University, Nainital
- HNB Garhwal University, Srinagar
- Guwahati University, Assam
- Nagaland University, Kohima
- Rajiv Gandhi University, Arunachal Pradesh
- Bhimrao Ambedkar Central University, Lucknow
- West Bengal University of Animal and Fisheries Science
- Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh
- Assam Don Bosco University, Guwahati

13.5 Krishi Vigyan Kendras (KVK)

- KVK Lohaghat
- KVK Almora
- KVK West Kameng
- KVK Tawang
- KVK Lower Subansiri
- KVK Upper Subansiri
- KVK Lower Dibang valley
- KVK East Siang

13.6 Registered Societies

- Devan Hills Plantations Company (P) Ltd, Munnar, Kerala
- Gaumco Multipurpose Cooperative Society (P) Ltd, Ziro, Arunachal Pradesh
- ABACA, Nameri, Tezpur, Assam
- Jasingfaa Aqua Tourism Centre at Nagaon, Assam
- ICICI Pvt. Limited, Mumbai
- SPY Agro Pvt. Ltd. Nadyal, Kurnool, Andhra Pradesh
- String Bio Pvt. Ltd.

Awards, Honours and Recognitions

14

- The research paper entitled 'Antimicrobial drug resistance pattern and extended–spectrum beta lactamase detection in *Escherichia coli* isolated from fish farms in Western and Central Himalayan region, India' authored by Manisha Gupta, Sumanta K Mallik, Gunja Gupta, Neetu Shahi, Suresh Chandra and Debajit Sarma received the best oral presentation award under young scientist category at the "National symposium on coldwater fisheries developments in India: Innovative approaches and way forward for enhancing hill farmers income" at ICAR-DCFR, Bhimtal during 24-25th September 2019.
- The research paper entitled 'Isolation and antimicrobial resistance profile of *Staphylococcus* isolated from fish farms in western and central Himalayan region of India' authored by Manisha Gupta, Gunja, Neetu Shahi, Debajit Sarma and Sumanta K Mallik received the best oral presentation award in the session 'AMR in Fisheries' at the national seminar on "AMR in Indian Fisheries: Measures of mitigation" organized by SOFT(I), ICAR-CIFT and MPEDA, during 7-8th November 2019 at ICAR-CIFT, Cochin, India.
- R. S. Haldar received certificate of appreciation from the Secretary, Department of Fisheries and Aquatic Resources, Govt. of Nagaland, India on 17th May, 2019 for his dedicated efforts, sincere co-operation and scientific commitments for the breeding of mahseer at Longkong, Mokokchung district and for establishment and development of rainbow trout hatchery and raceways at Dzuleke village, Kohima District, Nagaland during September, 2018.
- R. S. Haldar was awarded Gold Medal by the Coldwater Fisheries Society of India (CFSI), Bhimtal for his contributions in development of coldwater fisheries during the National Seminar on "Coldwater Fisheries Development in India: Innovative Approaches and Way Forward for Enhancing Hill Farmers Income & 32nd Foundation Day Celebration" organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with Coldwater Fisheries Society of India during 24-25th September, 2019.
- R. S. Patiyal received best poster presentation award in aquaculture section during national workshop on "Coldwater Fisheries Development In India: Innovative Approaches and way Forward for Enhancing Hill Farmers Income" organised by ICAR-DCFR Bhimtal in collaboration with Coldwater Fisheries Society of India during 24-25th September, 2019.

R. S. Haldar receiving CFSI Gold Medal from Dr. J. K. Jena, DDG (Fy. Sc.), ICAR, New Delhi

- The poster (abstract no. FHM-12) entitled 'Morphometric and molecular characterization of *Argulus sp.* from endangered golden mahseer, *Tor putitora* authored by Kavya, K. K., Tandel,

R. S., Dash, P., Chandra, S. and Sarma, D. bagged best poster presentation award during national workshop on "Coldwater Fisheries Development In India: Innovative Approaches and way Forward for Enhancing Hill Farmers Income" organised by ICAR-DCFR Bhimtal in collaboration with Coldwater Fisheries Society of India during 24-25th September, 2019.

- The research paper entitled 'Study on condition factor to assess the field level well-being of three age group of farmed rainbow trout (*Oncorhynchus mykiss*)' authored by Chandra, S., Gehlot, B., Kavya, K.K., Patiyal, R. S., Mallik, S.K., Mir, M. I., Datt, V. and Sarma, D. bagged best paper presentation award during national seminar on 'Biodiversity: Issues, challenges and opportunities, organised during 16-17th July, 2019, at Department of Zoology and Aquaculture.

Publications

15

15.1 Research papers

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- Sharma, L., Ali, S., Siva, C., Kumar, R., Barat, A., Sahoo, P.K. and Pande, V., 2019. Genetic diversity and population structure of the threatened chocolate mahseer (*Neolissochilus hexagonolepis* McClelland 1839) based on SSR markers: implications for conservation management in Northeast India. Molecular

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15.2 Technical and popular articles

- Baruah, D., Ganie, P.A., Kunal, K., Posti, R., Chisi. K. and Yonggam T. 2019. Trout fisheries resources and potentialities in the Menchukha region of Arunachal Pradesh, Aquaculture Asia, 23(3): 30-39.
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- Dash, P., Tandel R.S., Baruah, D. and Sarma, D. 2020. Mahseer sanctuaries of Meghalaya: A conservation and recreational perspective. Aquaculture Asia, 24 (1): 3-7.
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15.3 Books and book chapters

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- Ali, S. and Siva, C. 2019: Fish diversity assessment and biomonitoring of Himalayan rivers. In: Sarma, D. and Shahi, N. (Eds.), Coldwater Fisheries and Aquaculture, Narendra Publishing House, New Delhi. India.
- Ali, S., Sharma L., Siva, C., Sharma, A., Barat, A., Sahoo P.K. 2019. Mitochondrial gene sequences analysis suggests conservation priority for threatened chocolate mahseer (*Neolissochilus hexagonolepis*) in northeast India. Abstract No. 247; XIV Agricultural Science Congress, 20-23 February, 2019, NASC, Pusa, New Delhi, India, p. 344.
- Ali, S., Siva C. Sharma, L. Sharma A., Barat A. and Sarma D. 2019. Conservation priority for threatened chocolate mahseer (*Neolissochilus hexagonolepis*) in Northeast India inferred from mitochondrial gene sequence analysis. Abstract No. OHES-40. The 39th Annual conference of the Academy of Environmental Biology and One health and Ecosystem Services, 29-30 November 2019, ICAR-NBFGR, Lucknow.

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- Sarma, D., Akhtar, M. S., Ciji, A., 2019. Breeding and seed production of golden mahseer (*Tor putitora*). In: Akhtar, M.S., Ciji, A., Dash, P. (Eds.), NFDB sponsored training manual on 'Recent advances in breeding and hatchery management of golden and chocolate mahseer', Pp: 9-12.
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- Baruah, D., Sarma, D., Sarma, Dandadhar & Tandel, R.S. 2019. Fish based eco-tourism as an avenue for supporting livelihood to scheduled caste population in northeast India. *Technical Pamphlet*, ICAR-DCFR, Bhimtal.
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15.5 Abstracts

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15.6 NCBI Submissions

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- Akhtar, M.S., Rajesh, M., Ciji, A., Tripathi, P.H. and Pandey, A. *Tor putitora* tumor necrosis factor alpha (tnfa) mRNA, partial cds (MN193586).
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phosphoprotein 1 (*stip1*) mRNA (MN306526).

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- Tandel, R. S., Dash, P., Bhat, R. A. H., Kavya, K. and Sarma, D. *Saprolegnia australis* isolate DMEB-6 internal transcribed spacer 1, partial sequence (MK415667).
- Tandel, R. S., Dash, P., Bhat, R. A. H., Kavya, K. and Sarma, D. *Saprolegnia australis* isolate DMEB-7 internal transcribed spacer 1, partial sequence (MK415668).
- Tandel, R. S., Dash, P., Bhat, R. A. H., Kavya, K. and Sarma, D. *Saprolegnia parasitica* isolate GMEF-8 internal transcribed spacer 1, partial sequence (MK415669).
- Tandel, R. S., Dash, P., Kalingapuram, K., and Chandra, S. *Argulus siamensis* isolate UKBGM F small subunit ribosomal RNA gene, partial sequence, (MT045991.1).
- Tandel, R. S., Dash, P., Bhat, R. A. H., Kavya, K. and Sarma, D. *Saprolegnia parasitica* isolate STEC-5 internal transcribed spacer 1, partial sequence (MK415666).
- Tandel, R.S., Dash, P., Adil, R.H.B. and Kavya, K. *Saprolegnia australis*, ITS 1 mRNA partial cds.(MH412809).
- Tandel, R.S., Dash, P., Adil, R.H.B. and Kavya, K. *Saprolegnia parasitica*, ITS 1 mRNA partial cds (MH412810).

