



ANNUAL REPORT 2015-2016

ICAR-Directorate of Coldwater Fisheries Research
Bhimtal, Uttarakhand, India





Front Cover:
Theme - Research activities carried out by ICAR-DCFR in golden mahseer



Back Cover:
Theme - Aquaculture initiatives taken by ICAR-DCFR under Tribal Sub-Plan



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ICAR-Directorate of Coldwater Fisheries Research
Bhimtal - 263136, Nainital
Uttarakhand, India



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During the year 2015-2016, the multidisciplinary team of the Directorate undertook various research and development initiatives with the focus on sustainably augmenting fish production in the Indian uplands. The noteworthy achievements includes the successful captive breeding of *Labeo pangusia*; seed production from farm raised snow trout *Schizothorax richardsonii*; characterization of the complete mitochondrial genomes of brown trout and chocolate mahseer; transcriptome profiling of novel genes related to immune response in golden mahseer and thermal tolerance in snow trout; identification of highly polymorphic SSR markers in *Schistura sikmaiensis*; characterization of kisspeptin peptide and receptor in golden mahseer; development of cost-effective starter feed for rainbow trout; nutrient profiling of snow trout species; and systematic surveillance of coldwater fish pathogens. Significant efforts have also been directed towards the captive maturation of golden mahseer through photoperiod manipulation and elucidation of the physiological mechanisms that constraints growth in snow trout. Furthermore, novel developments such as a method to detect the presence of virus signal in clinical fish samples, bacterial bioremediation measure to mitigate harmful algal blooms in aquaculture ponds and peptide nano system for intracellular delivery of biomolecules are in progress. In terms of resource assessment, efforts are being concentrated to develop a spatial database of coldwater resources in the western Himalayan regions and to explicate the eco-biology of selected Himalayan rivers and mountain lakes. The Directorate is also an active partner in the National Mission for Sustaining the Himalayan Ecosystem and in the National network of germplasm centre for prioritized finfishes of Ganga basin.

Involving all the stakeholders, a National Consultation on the prospects and challenges of rainbow trout farming was organized to plan strategies to invigorate trout production in India. Similarly, a National Workshop on coldwater endemic fishes of north-east was organized to prepare an action plan for the development of their breeding and captive management protocols. The Directorate also organized various other trainings, field demonstrations, scientist-farmer interaction meets, farmer advisories and exhibitions to disseminate scientific knowledge on various aspects of coldwater fisheries and aquaculture to farmers, fisheries officers and other concerned stakeholders. Awareness-cum-ranching programmes were also organized to revive the natural population of golden mahseer. Under the north-east hill plan and tribal sub-plan, farm input distribution programmes, hands on trainings and frontline

demonstrations were organised. Technical and financial support was also provided to the farmers and fisheries departments to expand rainbow trout farming in disadvantaged areas. Particularly, two chocolate mahseer hatcheries were established in Meghalaya and Nagaland.

In addition, the Directorate has strengthened linkages with the fisheries departments of different hill states, research institutes, universities, non-governmental organisations and central agencies such as National Fisheries Development Board and Department of Biotechnology for promoting research and developmental activities. I sincerely appreciate the collective contribution of all the scientists and staff members of the Directorate for the successful progress and achievements made during the year. I also thank the members of the editorial committee for their meticulous effort in compiling and bringing out the Annual Report 2015-2016.

The Directorate has received unflinching support from ICAR to pursue its various activities. In this regards, I am deeply indebted to Secretary (DARE) and Director General (ICAR), Dr. S. Ayyappan (up to February 2016) and Dr. T. Mohapatra for their visionary support and guidance. I am also grateful to the Deputy Director General (Fisheries), Dr. J.K. Jena and the Assistant Director General (Inland Fisheries), Dr. S.D. Singh (up to December 2015) and Dr. S. Raizada for their continuous support, encouragement and guidance in the planning and execution of research, extension and other activities of this Directorate.



(A.K. Singh)
Director

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EXECUTIVE SUMMARY

The mandate of ICAR-Directorate of Coldwater Fisheries Research is to carry out comprehensive research, technological interventions and knowledge transfer for expanding and augmenting hill aquaculture production and managing coldwater fisheries resources in Indian uplands. The accomplishments and various activities of the Directorate during the reporting period 2015-2016 are summarized as follows:

Resource assessment and management

- Ichthyofaunal diversity, habitat status and hydrobiology of the rivers Western Ramganga and Kosi are being meticulously investigated under the project on ecosystem assessment and mapping of aquatic resources in selected Himalayan drainages. Preliminary analysis on quantitative pattern, richness and evenness of fish fauna indicated poor fish diversity in the sampled stretch of the river Western Ramganga.
- Eco-biological study of selected mountain lakes in central and north-east Himalayan regions have been initiated to understand the changing trophic dynamics of the targeted lacustrine ecosystem. The hydro-biological information generated from some of the high altitudinal lakes of Arunachal Pradesh and Sikkim are the first scientific reports.
- In order to develop a spatial database of coldwater resources in the Western Himalayan region, the natural water resources (rivers, lakes and reservoirs) of Jammu & Kashmir and Himachal Pradesh are being mapped and digitized using satellite information and surveys.
- The Directorate is associated in the National Mission for Sustaining the Himalayan Ecosystem, with the responsibility to conduct

research on sustainable development of coldwater fisheries and ecosystem monitoring in selected Himalayan regions.

- The Directorate is also involved in the national network of germplasm centre for prioritized finfishes of Ganga basin (upland), with the primary objective to develop a germplasm repository of important indigenous coldwater fishes.

Aquaculture oriented research progress

- Potential indigenous fishes of food value have been targeted for complete domestication under the prioritized programme on species diversification for hill aquaculture. Captive breeding of *Labeo pangusia* has been achieved and *Raiamas bola* is targeted next.
- Field trials on the prospect of including endemic fishes *Bangana devdevi* and *Osteobrama belangeri* in composite culture of Chinese carps suggested economic advantage.
- Photo-thermal manipulation for gonadal maturity of golden mahseer in captivity is being experimentally attempted to overcome the exclusive dependence on wild collected female brooders for seed production. Photoperiod induced changes in the profile of reproductive hormones has been recorded and aromatase encoding genes were partially characterized.
- Full length cDNA of kisspeptin1, kisspeptin1 receptor and kisspeptin2 of golden mahseer were cloned and characterized. Further, the structural analysis of the predicted *kiss1* and *kiss1r* peptides have been carried out to support *in vivo* physiological studies later.
- A broad ranging project has been taken up to decipher the physiological mechanisms underlying nutrient mediated regulation

of growth and maturation in *Schizothorax richardsonii*. Wild collected snow trout have been successfully acclimatized and reared in captivity. The effect of nutritional status on growth physiology is being experimentally elucidated. Concurrently, captive breeding of farm raised brooders have been achieved.

- The biochemical composition, fatty acid profile, cholesterol, triglyceride and mineral concentration of six different snow trout species has been estimated to accentuate its nutritional value as a dietary component for human consumption.
- Under feed outreach activity, two cost-effective rainbow trout starter feed formulations were developed and experimentally found to outperform existing commercial feeds.
- Breeding and seed production of important coldwater fishes such as rainbow trout (2.34 lakh eyed ova), improved Hungarian common carp (1.3 lakh fry), golden mahseer (45,000 fingerlings), minor carps (3 lakh fry) and ornamental fishes was successfully carried out. The revenue generated from the sale of rainbow trout, common carp and golden mahseer seed amounted to 2.26 lakh rupees.

Disease surveillance and health management

- Potential bacterial pathogens present in the rainbow trout farms of Sikkim and Himachal Pradesh were profiled and maintained in the laboratory. The overall observations suggest the prevalence of secondary bacterial pathogens.
- Under the National Surveillance Programme on Aquatic Animal Diseases, 25 rainbow trout and carp farms of Himachal Pradesh, Jammu & Kashmir and Uttarakhand were surveyed for the presence of coldwater fish diseases. The results indicated the absence of infectious pancreatic necrosis virus and viral haemorrhagic septicemia virus.
- Mx gene and Mx promoter of snow trout have been identified and characterized at the molecular level in the first phase of an approach to develop a method for detecting the presence of virus signal in clinical samples of fish.
- Based on their algicidal activities, 10 bacterial isolates were identified and characterized in order to develop a bacterial bioremediation measure that can mitigate *Microcystis aeruginosa* blooms in aquaculture ponds and water bodies.
- Under the All India Network Project on fish health, primary data concerning the use of aqua drugs, medicines, antibiotics and treatment kits were collected from nearly 300 fish farms in six hill states. Table salt, lime and potassium permanganate were found to be the commonly used agents for fish health management in hill aquaculture practices.

Molecular genetics and biotechnological contribution

- The complete mitogenomes of brown trout and chocolate mahseer have been characterized through next generation sequencing.
- The genetic differences between geographically distinct chocolate mahseer and brown trout populations are being analysed using mitochondrial gene markers. Moreover, a partial genomic library was constructed and used to isolate SSR markers for genotyping the 11 chocolate mahseer and 5 brown trout populations.
- Similarly, 3876 SSR containing sequences were obtained from the partial genomic library of *Schistura sikmaiensis*. Among the 32 loci selected for genotyping the different populations, 18 loci were found to be highly polymorphic.
- Transcriptome analysis of heat shock responsive transcripts in *Schizothorax richardsonii* revealed that out of 20,506 unigenes annotated into 35 functional groups, genes related to

the regulation of metabolic processes was an integral part of thermal tolerance.

- *In silico* transcriptome analysis of the response of golden mahseer to *Aeromonas hydrophila* infection indicated that out of the 2,408 differentially expressed transcripts, the majority were found to be involved in the reorganization of the cellular system.
- Three novel cell penetrating peptides have been identified from fish viruses to develop a nano system for intracellular delivery of biomolecules. The structural analysis of these peptide nano systems have been carried out and their synthesis is in progress.

Important events, extension activities and trainings

- A two days national consultation on the prospects and challenges of rainbow trout farming was organized at Bhimtal during 20-21 September 2015. Based on the thorough deliberations, an action plan was drafted to target higher productivity through scientific improvement in inputs, management practices and better governance.
- The Directorate also hosted the launch workshop of the taskforce on Himalayan agriculture under the National Mission for Sustaining the Himalayan Ecosystem.
- Through direct visits and other mode of communication, farm specific advisories and technical support were provided to more than 50 rainbow trout growers of Sikkim and Himachal Pradesh and 85 carp farmers of Uttarakhand, including those from the villages adopted under the 'Mera Gaon Mera Gaurav' programme.
- As a routine activity and on special occasions such as 'Fish farmers day' and 'Jai Kisan Jai Vigyan week', practical demonstrations of rainbow trout and carp breeding; awareness programmes on fish health management; farmer-scientist interaction meets and farm input distribution programmes were organized by the ICAR-DCFR field centre, Champawat.
- Rainbow trout farming in clusters was promoted as a remunerative livelihood option in Kumaon and Garhwal regions of Uttarakhand through the NFDB sponsored technology upgradation programme.
- To rehabilitate and revive golden mahseer population in their natural habitats, 20,000 hatchery reared fingerlings were released in the mahseer sanctuary near Baijnath temple, Bageshwar and 9000 fingerlings in Bhimtal lake, Uttarakhand.
- The research and development activities of the Directorate were exhibited and disseminated to farmers and other stakeholders at sixteen different conferences, seminars and melas organized across the country.
- Several groups of students and farmers visited the facilities of the Directorate at Bhimtal and Champawat, and interacted with the scientists.
- Under the Tehri Hydro Development Corporation consultancy, a fisheries management plan is being prepared for implementation in the Vishnugad-Pipalkoti hydroelectric project.
- Two NFDB sponsored training programmes on specific aspects of hill aquaculture were conducted for state fisheries department officials at Mawpun-Meghalaya and Chatlang-Mizoram. Likewise, two other NFDB sponsored trainings were conducted for fish farmers at Dirang-Arunachal Pradesh and Toli-Uttarakhand.
- Under the HRD initiative, the scientific, technical and administrative staffs of the Directorate were encouraged to attend essential capacity building programmes. At the same time, several student research projects are also being supervised and carried out.

Initiatives under north-east hill plan and tribal sub-plan

- A national workshop on 'coldwater endemic fishes of north-east: avenues and challenges' was organized at Gangtok, to prepare an action plan for the development of breeding and

captive management protocols of important endemic species like *Semiplotus semiplotus*, *Neolissocheilus hexagonolepis*, *Osteobrama belangiri*, etc.

- Technical and financial support was provided to the state fisheries departments of Sikkim and Arunachal Pradesh in various aspects of rainbow trout farming.
- Two chocolate mahseer hatcheries were established at Tura, Meghalaya and Tuensang, Nagaland. Captive rearing of golden mahseer at Makka, Sikkim was also facilitated.
- Under TSP, several training programmes were conducted for tribal fish farmers and women folk on integrated aquaculture in the hills and post-harvest value addition of fish.
- Rainbow trout farming was initiated and

promoted in disadvantaged areas such as Dharchula in Uttarakhand and Leh in Jammu & Kashmir.

- Frontline demonstrations were organised to create interest and awareness among tribal farmers on the economic benefits of adopting aquaculture. Critical farm inputs such as feed, seed and nets were also distributed to the adopted farmers.

Other achievements

- The Directorate received the best annual report award of ICAR for the year 2013-2014, under the small institute category.
- The research activities of the Directorate resulted in 42 publications in international and national journals during the reporting period.

INTRODUCTION

2.1. Brief history

During the seventh five year plan, the Indian Council of Agricultural Research established the National Research Centre on Coldwater Fisheries (NRCCWF) on 24th September 1987 to address the research and development needs of the coldwater fisheries sector. Since its inception, the centre has made valuable contributions in the appraisal of coldwater fishery resources and developed breeding and rearing technologies for the culture of important exotic and indigenous coldwater fish species in the hilly expanse of the country, albeit the constraints in terms of manpower and infrastructure.



ICAR-DCFR, Bhimtal

Considering the expanding activities of NRCCWF and the promising prospects of coldwater aquaculture and fisheries in different Himalayan states, the research centre was upgraded to ICAR-Directorate of Coldwater Fisheries Research (DCFR) during the eleventh five year plan. Since then, the Directorate has made commendable efforts to develop location and situation specific aquaculture technologies for all the Himalayan states extending from Jammu & Kashmir to Arunachal Pradesh and to harness the available fishery resources in a sustainable manner.

Over the past 28 years of existence, the Directorate has emerged as the nodal facility in the country to carry out research investigations focused on endemic coldwater fish species, priced exotic trouts (rainbow and brown trout) and carps (Chinese and common carp). The Directorate is evolving continuously to address new challenges in the coldwater fisheries sector and it is striving towards sustainable enhancement of fish production in Indian uplands.

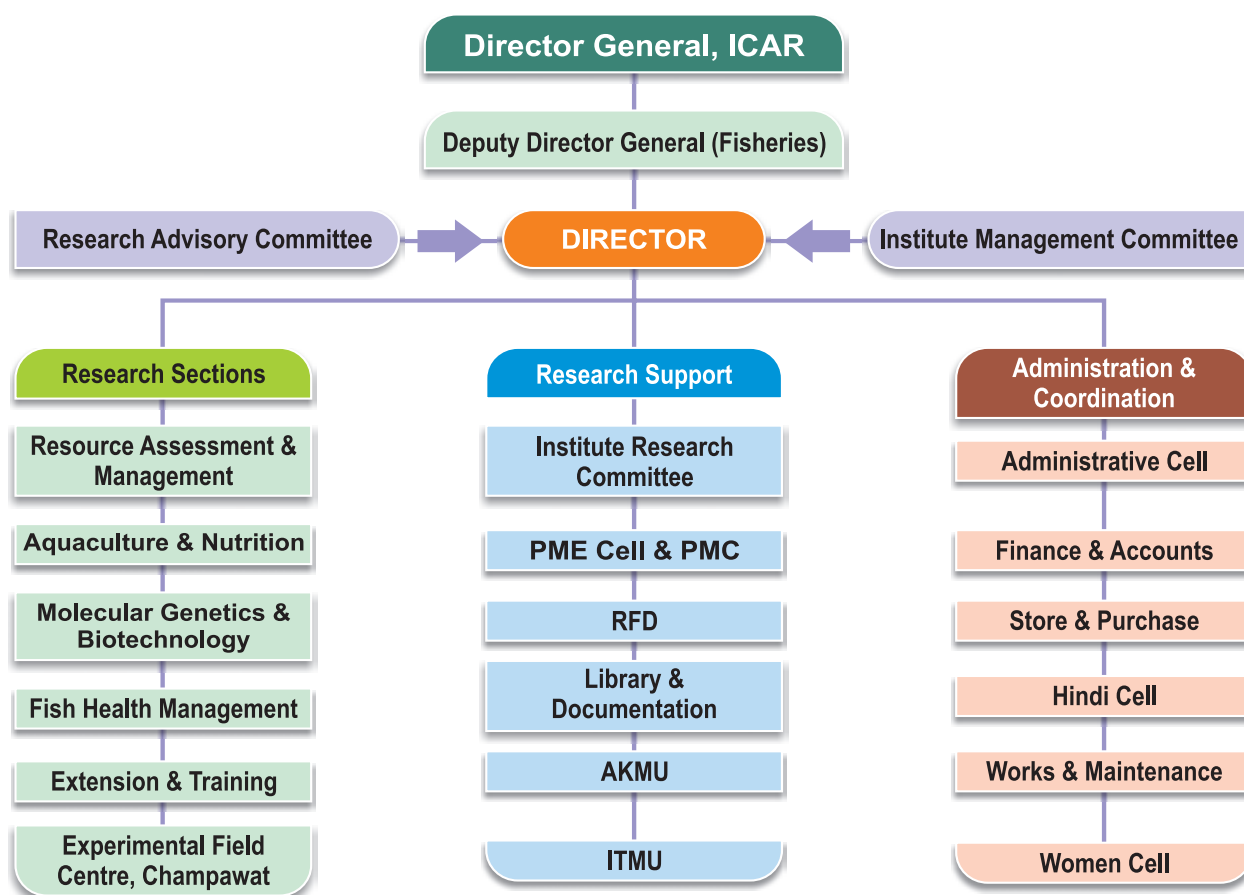
2.2. Location

The headquarters of ICAR-DCFR is located at Bhimtal (29°19'52.647"N 79°33'18.083"E), Nainital district, Uttarakhand, at an altitude of 1470 m above msl. The nearest railway station is Kathgodam, which is 22 km from Bhimtal and 278 km from Delhi. The nearest major airport is Indira Gandhi International Airport, New Delhi. At present, a small airport is also in operation at Pantnagar. The experimental field centre of the Directorate is 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. Mandate

- To conduct basic, strategic and applied research in coldwater fisheries and aquaculture
- To develop stock management models and culture technologies for major coldwater fish species
- To create awareness and provide training and consultancy

2.4. Organizational set-up



2.5. Management

As mandated by the Indian Council of Agricultural Research, a high powered Research Advisory Committee (RAC) guides the Directorate on thrust areas of research and on new initiatives. The RAC also evaluates and monitors the progress of research activities carried out in the Directorate. Similarly, the Institute Management Committee (IMC) supervises the various management aspects of the Directorate, under the chairmanship of the Director. A number of other internal committees such as Institute Research Committee (IRC) and Institute Joint Staff Council (IJSC) are in place for decentralized management.