Chocolate mahseer *(Neolissochilus hexagonolepis)*

- Mitochondrial gene:
- Cytb (n=101 no.) : Accession no. KX594489 - KX594581& MG593305- MG593314
- ATPase 6/8 (n= 101): Accession no. KX594582- KX594634 & MG593315- MG593364
- CO-I (n= 69) Accession no. KX594419- KX594488
- Microsatellite markers (n=25) : Accession no. MH746735- MH746760
- SRA File (NGS data): PRJNA490417

Brown trout (*Salmo trutta fario*)

- Mitochondrial gene:
- Cyt b gene (n=61) Accession no. KX594698- KX594759
- ATPase6/8 (n= 59) Accession no. KX594760- KX594819
- CO1(n= 62) Accession no. KX594635- KX594697
- Microsatellite markers (n=11): Accession no. MG593293- MG593304
- SRA File (NGS data): PRJNA526610

15.7 Bacterial sequences submitted to NCBI

Bacteria	Laboratory Strain number	NCBI Accession Number	Authors
Pseudomonas paralactis	RTFHPD 264	MT122810	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Rouxiella chamberiensis,	RTFHPD 265	MT122817	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Aeromonas salmonicida subsp. masoucida,	RTFHPD 266	MT122821	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Staphylococcus cohnii	RTFHPD 267	MT122816	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.

Bacteria	Laboratory Strain number	NCBI Accession Number	Authors
Aeromonas salmonicida subsp. masoucida	RTFHPD 268	MT125864	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Aeromonas salmonicida subsp. masoucida	RTFHPD 269	MT125866	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Aeromonas salmonicida subsp. masoucida	RTFHPD 270	MT125868	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Micrococcus sp.	RTFHPD 271	MT125954	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Micrococcus aloeverae	RTFHPD 272	MT125955	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Proteus mirabilis	RTFHPD 273	MT125956	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Micrococcus yunnanensis	RTFHPD 274	MT125957	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Pseudomonas poae	RTFHPD 275	MT125959	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Pseudomonas sp.	RTFHPD 276	MT126621	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Rahnella aquatilis	RTFHPD 277	MT126030	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Algoriella xinjiangensis	RTFHPD 278	MT126032	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Pseudarthrobacter siccitolerans	RTFHPD 279	MT126035	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Bacillus mycoides	RTFHPD 280	MT126036	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Serratia fonticola	RTFHPD 281	MT126037	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Flavobacterium saccharophilum	RTFHPD 282	MT126038	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Janthinobacterium lividum,	RTFHPD 283	MT126313	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Flavobacterium piscis	RTFHPD 284	MT126314	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Curvibacter delicatus	RTFHPD 285	MT126470	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Lactobacillus plantarum	RTFHPD 286	MT126474	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Lactococcus lactis	RTFHPD 287	MT126511	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Pseudomonas peli	RTFHPD 288	MT126614	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Rahnella aquatilis	RTFHPD 289	MT131280	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.

Bacteria	Laboratory Strain number	NCBI Accession Number	Authors
Enterococcus sp.	RTFHPD 290	MT131297	Mallik, S. K., Shahi, N., Chandra, S., Bhat, R. A., Sharma, P., Singh, S., Kala, K., Pant, K., Patiyal, R. S. & Sarma, D.
Aeromonas hydrophila	RTFG242	MN894071	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFG243	MN894075	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFG244	MN894076	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFG245	MN894077	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFG246	MN894078	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFG247	MN894081	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Patiyal,R.S., Pande,V.
Vibrio anguillarum	MHJL248	MN900589	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Vibrio anguillarum	MHJL249	MN900590	Mallik,S.K., Kala,K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas salmonicida sbsp. masoucida	MHJL250	MN900593	Mallik,S.K., Kala,K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Acenitobacter tjermbergiae	MHJL251	MN901261	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Fermicutis bacterium	MHJL252	MN901260	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Acinetobacter sp.	RTFB253	MN904976	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Shewanella xiamensis	MHJL254	MN904977	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFI255	MN960046	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas hydrophila	RTFM256	MN960066	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJG257	MN960072	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	RTFI258	MT023717	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJB259	MT023718	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJB260	MT023728	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJI261	MT026977	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJM262	MT026978	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.
Aeromonas veronii	MHJK263	MT026979	Kala,K., Mallik,S.K., Shahi,N., Singh,S., Pathak, R., Patiyal,R.S., Pande,V.

Participation in Conference, Symposia, Workshop, Meeting and Training

16

16.1 Participation in Conference, Symposia, Workshop and Training

- Meetings /seminars/conferences/workshops attended by Dr. Debajit Sarma, Director during 01.01.2019 to 31.12.2019:

S. No	Date	Place	Purpose
1	07.01.2019	Delhi	◆ Meeting with Norwayan Delegates at Delhi.
	09.01.2019	Assam	◆ Meeting with Department of Fisheries, Assam
	13.01.2019	Guwahati University, Guwahati	◆ Delivering a lecture at Guwahati University, Guwahati
	15.01.2019	Agartala, Tripura	◆ Participated in National Symposium on Client Smart Aquaculture & Fisheries (CSAF), Agartala, Tripura on January 15-16, 2019
2	23.01.2019 to 25.01.2019	Chennai	◆ Participated in Brackishwater Aquaculture (BRAQCON 2019) to be organized by ICAR-CIBA Chennai from January 23-25, 2019.
3	31.01.2019 to 02.02.2019	New Delhi	◆ Attended ICAR Directors' conference & Directors' of Fisheries Institutes at NASC Complex, New Delhi from January 31- February 2, 2019.
4	20.02.2019	New Delhi	◆ Participated in XIVth Agricultural Science Congress at New Delhi.
5	26.02.2019 to 27.02.2019	Guwahati	◆ Organized & participated in the National Workshop under Scheduled Caste Sub Plan (SCSP) being organized by ICAR-DCFR Bhimtal in collaboration with Department of Zoology, Gauhati University, Guwahati at Deptt. of Zoology, Gauhati University, Guwahati.
6	02.03.2019	Pantnagar	◆ Invitation to Vice Chancellor & other delegates at GBPUA&T Pantnagar and discussion on SCSP programme at College of Fisheries, GBPUA&T Pantnagar.
7	09.03.2019 to 10.03.2019	Khatima	◆ Organized & participated in the Two days Farmers-Scientists Interactive workshop cum orientation programme for the tribal farmers inhabiting in tarai area of Uttarakhand during March 9-10, 2019 at Khatima, Uttarakhand.
8	11.03.2019 to 12.03.2019	Champawat	◆ Organized & participated in the Two days Farmers-Scientists Interactive workshop cum Kisan Mela under Scheduled Caste Sub Plan (SCSP) component during March 11-12, 2019 at ICAR-DCFR Experimental Fish Farm & Field Centre, Champawat, Uttarakhand
9	10.04.2019 to 11.04.2019	Gorakhpur	◆ Conducted Viva-voce examination of PhD student at DDU, Gorakhpur & Delivered lecture at St. Andrew's PG College, Gorakhpur.

S. No	Date	Place	Purpose
10	24.04.2019	Hyderabad	◆ Attended Review meeting at National Fisheries Development Board (NFDB), Hyderabad.
11	11.05.2019 to 14.05.2019	Nagaland	◆ Participated in the meeting on Development of Trout farming in Nagaland in association with Department of Fisheries, Govt. of Nagaland.
12	23.05.2019	Delhi	◆ Attended meeting convened by the DDG (Fy.), ICAR regarding EFC revision.
13	30.05.2019	Ramnagar, Almora	◆ Attended Hill Fish Farming workshop at Ramnagar and NEIL village (Almora) in collaboration with ICICI Foundation.
14	03.06.2019	Delhi	◆ Attended urgent official work at SMD ICAR Hqrs, New Delhi.
15	09.06.2019	Guwahati, Assam	◆ Organized & attended the National Workshop under SCSP program in collaboration with Assam Agricultural University (AAU), Khanapara outcampus.
16	14.06.2019 to 15.06.2019	Pauri, Garhwal	◆ Attended interactive workshop on Scheduled Caste Sub Plan (SCSP) component at Pauri, Garhwal.
17	18.06.2019 to 20.06.2019	Chennai, Tamil Nadu	◆ Participated in Asian Pacific Aquaculture (APA-2019) in collaboration with World Aquaculture Society at Chennai, Tamil Nadu.
18	25.06.2019	Delhi	◆ Participated in the meeting with Secretary DARE & DG (ICAR) and Hon'ble Minister of Fisheries, Animal Husbandry & Dairying, Govt. of India, Krishi Bhawan, New Delhi & other official work at SMD ICAR Hqrs., New Delhi.
19	16.07.2019 to 18.07.2019	Delhi,	◆ Participated in the Foundation Day and Award Ceremony of ICAR at NASC Complex, New Delhi on July 16, 2019 and Director's meeting at SMD ICAR Hqrs., New Delhi on July 17, 2019.
		Srinagar	◆ Attended one day National Symposium at SKUAS&T, Srinagar on July 18, 2019.
20	17.08.2019 to 18.08.2019	Sikkim, Guwahati	◆ Organized & participate in Farmers Interactive meet at Shreebadam, Sikkim & Discussion SCSP programme implementation with Dean, College of Fisheries, Raha, Assam.
21	30.08.2019	Hyderabad	◆ Participated in the Stakeholders Interface meeting at National Fisheries Development Board (NFDB) Hyderabad.
22	03.09.2019 to 04.09.2019	Noida	◆ Monitoring of RAS system at Noida.
		Aligarh	◆ Attended meeting at Aligarh Muslim University (AMU), Aligarh.
		Delhi	◆ Attended Official work at SMD/ICAR Hqrs., New Delhi.
23	07.10.2019	Bhopal	◆ Attended meeting at MP Fisheries Federation, Bhopal.
24	19.10.2019 to 20.10.2019	Jasingfaa, Assam	◆ Participated in 9th National Jasingfaa Fish Festival -2019 at Jasingfaa, Nagaon, Assam
25	27.10.2019 to 30.10.2019	Barapani, Meghalaya	◆ Monitoring of different activities under NEH and SCSP component in NE region. ◆ Discussion for ecotourism development.
26	14.11.2019	Hisar, Haryana	◆ Attended meeting of BOS regarding issues related with College of Fisheries Sciences at CCS Haryana Agricultural University, Hisar

S. No	Date	Place	Purpose
27	23.11.2019 to 24.11.2019	Barapani, Assam	◆ Attended 23rd meeting of ICAR Regional Committee –III at, ICAR-NEH Barapani, Assam.
28	04.12.2019 to 05.12.2019	Nagaland	◆ Attended meeting with Director of Fisheries, Govt. of Nagaland, Kohima and attended Hornbill Angling Festival & Ranching programme.
29	17.12.2019 to 19.12.2019	Delhi	◆ Attended NICRA Review meeting at NASC Complex, New Delhi. ◆ Attended Official work at SMD/ICAR Hqrs. New Delhi.
30	21.12.2019 to 24.12.2019	Bangalore	◆ Discussion regarding conservation of Mahseer with State Fisheries Department & NGO's (Cauvery Fisheries Camp). ◆ Discussion with "Fish Feed Company" regarding production of DCFR larval trout feed.

- A. K. Giri participated in the National Symposium on "Coldwater fisheries development in India: Innovative approaches and way forward for enhancing hill farmers income" organized during 24-25th September, 2019 at ICAR-DCFR, Bhimtal.
- A. K. Giri, Scientist prepared technical draft on "Brood bank guidelines for golden mahseer, *Tor putitora* and rainbow trout, *Oncorhynchus mykiss*" for the establishment of brood banks in Indian Himalayan regions with technical supervision of ICAR-DCFR.
- Amit Pande attended and presented a paper on 'dsRNA dependent protein kinase of *Schizothorax richardsonii* has three dsRNA binding motifs in International Symposium on International Resources and Blue Economy AQUABE-2019, held at La Meridian, Kochi, during 29-30th November, 2019.
- Amit Pande participated and delivered an oral presentation on 'Diagnosis of viral diseases-Development of All or none test for detection of fish viruses' in National symposium on "Coldwater fisheries development in India: Innovative approaches and way forward for enhancing hill farmers income" during 24-25th September, 2019 at ICAR-DCFR, Bhimtal.
- Amit Pande participated and presented a paper on 'Chatactrization of *Schizothorax richardsonii* dsRNA dependent protein kinase and its promoter sequence' in National symposium on "One Health & Ecosystem Services (OHES-2019)" held at ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow during 29-30th November, 2019.
- Amit Pande participated and presented a poster on 'Characterization of IRF3 promoter from Coldwater fish snow trout *Schizothorax richardsonii* in National symposium on "One Health & Ecosystem Services (OHES-2019)" held at ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow during 29-30th November, 2019.
- B.S. Kamalam attended the '7th National Innovations on Climate Resilient Agriculture annual review workshop' held at NASC, New Delhi during 17-18th December, 2019 and presented the progress made under the ICAR-DCFR project component.
- B.S. Kamalam attended the National Innovations on Climate Resilient Agriculture review workshop for ICAR Fisheries and Animal Science institutes held at NASC, New Delhi during 24th July 2019 and presented the ICAR-DCFR work progress.
- B.S. Kamalam attended the national symposium on 'Coldwater fisheries development in India: Innovative approaches and way forward for enhancing hill farmers income' held at ICAR-DCFR, Bhimtal during 24-25th September, 2019 and delivered a theme talk on 'ICAR-DCFR research and development on rainbow trout feeds'.
- B.S. Kamalam attended the regional conference on 'Himalaya matters in a changing world' held at G.B. Pant Institute of Himalayan Ecosystem

and Development, Almora during 9-11th December, 2019 and delivered an invited talk on 'Climate resilient technologies for coldwater fisheries in the Indian Himalayan region'.

- B.S. Kamalam completed the Deakin University's animal ethics training module on 'Regulatory issues in the care and use of animals for research and teaching' at Queenscliff, Australia on 20th March 2019.
- D. Baruah coordinated as Committee Member for screening and evaluation of empanelled firms of the DKMA (ICAR) for production of documentary film of ICAR-DCFR.
- Kishor Kunal and P A Ganie and Raghvendra Kishor Kunal participated and gave an oral presentation in the National Symposium on "Coldwater Fisheries Development in India: Innovative approaches and way forward for enhancing hill farmers income" from 24th to 25th Sept., 2019 at ICAR-DCFR, Bhimtal.
- M. S. Akhtar participated and delivered an oral presentation on 'Inducing captive maturity and breeding of endangered golden mahseer (*T. putitora*) through environmental manipulations' in National symposium on "Coldwater fisheries development in India: Innovative approaches and way forward for enhancing hill farmers income" during 24-25th September, 2019 at ICAR-DCFR, Bhimtal.
- M. S. Akhtar participated and delivered an oral presentation on 'Inducing captive maturity and breeding of endangered golden mahseer (*T. putitora*) through environmental manipulations' in Asia-Pacific Aquaculture – an international conference and exposition during 19-21st June, 2019 in Chennai.
- Neetu Shahi attended *GETin* workshop on "CRISPR editing in mammalian cells and embryos" held at ICAR-CIRB, Hisar, Haryana during 4-9th November 2019.
- Neetu Shahi gave an oral presentation on "Comparative genomics of zoonotic fish pathogen, *Lactococcus garvieae* RTCLI04, isolated from farmed rainbow trout, *Oncorhynchus mykiss* in India" during BRAQCON 2019 at ICAR-Central Institute of Brackish water Aquaculture, Chennai during 22-25th January 2019.
- Neetu Shahi gave an oral presentation on "RNA-sequencing revealed differentially expressed reproduction related genes in the brain of sexually matured male and female golden mahseer, *Tor putitora*" at national symposium on Coldwater fisheries developments in India: Innovative approaches and way forward for enhancing hill farmers income at ICAR-DCFR, Bhimtal during 24-25th September 2019.
- Neetu Shahi attended FAO –ICAR-USAID 2nd annual meeting of INFAAR on 19th September 2019 at Kolkata, India.
- Neetu Shahi participated and delivered a poster presentation on "The antimicrobial activity of novel synthetic peptide RR20 against *L. garvieae* isolated from diseased rainbow trout, *Oncorhynchus mykiss*" in the National seminar on "AMR in Indian Fisheries: Measures of mitigation" organized by SOFT(I), ICAR-CIFT and MPEDA, during 7-8th November 2019 at ICAR-CIFT, Cochin, India.
- P. Dash participated and presented a paper in 4th PAF congress on "Increasing aquaculture production in India through synergistic approach between multinational industries, domestic entrepreneurs and aquaculturists" organized by ICAR-CIFA, Bhubaneswar, Odisha during 15-17th November, 2019.
- P. Dash participated and presented a paper in International Conference and Exposition on Asian-pacific Aquaculture 2019 organized by Asia Pacific chapter, World Aquaculture Society during 19-21st June, 2019 at Chennai, Tamilnadu , India.
- P. Dash participated and presented a paper in National Symposium on "Coldwater Fisheries Development in India: Innovative approaches and way forward for enhancing hill farmers income" organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal during 24-25th September, 2019
- Parvaiz Ahmad Ganie participated and

presented a poster "Integration of GIS and multi criteria decision analysis for rainbow trout farming development in district Shiyomi, Arunachal Pradesh" in the National Symposium on "Coldwater Fisheries Development in India: Innovative approaches and way forward for enhancing hill farmers income" from 24-25th September, 2019 at ICAR-DCFR, Bhimtal.