2.6. Infrastructure

Building and farm

The Directorate is functioning from its building complex situated at Industrial area, Bhimtal. The main complex has several facilities such as laboratories, library, AKMU cell, aquarium, wet labs, flow-through raceways, hatchery, guest house and auditorium. A mahseer seed production unit is also operational at a separate site in Bhimtal. Moreover, the Directorate has an experimental fish farm facility at Chhirapani, Champawat, Uttarakhand. The field centre has trout hatchery, cemented nursery and grow-out raceways, ponds, tanks for conducting experiments, laboratories, meeting hall, staff quarters and guest house. Recently, the construction of an outdoor high capacity water recirculation system has been completed.



Farm complex at ICAR-DCFR, Bhimtal



Mahseer hatchery complex, Bhimtal



Experimental field centre, Champawat



Trout nursery raceways, Champawat

Laboratory facilities

The Directorate has well equipped laboratories to support research on molecular genetics, diagnostic virology, bacteriology, environmental fish biology, nutrition and geo-informatics. Further, new laboratories on ‘molecular biochemistry’ and ‘nutritional physiology’ are being set-up to support

related research. The wet laboratory facilities have been strengthened by the addition of flow through experimental units that can facilitate the conduct of growth trials and physiological experiments in coldwater fishes. One feed mill is also installed in the main campus of the Directorate to meet the basic requirement of fish feeds in the experimental farm.



Laboratory facilities

2.7. Support services

Prioritization Monitoring and Evaluation cell

A separate unit called the Prioritization

Monitoring and Evaluation cell monitors the implementation and progress of research projects undertaken by the Directorate. This cell organizes

the annual meeting of Institute Research Committee (IRC) to evaluate the progress made in each research project and approve the work programme for the following year. The new proposals are also approved by the IRC after thorough evaluation of the objectives, practical utility, manpower and financial involvement. The PME cell is responsible for maintaining record of project reports through RPP system and for dealing with all the associated technical matters. The cell also keeps a record of publications, training programmes, deputation and participation of scientists in seminars, symposia, workshop and conferences.

Agricultural Knowledge Management Unit

The Agricultural Knowledge Management Unit (AKMU) of this Directorate provides the facilities for internet access (BSNL), scanning and printing 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 VSAT.

The website of this Directorate (<http://www.dcf.res.in>) is being regularly updated by AKMU cell 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>). Electronic mail and messaging solutions (mail server) are also maintained at this Directorate for smooth information communication via webmail. Individual user login credentials are allotted for each staff member for appropriate use of the mail server.

Library and documentation unit

The library and documentation unit of the Directorate acts as a repository of literature and

information. It provides services to scientists, staff members, research scholars, students and other individuals from neighboring organizations 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. Recently, an inventory of e-journals containing 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. The library maintains exchange relationship with several other research organizations. The annual reports, special publications and technical bulletins published from time to time are being mailed to about 250 organizations, institutions, fishery agencies, etc.



Library

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.

2.8. Staff strength (as on 31.03.2016)

Category	Sanctioned	Filled	Vacant
Director (RMP)	1	1	-
Scientific	30	24	6
Technical	14	13	1
Administrative	13	12	1
Supporting	15	11	4
Total	73	61	12

2.9. Financial statement

(Rupees in lakh)

Major Head of Account	Approved R.E. 2015-16	Actual Expenditure 2015-16
Non-Plan	537.00	535.93
Plan	454.00	453.93

Budget statement for the year 2015-16

(Rupees in lakh)

Head of Account	Budget (R.E.)		Expenditure	
	Plan	Non-Plan	Plan	Non-Plan
Pay and allowance	0	460.00	0	460.00
Travelling allowance	25.00	1.00	25.00	1.00
Research and operational expense	118.00	30.00	118.00	30.00
Administrative expense	134.00	35.00	134.00	35.00
Building	21.00	0	21.00	0
Equipment	30.00	2.00	29.97	1.95
Information technology	11.00	0	10.99	0
Library	40.00	3.00	40.00	3.00
Furniture and fixture	0	2.00	0	1.00
Miscellaneous expenses	15.00	4.00	15.00	3.98
NEH component	35.00	0	34.99	0
TSP component	25.00	0	24.98	0
Total	454.00	537.00	453.93	535.93

RESEARCH ACHIEVEMENTS

3.1. Resource assessment

The Directorate is committed to explore the extremely diverse coldwater ecosystems (streams, rivers and lakes) and develop a scientific approach to sustainably manage and utilize the distinct class of fishes inhabiting them. As part of this effort, it has undertaken to perform ecosystem assessment and mapping of aquatic resources in selected Himalayan drainages.

3.1.1. Ichthyofaunal diversity, habitat assessment and molecular characterization of important species from selected Himalayan drainages

The multiple uses of Himalayan drainages in terms of fisheries, hydropower generation, irrigation,

or distribution of fish species, develop resource maps and identify critical areas for conservation. Considering the fact that fish species richness and relative abundance are influenced by the number of geomorphic units sampled and effort, the present investigation followed the protocol developed by David et al. (2010) for reach scale sampling.

From various locations of the river Western Ramganga (Amshyari, Kheeda and Chaukhutiya), field sampling was done during the month of December 2015 for recording and collection of species and hydrobiological data. The important ichthyofauna recorded were *Tor putitora*, *Naziritor chelynoides*, *Schizothorax richardsonii*, *Barilius bendelisis*, *Garra gotyla gotyla*, *Glyptothorax sp.* and



Map of river Western Ramganga (left) and Kosi (right) showing different sampling locations

ecotourism has necessitated its assessment and mapping for better management and sustainable exploitation. The present investigation involves habitat assessment and fish fauna diversity analysis in the selected rivers namely Western Ramganga and River Kosi, which are known to be rich in piscine diversity. In this project, it is envisaged to study the different factors responsible for the dispersal

Crossocheilus latius latius. The physico-chemical parameters recorded were water velocity (0.6-1.2 m/s); temperature (15.5-19.5°C); dissolved oxygen (8.2-9.1 mg/L); pH (6.8); TDS (159-175 mg/L); alkalinity (88-150 mg/L); hardness (80- 120 mg/L), NO₂⁻ (Nil), NO₃⁻ (0.02-0.03 mg/L) and conductivity (223- 244 μohms/cm).



Fish specimens collected from Western Ramganga river

Diversity indices	Amshyari	Chaukhutiya	Kheeda
Dominance, D	0.2781	0.2287	0.225
Shannon, H	1.568	1.621	1.544
Simpson, 1-D	0.7219	0.7713	0.775
Evenness, e ^{H/S}	0.6855	0.8428	0.9371
Menhinick	1.373	1.251	1.118
Margalef	1.842	1.595	1.335
Equitability, J	0.806	0.9045	0.9596
Fisher, α	3.143	2.639	2.14
Berger-Parker	0.4615	0.3478	0.3

Moreover, different diversity indices were calculated to find out the quantitative pattern, richness as well as evenness of fish diversity in the sampled river stretch. The diversity indices indicated poor fish diversity in the sampled area of the river, which might be due to winter migration. However, more number of sampling in different seasons will be done to ascertain the reality.

3.1.2. Habitat assessment and eco-biological study of selected mountain lakes of central and north-eastern Himalayan region

Under this project three lakes from Sikkim (Memcheno, Hangu and Lampokhari), three lakes from Arunachal Pradesh (Pangang Tang Tso, Tshungatser and Sela lake 1) and four lakes from Kumaun region (Bhimtal, Sattal, Naukuchiatal



Sampling at Hangu lake, Sikkim

Physicochemical parameters of north-east lakes as measured in December 2015 are given below:

Parameter	Hangu	Memcheno	Lampokhari	Pangang Tang Tso	Tshungatser	Sela-1
pH	7.8	8.4	9.4	9.1	8.9	9.9
Temp. (°C)	4.6	8.6	11.2	4.3	2.7	3
Free CO ₂ (mg/L)	11	15	15	5.8	4.2	4
TDS (mg/L)	122	18.5	13	12	22	19
Alkalinity (mg/L)	121	116	133	50	42	46
Total hardness (mg/L)	164	102	83	62	42	88
Ca hardness (mg/L)	22.4	14.6	11	10.5	9.4	18.4
Mg hardness (mg/L)	34.4	21.2	17.5	11.8	7.9	15.4
Conductivity (μS/cm)	244.5	37.5	26	24	44	38
Phosphate (mg/L)	0.44	<0.01	0.16	0.1	0.08	0.18
Nitrate (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sulphate (mg/L)	2.2	2.7	2	3.2	4.1	4.8
Chloride (mg/L)	<10	<10	<10	<10	<10	<10

and Nainital) were selected for analysing the fish diversity, plankton population and habitat ecology. In these mid and high altitudinal lakes, different sampling stations were marked up and periodic sampling was carried out for analysing physicochemical parameters, planktons and fish fauna. Efforts are being made to understand the trophic dynamics of the lake ecosystem with the help of few other eco-biological parameters. Some of the information generated from the high altitudinal lakes of Arunachal Pradesh and Sikkim are the first scientific reports.

3.1.3. Study on development of spatial database of coldwater fishery resources in western Himalayan region

Geoinformatic tools were used to detect and map the natural water resources of the western Himalayan states i.e., Jammu & Kashmir and Himachal Pradesh. At first, a preliminary survey was carried out in the western Himalayan region and database on aquatic resources such as lakes, reservoirs and rivers were digitized using the ArcGIS 10.1 software. For this purpose data from Digital Globe Quick Bird, India Wris (ISRO) and ASTER satellites were used.

Jammu and Kashmir falls in the great north-western complex of the Himalayan ranges with marked relief variation, snow-capped summits, antecedent drainage and complex geological structure. There are three divisions viz Jammu, Kashmir and Ladakh. Maps of major aquatic resources including lakes, reservoirs and rivers were digitized and mapped.



Major water bodies of Jammu & Kashmir

Himachal Pradesh is bordered by Jammu and Kashmir on the north, Punjab on the west, Haryana on the south-west, Uttarakhand on the south-east and Chinese ruled Tibet autonomous region on the north-east. It is one of the leading states in rainbow trout farming and has great potential for fisheries development. The aquatic resources were digitized as depicted in the map hereunder.



Major water bodies of Himachal Pradesh

3.2. Aquaculture

For expanding hill aquaculture, more emphasis has been laid on addressing the various challenges in breeding and captive management of important endemic coldwater fish species. Species diversification, complete domestication and standardization of culture practice forms the thrust areas of the research projects undertaken by the Directorate.

3.2.1. Domestication, biology and breeding of selected indigenous fishes for species diversification in mid-hill aquaculture

Under the Directorate's prioritized programme of species diversification for hill aquaculture, potential indigenous fishes of food value have been targeted for complete domestication.

Captive breeding of *Labeo pungusia*

Labeo pungusia is an important endemic fish distributed in the hill streams of north-eastern India. As per IUCN red list, it is considered as a threatened species due to drastic decline in their natural population. To conserve and rehabilitate, efforts have been made through public-private

partnership mode to rear and breed the fish under captivity at the hatchery premises of Eco-camp, ABACA, Nameri, Assam. Wild collected fry from Jia-Bharali river were reared in cement cisterns. Both male and female fish were found to attain sexual maturity at 3+ years. In the month of July 2015, induced breeding was successfully carried out using three pairs weighing 1.3-1.5 kg. A total of 1.9 lakh spawn was produced from nearly 4 lakh eggs. The seed production protocol developed is an important breakthrough in terms of conservation and species diversification for hill aquaculture.



Mature specimen of *Labeo pangusia*

Pond culture of *Bangana devdevi*

Bangana devdevi is locally known as Khabak in Manipur and relished as a food fish from the Irrawaddy river system. But, there is a general lack of information regarding culture aspects such as breeding and annual growth rate. Hence, ICAR-DCFR in collaboration with Krishi Vigyan Kendra, Thoubal, Manipur had undertaken an initiative to culture *Bangana devdevi* in ten farmers pond. At the end of the experimental trial, it was found that the composite culture of *Bangana devdevi* with *Osteobrama belangeri* (Pengba) at a ratio 50:50 showed better results. Similarly, a consignment of *Bangana devdevi* was brought to Bhimtal and reared in the farm facility of the Directorate. It was found to accept artificial feed and in 8 months culture duration, the fish of average initial body weight 4.8-5.8 g (initial length 5.0-5.5 cm) was found to attain a



Advanced fingerlings of *Bangana devdevi*

final average body weight of 130-150 g (final length 16.2-18.1 cm).

Composite culture of *Osteobrama belangeri* with Chinese carps

Osteobrama belangeri, locally known as Pengba, is the state fish of Manipur. Though it is known that Pengba can be included in composite fish culture, the present study aimed to determine the right stocking combination in terms of growth performance, yield and cost-benefit ratio. The experiment was conducted in 10 farmer ponds in collaboration with Krishi Vigyan Kendra, Thoubal. Five different combinations of Pengba, grass carp and silver carp was evaluated in duplicate ponds viz. 20, 30, 40, 50 and 60 percent Pengba and the remaining portions contributed equally by grass carp and silver carp. Manuring and liming was done using raw cow dung and quick lime at the rate of 15000 and 300 kg/ha/yr. Supplementary feed made up of rice bran and mustard oil cake in the ratio 1:1, plus vitamins and minerals was fed at the rate of 3% biomass per day. Macro vegetation and *Lemna* sp. were also fed for grass carp and Pengba. The water temperature and pH were $24\pm 3^\circ\text{C}$ and 7.5 ± 0.5 , respectively. After a culture period of 11 months, it was found that the fish production (4294.2 kg/ha/yr), cost-benefit ratio (5.4), gross and net income was maximum in the combination of 40:30:30 (Pengba: grass carp: silver carp). The maximum weight of Pengba, grass carp and silver carp recorded during the study period were 115, 1220 and 1010 g, respectively.



Harvest of Pengba cultured with Chinese carps

Captive rearing of *Semiplotus semiplotus*

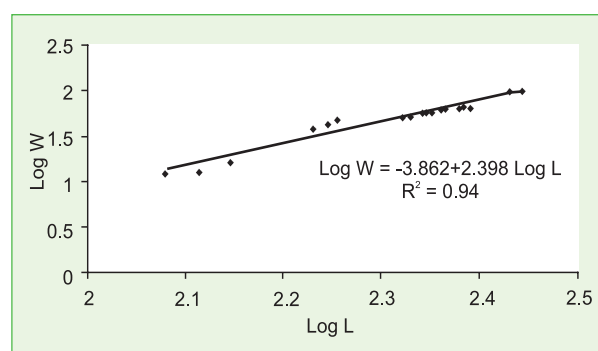
Semiplotus semiplotus is a highly preferred food fish endemic to the north-eastern states. Captive rearing and propagation of this Assamese king fish have been necessitated by the alarming decline in its natural population due to over exploitation and other anthropogenic activities. Nearly 1050 live specimens of *Semiplotus semiplotus* were collected from Dikrong river and Sinki river of Papumpare district, Arunachal Pradesh. The catch frequencies of different size groups were not even, particularly adult fishes were rarely found. The collected fishes were brought to the rearing facility in Rajiv Gandhi University, acclimatized in flowing water cement cisterns and sorted according to size. Advanced size groups (4.5-8.5 cm) were shifted to Pavoil fish farms. In the farms and cisterns, water quality was regularly monitored and in addition to weekly application of natural algae, supplementary feed was given at the rate of 5% biomass. The entire rearing program is progressing satisfactorily. Moreover, a consignment of *Semiplotus semiplotus* was transported to Bhimtal and experimentally reared in the farm facility of the Directorate. It was found to accept artificial feed but exhibited slow growth in the first 8 months duration. The fish of average initial body weight 5.3-

5.6 g (initial length 6.5-7.9 cm) was found to attain a final average body weight of 20-25 g (final length 14.2-14.4 cm).