- R S Tandel participated and delivered an oral presentation in International Conference and Exposition on Asian-pacific Aquaculture 2019 organized by Asia Pacific chapter, World Aquaculture Society during 19-21st June, 2019 at Chennai, Tamil Nadu , India.
- R S Tandel participated and presented a paper (oral) in 4th PAF congress on "Increasing aquaculture production in India through synergistic approach between multinational industries, domestic entrepreneurs and aquaculturists" organized by ICAR-CIFA, Bhubaneswar, Odisha during 15-17th November, 2019.
- R S Tandel participated and presented a paper in National Symposium on "Coldwater Fisheries Development in India: Innovative approaches and way forward for enhancing hill farmers income" organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal during 24-25th September, 2019.
- R. S. Haldar participated in the "106th Pantnagar Kisan Mela & Agro-Industrial Exhibition" organized by Govind Ballav Pant University of Agriculture and Technology, Pantnagar during 27-30th September, 2019 at GBPUAT, Pantnagar (Uttarakhand).
- R. S. Haldar participated in the "International Conference Asia Pacific Aquaculture (APA-2019)" organized by World Aquaculture Society (WAS), Asian Pacific Chapter in association with Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU) during 19-21st June, 2019 at Chennai Trade Centre, Chennai, Tamil Nadu.
- R. S. Haldar participated in the "Kisan mela and gosthi on Jal Shakti Abhiyan -2019" organized by Krishi Vigyan Kendra, Jeolikote, Nainital (Uttarakhand) on 3rd September, 2019 at ICAR-DCFR, Bhimtal.
- R. S. Haldar participated in the "National Symposium on Coldwater Fisheries Development in India: Innovative Approaches and Way Forward for Enhancing Hill Farmers Income & 32nd Foundation Day Celebration" organized by ICAR-Directorate of Coldwater Fisheries Research, Bhimtal in collaboration with Coldwater Fisheries Society of India during 24-25th September, 2019 at ICAR-DCFR, Bhimtal.
- Raghvendra Singh participated in the National Symposium on "Coldwater Fisheries Development in India: Innovative approaches and way forward for enhancing hill farmers income" from 24-25th September, 2019 at ICAR-DCFR, Bhimtal.
- Rajesh M attended seminar on "Development and challenges in coldwater fisheries" organized by Himachal Pradesh State Fisheries Department" on 31st January, 2019 at Bilaspur, Himachal Pradesh.
- S. Ali attended 4th National Workshop on Research Data management – Krishi Portal organized by ICAR-IASRI during 10-11th December, 2019 at NASC Complex, New Delhi.
- S. Ali participated in 32nd Foundation Day" and "National Symposium on Coldwater Fisheries Development in India: Innovative Approaches and Ways Forward for enhancing Hill Farmers Income during 24-25th September, 2019 at ICAR-DCFR Bhimtal.
- S. Ali participated in the XIV Agricultural Science Congress during 20-23rd February, 2019 at NASC complex, New Delhi.
- Siva, C participated and presented a paper on 'Conservation priority for threatened chocolate mahseer (*Neolissochilus hexagonolepis*) in Northeast India inferred from mitochondrial gene sequence analysis' at 39th annual conference on One Health & Ecosystem services organized by National Bureau of Fish Genetic Resources Chennai during 29-30th November, 2019.

16.2 Participation in Meetings

- R. S. Patiyal attended skill India training programme on skill development training during 1-4th December, 2019 organized by ATARI, Ludhiana, Punjab. .
- R. S. Patiyal attended a meeting with District Magistrate, Pithoragarh, Uttrakhand regarding land acquisition for trout farm on 9th December, 2019.
- R. S. Patiyal attended a meeting with officials of EEF, ICAR-DCFR, Champawat on 28th June, 2019 to discuss various issues of the centre.
- R. S. Patiyal attended a meeting with District Magistrate, Nainital on 10th May, 2019 to discuss some official issues.
- R. S. Patiyal attended a meeting of Sanyukt Karmcharee Pareesad Ki Timaahee Baithak at ICAR-DCFR, Bhimtal on 7th May, 2019.
- R. S. Patiyal attended a video conference meeting on 25th April, 2019 for the hearing of a legal case at the Hon'ble Information Commissioner in respect of RTI dated 10.6.17.
- S. Ali participated in the 21st EAC meeting of MoEF&CC, GoI, New Delhi on 28th January 2019 with respect to Cumulative Impact Assessment of hydroelectric projects in Sutlej River Basin in Himachal Pradesh.
- S. Ali participated in 22nd EAC meeting of River Valley and Hydroelectric projects of MoEF&CC, GoI, New Delhi on 27th February, 2019 with respect to CEIA study of hydroelectric projects in Yamuna, Tons and its tributaries in Uttarakhand.

16.3 Lectures and talks delivered

- Kishor Kunal attended Training of Trainers programme from 11-13th December, 2019 at ICAR-ATARI, Umiam, Barapani, Meghalaya and qualified as a certified trainer for "Freshwater Aquaculture Farmer" under Agriculture Skill Council of India.
- A. K. Giri delivered a lecture on 'Candidate fish species for coldwater aquaculture' to the B.F.Sc. students of CoF, Chandra Shekhar Azad University of Agriculture and Technology, Etawah, Uttar Pradesh.
- B.S. Kamalam delivered a lecture on 'Brood stock nutrition of mahseer' in the NFDB sponsored Training of Trainers programme 'Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer' organized at ICAR-DCFR, Bhimtal during 5-9th August 2019.
- B.S. Kamalam delivered a lecture on 'Coldwater fish nutrition' for M.F.Sc. students of ICAR-CIFE during their exposure visit to Bhimtal during 11-17th September 2019.
- B.S. Kamalam delivered a lecture on 'Nutritional diseases in rainbow trout: diagnosis and prevention' in the NFDB sponsored Training of Trainers programme 'Coldwater fish disease management' organized at ICAR-DCFR, Bhimtal during 7-11th October 2019.
- B.S. Kamalam delivered a theme talk on 'ICAR-DCFR research and development on rainbow trout feeds' in the national symposium on 'Coldwater fisheries development in India: Innovative approaches and way forward for enhancing hill farmers income' organized at ICAR-DCFR, Bhimtal during 24-25th September 2019.
- B.S. Kamalam delivered an awareness talk on 'A glimpse of fisheries and aquaculture science and research in India' for high school students of Woodbridge School, Bhimtal, on 31th July 2019.
- B.S. Kamalam delivered an invited talk on 'Climate resilient technologies for coldwater fisheries in the Indian Himalayan region' in the regional conference on 'Himalaya matters in a changing world' organized at G. B. Pant Institute of Himalayan Ecosystem and Sustainable Development, Almora, during 9-11th December 2019.
- B.S. Kamalam delivered two lectures on 'Feed ingredients and feed preparation machinery' and 'Nutritional deficiency diseases in fish' for B.F.Sc. students of Chandrasekhar Azad University of Agriculture and Technology, as part of their FWEP at Bhimtal during 22-29th

July 2019.