Captive reared fingerling of *Semiplotus semiplotus*

Basic biology of Indian trout *Raiamas bola*

Raiamas bola (Hamilton, 1822), is commonly known as 'Indian trout' or 'Trout barb' and it is considered as a potential food and game fish belonging to the family Cyprinidae. Although it is listed under the IUCN (2014) least concern category, there is a serious decline in wild population and occurrence is low in their natural habitat. This necessitated a clear understanding of their biology and development of captive breeding protocol. Initially, some wild specimens of *Raiamas bola* were collected and length-weight relationship was determined. Linear regression analysis of the data indicated a high degree of positive correlation between length and weight. The length weight equation obtained was $W = 0.021026L^{2.398}$ and the analysed specimens showed a non-isometric growth pattern ($b \neq 3$), as the slope value (2.39) was less than the ideal value of 3. Similarly, the mean condition factor (K) was 0.6 ± 0.1 , much less than unity. This indicated that the present wild stock of this species may be stressed or not in good condition. However, more seasonal data are required for ascertaining these facts.

Length-weight relationship of wild collected *Raiamas bola*



Raiamas bola specimen

3.2.2. Photo-thermal manipulation for gonadal maturity of golden mahseer in captivity

The major bottleneck for mass scale seed production of golden mahseer is the unavailability of captive broodstock and the exclusive dependence on wild collected female brooders. Moreover, information concerning the optimum environmental factors required for captive maturation is scant. In this context, the objective of the present project was to elucidate the effect of photoperiod and temperature on gonadal maturity of golden mahseer in captivity. In the first trial, adult golden mahseers were maintained under three different photoperiodic treatments viz. 8 h light and 16 h dark (8L: 16D), 12 h light and 12 h dark (12L: 12D) and 16 h dark and 8 h light (8L: 16D) for 100 days. The light intensity was maintained at 1400 ± 80 Lux. The dark condition was maintained by covering the tanks with thick black plastic sheets. The fishes were randomly distributed in 2000 litre FRP tanks provided with internal water circulation using submersible pumps, continuous aeration and mesh covering. The experimentation began after one week acclimatization period and the fishes were fed twice a day *ad libitum* with a broodstock diet



Experimental set-up and sampling

containing 35% crude protein. At the end of the trial, tissue samples were collected and properly stored for various molecular, biochemical and histological analysis.

Estimation of plasma hormone levels

Plasma levels of important maturation related hormones were estimated using commercial ELISA kits. In case of vitellogenin (VTG), there was a significant difference in plasma VTG levels in female and male golden mahseer reared under different photoperiodic regimes. Among females, the highest level of vitellogenin was observed in 12D:12L group followed by 8D:16L group and the group under 16D:8L regime registered lowest values. Interestingly, vitellogenin was also estimated in males and 16D:8L regime registered higher value. In case of aromatase activity, no statistical difference was evident among the different photoperiodic treatments. However according to the trend, the highest activity was found in males under 8D:16L treatment and lowest activity was observed in both the sexes kept under 12D:12L. The plasma concentrations of 17β -estradiol (E_2) showed a significant difference between the different photoperiodic regimes. The levels of E_2 in females under 12D:12L and 8D:16L treatment group were comparable and significantly higher than the 16D:8L treatment group. The males in all the three treatment groups registered very lower values of plasma E_2 . In case of $17\alpha, 20\beta$ -dihydroxyprogesterone ($17,20\beta$ -P), the results revealed that photoperiodic treatments had significant impact. The highest levels were observed in males under 16L:8D group followed

by females of 12D:12L. Moreover, the females and males in 16D:8L group had lower levels of plasma 17,20 β -P compared to other treatment groups. Photoperiod did not have any significant impact on plasma levels of 11-ketotestosterone in both the sexes of golden mahseer. However, the levels of 11-KT in males were almost 10 times higher than females in all the three treatments. Concerning plasma levels of melatonin, the highest values were found in 16D:8L followed by 12D:12L and lowest was observed in 16L: 8D. Interestingly, sex specific variation in plasma melatonin levels were observed in all the treatment groups where males registered significantly higher melatonin levels compared to their female counterparts.

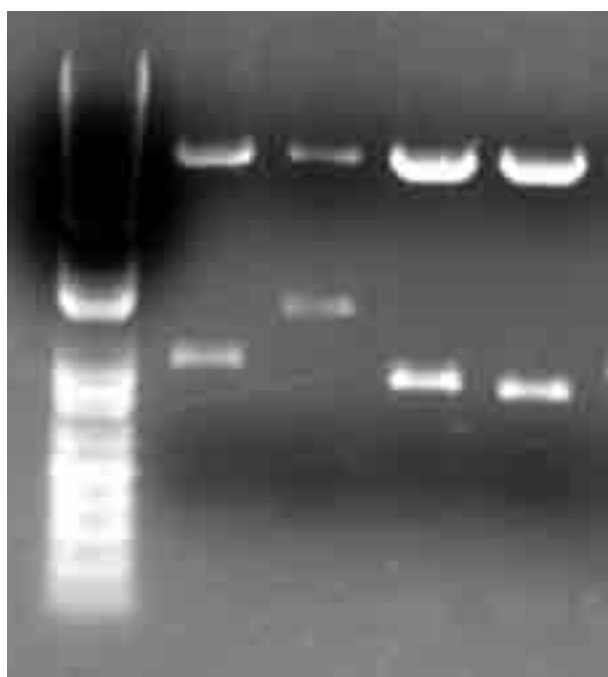
Characterization of aromatase (*cyp19a* and *cyp19b*) genes

Tissue sample of brain, gonad and liver were collected aseptically and total RNA was extracted by Trizol method. After DNase treatment, the total RNA was reverse transcribed to cDNA. From this template cDNA, amplification of *cyp19a*, *cyp19b*, β -actin and *ef1a* was performed using specifically designed degenerate primers. The resultant PCR products were gel extracted, purified, ligated to PCR 4.0 TOPO TA vector and transformed into

DH5 α *E. coli* strain using heat shock method. From the positive colonies, plasmid was isolated and sequenced after confirming the presence of insert by restriction digestion. Deduced sequences (643 bp of *cyp19a*, 812 bp of *cyp19b*, 1257 bp of *ef1a* and 827 bp of β -actin) of the target genes were then verified and submitted to NCBI Gen Bank.

3.2.3. Molecular characterization and gene expression profiles of kiss genes in golden mahseer during different gonadal development stages

The full-length cDNA of *kiss1r* was cloned and characterized from the brain tissue of adult golden mahseer, *Tor putitora* (KP748255). The *gmKiss1r* cDNA is 1383 bp, with an open reading frame of 1004 bp encoding a 334 amino acid protein, 318 bp of 5'-UTR and 31 bp of 3'-UTR. The molecular weight of the predicted *gmKiss1r* protein is 31.71 kDa. The structural analysis of *gmKiss1r* protein revealed that it has a coiled beta helical structure and seven conserved transmembrane domains present in between 15-299 amino acids. The homology modelling of *gmKiss1r* showed strong conservation of tertiary structure with other vertebrates. *GmKiss1r* sequence has higher identity with zebrafish, common carp and catla.

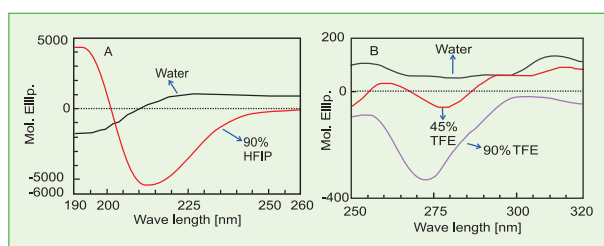


Agarose gel image of restriction digested (*EcoRI*) plasmid (R to L: *cyp19b*, β -actin, *ef1a*, *cyp19a*)



Tertiary structure of golden mahseer *kiss1r*

The structural analysis of kiss1 peptide in 90% hexafluoroisopropanol using far-UV CD spectroscopy revealed a dominant β structure while interacting with cell membrane. Near-UV CD spectroscopy (250-320 nm) conducted to examine the tertiary packing around aromatic residues of kiss1 peptide and the kiss1 peptide-membrane complex showed that it contains three tyrosine residues in its polypeptide chain. The influence of these aromatic residues was apparent in the near-UV spectrum of kiss1 peptide, as indicated by the presence of prominent negative band at around 275 nm when shifted from water to the membrane mimetic solution trifluoroethanol. The CD spectra of the membrane-bound peptide were significantly different from the peptide in the aqueous environment in near-UV region.



CD spectra of kiss1 peptide (A: Far-UV CD, B: Near-UV CD)

Full length cDNA of kisspeptin 2 (*gm_{kiss2}*, 623 bp) was amplified from the brain of golden mahseer (KX024449). Comparison of the deduced amino acid sequences of *gm_{kiss2}* with those of other vertebrate species showed a high degree of conservation only in the kisspeptin-10 region (Kp-10). Besides, the partial cDNA of housekeeping gene *β -actin* was amplified from golden mahseer (KT966391, 289 bp) for qRT-PCR analysis. Tissue samples of various organs from adult male and female golden mahseer of different gonadal developmental stages were also collected for quantitative RT-PCR analysis of kisspeptin gene expression profile. Moreover, live golden mahseer specimens of both the sexes in various developmental stages are maintained for further studies under this project.

3.2.4. Decoding the constraints in growth, maturation and captive management of snow trout (*Schizothorax richardsonii*, Gray 1832)

Slow growth, early maturity and lack of proper captive management protocols are critical factors that hinder the prospects of including endemic coldwater fishes such as snow trout in hill aquaculture. To decipher the physiological mechanisms underlying nutrient mediated regulation of appetite, nutrient uptake, metabolism, myogenesis and endocrine aspects, a broad ranging project has been taken up. Nearly 1500 snow trout of different size groups were collected from Kalsa rivulet in the Chaffi stretch of river Gola and acclimatized to captive rearing conditions. The method of electro-fishing was standardized during the process. In the preliminary phase, basic biological aspects such as condition factor and internal anatomical features of the fish were studied. Subsequently, *in situ* sampling was carried out to study the physiological indices and gut microbiome of wild individuals. For acclimatization purpose, an experimental diet containing 35% protein, 6% lipid and 38% carbohydrate was prepared using casein and gelatine as the protein source; blend of cod liver oil and vegetable oil as lipid source; and starch and dextrin as carbohydrate source. The purified diet was well accepted by fish of all size groups. Further, two new wet-laboratory facilities with flow through experimental set-up have been created to carry out nutrition and growth related trials.

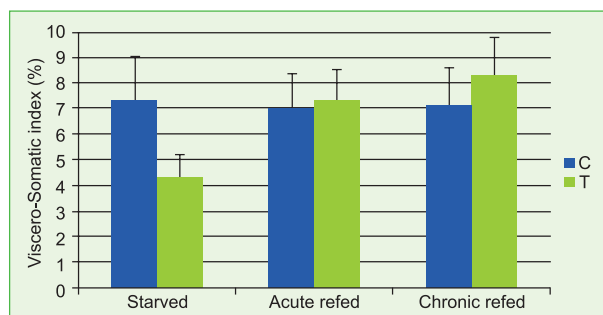


Wet laboratory for snow trout growth trials

Nutritional status and growth trial

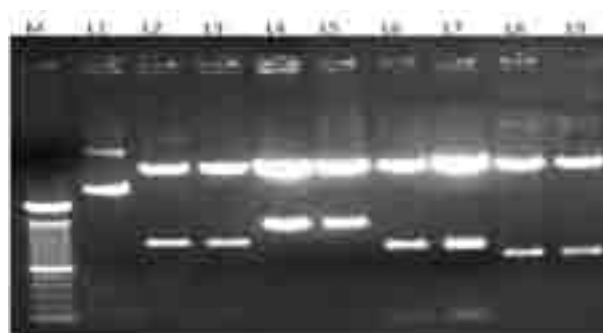
To elucidate the effect of nutritional status on growth and the underlying biochemistry, a 6 week feeding trial was conducted in snow trout

of 5 g size. While the control group was fed continuously throughout the trial, the treatment group was starved for the first 21 days and re-fed for the remaining period. Blood and tissue sampling was carried out at three different time points to determine the effect of starvation, acute re-feeding and chronic re-feeding. The starved group lost weight (-5.4%) during the first experimental phase, but showed a kind of compensatory growth (24.8%) in the final phase. At the same time, the weight gain in the control group was 16.8% in the first and 9.6% in the second phase. The viscera-somatic index of the treatment group was significantly lower than the control group after the starvation period. Nevertheless, the gain in VSI was dramatic after 2 days of re-feeding in the treatment group, almost at par with the control group. After 21 days of re-feeding, the VSI of treatment group was even significantly higher than the control group. This phenotype indicates the possibility of distinct metabolic changes due to nutritional status in snow trout, which will be analysed further.



Molecular characterization of target gene markers

For cloning and sequencing target genes of interest, total RNA was isolated from different tissues of snow trout (*Schizothorax richardsonii*) and first strand cDNA synthesis was carried out. Reference genes *ef1 α* and *β -actin*, and target aromatase genes *cyp19a* and *cyp19b* were PCR amplified using specifically designed primers. The amplicons were then cloned using suitable vector and competent cells, sequenced, verified and submitted to NCBI GenBank (KU715836, KU715835, KU715837 and KU715838).



Gel picture of restriction digested (EcoRI) cloned plasmid (L1: uncut plasmid, L2-3: β -actin, L4-5: *ef1 α* , L6-7: *cyp19b*, L8-9: *cyp19a*)

Breeding of farm raised *Schizothorax richardsonii*

Under the captive management sub-project, snow trout were collected from various riverine stretches namely, river Gaudi, eastern Ramganga, confluence of river Kali and Saryu at Pancheswar, Ladhiya and Chirrapani. The collected fish were then raised in flow through raceways at a stocking density of 5-10 fish/m² (0.4-1 kg/m²). Continuous water flow rate of 30-50 L/min was maintained. Commercial pelleted feed was provided twice a day. Growth rate, maturity status and water quality were recorded. After maturation, breeding of farm raised snow trout was successfully undertaken at Champawat field centre. Oozing male and female were collected from the rearing raceways and stripped. Totally 92,000 eggs were stripped from 70 female snow trout (64-156 g) in four phases during the month of September. The fecundity was nearly 16,270-18,340/kg body weight. The fertilization rate was 35-40% and hatching rate was between 60-70%, with an incubation period of 105-125 h at a temperature of 17.1-21.6°C. Overall 18,000 fry have been produced and are being reared in flow through troughs.



Farm raised snow trout brooders

3.3. Disease surveillance and health management

Potential bacterial pathogens in rainbow trout farms from northern India and maintenance of bacterial agents

Water samples and rainbow trout tissues were collected from 4 trout farms in Himachal Pradesh and 8 trout farms in Sikkim. In total, 21 rainbow trout specimens (weighing 150-300 g) and 33 water samples were processed aseptically for investigating the pathogenic bacteria profile. From the Himachal Pradesh and Sikkim samples, 35 and 62 representative bacterial isolates were purified, respectively. The bacterial load in rainbow trout tissues and water samples collected from Himachal Pradesh ranged between 10^2 - 10^8 CFU/g and 10^3 - 10^6 CFU/ml. Whereas in the case of Sikkim trout farms, the total plate count in tissues and water samples ranged between 10^2 - 10^7 CFU/g and 10^2 - 10^6 CFU/ml. The results of virulence assay suggested that 40% and 31% of the bacterial isolates from trout farms in Himachal Pradesh and Sikkim were virulent in nature. The pathogenic bacterial flora identified from the representative trout farms in Himachal Pradesh were *Citrobacter freundii*, *Proteus hauseri*, *Pantoea agglomerans*, *Erwinia rhapsontici*, *Aeromonas hydrophila*, *Aeromonas veronii*, *Hafnia alvei*, *Pseudomonas fluorescens*, *Plantibacter* sp., *Escherichia coli*, *Microbacterium* sp., *Morganella* sp., *Staphylococcus* sp., and *Plegiomonas* sp. The pathogenic bacterial flora identified from the sampled trout farms in Sikkim were *Serratia* sp., *Pseudomonas* sp., *Pseudomonas putida*, *Micrococcus* sp., *Vagococcus* sp., *Hafnia alvei*, *Morganella* sp., *Rahnella aqatilis*, *Klebsiella* sp., *Pantoea* sp., *Pseudomonas veronii*, *Carnobacterium maltaromaticum*, *Carnobacterium divergenes*, *Pseudomonas fluorescens*, *Yersinia* sp., *Erwinia* sp. and *Corynebacterium* sp. Based on the observations, it can be concluded that the presence of secondary bacterial pathogens and infection in the form of lesions, tail rot, gill rot and body hemorrhages may be due to farm management practices.



Sample collection from trout farm in Uttarey, Sikkim

3.4. Molecular genetics and biotechnology

3.4.1. Bioprospecting of genes and allele mining for thermal stress tolerance of *Schizothorax richardsonii*

In continuation with the transcriptome analysis for heat shock responsive transcripts and differentially expressed genes in *Schizothorax richardsonii*, functional annotations of RNA sequence data was performed. Blast2Go annotated 20506 unigenes into 35 functional groups with 107353 terms. Biological processes represent the majority (60114; 56%), followed by molecular function (23881; 22.3%) and cellular components (23358; 21.7%). Particularly, data indicated that regulation of metabolic processes is an important part of the heat shock response. In KEGG database, 4256 sequences were mapped to 124 KEGG pathways and 923 enzymes. The enzyme code distributions for major enzyme classes were also computed as oxidoreductases (709), transferases (2065), hydrolases (1702), lyases (162), isomerases (150) and ligases (359).

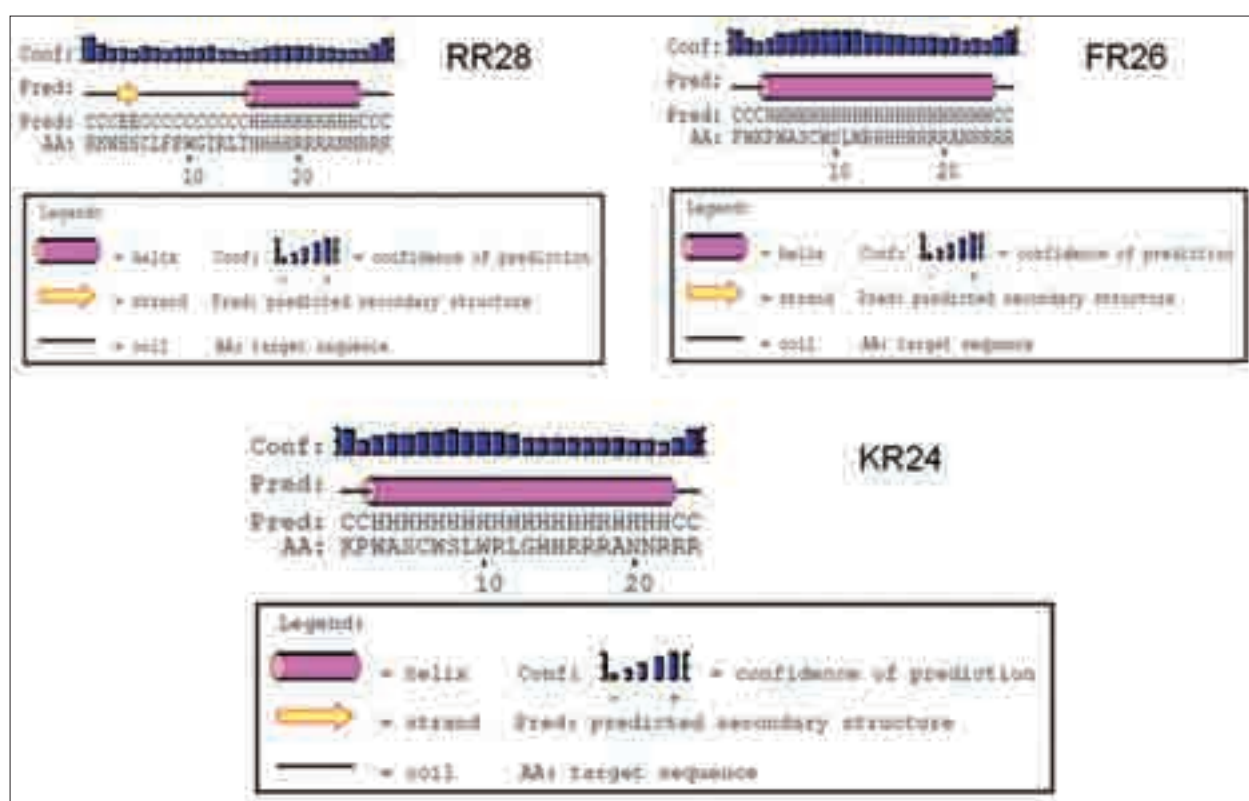
In silico identification of differentially expressed genes showed that 65 transcripts (42 up-regulated and 23 down-regulated) were differentially expressed in the liver of snow trout under heat shock challenge as compared to those under control conditions. Out of which, 8 genes (HSP90 α , 10kDa HSP, 60kDa HSP, HSP90 β , dnaJ homolog subfamily B member 9 precursor, creatine kinase

U-type, hypoxia-up-regulated protein 1 precursor, UPF044 transmembrane protein) were selected for qRT-PCR validation. In accordance with the *in silico* differential gene expression analysis, the mRNA levels of all the candidate genes were found to be highly up-regulated in the heat shock stressed samples when analysed by qRT-PCR.

3.4.2. Development of fish viral peptide based nano system for intracellular delivery of biomolecules

Three novel cell penetrating peptides (CPPs) were identified from fish IPN and IHN viruses using available online bioinformatic tools. The predicted CPPs have been explored to construct the

peptide nano systems viz. RR28, FR26 and KR24, in combination with the reported nuclear localization signal (NLS) derived from fish virus. Structural analysis of the peptide nano systems performed using online PSI-PRED tool revealed that these nano systems have various secondary structures, helix being the major contributor. It contains both hydrophilic and hydrophobic amino acids required for successful translocation inside the cells. In order to improve the endosomal escape property of these nano systems, a peptide linker (HHHH) was introduced in between the hydrophilic and hydrophobic domain. Synthesis of the peptide nano systems is in progress.



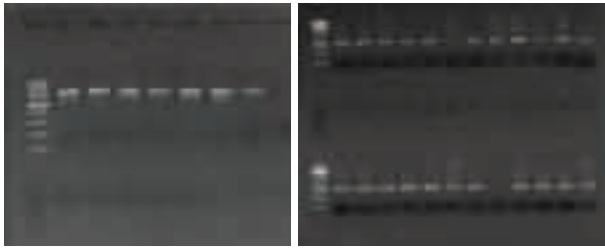
Predicted secondary structures of the three peptide nano systems

3.5. Outreach activities

3.5.1. Fish genetic stock

So far, representative samples from 11 populations of chocolate mahseer (*Neolissochilus hexagonolepis*) and 5 populations of brown trout (*Salmo trutta fario*) have been collected. Genomic DNA was isolated from the fin tissue of each sample.

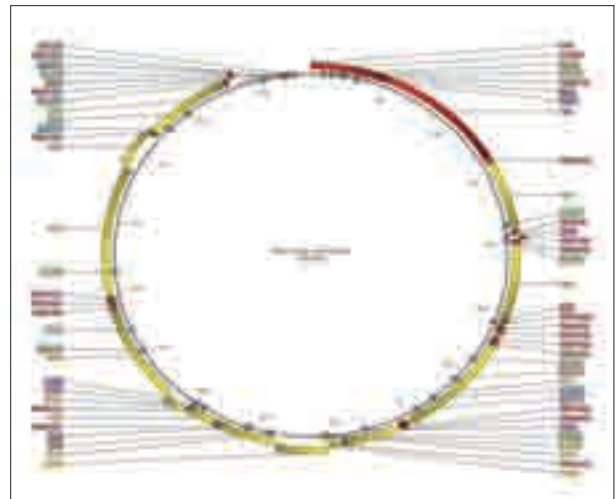
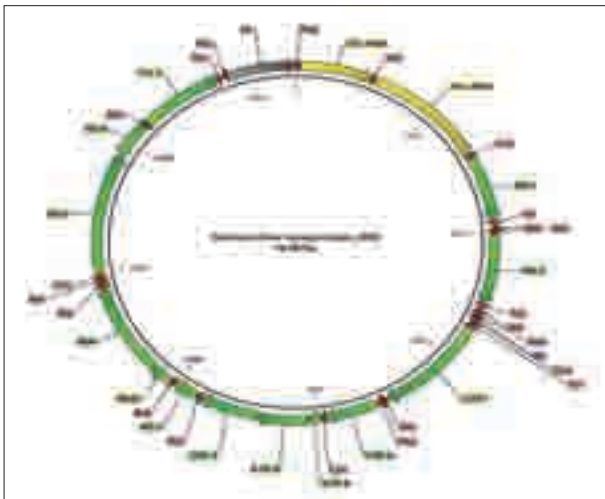
Mitochondrial genes i.e., cytochrome oxidase (CO-I), ATP synthase-6/8 gene (ATPase 6/8) and cytochrome b (Cyt-b) were used to characterize the populations of chocolate mahseer and brown trout. Sequence analysis of the PCR products (CO-I, ATPase 6/8 and Cyt-b genes) amplified from the different populations of brown trout and chocolate mahseer is in progress.



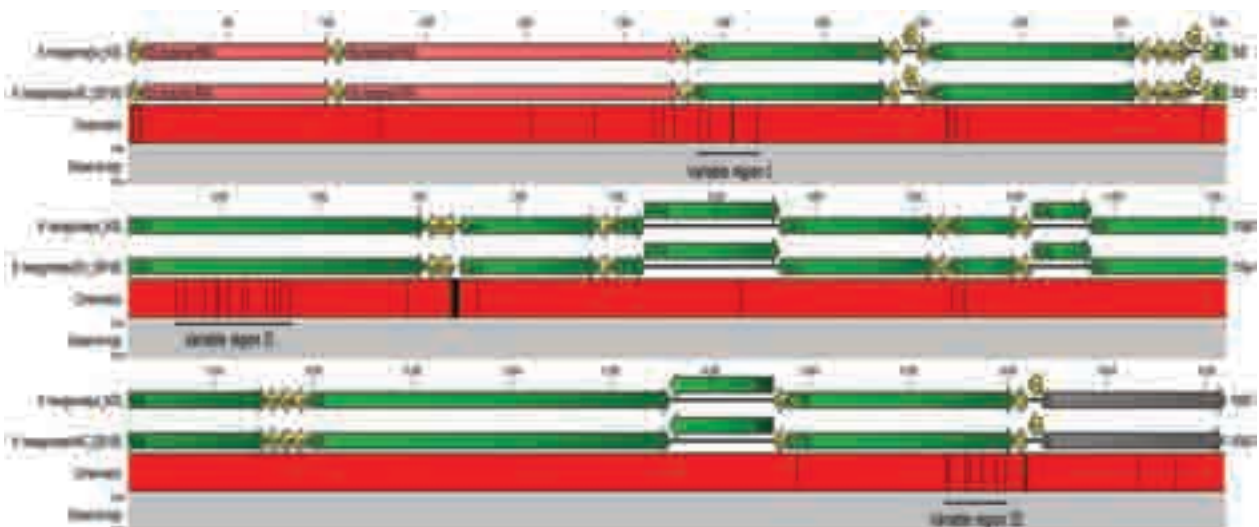
PCR amplified COI (left) and ATP6/8 (right) genes from chocolate mahseer populations

Through next generation sequencing on Illumina Miseq platform, a partial genomic library was constructed for isolation of SSR markers using genomic DNA of chocolate mahseer and brown trout. High quality data of 1.42 and 3 GB corresponding to an estimated ~1.79x and ~2.0x per base coverage was obtained for brown trout and chocolate mahseer, respectively. Out of 14,093,645

and 8,269,226 raw reads for brown trout and chocolate mahseer, trimmed reads (13,225,170 and 4,871,481) were further subjected to *de novo* assembly in CLC genomics workbench 7.5.2. A total of 319,440 and 176,852 contigs were obtained with N50 value of 677 and 720. The maximum contig length was observed to be 16,677 and 16,597 bp for brown trout and chocolate mahseer, respectively. Contigs >10 kb were analysed using BLAST search and contig representing the mitogenomes was extracted and annotated. tRNA and rRNA regions were identified by tRNAscan-SE 1.21 and Rfam 12.0 online database and CDS search by BLASTx NCBI. Complete mitogenomes of *Salmo trutta fario* and *N. hexagonolepis* thus obtained were submitted to NCBI database.



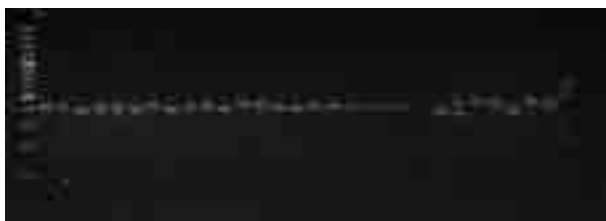
Graphical representation of complete mitogenome of chocolate mahseer (left) and brown trout (right)



Heat map illustrating the comparison of mitogenomes in two chocolate mahseer populations

In order to identify the most variable region in the mitogenome that can be targeted for population specific studies, NGS technology derived mitochondrial DNA of chocolate mahseer from Wah-khri river, Meghalaya was compared with conventionally sequenced mitogenome of chocolate mahseer from river Jia Bhoreli, Assam. This PCG comparison of the two population revealed 155 variable sites (0.01 genetic distance) and three major variable region in protein coding genes (ND1-variable region I; COI-variable region II; Cyt b- variable region III). Overall, NGS platform proved to be a rapid and time saving technology to reveal complete mitogenome with higher resolution capacity (4.26 per base coverage).

From *de novo* assembled contigs, about 19,786 and 1,84,882 SSR were identified in brown trout and chocolate mahseer, respectively. Initially, 56 and 31 SSR markers were selected for PCR-genotyping in brown trout and chocolate mahseer populations.



Genotyping of SSR in chocolate mahseer population

3.5.2. Fish feed

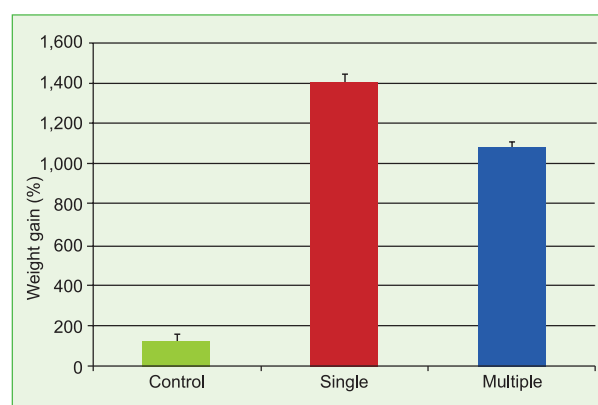
Starter feed for rainbow trout

Two cost-effective practical starter feeds were formulated for first feeding rainbow trout fry, based on single or multiple protein sources. The experimental diets were made up of commercial ingredients and were conventionally prepared by steam cooking, pelleting and drying. To evaluate the performance of these two diets as compared to a widely used commercial diet, a five week feeding trial was conducted in rainbow trout fry weighing 192 mg on average. For the experimental purpose, an experimental prototype unit was designed and fabricated with proper arrangement of water flow-through and aeration.



Experimental prototype unit

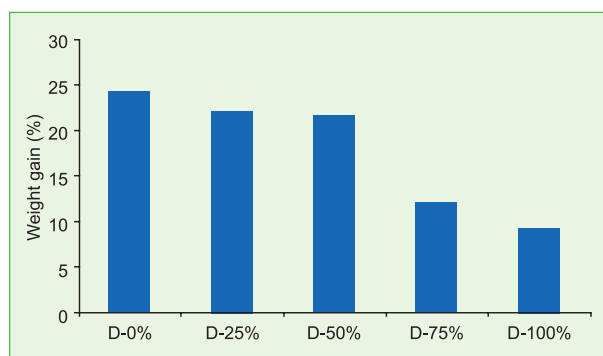
At the end of the experimental duration, the mean final body weight was 2.9, 2.3 and 0.4 gram in the single, multiple and control group respectively. Likewise, fish survival was significantly better in the test diet groups (>90%) as compared to the control group (<75%). Size heterogeneity and the resulting cannibalism were apparently higher in the control group. Fish and tissue samples have been collected and stored for further biochemical analysis. Moreover, the findings are further being validated in Champawat field centre.



Fish meal replacement study in snow trout

Five experimental diets containing 33.5-35% protein and 6.1-7% lipid were prepared using fish meal, soya meal and mustard oil cake as protein

source; vegetable oil as lipid source; and wheat bran as carbohydrate source. In the test diets, 0 (Diet 100/0), 25 (75/25), 50 (50/50), 75 (25/75) and 100% (0/100) of fish meal was replaced by locally available heat treated black soyabean meal. Based on the known requirement of carps, dietary amino acid levels were balanced by supplementing crystalline lysine, methionine and threonine. A 60 day feeding trial was conducted during June-July 2015 using 200 snow trout (*Schizothorax plagiostomus*) of 3-4 cm size randomly distributed in 15 experimental tanks. The results suggested that 25-50% of fish meal can be replaced without any adverse effect on growth. At the end of the trial, intestine, liver and muscle were collected, processed and stored for subsequent enzyme assays.



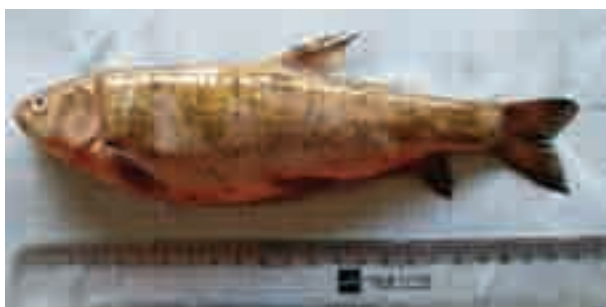
3.5.3. Nutrient profiling and evaluation of fish as a dietary component

Precise data on the nutrient composition of different snow trout species is not available despite their wide distribution, high consumer preference and economic value. Therefore, the objective of the present study was to determine the biochemical composition, fatty acid profile, cholesterol, triglycerides and mineral concentration of different snow trout species. For this purpose, *Schizothorax* species viz. *S. curvifrons*, *S. esocinus*, *S. niger* and *S. labiatus* were collected from the local fish market of Srinagar, Jammu & Kashmir and *S. plagiostomus* and *S. progastus* were similarly collected from Srinagar, Garhwal, Uttarakhand. A minimum of 3 individuals from each species were collected, beheaded, gutted, filleted and muscle tissue was minced for analysis after measurement of its weight and length.