- Ciji Alexander delivered a lecture on 'Principles of fish nutrition and nutritional requirement of fishes' to the BFSc students of Etawah campus, College of Fisheries Science and Research, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during 22-29th July, 2019 at ICAR-DCFR, Bhimtal.
- Ciji Alexander delivered two lectures as a resource person on 'Larval nutrition and feed formulation of mahseer' as well as carried out a practical demonstration on 'Mahseer feed preparation' in the NFDB sponsored ToT training programme on 'Recent advances in breeding and hatchery management of golden and chocolate mahseer at ICAR-DCFR, Bhimtal during 5-9th August, 2019.
- D. Baruah delivered a lecture on "Fish breeding and hatchery management" during training programme for Skilled Supporting Staff on Motivation, stress mitigation and farm management during 6-8th March, 2019.
- D. Baruah delivered a lecture on "Trout farming for livelihood support" during training programme for 5-days Training of Trainers (TOT) on Breeding, seed production and health management of rainbow trout during 4-8th March, 2019.
- D. Baruah delivered lecture on "Promotion of trout farming and fish based eco-tourism in upland regions of IHR" during an awareness programme jointly organized by Department of Fisheries, Government of Arunachal Pradesh in collaboration with ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, Nainital, Uttarakhand at Menchukha of newly declared Shi Yomi district of Arunachal Pradesh during 12-13th February 2019 on the topic "Coldwater fish culture in Menchukha region".
- K. Kunal delivered 8 lectures i) Snow trout: Distribution and current status in India, ii) Taxonomy of fishes, iii) Breeding and seed production of snow trout, iv) Gut content analysis of fish, v) Anatomy of fin fishes, vi) Gear and craft technology, vii) Food and feeding habits of fish, viii) Respiratory system in fishes to the students of COFSc & R Etawah, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, UP during the period from 21st August 2019 to 10th September 2019 at EFF, ICAR-DCFR, Champawat.
- K. Kunal delivered a lecture on 'Culture and feed management of rainbow trout' to the trainees under NFDB sponsored training programme on 26th December, 2019.
- K. Kunal delivered a lecture on 'Estimation of water quality parameters' to the trainees under NFDB sponsored ToT training programme on 24th December, 2019.
- K. Kunal delivered a lecture on "Career in agriculture and fisheries" to students of Govt. Inter College, Jankidhar, Lohaghat on 16th February, 2019.
- K. Kunal delivered a lecture on "Fish farming practices in Champawat district" to students of Govt. Inter College, Pulhindola, Lohaghat on 15th February, 2019.
- M. S. Akhtar and R. S. Patiyal prepared a consultancy project proposal on "Study on habitat ecology and biodiversity of mahseer and other indigenous fish species for developing conservation strategies in the Vyasi hydro electric project site on river Yamuna, Uttarakhand and submitted to Uttarakhand Jal Vidyut Nigam Ltd.
- M. S. Akhtar delivered three lectures on (i) Mahseer hatchery management and seed production of golden mahseer (ii) Photo-thermal manipulations for maturation and spawning of golden mahseer in captivity and (iii) Mahseer breeding and seed production techniques (practical) in NFDB sponsored Training of Trainers (ToT) Programme on 'Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer during 5-9th August, 2019 organized by ICAR-DCFR at Bhimtal.
- P. A. Ganie delivered 8 lectures i) Introduction to ICAR-DCFR- Its history, vision, mandate, structure and achievements, ii) Coldwater

fishery resources of India, iii) Exotic trout in Indian waters: History and present status, iv) Rainbow trout breeding and seed production, v) Nursery rearing practices of rainbow trout, vii) Basics of inland fishery resources of India, vii) Broodstock management practices of rainbow trout, viii) Disease management in rainbow trout to the students of COFSc & R, Etawah, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, UP during the period from 21st August 2019 to 10th September 2019 at EFF, ICAR-DCFR, Champawat.

- P. A. Ganie delivered a lecture on 'Rainbow trout farming in India- Introduction and current status' to the trainees under NFDB sponsored ToT training programme on 23rd December, 2019.
- P. A. Ganie delivered a lecture on 'Site selection for rainbow trout farming- conventional and modern approach' to the trainees under NFDB sponsored ToT training programme on 24th December, 2019.
- P. Dash delivered 3 lectures on (i) Water quality management for coldwater aquaculture, (ii) Biofloc system, and (iii) Breeding and seed production of mahseer in the course of "Recent advances in coldwater aquaculture technique of hatchery and farm management" in the in-plant training program for BFSc IV semester students, College of fisheries science & research centre, Etawah during 30th July to 3rd August, 2019 at ICAR-DCFR, Bhimtal.
- P. Dash delivered 5 lectures cum practical demonstrations on (i) Aquarium management and fish keeping (ii) Coldwater ornamental fish breeding and seed production (iii) Induced breeding of algae eaters and (iv) Embryonic development study (v) Qualitative and quantitative estimation of plankton, live feed culture in the course of "Rearing, breeding and large scale seed production of ornamental fishes" in the in-plant training program for BFSc IV semester students, College of fisheries science & research centre, Etawah during 5-8th August, 2019 at ICAR-DCFR, Bhimtal.
- P. Dash delivered a lecture on captive breeding technique of chocolate mahseer in the ToT programme on "Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer" during 5-9th August, 2019 at ICAR-DCFR, Bhimtal.
- R S Tandel delivered 3 lectures and practical demonstration on (i) Emerging oomycetes infections in coldwater fishes (ii) infections with *Aphanomycetes* infections, and (iii) Drugs and chemicals used to control fish diseases" in the in-plant training program for BFSc IV semester students, College of fisheries science & research centre, Etawah during 30th July to 3rd August, 2019 at ICAR-DCFR, Bhimtal.
- R S Tandel delivered a lecture on health management of mahseer during culture and hatchery operations in the Recent advances in breeding and hatchery management of golden mahseer and chocolate mahseer" during 5-9th August, 2019 at ICAR-DCFR, Bhimtal.
- R. S. Haldar delivered a lecture on "Breeding and culture of rainbow trout" to a group of 11 post graduate students from Department of Zoology, Aligarh Muslim University, Aligarh-202002 (U.P.) during their exposure visit to ICAR-DCFR, Bhimtal on April 16, 2019.
- R. S. Haldar delivered a lecture on "Breeding and culture of rainbow trout" to a group of 26 B.F.Sc. 3rd year students from College of Fishery Sciences, Sri Venkateswara Veterinary University, Muthukur-524 344, SPSR Nellore district (Andhra Pradesh) during their exposure visit to ICAR-DCFR, Bhimtal during 6-8th July, 2019.
- R. S. Haldar delivered a lecture on "Breeding and culture of rainbow trout" to a group of 18 fish farmers under ATMA scheme along with two veterinary officers from the Department of Animal Resources Development, Govt. of West Bengal, Krishnagar, Distt.-Nadia (West Bengal) on 20th July, 2019 during their exposure visit to ICAR-DCFR, Bhimtal during 19-20th July, 2019.
- R. S. Haldar delivered a lecture on "Breeding and culture of rainbow trout" to a group of 29 students

of B.F.Sc. 3rd year from College of Fisheries, Chhattisgarh Kamdhenu Vishwavidyalaya, Kawardha, Kabirdham-491995 (Chhattisgarh) during their exposure visit to ICAR-DCFR, Bhimtal on 30th December, 2019.

- R. S. Haldar delivered a lecture on "Breeding and seed production techniques of mahseer" to a group of 09 post graduate students from Deptt. of Zoology, D.S.B. Campus, Kumaun University, Nainital (Uttarakhand) during their Exposure visit to ICAR-DCFR, Bhimtal on 5th April, 2019.
- R. S. Haldar delivered a lecture on "Breeding and seed production techniques of mahseer" to the group of 31 post graduate students from Deptt. of Zoology, Kumaun University, Almora Campus (Uttarakhand) during their exposure visit to ICAR-DCFR, Bhimtal on 19th April, 2019.
- R. S. Haldar delivered a lecture on "Breeding and seed production techniques of mahseer" to a group of 33 students of B.Sc. Zoology (Hons) from Department of Zoology, Hindu College, University of Delhi, Delhi-110 007 during their exposure visit to ICAR-DCFR, Bhimtal on 30th September, 2019.
- R. S. Haldar delivered a lecture on "Present status and future perspective of coldwater fisheries in India" to a group of 59 third year B.Sc. (Ag) students from RMD College of Agriculture & Research Station, Indira Gandhi Krishi Vishwavidyalaya, Ambikapur, Surguja (Chhatishgarh) during their exposure visit to ICAR-DCFR, Bhimtal on 3rd May, 2019.
- R. S. Haldar delivered a lecture on "Present status and future perspective of coldwater fisheries in India" to a group of 16 French students (DEFIAA Consortium, French Ministry for Food, Agriculture and Forestry) during their exposure visit to ICAR-DCFR, Bhimtal during 12-13th August, 2019.
- R. S. Haldar delivered a lecture on "Present status and future perspective of coldwater fisheries in India" to a group of 44 B.Sc. (Ag) students from Ranchi Agriculture College, Birsa Agricultural University, Kanke, Ranchi – 834006 (Jharkhand) during their Exposure visit to ICAR-DCFR, Bhimtal during 20-21st August, 2019.
- R. S. Haldar delivered a lecture on "Present status and future perspective of coldwater fisheries in India" to a group of 11 Officers from Department of Land Reforms, Govt. of Nagaland during their exposure visit to ICAR-DCFR, Bhimtal on 01st October, 2019.
- R. S. Haldar delivered a lecture on "Present status and future perspective of coldwater fisheries in India" to a group of 16 students of B.Sc. (Fisheries) from the Agriculture and Forestry University, Deptt. of Animal Science, Veterinary Science and Fisheries, Rampur, Chitwan, Nepal during their Exposure visit to ICAR-DCFR, Bhimtal on 10th December, 2019.
- R. S. Haldar delivered a lecture on "Present status of coldwater fisheries in India" to a group of 39 students of B.F.Sc. from College of Fisheries, Babasaheb Sawant Konkan Krishi Vidyapith, Shirgaon, Ratnagiri – 415629 (Maharashtra) during their exposure visit to ICAR-DCFR, Bhimtal on 27th November, 2019.
- R. S. Haldar delivered a lecture on "Present status of coldwater fisheries in India" to a group of third year B.Sc. (Zoology) students from Department of Zoology, Hooghly Women's College (Affiliated to Burdwan University), Hooghly (West Bengal) during their exposure visit to ICAR-DCFR, Bhimtal on 17th December, 2019.
- R. S. Patiyal delivered a lecture on 'Mahaseer conservation and ecotourism" to MFSc students of ICAR-CIFE, Mumbai on 12th September, 2019.
- R. S. Patiyal delivered a lecture on 'Ornamental fish as option for livelihood security' to BFSc students of CoF, Etawah on 1st August 2019.
- R. Singh delivered 7 lectures i) Management practices of rainbow trout farming, ii) Status of carp farming in India, iii) Poly-culture of carps: principles and practices, iv) Breeding and seed production of carps, v) Selection of site for carp farming, vi) Management practices