Proximate composition analysis of the edible fish tissue indicated an inverse relationship between crude fat and moisture content in *S. curvifrons* and *S. richardsonii*. While *S. niger*, *S. curvifrons*, *S. esocinus* and *S. labiatus* could be considered as medium fat fish that contains 4-8 g fat/100g, *S. plagiostomus*, *S. richardsonii* and *S. progastus* can be classified as low fat or lean fish with a fat content of below 2 g/100 g. The similarity pattern of fat content in different species can be attributed to the geographical location of collection. From GC-MS analysis, it was observed that the fatty acid composition of total lipids varied greatly in the muscle of all six *Schizothorax* species (*S. richardsonii*, *S. plagiostomus*, *S. progastus*, *S. esocinus*, *S. curvifrons* and *S. niger*). PUFA content was lesser (10.5-14.5%) than the saturated fatty acids (57.5-66.1%) and MUFA (19.4-31.7%). Among the saturated fatty acid, palmitic acid (26.1-49.2%) occurred in the highest proportion, followed by myristic acid (7.6-13.6%) and stearic acid (0.07-7.5). Triglyceride level ranged from 756.7 in *S. labiatus* to 2701.7 mg/dl in *S. richardsonii*. Cholesterol content ranged from 21.3 mg/100g in *S. esocinus* to 27 mg/100g in *S. labiatus*. Crude protein content ranged from 15.4±0.6 g/100g (*S. niger*) to 18.8±0.2 g/100g (*S. labiatus*). Among the trace elements, iron had the highest concentration followed by zinc, copper and manganese. The lowest and highest iron concentrations were found to be 70.2 mg/kg in *S. labiatus* and 125.9 mg/kg in *S. progastus*. Zinc content ranged in between 26.4 to 64.5 mg/kg for *S. plagiostomus* and *S. labiatus*, respectively. Copper concentration ranged in between 7.2 to 18.1 mg/kg and the highest Cu concentration was observed in *S. progastus* (2.6 mg/kg).



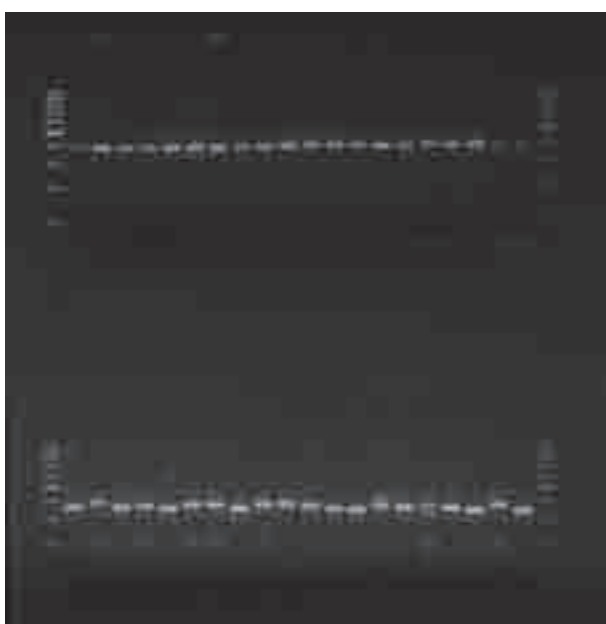
S. niger

*S. labiatus**S. esocinus*

3.6. Externally funded projects

3.6.1. Development and characterization of microsatellite markers and assessment of genetic diversity of *Schistura sikmaiensis* from north-east India (DBT-Twin-NE)

A partial genomic library was constructed for isolation of SSR markers using genomic DNA of *Schistura sikmaiensis*. The sequencing and shotgun libraries were then subjected to next generation

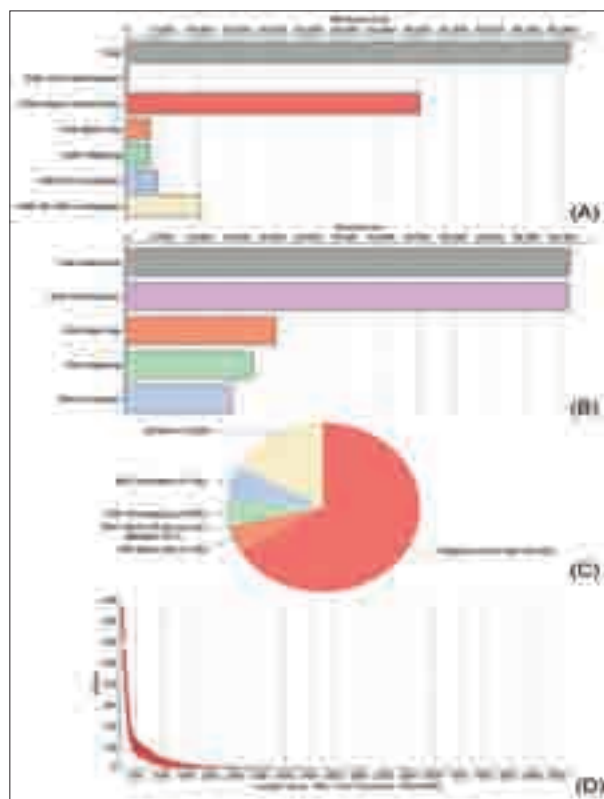


Genotyping of SSRs in *Schistura sikmaiensis* population

sequencing on Illumina Miseq platform (Genotypic Technology Pvt. Ltd., Bangalore). From the 30,270,176 raw reads obtained, 29,685,429 trimmed reads were subjected to *de novo* assembly in CLC genomics workbench 7.5.2. A total of 435,744 contigs were obtained in *S. sikmaiensis* with N50 value of 1412. The maximum contig length was 16,572 bp. Among the 3876 SSR containing sequences obtained, 32 loci were selected for genotyping in different populations of *Schistura sikmaiensis*. Out of 32 loci, 20 were PCR amplified in 40 individuals from two populations and 18 loci were found to be highly polymorphic.

3.6.2. Transcriptome profiling of immune responsive genes in golden mahseer (DBT)

In continuation of earlier work, the CDS prediction was carried out on the assembled transcripts (77907) using Transdecoder. The functional annotation for the CDS was carried out by aligning the CDS to non-redundant database of NCBI using BLASTx (e value $1e-05$). The majority



Summary of transcript annotation A. Data distribution of BLASTx search statistics; B. Inter Pro Scan; C. Overall statistics of BLASTx and InterPro Scan; D. Number of sequences that were successfully annotated

of the hits were found with *Danio rerio*. The BLASTx hit resulted in the annotation of 20,653 contigs and 40,389 contigs of no BLAST hit. The maximum number of CDS were GO annotated for cellular components (16,295) followed by biological processes (44,310) and molecular function (33,405). The highest assignments of GO terms mapped were cellular and metabolic process in association with the biological process; cell and organelle associated with the molecular function; and binding and catalytic activity in connection with the cellular component process. The analysis of differential gene expression in response to *Aeromonas hydrophila* infection was performed based on RPKM values assigned to each read and 2,408 transcripts were differentially expressing in test samples. Out of 2408 transcripts, 1104 (45.5%) and 1304 (54.5%) were found to be up-regulated and down-regulated, respectively. Initial findings indicate that major transcripts were involved in the reorganization of cellular system due to the pathogenic infection.

3.6.3. Development of bacterial bioremediation measures for the mitigation of microalgal blooms in freshwater aquaculture ponds (DBT)

Water samples were collected from different water bodies of Champawat, Naukuchiyatal, Sattal, Chaffi and Bhimtal regions of Uttarakhand for isolation and culture of *Microcystis aeruginosa* and algicidal bacteria as well. *Microcystis aeruginosa* was successfully grown in laboratory environment in the algae culture medium. Altogether, 100 pure culture of bacterium were screened for algicidal property against *Microcystis aeruginosa* on Cyanophycean agar plate and on microcosm culture of algae. Out of the 100 isolates, only 10 bacteria showed growth inhibiting and algicidal activity against *Microcystis aeruginosa*. Screened bacterial isolates were identified by morphological, biochemical and molecular method as *Exiguobacterium acetylicum* (laboratory strain TM2), *Aeromonas veronii* (laboratory strain TM5) *Enterobacter sp.* (laboratory

strain TM8) *Citrobacter freundii* (laboratory strain K33) *Leclercia adecarboxylate* (laboratory strain K36), *Pseudomonas fulva* (laboratory strain X6) and *Enterococcus faecalis* (laboratory strain L32). The pathogenicity of the identified bacterial isolates was also tested by enzymatic assays.



Culture of *Microcystis aeruginosa*



Growth inhibition of *Microcystis aeruginosa* by bacteria



Lysis of *Microcystis aeruginosa* by algalytic bacteria

3.6.4. Surveillance of coldwater fish diseases under National Surveillance Programme on Aquatic Animal Diseases (NSPAAD)

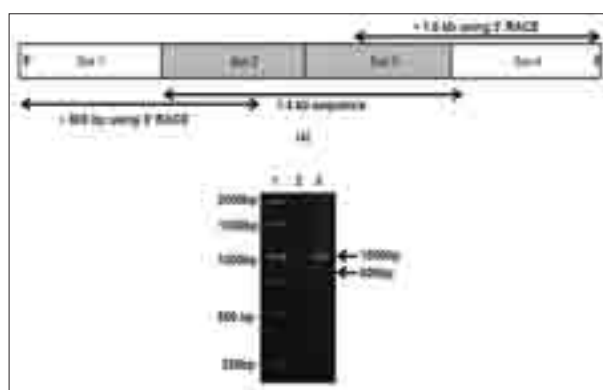
Active disease surveillance was carried out in 25 trout and carp farms from three states. It includes 5 carp farms of Udhampur district (Jammu and Kashmir); 7 trout farms of Kullu and 9 trout farms of Mandi (Himachal Pradesh); and 1 trout and 3 carp farms of Champawat district (Uttarakhand). Besides base line data generation, the presence of coldwater fish viruses namely, infectious pancreatic necrosis virus (IPNV) and viral hemorrhagic septicemia virus (VHSV) was screened in 56 pooled samples collected from morbid fish in the said farms. Some samples were collected also for bacterial (20), histopathological (47) and fungal (9) investigations. For detailed analysis, the samples were transported to the laboratory by maintaining cold chain. Using discrete primers of IPNV and VHSV and positive controls developed earlier, RT-PCR was carried out in selected samples. So far, none of the samples tested positive suggesting the absence of the said viruses in the surveyed farms. With respect to bacterial analysis, samples were processed aseptically for isolation and molecular identification of pathogenic bacteria. Total plate count of bacteria in the tissues samples ranged between 10^2 - 10^8 CFU/g. In total, 35 bacterial isolates were purified for molecular characterization. The identified bacterial isolates were *Citrobacter freundii*, *Proteus hauseri*, *Pantoea agglomerans*, *Erwinia raphontici*, *Aeromonas hydrophila*, *Aeromonas veronii*, *Hafnia alvei*, *Pseudomonas fluorescens*, *Plantibacter* sp., *Escherichia coli*, *Microbacterium* sp., *Morganella* sp., *Staphylococcus* sp. and *Plegiomonas* sp.



Sample collection from morbid fish

3.6.5. Development of a method for detecting the presence of any virus signal in clinical sample of fish (ICAR National Fellowship)

Attempts were made to identify the Mx promoter and Mx gene of snow trout (*Schizothorax richardsonii*). In case of Mx gene, four sets of primers were designed for the amplification of ~2.2 kb fragment. With these primers, four fragments of Mx coding region that were supposed to overlap corresponding to 630, 989, 970 and 730 bp could be amplified. Out of the four, two overlapping fragments in the middle of the coding region could be aligned to deduce a partial nucleotide sequence of 1472 bp, which was submitted to GenBank database. This sequence had 100% similarity with the Mx coding region of several fish. However, the nucleotide sequence of the two fragments obtained at 5' and 3' region had no identity with Mx coding region. An alternate strategy (RACE) was therefore employed to amplify the complete Mx coding sequence. 5' and 3' gene specific primers were designed from the sequenced 1472 bp region. Amplicons of 800 and 1000 bp was obtained with the standardized 5' and 3' RACE. These amplicons have been further cloned and outsourced for nucleotide sequencing, the results of which are awaited.



Amplification of 5' and 3' ends of snow trout Mx gene by RACE

For the identification of Mx promoter of snow trout, five sets of primers were designed to amplify five overlapping fragments. Four amplicons of 362, 348, 381 and 310 bp were obtained and sequenced. However, a PCR product of 328 bp could not be obtained. The deduced nucleotide sequence of the four PCR products had no similarity with any of the reported promoters, besides lacking an ISRE

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GTCATTGGGTGTGAAAAGAATCTAGATGCATTCGCGAGGKACCGAGCTCGAATTCCTACTGGCCGTCR
TTTTACAACGTCGTGACTGGRAAAACCCTGGCGTTACCCAACCTAATCGCCTTGCASCACATCCCC
CTTTCGCCRGCTGGCGTAATAGCGAASAGGCCCGCACCGATCGCCCTTCCCAACAGTTGCGCAR
CCTGAATGGCGAATGGAAATTGTAAGCGTTAATATTTTGTAAAATTTCGCGTTAAATTTTGTAAATC
AGCTCATTTTTTAACCRATAKGCCGAAATCGGCAAARTCCCTTAKAAATCAAAAGAATASACCGAGA
TAGGGTTGAGTGTGTTCCAGTTTGGAACAAGAGTCCACTATTAAGAAGCGTGGACTCCAACGTC
AAAGGGCGAAAAACCGTCTATCAKGGCGATGGCCCACTACGTGAACCATCACCTAATCRAGTTTT
TTGGGGTCGAGGTGCCGTAAAGCACTARATCGGAACCCTAAAGGGAGCCCCCGAKTTASAGCTTG
ACGGGGAAAGCCGGCGAACGTGGCGAGAAAGGAAGGGAAGAAAGCGAAAGGAGCGGGCGCT
AGGGCGCTGGYMGYGTAGCGGTCAYGCTGCGCGAACCACACCCGCGCGCTTAATGCG
CCGCTACAGGGCGCGTCAGTGGCACTTTTCGGGGAAATGTGCGCGGAACCCTATTTGTTATTTTT
CTAATACATTCAAATATGTATCCGCTCATGAGACATAACCCTGATAAATGACCTGAGAGAGTCCACT
AGATCAAT

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Nucleotide sequence of snow trout Mx promoter indicating the presence of a TATA box and ISRE sequence

sequence. To resolve this issue, an alternate strategy of chromosome walking was attempted and a PCR product of ~1.2 kb was obtained and sequenced. Out of sixteen clones sequenced, first read of the clone pGWMxpro1.1 revealed the presence of an interferon stimulated regulatory element (ISRE) specific sequence GAAAGCGAAA. It can be interesting to explore for more ISREs in the Mx promoter of snow trout as two or more ISREs have been reported in other fishes such as zebra fish and rainbow trout. Moreover, JASPAR the largest open-access database of matrix based nucleotide profiles describing the binding preference of transcription factors from multiple species revealed two putative TATA-box sites in the 1.2 kb amplicon obtained from snow trout. Using TATA-box model POL012.1, a relative profile score of 85% was obtained that possibly suggests the sequence to be a putative promoter. Overall, the preliminary findings have enabled the identification and molecular characterization of the Mx gene and Mx promoter of snow trout.

3.6.6. National Mission for Sustaining the Himalayan Ecosystems - Ecosystem monitoring and sustainable development of coldwater fisheries in Himalayan regions of India

The Directorate has been entrusted with the responsibility of carrying out a specific component of research under the task force 6 of NMSHE, concerning sustainable fisheries and food security through resource mapping, ecosystem monitoring and development of integrated fish farming in selected Himalayan regions.

Initially, data collection from primary and secondary sources is being carried out to prepare Himalayan aquatic resource database for the Himalayan agriculture knowledge portal. Data on ichthyofauna and hydro-biological parameters from different river systems of the Himalayan region (Uttarakhand and Himachal Pradesh) is being compiled from published sources. Moreover, primary data on fish faunal diversity and other physicochemical parameters were collected

on seasonal basis from river Kosi and western Ramganga. The collected data will be used to understand the seasonal pattern of fish distribution, factors affecting their dispersal and for generating resource map of the target aquatic water bodies.

The process of adapting and validating the applicability of existing models for fisheries management and impact assessment in the lower and middle Himalaya regions have been initiated. Monitoring indicators have been selected for vulnerability assessment of ecosystem and native fishes under the three main components defined by IPCC, namely exposure, sensitivity and adaptive capacity. Pilot sites have been identified in the vulnerable areas for the implementation of interventions. Jurkafun village in Almora district of Uttarakhand and Kumali village in Shimla district of Himachal Pradesh have been identified for the establishment of demonstration unit involving all partner institutes in the field of agriculture, horticulture, soil and water conservation, fisheries and watershed development. On the other hand, suitable sites for developing climate resilient aquaculture activities has been selected in Dudholi and Todra villages in Almora district, Uttarakhand. Around 40 fish farmers have been targeted to develop hill aquaculture with suitable fish species under climate change scenario. Different combination of fishes will be stocked in different culture system to evaluate the response of the fishes and production performance under changing climatic condition and thermal regime.

3.6.7. Rainbow trout farming for promotion of livelihood in Central Himalayas (NFDB)

Keeping in view the resource availability and livelihood condition of the people residing in the Uttarakhand hills, the present project was taken up to promote rainbow trout farming as a economically viable livelihood option. To achieve this objective, experimental clusters of five farmers in two different climatic regions (Kumaon and Garhwal region of Uttarakhand) were selected. After a preliminary feasibility survey of potential trout farming sites

based on accessibility, water availability, water quality, terrain nature and willingness of farmers, two sites were selected for the establishment of raceways at village Kathad, district Champawat and village Singot, district Uttarkashi. A pair of identical raceways (15x2x1.5 m) was constructed for each adopted farmer with an allocated subsidy of Rs. 55000 per raceway. Eyed ova of rainbow trout were procured from Himachal Pradesh and DCFR Champawat field centre, incubated and reared in a flow through hatchery. One month old fry were stocked at the rate of 40-45 fry/m² in adopted raceways. Practical demonstration was given with respect to handling of the stock, cleaning of raceways, feeding and water quality monitoring (especially for temperature, dissolved oxygen and water flow). Starter feed was also provided to the farmers. Moreover, a small extruder with 20 kg/hr feed production capacity and necessary feed ingredients were procured and supplied to the adopted farmers. The culture trial is in progress.