in carp culture, vii) Reproductive physiology and endocrinology of rainbow trout to the students of COFSc & R, Etawah, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, UP during the period from 21st August 2019 to 10th September 2019 at EFF, ICAR-DCFR, Champawat.

- R. Singh delivered a lecture on 'Breeding seed production and health management of Rainbow trout' to the trainees under NFDB sponsored ToT training programme on 26th December, 2019.
- R. Singh delivered a lecture on "Career in agriculture and fisheries" to students of Govt. Inter College, Pulhindola, Lohaghat on 15th February, 2019.
- R. Singh delivered a lecture on "Fish farming practices in Champawat district" to students of Govt. Inter College, Jankidhar, Lohaghat on 16.02.2019.
- S. Ali delivered a lecture on the "Role of fish genetics in enhancing fish production" during Five days NFDB sponsored Training of Trainers (ToT) Programme on Coldwater Fish Disease Management 07-11th October, 2019.
- S. Chandra delivered a talk on 'Rainbow trout farming in midi hill raceways for livelihood generation' on 14th June 2019 at Vikash Bhawan, Pauri Garhwal in the workshop on "Up-Scaling of fish farming practices in Garhwal region for livelihood development of Schedule Caste population", Uttarakhand.
- S. Chandra gave a lecture cum demonstration to the 18 progressive fish farmers on 19th July, 2019 under ATMA scheme of the Animal Resources Development Department, Nadia District, West Bengal.
- S. Chandra gave an invited talk on 'Improved techniques of coldwater fish farming' on 1st July, 2019 to about 50 fish farmers of Uttarakhand at Bhimtal under Blue Revolution Workshop organized by Uttarakhand State Fisheries Department.
- S. Chandra gave two lectures on 'Fish farming for livelihood and employment generation' and on 'Fish health management' to 50 fish farmers at KVK, ICAR-IVRI, Izatnagar, Bareilly on 30th July, 2019.
- S. Chandra gave two talks on 'Parasitic diseases and their control' and 'Biosafety measures in fish farms and hatcheries' and took two practical class on identification of parasites and treatment techniques to 10 B F Sc students of CoF, Etawah.UP.

Library and Information Services

17

17.1 Library procurement and holdings

The ICAR-DCFR library and documentation unit acts as a repository of literature and provides latest information in the field of fisheries and allied subjects.

During the year 2019, the Directorate subscribed 3 Indian journals and several periodicals besides providing access to the ICAR CeRA journals through J-gate platform. Further, the library finalized the process of procurement of more than 200 scientific books of both Indian and foreign authors worth approx. Rs. 14 lakhs through exhibition by Directorate's empanelled book suppliers/vendors. The book exhibition was held on 29th January, 2019. The current holdings of the library includes ~ 6800 books, ~1700 volumes of foreign journals, ~550 volumes of Indian journals and more than 9000 other publications. The library provides services to the scientists and other staff members of the institute apart from scholars, researchers, students and other stakeholders from local organizations interested in scientific literature on coldwater fisheries and allied subjects.

Scientists selecting books during the exhibition on 29th January, 2019.

17.2 Library automation

Various activities of library have been computerized using TLS software. The records of books, journals, bulletins etc. were entered in the database. The barcoding of books and periodicals are actively being done. The digitalization work of the institute's in–house publications has been completed and hosted in the Directorates website.

17.3 Information services

The library also provides platform to access free online downloads of publications and articles of many international and national journals through www.cera.jece.in. The library is further continuing its efforts in collection, processing and disseminating scientific/technical information to the potential users. The library, during 2019, has provided many scanned reprints of offline/back volume research articles to various distant users/researchers of NARS through DDR (document delivery request), an online document deliver service of J-gate plus under CeRA of ICAR.

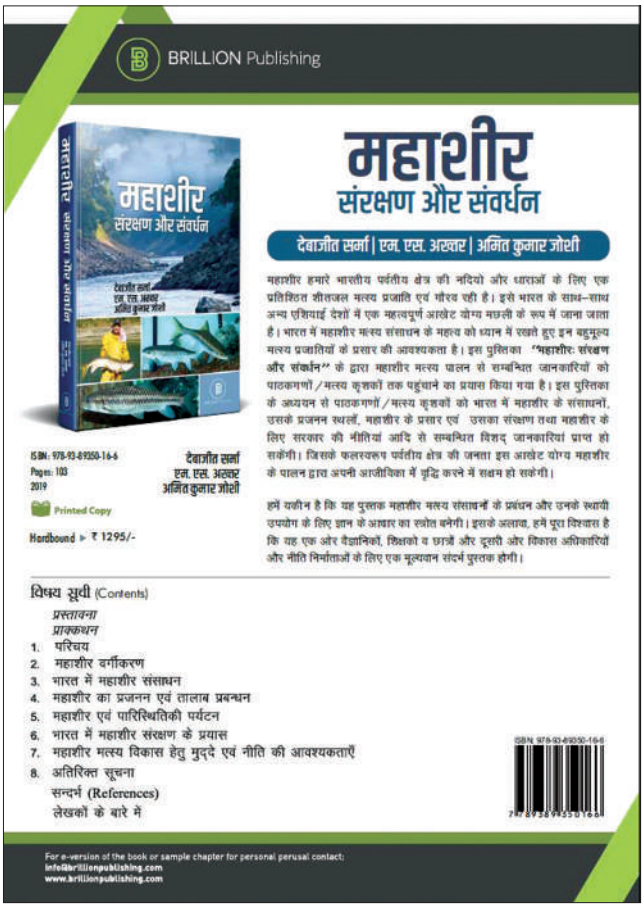
17.4 Exchanges services

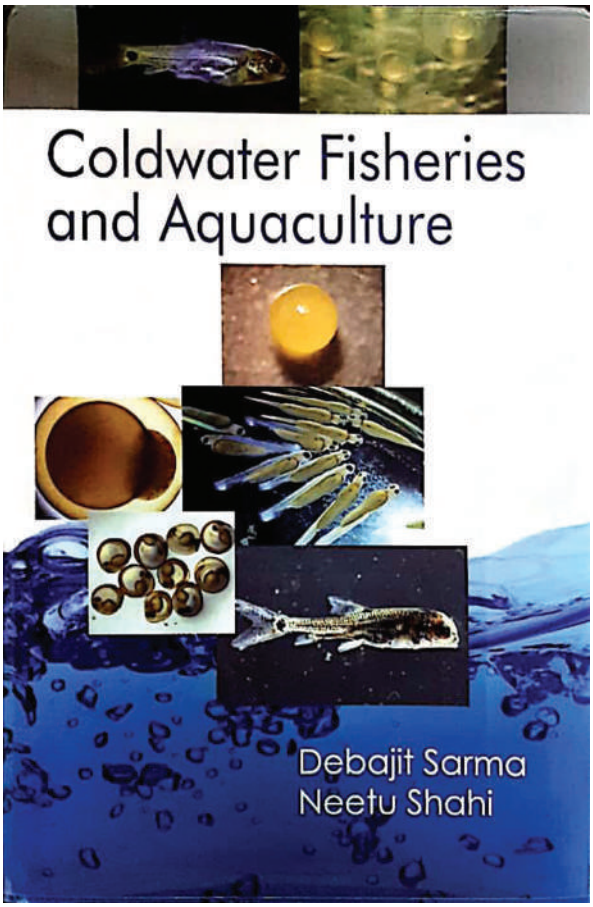
The library maintained exchange relationship with various research organizations and institute of national and international repute. The annual reports, newsletters, special publications and technical bulletins published from time to time have been mailed to more than 250 organizations, institutions, Fisheries Directors, Deans, and fishery agencies, and other stakeholders.

17.5 Documentation section

The documentation section of the library is entrusted with responsibility of publishing in-house publications such as scientific bulletins, brochures, pamphlets, annual reports, newsletters, monographs etc. During the year, this section published one annual report of 2018, three bulletins, three leaflets, one Hindi magazine (Himjyoti) and one coffee table book of the Directorate.

ICAR-DCFR's in-house publications during the year 2019.





ICAR-DCFR's priced publications during the year 2019.

Distinguished Visitors

18

- Dr. K. K. Vass, Former Director, ICAR-CIFRI, Barrackpore and ICAR-DCFR, Bhimtal visited the Directorate's facilities on 13th March, 2019.

Dr. K. K. Vass visiting the Directorate's wet lab. unit

- Dr. M. Sinha, Former Director, ICAR-CIFRI, Barrackpore and Chairman, RAC visited the Directorate during 28-29th March, 2019.
- Dr. S.C. Mukherjee, Former Joint Director, ICAR-CIFE, Mumbai and Member, RAC visited the Directorate 28-29th March, 2019.
- Dr. A.K. Sahu, Former Principal Scientist, ICAR-CIFA and Member, RAC visited the Directorate during 28-29th March, 2019.
- Dr. H.C.S. Bisht, Professor, Department of Zoology, Kumaon University, Nainital and Member, RAC visited the Directorate during 28-29th March, 2019.

DCFR Scientists with outgoing RAC committee during 28-29 March, 2019

- Sh. Sushil Kumar (IAS), Additional Secretary, DARE and Secretary, ICAR, New Delhi along with Dr. R. K. Singh, Director, IVRI, Izatnagar, Bareilly visited the institute during 14 - 15th May 2019. He first visited various facilities available at the Directorate including laboratory facilities, ornamental fish unit and fish farm ponds. An interactive session was also convened along with the scientists, technical and administrative staffs and took appraisal of the progress made by the Directorate. He emphasized doing the technological interventions for doubling the farmer's income.

Sh. Sushil Kumar (IAS) visiting the farm facilities of ICAR-DCFR

- Dr. Punjab Singh, Former Director General, ICAR, New Delhi visited the Directorate on 19th July, 2019.

Dr. Punjab Singh, Former DG, ICAR, New Delhi visiting the aquarium facility of ICAR-DCFR.

- Quinquennial Review Team (QRT) comprising Dr. Dilip Kumar, Chairman and Former Director, ICAR-CIFE, Mumbai and members (QRT) Dr. J. R. Dhanze, Dr. Atul Borgohain, Dr. Madan Mohan and Dr S. D. Gupta visited the Directorate during 18-25th September, 2019
- Quinquennial Review Team (QRT) members Dr. J. R. Dhanze, Dr. Atul Borgohain and Dr S. D. Gupta visited EFF, Champawat and a progressive fish farm during 21-22nd September, 2019

The QRT team interacting with the scientists and staff of ICAR-DCFR

Visit of QRT Team members at EFF, Champawat

- Dr. J.K. Jena, Deputy Director General (Fisheries Sciences & Animal Science, ICAR), New Delhi, Dr. A. K. Singh, Former Director, ICAR-DCFR, Dr. A. G. Ponniah, Former Director, ICAR-NBFGR & ICAR-CIBA, Dr. K. K Vass, Former Director, ICAR-CIFRI, Dr. V. V. Sugunan, Former Director, ICAR-CIFRI, Dr. Arun Ninawe, Former advisor, DBT, New Delhi, Sh. Satpal Mehta, Director, Dept. of Fisheries, Himachal Pradesh, Dr. Rina Chakraborty, Head, Dept. of Zoology, Delhi University visited the Directorate on 24th September, 2019 on the occasion of DCFR's 32nd foundation day.

Dr. J. K. Jena alongwith other distinguished guests visiting RAS facility on 24th September, 2019.

- Dr. S. K. Mahajan, Dean, College of Fisheries, Jabalpur visited the Directorate on 11th December, 2019.

Dr. S. K. Mahajan at mahseer hatchery, ICAR-DCFR

- Dr. M. Prabhakar, Principal Scientist, ICAR-CRIDA and Principal Investigator, NICRA project visited the Directorate's RAS facility (created under NICRA project) on 10th December, 2019.

Dr. M. Prabhakar visiting the Directorate's RAS Unit

Important Committees

19

19.1. Members of Research Advisory Committee

Dr. M. Sinha, Former Director, ICAR-CIFRI & Former Advisor, Department of Fisheries, Tripura Raghubir Sadan, District Judge's Compound, Civil Lines, Gorakhpur-273001, Uttar Pradesh.	Chairman
Shri I. P. Chhetri, Former Director (Fisheries), Dept. of Animal Husbandry, Livestock & Fisheries Services, Government of Sikkim, Krishi Bhawan, Tadong, Sikkim.	Member
Dr. S.C. Mukherjee, Former Joint Director, ICAR-CIFE, 187 A, Sahid Nagar, Bhubaneswar-751007, Odisha.	Member
Dr. A.K. Sahu, Former Principal Scientist, ICAR-CIFA, 16, Bhimpur Duplex Colony, Bhubaneswar-751020, Odisha.	Member
Dr. H.C.S. Bisht, Professor, Department of Zoology, Kumaon University, DSB campus, Nainital-263001, Uttarakhand.	Member
Dr. Pravin Putra, Asst. Director General (Marine Fisheries), ICAR, Krishi Anusandhan Bhawan-II, New Delhi-110012.	Member
Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal.	Member
Dr. N.N. Pandey, Principal Scientist, ICAR-DCFR, Bhimtal.	Member Secretary

19.2. Members of Institute Management Committee

Dr. Debajit Sarma, Director (Acting), ICAR-DCFR	Chairman
The Assistant Director General (Inland Fisheries), ICAR, Krishi Anusandhan Bhawan -II, Pusa, New Delhi-110012.	Member
Dr. B.P. Madhwal, Director, Directorate of Fisheries, Badasi Grand Dhanyari, Raipur Road, Dehradun (UK)	Member
Dr. R.K. Sangwan, Director of Fisheries, Government of Haryana, Panchkula Haryana	Member
Dr. I.J. Singh, Dean, CFSc., GBPU&T, Pantnagar US Nagar(UK)	Member
Dr. K.D. Joshi, Pr. Scientist, ICAR-BBFGR, Dilkusha, Lucknow-226002 (UP)	Member
Dr. S.K. Das, Head ICAR Research Complex, Barapani, Meghalaya-793103	Member
Dr. B.P. Mohanty, Head of Department CIFRI, Barrackpore-700120	Member
Dr. Mukunda Goswami, Principal Scientist, ICAR-CIFE, Mumbai, Punch Marg, off Yari Road, Versova, Andheri (West) 400061.	Member
Shri. Kunal Kalia, F&AO, ICAR Hqrs, Krishi Bhawan, New Delhi-110001	Member
Mr. Pushkar Joshi, Bharoment, Jeolikote, Post-Jeolikote-27 Distt-Nainital	Member
Mr. Vivek Sah, P/o Naini Cottage, Cantt. Tallital Nainital	Member
Shri. R.S. Negi, Administrative Officer, ICAR-DCFR	Member Secretary

19.3. Members of Prioritization Monitoring & Evaluation Cell

Dr. N.N. Pandey, Principal Scientist	In-charge
Dr. Shahnawaz Ali, Scientist	Member
Dr. Kh. Victoria Chanu, Scientist	Member
Sh. Amit Kumar Saxena, Sr. Technical Assistant	Technical support
Smt. Susheela Tewari, Private Secretary to Director	Secretarial assistance

19.4. Members of Prioritization Monitoring & Evaluation Committee

Dr. Debajit Sarma, Director	Chairman
Dr. S. Chandra, Principal Scientist	Member
Dr. R.S. Patiyal, Principal Scientist	Member
Dr. N.N. Pandey, Principal Scientist	Member Secretary