Stocking of rainbow trout fry in the constructed raceways at Kathad village

3.6.8. All India network project on fish health - Aquaculture medicine and therapeutics

Primary data about the aqua drugs, medicines, antibiotics and treatment kits used in hill aquaculture were collected from Uttarakhand (45 farms), Himachal Pradesh (26 farms), Sikkim (68 farms), Tripura (62 farms), Meghalaya (65 farms)



Questionnaire based survey in fish farms

and Arunachal Pradesh (30 farms). The documented aqua-drugs and medicines were salt, lime, $KMnO_4$, cypermethrin-high cis (TIK-OUT), WASORICH (probiotics), Q4ALL (for broad spectrum biodegradable disease control), aqua promass and aquamin (as growth promoters), tetracycline hydrochloride, malachite green, betadine, CIFAX, bleaching powder, clinar, apiclin, vazra, domax, etc. Nevertheless, it was recorded that table salt, lime and potassium permanganate were the most commonly used agents for fish health management in hill aquaculture practices. It was also observed that the

farmers were not much aware of the availability of different antibacterial and antifungal agents in the market. The second phase of the project concerning the use of antibiotics is in progress.

3.6.9. National network of germplasm centre for prioritized finfishes of Ganga basin (upland) for conservation and aquaculture (Agri-CRP)

This project was recently initiated with the objective to develop a germplasm repository of important indigenous coldwater fish species of upland Ganga river basin and to develop standard protocols for their conservation, stock enhancement and aquaculture. The targeted fish species are *Schizothorax richardsonii*, *Nazitor chelynooides*, *Labeo dyocheilus*, *Bangana dero*, *Tor putitora* and ornamental fishes such as *Barilius bendelisis* and *Chagunius chagunio*. Exploratory surveys were conducted in some of the riverine stretches of upland Ganga basin viz. Kosi, Ganga, Gomati and western Ramganga and sampling stations were identified. Live specimens of *Schizothorax richardsonii* (200 no), *Nazitor chelynooides* (55), *Tor putitora* (25), *Barilius bendelisis* (110) and *Schistura obliquofascia* (50) have been collected and are maintained at the infrastructure developed at ICAR-DCFR, Bhimtal and Champawat. After the study of life history traits, breeding trials of the targeted species will commence.



Fishes maintained in the germplasm repository at Bhimtal

LIST OF ONGOING PROJECTS

4.1. Institutional Projects

Project code	Project title	Project leader & associates	Year of start	Year of completion
CF-6	Ecosystem assessment and mapping of aquatic resources in Indian Himalayan regions	D. Sarma (Coordinator)	2015	2018
	Sub-project 1: Ichthyofaunal diversity, habitat assessment and molecular characterization of important species from the selected Himalayan drainages	S. Ali N.N. Pandey P. Kumar S.K. Mallik		
	Sub-project 2: Habitat assessment and eco-biological study of selected mountain lakes of central and north-eastern Himalayan region	D. Sarma R.S. Patiyal D. Baruah P. Sharma R.S. Tandel R.S. Haldar		
	Sub-project 3: Study on development of spatial database of coldwater fishery resources in western Himalayan region	P. Kumar A.K. Giri A.K. Saxena		
AQ-13	Potential bacterial pathogens in rainbow trout farms from northern India and maintenance of bacterial agents	S.K. Mallik N. Shahi S. Chandra R.S. Tandel	2011	2016
AQ-15	Bioprospecting of genes and allele mining for thermal stress tolerance of <i>Schizothorax richardsonii</i>	A. Barat P.K. Sahoo S. Ali C. Siva	2014	2017
AQ-16	Photo-thermal manipulation and profiling of Kiss genes during gonadal maturity of golden mahseer for captive breeding	A.K. Singh (Coordinator)	2014	2017
	Sub-project 1: Photo-thermal manipulation for gonadal maturity of golden mahseer in captivity.	M.S. Akhtar D. Sarma A. Ciji Rajesh M		
	Sub-project 2: Molecular characterization and gene expression profiles of kiss genes in golden mahseer during different gonadal development stages	N. Shahi D. Thakuria		

Project code	Project title	Project leader & associates	Year of start	Year of completion
AQ-17	Decoding the constraints in growth, maturation and captive management of snow trout (<i>Schizothorax richardsonii</i> , Gray, 1832)	A.K. Singh (Coordinator)	2015	2019
	Sub-project 1: Central and peripheral regulation of feed ingestion and nutrient uptake in snow trout, <i>Schizothorax richardsonii</i>	B.S. Kamalam N.N. Pandey P. Sharma		
	Sub-project 2: Nutrient mediated metabolic regulation of growth and well being in snow trout, <i>Schizothorax richardsonii</i>	M.S. Akhtar A. Ciji A.K. Giri		
	Sub-project 3: Myogenic regulation and protein turnover of muscle growth in snow trout <i>Schizothorax richardsonii</i>	Rajesh M D. Thakuria B.S. Kamalam		
	Sub-project 4: Endocrine aspects of growth and maturity of snow trout, <i>Schizothorax richardsonii</i>	A. Ciji Rajesh M. P. Sharma P. Dash		
	Sub-project 5: Development of captive management and seed production protocol of snow trout, <i>Schizothorax richardsonii</i>	S. Chandra A.K. Giri		
AQ-18	Development of fish viral peptide based nano system for intracellular delivery of biomolecules	D. Thakuria K.V. Chanu N. Shahi	2015	2018
AQ-19	Domestication, biology and captive breeding of Indian trout <i>Raiamas bola</i> (Hamilton, 1822)	N.N. Pandey S. Ali P. Dash R.S. Haldar	2015	2018

4.2. Inter-Institutional Outreach Activities (Fisheries Division-ICAR)

Project code	Project title	Project leader & associates	Year of start	Year of completion
NMP-1	Fish genetic stock	A. Barat P.K. Sahoo S. Ali R.S. Patiyal C. Siva	2014	2017
NMP-2	Fish feed	N.N. Pandey M.S. Akhtar B.S. Kamalam	2014	2017
NMP-3	Nutrient profiling and evaluation of fish as a dietary component	D. Sarma M.S. Akhtar A. Ciji M. Rajesh	2014	2017

4.3. Externally Funded Projects

Project code	Project title	Project leader & associates	Year of start	Year of completion
DBT-Twin project-2	Development and characterization of microsatellite marker and assessment of genetic diversity of <i>Schistura sikmaiensis</i> from NE India	A. Barat P.K. Sahoo	2012	2016
DBT-3	Economic development of SC & ST community of mid-hill region of Pithoragarh district through aquaculture intervention	R.S. Patiyal P.K. Sahoo	2012	2015
DBT-4	Transcriptome profiling of immune responsive genes in golden mahseer (<i>Tor putitora</i>)	A. Barat P.K. Sahoo	2013	2016
DBT-5	Development of bacterial bioremediation measures for the mitigation of microalgal blooms in freshwater aquaculture ponds	N. Shahi S.K. Mallik	2014	2017
NSPAAD	National surveillance programme for aquatic animal diseases - Surveillance of coldwater fish diseases in Himachal Pradesh and Jammu & Kashmir	S. Chandra S.K. Mallik R.S. Tandel	2014	2017
ICAR-National Fellow	Development of a method for detecting the presence of any virus signal in clinical samples of fish	A. Pande	2015	2020
NMSHE	National Mission for Sustaining the Himalayan Ecosystems (Taskforce 6 for Himalayan Agriculture) (A) Ecosystem monitoring and sustainable development of coldwater fisheries in lower and mid Himalayan regions of India	N.N. Pandey S. Ali R.S. Patiyal Rajesh M P. Kumar	2015	2019
	(B) Ecosystem monitoring and sustainable development of coldwater fisheries in cold desert Himalayan regions of India	P. Kumar N.N. Pandey B.S. Kamalam A.K. Giri	2015	2019
NFDB- Trout project	Rainbow trout farming for promotion of livelihood in central Himalayas under technology up-gradation programme	N.N. Pandey S. Ali	2014	2016
AINP-FH (CIBA)	All India network project on fish health: Aquaculture medicine and therapeutics (Component-1)	S.K. Mallik N. Shahi R.S. Tandel	2015	2017
Agri-CRP	National network of germplasm centre for prioritized finfishes of Ganga basin (upland) for conservation and aquaculture	R.S. Patiyal S. Chandra	2015	2018

IMPORTANT EVENTS AND MEETINGS

5.1. National consultation on rainbow trout farming

In collaboration with the National Fisheries Development Board and the Department of Biotechnology, a two days national consultation on 'Rainbow trout farming: prospects and challenges for strategic development' was organized at ICAR-DCFR, Bhimtal during 20-21 September 2015. Considering its status as the most remunerative coldwater fish species cultured across the hilly regions of the country, the various challenges and opportunities for augmenting rainbow trout farming and production was discussed during the consultation. The meet was inaugurated and chaired by Shri A.K. Joshi, Joint Secretary, Department of Animal Husbandry, Dairying & Fisheries. Other dignitaries present were Dr. B. Meenakumari, Dr. A.S. Ninawe, Dr. K.K. Vass, Dr. P.C. Mahanta, Dr. J.R. Dhanze, Dr. S.D. Singh, Dr. A.P. Sharma, Shri G. Singh and Shri I.P. Chetri. There were over 70 participants including scientists, professors, fisheries officers, farmers and students from rainbow trout producing states like Himachal Pradesh, Sikkim, Arunachal Pradesh and Uttarakhand. Based on the keynote address of Dr. A.K. Singh, Director, ICAR-DCFR and several other deliberations on many critical issues concerning production system, farm operation, value addition, marketing and policies, an action plan was drafted to target higher productivity through scientific improvement in inputs, management practices and better governance.



Expert panel discussion during the consultation



Release of a technical bulletin on rainbow trout farming

5.2. Launch workshop of the National Mission for Sustaining the Himalayan Ecosystem

A zonal workshop was organized at ICAR-DCFR, Bhimtal during 4-5 June 2015 to launch the task force on Himalayan agriculture under the National Mission for Sustaining the Himalayan Ecosystems (NMSHE) sponsored by the Department of Science and Technology. The workshop was chaired by Dr. Mohan Kumar, ADG (NRM), ICAR, convened by Dr. A.K. Singh, Director, ICAR-DCFR and attended by Dr. P.K. Mishra, Director, ICAR-IISWC, Dr. A. Pattanayak, Director, ICAR-VPKAS and 35 scientists representing IVRI, CITH, IISWC, CAFRI, VPKAS and DCFR in the multidisciplinary team. The theme presentations on different components and work elements of NMSHE were given by lead scientists from the nodal institute ICAR-IISWC. The workshop was followed by field visit for selection of sites for developing climate resilient farming systems. It is a matter of great significance that the NMSHE task force on Himalayan agriculture forms a part of the national action plan for climate change. There are six partners in this task force representing different sectors of agriculture and three nodal centers viz. northeastern Himalayas led by ICAR research complex for NEH, Barapani; lower and

middle Himalayas led by ICAR-IISWC, Dehradun; and cold desert Himalayas led by ICAR-CAZRI regional centre, Leh.



NMSHE launch workshop

5.3. Workshop on Intellectual Property Rights

The Institute Technology Management Unit organized a one day workshop on the occasion of Intellectual Property Rights day on 28th April 2015, to sensitize scientists and research scholars towards IPR issues and rights provided under the law. The workshop was held under the chairmanship of Dr. A.K. Singh, Director, and around 70 participants from ICAR-DCFR and regional stations of ICAR-CITH and ICAR-NBPGR attended the workshop. On this occasion, a series of lectures were delivered on the fundamentals and emerging issues of IPR. This was followed by an interactive session for open discussion and exchange of ideas.



Open discussion during the IPR workshop

5.4. Research Advisory Committee meeting

In the reporting period, two meetings of the RAC were convened at Bhimtal during 13-14 April 2015 and 25-26 February 2016. The meetings were chaired by Dr. J.R. Dhanze and attended by the esteemed

members Dr. S.D. Singh, Dr. H.S. Raina, Dr. S.N. Mohanty, Dr. S.K. Singh and Shri B.A. Bhat. After a brief presentation by the principal investigators, the RAC critically examined the progress and achievements of ongoing and completed projects. The committee also gave important comments on new project proposals and appreciated the collective efforts made by the Directorate to address research gaps and challenges in coldwater fisheries and aquaculture sector. During the second meeting, the RAC chairman and members released the Vision 2050 document of the Directorate.



Release of Vision 2050 document by RAC

5.5. Institute Research Committee meeting

The IRC meeting of the Directorate was held on 9-10 April 2015 under the chairmanship of Dr. A.K. Singh, Director. Progress of the ongoing institute funded research projects and proposals for new projects were presented by concerned scientists. This was followed by thorough discussion, appraisal and future orientation of the technical programme. Further, to fast track project activities, a mid-term IRC meeting was held during 15-16 December 2015.



Concept note presentation in IRC

5.6. Institute Management Committee meeting

The IMC meeting was convened on 12th February 2016 under the chairmanship of Dr. A.K. Singh, Director. Other respected members present during the meeting were Dr. S. Raizada, ADG (Inland Fisheries), Dr. R. S. Chauhan, Dr. J. K. Bisht, Dr. S. K. Verma, Shri K. Kalia, Shri V. Pandey, Shri P. Bisht and Shri Y.S. Dhanik (member secretary). Issues related to institute management and procurement proposals were discussed and approved.



IMC meeting

5.7. ICAR-DCFR Foundation day celebration

The 28th foundation day of the Directorate was celebrated on 24th September 2015. The occasion was graced by guests of honour Dr. A. Pattanayak, Director, VPKAS, Dr. N.P. Melkania, former Director, IGRI and Dr. P.C. Mahanta, former Director, DCFR. The function was attended by all the staff and research scholars of the Directorate, local dignitaries, farmers and students of Lakes International School. Dr. A.K. Singh, Director, briefed the gathering about the historical progress, achievements and future challenges of the Directorate. Dr. N.P. Melkania delivered a special lecture on the impact of climate



Lighting of lamp by the guests of honour

change on ecosystems and the importance of carbon sequestration. Following which, Dr. P.C. Mahanta gave a talk on the role of indigenous traditional knowledge in fisheries.

5.8. Independence and Republic day celebration

On 15th August 2015 and 26th January 2016, the Independence and Republic day of our nation was celebrated with a flag hoisting ceremony attended by all the staff members of the Directorate. Dr. A. K. Singh, Director, unfurled the national flag and earnestly urged the gathering to work in unison towards scientific breakthroughs that will enhance the socio-economic well-being of the upland population.



Flag hoisting ceremony

5.9. Hindi 'Saptah samaroh' celebration

To promote and recognise Hindi knowledge among the staff of the Directorate, the Hindi section conducted several intramural linguistic competitions on September 2015. Prizes were distributed to the winners during the foundation day celebration.



Hindi competition

EXTENSION ACTIVITIES AND OTHER SERVICES

Various extension activities such as frontline demonstrations, farmer advisories, scientist-farmer interaction meets, distribution of farm inputs, technical guidance, awareness programmes and exhibitions were carried out to effectively transfer the technological developments made by the Directorate to farmers and other stakeholders.

6.1. Farmer oriented extension activities

- To commemorate 'Fish farmers day' on 10th July 2015, a farmer-scientist interaction meet was organized at Katahar village, Champawat. About 50 participants including 35 farmers from Champawat district attended the meet. During the interaction, scientists responded to various queries and concerns raised by the farmers related to availability of quality seed and feed, water budgeting and good management practices. Shri Laxman Singh, a progressive fish farmer elaborated the benefits of integrated aquaculture in terms of income generation and livelihood security. Moreover on the occasion, rainbow trout and Hungarian common carp seed was distributed to selected farmers.



Scientist-farmer interaction at Katahar village

- On the occasion of 'Jai Kisan Jai Vigyan week', a demonstration programme on rainbow trout

breeding and seed production was conducted for fish farmers and interested public at the ICAR-DCFR field centre, Champawat on 29th December 2015. Local fish farmers, SSB soldiers and a group of 60 students from P.G. College, Champawat participated in the demonstration. The participants were shown different aspects of trout seed production such as selection of brooders, egg stripping, fertilization and hatchery incubation techniques.



Netting of rainbow trout brooders for demonstration

- To create an understanding and alertness about fish diseases and their control among the fish farmers of Champawat district, an awareness programme was conducted at Toli village on 12th January 2016, under the national



Awareness programme on fish diseases at Toli

surveillance programme for aquatic animal diseases. Altogether, 79 farmers belonging to 15 villages in Patti, Devidhura and Reetha area of Champawat district attended the programme. The participating farmers were educated about the various measures for maintaining a healthy fish stock and the harmful effects of using banned chemicals and medicines. Water and soil quality monitoring was also demonstrated.

- The scientific team of the Directorate is actively involved in providing technical support and advisory service to fish farmers of several hill states through direct visits and other mode of communication. Farm specific advisories were provided to more than 50 rainbow trout growers of Sikkim and Himachal Pradesh. Similarly, technical guidance on composite culture of exotic carps was rendered to 85 fish farmers of Champawat and Almora district in Uttarakhand. Under the 'Mera Gaon Mera Gaurav' scheme, farm advisories and special monitoring was provided to fish farmers of the adopted villages Todera and Dudhauri in Uttarakhand. Besides, 149 pond soil samples of fish farmers from Arunachal Pradesh and Uttarakhand were collected, analysed and aquaculture soil health cards were provided.