19.5. Members of Institute Technology Management Committee

Dr. Debajit Sarma, Director	Chairman
Dr. Veena Pande, Head, Dept. of Biotechnology, Kumaon, University, Bhimtal Campus.	External Member
Dr. N.N. Pandey, Principal Scientist	Member
Dr. Neetu Shahi, Scientist	Member
Dr. M.S. Akhtar, Scientist	Member
Dr. Biju Sam Kamalam, Scientist	Member
Mr. R.S. Tandel, Scientist	Member
Dr. R.S. Patiyal, Principal Scientist	Member Secretary

19.6. Members of Institute Technology Management Unit

Dr. R.S. Patiyal, Principal Scientist	In-charge
Dr. Biju Sam Kamalam, Scientist	Member

19.7. Members of Agricultural Knowledge Management Unit

Sh. R.S. Tandel, Scientist	In-charge
Sh. S.K. Mallik, Scientist	Member
Dr. M.S. Akhtar, Scientist	Member
Sh. A.K. Saxena, Sr. Technical Assistant	Technical support

19.8. HYPM, PIMS

Dr. N.N. Pandey, Principal Scientist	In-charge
Sh. A.K. Saxena, Sr. Technical Assistant	Technical support

19.9. Library Advisory Committee

Dr. D. Sarma, Director (Act.)	Chairman
Dr. N.N. Pandey, Principal Scientist	Member
Dr. Shahnawaz Ali, Scientist	Member
Sh. R.S. Negi, Administrative Officer	Member
Sh. Baldev Singh, Senior Technical Officer	Member
Sh. Sayed Mohsin Ali, Asst. Fin. & Acc. Officer	Member
Dr. M.S. Akhtar, Scientist & I/c Library	Member Secretary

19.10. Institute Joint Staff Council

Official side	
Dr. Debajit Sarma, Director	Chairman
Dr. R.S. Patiyal, Principal Scientist	Member
Dr. Deepjyoti Baruah, Sr. Scientist	Member
Dr. R. S. Haldar, ACTO	Member
Sh. Sayed Mohsin Ali, Asst. Fin. & Acc. Officer	Member
Sh. R.S. Negi, Admin. Officer	Member Secretary
Staff side	
Sh. Ankesh Sinha, Assistant Admin. Officer	Member, CJSC
Sh. Hansa Singh Bhandari, LDC	Member
Sh. T. M. Sharma, Sr. Technical Assistant	Member Secretary
Sh. Gopal, Sr. Technical Assistant	Member
Sh. Manoj Kumar, Skilled Supporting Staff	Member
Sh. Ravinder Kumar, Skilled Supporting Staff	Member

19.11. Institute Biosafety Committee

Dr. Debajit Sarma, Director, ICAR-DCFR, Bhimtal.	Chairman
Dr. A. K. Tiwari, Principal Scientist & Head, Division of Standardization, ICAR-IVRI, Izatnagar.	DBT Nominee
Dr. A. B. Pandey, Principal Scientist & Head, Division of Virology, ICAR-IVRI, Mukteshwar.	Outside Expert
Dr. A. K. Sharma, Principal Scientist, ICAR-IVRI, Mukteshwar.	Outside Expert
Col. (Dr.) C. S. Rawat, MBBS, DPH, FRIPHH	Biosafety Officer
Dr. Neetu Shahi, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Dimpal Thakuria, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Amit Pande, ICAR National Fellow, ICAR-DCFR, Bhimtal.	Member Secretary

19.12. Store Purchase Advisory Committee

Dr. Shahnawaz Ali, Scientist	Chairman
Sh. S. K. Mallik, Scientist	Member
Dr. Neetu Shahi, Scientist	Member
Dr. M. S. Akhtar, Scientist	Member
Dr. Dimpal Thakuria, Scientist	Member
Sh. R. S. Negi, Administrative Officer	Member
Sh. Sayed Mohsin Ali, Asst. Fin. & Acc. Officer	Member
Sh. Ankesh Sinha, Assistant Admin. Officer & I/C Store & Purchase	Member Secretary

20 Staff News

20.1. Promotions

- Mr. Pratap Singh Bisht promoted from UDC to the post of Assistant under DPC with effect from 12th September, 2019.

20.2. Resignation

- Mr. Arun Kumar Khulbe, Assistant was relieved from the Directorate on 24th October, 2019.

Bidding farewell to Sh. Arun Kumar Khulbe

Personnel

21

Staff list as on 31.12.2019

21.1 Research Management		
1.	Dr. Debajit Sarma	Director
21.2 Scientific Staff		
1.	Dr. Amit Pande	ICAR National Fellow (Biotechnology-Animal science)
2.	Dr. Nityanand Pandey	Principal Scientist (Aquaculture)
3.	Dr. Suresh Chandra	Principal Scientist (Fish Pathology)
4.	Dr. R.S. Patiyal	Principal Scientist (Fish Genetics & Breeding)
5.	Dr. Deepjyoti Baruah	Senior Scientist (Fish & Fishery Science)
6.	Dr. Shahnawaz Ali	Scientist (Aquaculture)
7.	Sh. Sumanta Kumar Mallik	Scientist (Aquaculture)
8.	Dr. Neetu Shahi	Scientist (Biotechnology-Animal Science)
9.	Dr. Md. Shahbaz Akhtar	Scientist (Fish & Fishery Science)
10.	Dr. Dimpal Thakuria	Scientist (Biochemistry-Animal science)
11.	Dr. Kh. Victoria Chanu	Scientist (Biochemistry-Animal science)
12.	Dr. Ciji Alexander	Scientist (Fish Nutrition)
13.	Dr. Biju Sam Kamalam J.	Scientist (Fish Nutrition)
14.	Dr. Rajesh M	Scientist (Fish Nutrition)
15	Sh. Tandel Ritesh Kumar Shantilal	Scientist (Fish Health)
16.	Sh. Abhay Kumar Giri	Scientist (Aquaculture)
17.	Smt. Pragyan Dash	Scientist (Aquaculture)
18.	Dr. Prakash Sharma	Scientist (Fish Nutrition)
19.	Sh. Siva, C.	Scientist (Fish Genetics & Breeding)
20.	Dr. Raghvendra Singh	Scientist (Aquaculture)
21.	Sh. Kishor Kunal	Scientist (Fisheries Resource Management)
22.	Sh. Parvaiz Ahmad Ganie	Scientist (Fisheries Resource Management)
23.	Sh. Raja Aadil Hussain Bhat	Scientist (Fish Health)
21.3 Technical Staff		
1.	Dr. R.S. Haldar	Assistant Chief Technical Officer
2.	Sh. Amit Kumar Joshi	Assistant Chief Technical Officer
3.	Sh. Baldev Singh	Sr. Technical Officer
4.	Sh. Santosh Kumar	Technical Officer
5.	Sh. Ravinder Kumar	Technical Officer

6.	Sh. Amit Kumar Saxena	Technical Officer
7.	Sh. Gopal C. Arya	Sr. Technical Assistant
8.	Sh. HansaDutt	Sr. Technical Assistant
9.	Sh. T.M. Sharma	Sr. Technical Assistant
10.	Sh. R.K. Arya	Sr. Technical Assistant
11.	Sh. Partha Das	Technical Assistant
12.	Sh. Manoj Kumar Yadav	Driver (Technical Assistant)

21.4 Administrative Staff

1.	Sh. Ravindra Singh Negi	Administrative Officer
2.	Sh. Sayed Mohsin Ali	Asstt. Fin. & Acc. Officer
3.	Smt. Khilawati Rawat	Asstt. Admn. Officer
4.	Sh. Ankesh Kumar Sinha	Asstt. Admn. Officer
5.	Smt. Susheela Tewari	Private Secretary
6.	Sh. P.C. Tewari	Assistant
7.	Sh. J.C. Bhandari	Assistant
8.	Sh. Pratap Singh Bisht	Assistant
9.	Smt. Munni Bhakt	UDC
10.	Sh. Hansa Singh Bhandari	LDC

21.5 Skilled Supporting Staff

1.	Sh. Ravinder Kumar	Skilled Supporting Staff
2.	Sh. Om Raj	-do-
3.	Sh. Sunder Lal	-do-
4.	Sh. Dharam Singh	-do-
5.	Sh. Pooran Chandra	-do-
6.	Sh. Manoj Kumar	-do-
7.	Sh. Kuldeep Kumar	-do-
8.	Sh. Bhola Dutt Mouni	-do-
9.	Smt. Basanti Devi	-do-
10.	Sh. Mangla Prasad	-do-

ICAR-Directorate of Coldwater Fisheries Research

Bhimtal-263 136, Nainital, Uttarakhand, India

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Website: www.dcfr.res.in