Advisory service to fish farmer at Champawat

- Field demonstration programmes were organized at ICAR-DCFR field centre, Champawat for the group of farmers from Khatima and Paudi Garhwal, Uttarakhand. Common carp seed production and rainbow trout farming techniques were demonstrated to the farmers.



Demonstration of common carp breeding

- Advanced fry of improved Hungarian common carp strain was distributed and stocked in fish ponds located at Dudh Pokhara village and within the Shastriya Seva Bal premises, Champawat. Furthermore, on-site technical support was provided.



Technical support on SSB site

- On the occasion of world environment day on 5th June 2015, a seed distribution programme was organized at ICAR-DCFR, Bhimtal. Carp seed and feed were distributed to 10 tribal farmers from Khatima by the guest of honour Dr. Mohan Kumar, ADG (NRM), ICAR, New Delhi and Dr. P.K. Mishra, Director, IISWC, Dehradun.



Seed and feed distribution to tribal farmers

6.2. Rehabilitation of endangered golden mahseer

The riverine stretch near Baijnath temple of Bageshwar district, Uttarakhand used to be a rich natural habitat of golden mahseer (*Tor putitora*). But recently, the entire population was wiped out after a heavy snowfall and hailstorm. In order to revive and rehabilitate the lost population of this endangered fish, ICAR-DCFR organized a one day seed ranching and awareness programme through which 20,000 hatchery reared golden mahseer fingerlings were released into its ideal habitat near the temple. The President, District Council of Bageshwar and other prominent villagers were present during the seed ranching event.



Golden mahseer seed ranching near Baijnath temple

6.3. Participation in exhibitions

The research and development activities of the Directorate were exhibited and disseminated to farmers and other stakeholders at several conferences and kisan melas organized across the country. The details of the participations are mentioned in the table below.

Kisan Mela, ICAR-VPKAS, Hawalbagh, Almora	8 April 2015
Kisan Mela, ICAR-VPKAS, Hawalbagh, Almora	29 September 2015
International conference on Science and Geopolitics of Arctic-Antarctic-Himalaya (SaGAA) III, New Delhi	29-30 September 2015
Krishi Kumbh, GBPUA&T, Pantnagar	1-4 October 2015
Krishi Darshan Expo-2015, Northern Region Farm Machinery Training & Testing Institute, Hisar	17-19 October 2015
26 th All India Congress of Zoology & International symposium on Innovation in Animal Sciences for Food Security, Health Security and Livelihood, Babasaheb Bhimrao Ambedkar University, Lucknow	29-31 October 2015
National workshop on Coldwater Endemic Fishes of North Eastern Himalaya: Avenues and Challenges, Gangtok, Sikkim	5-6 November 2015
5th International symposium on Cage Aquaculture in Asia (CAA5), Kochi, Kerala	25-28 November 2015
Kisan Mela, GBPUA&T Regional Agricultural Research Centre, Majhera	4 December 2015
11th National symposium on Innovations in Coastal Agriculture-Current Status and Potential under Changing Environment, ICAR-IIWM, Bhubaneswar	14-17 January 2016
National seminar on Aquaculture and Fisheries: Livelihood Security, Sustainability and Conservation, College of Fisheries, CAU, Lembucherra, Tripura	21-22 January 2016
2nd International symposium on Genomics in Aquaculture (ISGA-II), ICAR-CIFA, Bhubaneswar	28-30 January 2016
National conference on Hill Agriculture in Perspective, GBPUA&T, Pantnagar	26-28 February 2016
99th Kisan Mela and Agro-Industrial Exhibition, GBPUA&T, Pantnagar	10-13 March 2016
Krishi Unnati Mela 2016, ICAR- IARI, New Delhi	19-21 March 2016
Kisan Mela, KVK Lohaghat, Champawat	19 March 2016



Hon'ble Dr. S. Ayyappan in ICAR-DCFR stall at CAA5, Kochi



Exhibit in Kisan mela, Almora

in three phases from May, at a temperature of 20.9-23.3°C. The size of brooders ranged between 120 ±30 to 215 ±51 g and a total of 452 male and 331 female fish of the three varieties were used. Mature male and female brooders of the three strains were segregated and kept in separate breeding hapas in appropriate ratio. Disinfected gunny bag twines were used as egg collectors. Survival from spawn (4.9 lakh) to fry was between 25-28%, due to adverse and fluctuating climatic conditions. About 5200 improved Hungarian strain common carp seed have



Hungarian strain common carp stock in Champawat

6.4. Consultancy services

A fisheries management plan is being prepared for implementation in the Vishnugad - Pipalkoti hydroelectric project under Tehri Hydro Development Corporation (THDC) consultancy programme. During 11-19 May 2015, a scientific team of the Directorate visited Pipalkoti in Chamoli District, Uttarakhand and carried out various activities such as survey and selection of sampling sites within a 100 km stretch from Vishnuprayag to Karanprayag, collection and analysis of water samples, netting for assessment of fish diversity, training of concerned staff members and meeting with local people.

6.5. Farm activities

Breeding and seed production of common carp

Nearly 1.3 lakh fry were produced from three common carp strains in ICAR-DCFR field centre at Champawat. Breeding activity was accomplished

been distributed to fish farmers in Champawat and Pithoragarh districts of Uttarakhand.

Breeding and seed production of rainbow trout

In the annual spawning cycle of rainbow trout at ICAR-DCFR field centre, Champawat, first maturity in male and female fish was observed in the fourth week of September and first week of December 2015, respectively. From December 2015 to January 2016, total 2.34 lakh trout eggs were stripped from 135 female brooders (average weight 1.1 kg), fertilized and incubated in the trout hatchery at Champawat. The relative fecundity was 1510-1779 eggs/kg of fish and the average egg weight was 60.3-71.9 mg. Eggs started hatching after 58 days of incubation at water temperature ranging from 3.0 to 7.6°C. Average survival of 52-54% has been achieved from fertilized eggs to yolk sac larvae stage. During the reporting period, the field centre generated revenue of Rs 1.16 lakh through the sale of rainbow trout fry and Hungarian common carp fry.



Stripping of eggs from female rainbow trout

Seed production of golden mahseer

45,000 *Tor putitora* fingerlings were produced in the mahseer hatchery complex at ICAR-DCFR, Bhimtal. A gross revenue of rupees 1.1 lakh was earned by supplying golden mahseer seeds to Madhya Pradesh Fisheries Federation (10,000 nos.) and Department of Fisheries, Bihar (1000 nos.). 20,000 golden mahseer seed were ranched in the mahseer sanctuary near Baijnath temple and 9000 seed were released in Bhimtal lake to revive the native mahseer population. The remaining 5000 golden mahseer seed are reared in ICAR-DCFR floating cage facility at Bhimtal lake for culture and research purpose. In tandem, 1000 nos. of chocolate mahseer has also been produced and maintained for experimental studies.



Rearing of golden mahseer seed at Bhimtal

Seed production activities at ICAR-DCFR, Bhimtal

Brood stock of grass carp, silver carp, common carp, *Labeo dero*, *L. dyocheilus*, *Chagunius chagunio* and *Schizothorax richardsonii* were maintained at the farm facility in Bhimtal. Induced breeding of *L. dyocheilus*, *L. dero* and *Chagunius chagunio* were successfully carried out at low water temperature (18°C) in the carp hatchery facility. 3 lakh fry of *Labeo dyocheilus* and *Labeo dero* were produced, reared up to fingerling stage and stocked in farmers' ponds at village Todera and Dudhauri, Almora. Similarly, common carp was bred successfully at low water temperature (16°C) and 2 lakh spawn were produced. Moreover, 10,000 eyed ova were brought from Himachal Pradesh, incubated at relatively high water temperature (16-19°C). The trout fry produced were distributed to adopted farmers in Champawat. With respect to ornamental fishes, nearly 3000 seeds of gold fish and koi carp were produced in the breeding facility at Bhimtal.



Sorting of gold fish brooders

6.6. Farmer and student visits

- A group of 11 students from College of Fisheries, West Bengal visited the facilities of ICAR-DCFR at Bhimtal and Champawat during the first week of June 2015. Lectures and farm demonstrations were given on rainbow trout farming and other activities.



Student visitors from West Bengal at Champawat



Group of farmers from Garhwal at Bhimtal

- A group of 18 undergraduate students from College of Fisheries, GBPUA&T visited ICAR-DCFR, Bhimtal on 5th November 2015 and interacted with scientists.
- A group of 37 undergraduate students from College of Fisheries, Ratnagiri, Maharashtra visited ICAR-DCFR, Bhimtal on 5th December 2015 and interacted with scientists.
- A group of 35 students from Uttaranchal P.G. College of Biomedical Sciences and Hospital, Dehradun visited ICAR-DCFR, Bhimtal and interacted with scientists.
- A group of 24 students from P.G. College, Rudrapur visited ICAR-DCFR, Bhimtal on 2nd December 2015 and interacted with the scientists.
- A group of 11 farmers from Ramgad, Uttarakhand visited ICAR-DCFR, Bhimtal on 11th March 2016 and interacted with scientists.
- A group of 14 farmers from Chamoli district, Uttarakhand visited ICAR-DCFR on 19th March 2016 and interacted with scientists.

TRIBAL SUB PLAN (TSP) ACTIVITIES

During the reporting period, the Directorate undertook various initiatives under TSP programme in several states including Uttarakhand, Arunachal Pradesh and Jammu & Kashmir to promote hill aquaculture and allied activities as a means of livelihood enhancement for rural tribal farmers. The details are listed hereunder.

7.1. Training on integrated fish farming at Ziro valley, Arunachal Pradesh

In collaboration with Krishi Vigyan Kendra of Lower Subansiri district, the Directorate conducted two training cum demonstration programmes on 'Livelihood support to the hill tribes through integrated fish farming' at Hapoli and Yachuli during 5-8 March 2016. Each of the training was attended by a batch of 25 tribal folks which included farmers, women and rural youth. The inaugural chief guests were Mr. Tilling Tadi, a progressive farmer and Mr. G. Hocha, District Training Organizer, ATMA at Hapoli and Yachuli, respectively. During the training, the prospects and fundamentals of integrated fish farming were emphasized, with respect to available water resources, fish species and altitudinal regimes. Field demonstrations were organized, in which the participants were shown good management practices in terms of pond water quality and fish health. On this occasion, a training manual was also provided for easy understanding and adoption of hill aquaculture practices. Moreover, plans



Participants at Hapoli



Field visit and demonstration at Ziro valley

were also made to establish fish hatcheries at Ziro valley for making the farmers self sufficient in seed production.

7.2. Frontline demonstration of composite fish culture at Tharu-Thisaur, Uttarakhand

At the conclusion of a one year field trial in ponds belonging to Shri Sukhdev Singh, a frontline demonstration of composite fish culture was organized at the tribal village Tharu-Thisaur in Udham Singh Nagar district of Uttarakhand. The objective of the meet was to create awareness among tribal people about the economic benefits of adopting fish culture as an allied agriculture activity. 70 farmers including 30 women participated in the demonstration. The programme was inaugurated by Dr. A.K. Singh, Director, ICAR-DCFR and he urged the farmers to adopt an integrated approach of fish farming for enhancing their livelihood. On this occasion, a scientist-farmer interaction meet was also organized and farm inputs such as fish seed, feed and nets were distributed to the adopted farmers. Particularly, ornamental fish seed were provided to tribal women to promote back yard farming. Moreover, the efforts of the two progressive fish farmers Shri Sukhdev Singh and Shri Laxman Singh were duly appreciated.



Distribution of inputs to adopted farmers



Stocking of rainbow trout fry at Dharchula



Demonstration of carp harvest at Tharu

7.3. Aquaculture initiatives in disadvantaged areas of Uttarakhand

The first initiative towards rainbow trout farming in remote border areas of Dharchula was made by stocking advance trout fry produced at ICAR-DCFR field centre, Champawat in raceways constructed in Pangu village of Pithoragarh district under the TSP programme. Technical assistance on good management practices was extended to the concerned farmer Shri Ratan Singh Hayanki related to water flow rate, water quality monitoring, routine feeding and raceway cleaning. Moreover, improved Hungarian common carp fry were stocked in eight farmers pond located in Goti and Pangu villages. The queries of the farmers concerning various issues were also addressed through a scientist-farmer interaction meet.

7.4. Training on fish processing and value addition for tribal women of Uttarakhand

Following the aquaculture activities pioneered in remote villages of Dharchula in Pithoragarh district, a training was organized especially for the tribal women on 'Post-harvest handling and value addition of coldwater fishes' in collaboration with ICAR-CIFT, Kochi during 3-4 May 2015. The participants were 45 tribal women and 25 interested youth and fish farmers. Shri Ashok Nabiyal, President of Rang Kalyan Sanstha, inaugurated the training programme. During the training, practical demonstrations were given on the post-harvest handling of fish and preparation of fish fillet, fish fingers, fish balls, fish cutlets, fish steaks, fish curry, fish pickle and fish silage. The training created much interest among the participants to form self help groups and small scale enterprises in value addition of fish as a means of livelihood security.



Hands on training in value addition of fish at Dharchula

Similarly, another training programme on 'Value addition of freshwater fish through processing' was organized at Dehradun during 2-3 March 2016, in collaboration with ICAR-CIFT, Kochi. It was attended by 73 tribal women belonging to Bhotiya and Boksha community. The training was inaugurated by Shri N.S. Napalchyal, chairman, ST commission and former chief secretary (Govt. of Uttarakhand). With the objective to encourage



Release of training manual

small scale entrepreneurship among tribal women for livelihood support, practical demonstrations of the protocols for post harvest handling and preparation of value added products from fish were carried out. Training module of this kind received enthusiastic response from the participants and ICAR-DCFR extended technical support to start community based enterprises. In parallel to this training, backyard culture of ornamental fishes

was also demonstrated to these tribal women as an alternative option for livelihood support.



Practical demonstration on value addition of fish at Dehradun

7.5. Promotion of rainbow trout farming in Leh, Jammu & Kashmir

Under TSP programme, 13 raceways for rainbow trout culture were constructed and renovated in Leh region and seed stocking had been done. However due to the flash floods during August 2015, the entire rainbow trout stock was washed out and re-stocking was hindered by siltation and damages in raceways. Nevertheless, initiatives have been taken to establish an ova house in order to make the farmers self sufficient with respect to seed availability. Moreover, for the expansion of trout culture in Leh region, a new area in Kargil has been identified.

NORTH EAST HILL (NEH) ACTIVITIES

Under the NEH programme, various research and development activities have been carried out in different north-eastern states namely Assam, Sikkim, Arunachal Pradesh, Meghalaya, Nagaland and Manipur. The details of which are listed hereunder.

8.1. National workshop on coldwater endemic fishes of north east

North-east region of India is very rich in fish biodiversity and the endemic fish species present are an important part of the natural heritage of the country. Hence, their sustainable management is an important concern in the changing aquaculture and fisheries scenario. In this context, ICAR-DCFR organized a national workshop on 'Coldwater endemic fishes of north east: avenues and challenges' during 5-6 November 2015 at Gangtok, Sikkim. It was attended by over 116 participants from the state fisheries departments of Sikkim, Mizoram, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, ICAR research institutes, State Agriculture Universities, KVKs, NGOs and fish farmers. The workshop was inaugurated by Shri Somnath Poudyal, Minister of Fisheries, Government of Sikkim in the presence of Shri Sreenivasulu, Commissioner-cum-Secretary, Fisheries and Cooperation; Dr. V.V. Sugunan, Ex. ADG (Inland Fisheries), ICAR; Dr. Gopal Krishna, Director, ICAR-CIFE; and Shri I.P. Chetri, Director, Department of Fisheries, Sikkim. The theme of the workshop was briefed to the delegates by Dr. A.K. Singh, Director, ICAR-DCFR. The workshop ended with important recommendations and action plan for the development of captive management strategies and culture and breeding protocols of important endemic fish species such as *Semiplotus semiplotus*, *Neolissocheilus hexagonolepis*, *Osteobrama belangiri*, *Labeo pangusia*, *Schistura* spp., etc.



Release of workshop bulletin by the dignitaries



Inauguration of exhibition by the chief guest Shri Somnath Poudyal

8.2. Promotion of rainbow trout farming

With respect to the promotion and expansion of rainbow trout farming in north-eastern states, the Directorate provided scientific, technical and financial support to construct and operate a trout ova house and hatchery facility at Shergaon Govt. trout farm, Arunachal Pradesh. Continuous support was also provided to the State Fisheries Department of Sikkim in various aspects of trout farming such as broodstock development, seed production, hatchery renovation, construction of poly raceways, feed mill establishment and post-harvest processing like smoking.



Rainbow trout broodstock development at Uttarey, Sikkim



Polyculture of endemic minor carps

8.3. Captive breeding and rearing of mahseer and minor carps

For artificial propagation and seed production of chocolate mahseer, two hatcheries were established at Tura, West Garo Hills, Meghalaya and Thimlak fish farm, Tuensang district, Nagaland with the scientific, technical and financial support of the Directorate in collaboration with the respective state fisheries departments. Likewise, scientific and technical guidance was also provided for the establishment of a facility to maintain 250 potential brooders of golden mahseer (*Tor putitora*) at Makka fish farm, Sikkim.



Captive rearing of golden mahseer at Makka, Sikkim

Moreover, to scientifically promote the culture of endemic minor carps in conventional polyculture systems, a field trial with *Bangana devdevi* and exotic carps was conducted in the ponds of 10 fish farmers of Manipur in collaboration with Krishi Vigyan Kendra, Thoubal. Likewise, brood raising and artificial breeding of the minor carp, *Labeo pangusia* have been successfully carried out at Nameri Eco-park, Assam.

8.4. Farm input distribution

For promoting fish culture as a remunerative livelihood option in the mid-altitude regions of Donglok and Chug village, Dirang, West Kameng district in Arunachal Pradesh, critical farming inputs such as fish seed and nets for harvest operation were provided to thirty fish farmers. Besides, they were also provided training on basic farm management such as pond construction and maintenance, feeding, disease control and water quality monitoring.



Fish seed and net distribution to farmers

TRAINING AND CAPACITY BUILDING

The Directorate was actively involved in knowledge sharing through need based training programmes for farmers, state fisheries department officials and all other interested stakeholders. Concurrently, attention was also given to develop the aptitude and skills of the scientific, technical and administrative staff through various short courses and trainings. The details of the trainings organized and participated are provided below.

9.1. Training programme for farmers of Donglok and Chug village, Arunachal Pradesh

National Fisheries Development Board sponsored training programme on 'Techniques for fish farming in mid-altitude fish ponds of Donglok and Chug village in Dirang, Arunachal Pradesh' was organized by ICAR- DCFR in collaboration with Krishi Vigyan Kendra, West Kameng at Chug village during 1-5 December 2015. Altogether, 25 farmers of Chug and Donglok villages participated in the programme. The training programme was inaugurated by the chief guest Dr. H. Tama, Deputy Director, Regional Sheep Breeding Farm, Department of Animal Husbandry and Veterinary, Govt. of Arunachal Pradesh. With the focus on uplifting the socio-economic conditions of rural farmers and entrepreneurs through aquaculture, the 5 days programme imparted training on composite carp farming; management of feed, health and water quality; integrated fish farming; and hatchery management. Field visits were arranged for practical demonstration of fish farm management. Moreover, a farmer oriented training manual on fish farming techniques for mid-altitude Himalayan regions was released.



Release of training manual

9.2. Training programme for Fisheries Officers of Meghalaya

ICAR-DCFR organized a 5 days training program on 'Three pronged fish farming technique for development of coldwater fisheries in Meghalaya' for 20 officers of Department of Fisheries at Meghalaya State Fisheries Research & Training Institute, Mawpun during 18-22 January 2016. The dignitaries present in the inaugural session were Smt. I.R. Sangma, Director, Department of Fisheries, Govt. of Meghalaya; Shri D.B. Kharwanlang, Principal, MSFR&TI; and Dr. S.K. Das, Head of Department (Fisheries), ICAR-NEHR. Keeping in view the resources available in Meghalaya, the training consisted of lectures on various aspects of coldwater aquaculture including the culture prospects of rainbow trout, Chinese carps and other endemic fishes. Practical demonstrations and field visits were also arranged.



Lecture session

9.3. Training programme for Fisheries Officers of Mizoram

ICAR-DCFR organized a 5 days training programme on 'Hatchery management for seed production of golden and chocolate mahseer' for fisheries officers of Department of Fisheries, Mizoram at Aizawl during 24-28 January 2016. Twenty five fishery officers representing eight districts of Mizoram participated in the training. The programme was inaugurated by Shri Thlamuana, Secretary of Fisheries, Govt. of Mizoram in the presence of Shri B.D. Tyagi, Director of Fisheries, Shri S.P. Singh, Joint Director, Shri Lalhmangaiha, Deputy Director and other higher officials from the Department of Fisheries, Mizoram. The various biological facets, scientific developments and challenges in seed production of golden and chocolate mahseer were discussed during the training. Moreover, a field visit to Lengpui Govt. fish farm was arranged to provide a practical exposure to the participants. The valedictory function of the training was graced by Shri B.D. Chakma, Minister of Fisheries and Sericulture, Govt. of Mizoram.



Participants with Shri B.D. Chakma at the valedictory session

9.4. Training programme at farm school, Toli, Uttarakhand

National Fisheries Development Board sponsored training programme on 'Fish farming in hills - Parvateeya kshetryon mei machhli palan' was organized at farm School, Toli, Champawat during 9-13 March, 2016. The training was attended by 13 men and 12 women belonging to 11 villages of Pati block. Breeding and culture techniques of rainbow trout and carp, ornamental fish farming, fish farm management and health management of farmed fishes were the main topics covered during the training. A visit to the experimental fish farm of ICAR-DCFR at Champawat was also arranged to practically demonstrate rainbow trout and carp seed production and culture. Progressive fish farmer Shri Pitamber Gahtori shared his aquaculture experience with fellow farmers and encouraged them to take up fish culture for economic advantage. Hindi training manual was also provided to the participants as a supporting material. To transform the training into practical learning of cluster farming, improved Hungarian common carp yearlings were distributed to the 25 trainees along with other farm inputs such as breeding hapa and nets.



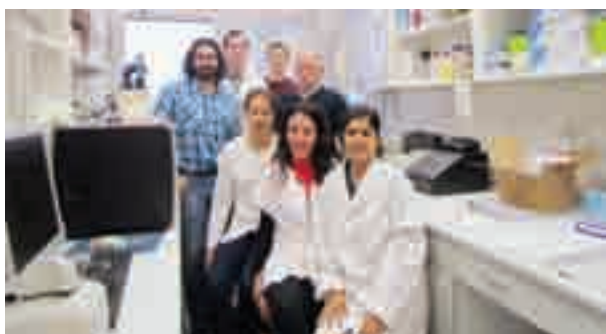
Exposure visit to DCFR field centre, Champawat

9.5. Participation in Training

Scientific staff

- A. K. Giri participated in the ICAR summer school on 'Aquaculture diversification towards boosting pond productivity and farm income' organized at ICAR-CIFA, Bhubaneswar during 8-28 July 2015.

- D. Thakuria attended the ICAR sponsored 21 days training programme on 'Analysis of high throughput sequencing and microarray data to unravel host-pathogen interactions' organised at ICAR-IVRI, Bareilly during 17 November to 7 December 2015.
- N. Shahi attended a 2 days training on 'Next Generation Sequencing - Bioinformatics and data analysis' organised at AU-KBC research centre, Chennai during 12-13 October 2015.
- N. Shahi completed four months of research stay at Department of Fish Genetics, Research Institute for Fisheries and Aquaculture, National Agricultural Research and Innovation Center, Szarvas, Hungary during the period of 20 November 2015 to 19 March 2016.



N. Shahi with the Fish Genetics group of NAIK-HAKI, Hungary

- P. Dash attended a national training on 'Application of nanotechnology in aquaculture and fisheries' organized by ICAR-CIFA at Bhubaneswar during 24-28 August 2015.
- R. S. Tandel participated in the ICAR sponsored short course on 'Molecular approaches in diagnosis and control of emerging and transboundary diseases of freshwater fish and shellfish' held at ICAR-CIFA, Bhubaneswar during 17-26 November 2015.
- S. Ali attended the 21 days CAFT training programme on 'Computational tools and techniques for molecular data analysis

in agriculture' organized by Centre for Agricultural Bioinformatics, ICAR-IASRI, New Delhi from 11 February to 2 March 2016.

- S. Ali participated in the training programme on 'Truss morphometry' under outreach activity on Fish Genetic Stock (Phase II) at ICAR-CIBA, Chennai during 18-19 May 2015.
- Siva, C. underwent a one month 'Institute Orientation Training' to fulfil the mandatory requirement for new ARS recruit at ICAR-DCFR, Bhimtal and field centre at Champawat from 9 October to 8 November 2015.
- Siva, C. underwent a three month 'Professional Attachment Training' to fulfil the mandatory requirement for new ARS recruit at ICAR-DCFR, Bhimtal in Fish Genetics laboratory under the guidance of Dr. A. Barat from 9 November 2015 to 8 February 2016.

Technical staff

- R. S. Haldar and S. Kumar attended the ICAR sponsored 10 days training programme on 'Competency enhancement programme for Technical Officers of ICAR' at NAARM, Hyderabad during 19-28 August 2015.

Administrative staff

- B. C. Pandey attended the 6 days training programme on 'Accrual accounting in Government' at NIFM, Faridabad, Haryana.
- H. S. Bhandari and J. C. Bhandari attended the 4 days training programme on 'Payroll module of FMS/MIS' at ICAR- IASRI, New Delhi.
- P. S. Bisht and H. S. Bhandari attended the 4 days training programme on 'Finance module of FMS/MIS' at ICAR- IASRI, New Delhi.
- P. S. Bisht attended the 3 days training programme on 'Microsoft power point module of FMS/MIS' at ISTM, New Delhi.

9.6. HRD physical targets and achievements

Category	Total No. of Employees	No. of trainings planned for 2015-16 as per ATP	No. of employees undergone training in 2015-16
Scientist	24	6	6
Technical	13	2	2
Administration & Finance	12	5	6
Skilled supporting staff	11	0	0

9.7. HRD fund allocation and utilization

(in lakhs)

Total HRD allocation as per RE 2015-16	Actual Expenditure 2015-16 for HRD
5	4.98

9.8. Students Guided

- Raghvendra Singh from ICAR-CIFE Mumbai completed his PhD under the supervision of Dr. N.N. Pandey on the topic 'Study on induced breeding and seed production of indigenous carp, *Chagunius chagunio* (Hamilton-Buchanan, 1822)'.
- Rohit Kumar from Kumaun University is pursuing his PhD under the supervision of Dr. P.K. Sahoo on the topic 'Isolation and characterization of immune responsive genes using transcriptome profiling of bacterial challenged golden mahseer'.
- Neeraj Kumar Sharma from H.N.B. University, Srinagar is pursuing his PhD under the supervision of Dr. N.N. Pandey on the topic 'Study on season dependent physio-metabolic indices and thermal tolerance of *Barilius bendelisis* (Hamilton)'.
- Neha Saxena from ICAR-CIFE, Mumbai is pursuing her PhD under the supervision of Dr. R.S. Patiyal on the topic 'Gonadal development and captive breeding of hill stream fish *Barilius bendelisis* (Hamilton, 1807)'.
- Jyoti Pandey from Kumaun University is pursuing her PhD under the supervision of Dr. D. Sarma and Dr. Neetu Shahi on the topic 'Screening and characterization of candidate probiotics from selected cold water fish'.
- Perna Sharma from Kumaun University is pursuing her PhD under the supervision of Dr. Neetu Shahi on the topic 'Investigation on prevalence biology and pathogenesis of *Chryseobacterium* sp. isolated from cold water fish and their environment'.
- Vineeta Joshi from Kumaun University is pursuing her PhD under the supervision of Dr. D. Sarma on the topic 'Nutrient profiling of snow trout (*Schizothorax* spp.) distributed in India subcontinent region'.
- Annu Sharma from Kumaun University is pursuing her PhD under the supervision of Dr. D. Sarma on the topic 'Changes in fatty acid profile with seasonal changes in environmental factors, natural food and thyroid endocrine system of golden mahseer (*Tor putitora*) in lacustrine ecosystem'.
- Ramesh Singh Chalal from Kumaun University is pursuing his PhD under the supervision of Dr. Prem Kumar on the topic 'Study on productivity assessment of Baigul reservoir using Geoinformatics with reference to fish production'.
- Kiran Belwal from Kumaun University is pursuing her PhD under the supervision of Dr. Amit Pande on the topic 'Characterisation of toll-like receptor 3 in *Schizothorax richardsonii*'.
- Preeti Chaturvedi from Kumaun University is pursuing her PhD under the supervision of Dr. Amit Pande on the topic 'Characterization of antimicrobial peptides in *Tor putitora*'.
- Pragya Pandey from Kumaun University is pursuing her M.Sc. dissertation under the supervision of Mr. S. K. Mallik on the topic 'Study on hematological and non-specific immune response of snow trout, *Schizothorax richardsonii* (Gray, 1832) to lipopolysaccharide extracted from *Pseudomonas gessardii*'.
- Kalpna Joshi from Kumaun University is pursuing her M.Sc. dissertation under the supervision of Dr. D. Thakuria on the topic 'Evaluation of antimicrobial activity of *de novo* designed peptides against fish bacteria'.

LINKAGES

ICAR-DCFR promoted collaboration with the following national organizations and agencies during the period under report.

ICAR Institutes

- ICAR-NBFGR, Lucknow
- ICAR-CIFT, Kochi
- ICAR-CIFE, Mumbai
- ICAR-CIFA, Bhubaneswar
- ICAR-CIBA, Chennai
- ICAR-CIFRI, Barrackpur
- ICAR Research Complex, NEH, Barapani
- ICAR-IISWC, Dehradun
- ICAR-VPKAS, Almora
- ICAR-IVRI, Mukteswar
- ICAR-PDFMD, Mukteswar
- ICAR-IASRI, Delhi
- ICAR-IARI, Delhi
- ICAR-NBSS LUP, Nagpur

Central Agencies/Departments

- National Fisheries Development Board
- Department of Biotechnology
- Department of Science & Technology

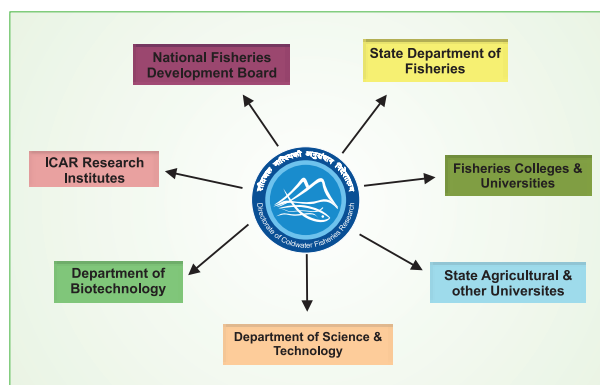
State Agencies/Departments

- 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, Tamil Nadu
- Uttarakhand Council for Biotechnology

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
- Tamil Nadu Fisheries University
- Kerala University of Fisheries & Oceanography
- CSKHP Agricultural University, Himachal Pradesh
- Kumaun University, Nainital
- HNB Garhwal University, Srinagar
- Guwahati University, Assam
- Rajiv Gandhi University, Arunachal Pradesh
- Bhimrao Ambedkar Central University, Lucknow



AWARDS/HONOUR/RECOGNITION

- The Directorate received the 'Best Annual Report Award' of ICAR for the year 2013-2014, under the small institute category, in May 2015.



Dr. A.K. Singh receiving the Best Annual Report award

snow trout species using complete mitogenomes in the 2nd International symposium on Genomics in Aquaculture held at ICAR-CIFA, Bhubaneswar during 28-30 January 2016.



Dr. L. Singh receiving the best poster award

- Dr. A. K. Singh (Director) was honoured with the 'Lifetime Achievement Award' in the field of fish biology by the Academy of Environmental Biologist in December 2015.
- Dr. R. S. Patiyal (Sr. Scientist) and Sh. A. K. Joshi (Sr. Technical Officer) received the 'Rajbhasha Shield' in the 28th Hindi sammelan evam karyashala organized by Rajya bhasha evam prabandhan vikash sanshta at Kodaikanal during 14-16 May 2016.
- Best poster award was given to N. N. Pandey, R. S. Haldar, S. Ali, P. Kumar, R. S. Patiyal, M. Gupta, S. Kumar and A. K. Singh for the poster presentation on Successful artificial breeding of *Labeo dero* (Hamilton, 1822) in captivity under cold water condition, in the national conference on Hill Agriculture in Perspective held at GBPUAT, Pantnagar during 26-28 February 2016.
- 2nd Best poster award was given to L. Singh, R. Kumar, C. Siva, P. K. Sahoo and A. Barat for the poster presentation on Phylogenetic relationship and molecular identification of snow trout species using complete mitogenomes in the 2nd International symposium on Genomics in Aquaculture held at ICAR-CIFA, Bhubaneswar during 28-30 January 2016.
- ICAR-DCFR guided farmer Sh. Tilling Tadi from Ziro, lower Subansiri, Arunachal Pradesh received the 'ICAR-IARI Innovative Farmers Award 2016' from Shri Radha Mohan Singh, honourable union minister of agriculture and farmers welfare, Government of India on 21 March 2016 at New Delhi.
- Sh. Rajesh, M. (Scientist) won second place in 800 m race and Sh. Vijoy Kumar Singh (Sr. Technical Assistant) won third place in Javelin throw in the ICAR zonal sports meet (North zone) organized by ICAR-IISWC at FRI, Dehradun.



Sh. Rajesh receiving the silver medal

PUBLICATIONS

12.1. Research Papers

- Ali, S., Chakraborty, S. K. and Kumar, P. (2015). Abundance and spatio-temporal distributional pattern of *Dotilla myctiroides* (Milne-Edwards) on exposed sandy beach of Aksa, Mumbai. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.*, 85(4):943-949.
- Barat, A., Kumar, R., Goel, C., Singh, A. K. and Sahoo, P. K. (2015). *De novo* assembly and characterization of tissue specific transcriptome in the endangered golden mahseer, *Tor putitora*. *Metagene*, DOI: 10.1016/j.mgene.2015.11.001
- Barat, A., Sahoo, P. K., Kumar, R., Goel, C. and Singh, A. K. (2016). Transcriptional response to heat shock in liver of snow trout (*Schizothorax richardsonii*) - a vulnerable Himalayan cyprinid fish. *Functional and Integrative Genomics*, DOI: 10.1007/s10142-016-0477-0
- Barat, A., Sahoo, P. K., Kumar, R., Mir, J. I., Ali, S., Patiyal, R. S. and Singh, A. K. (2015). Molecular characterization of rainbow trout, *Oncorhynchus mykiss* (Walbaum, 1972) stocks in India. *Journal of Genetics*, 94(13):e13-e18.
- Bashir, A., Bisht, B. S., Mir, J. I., Patiyal, R. S. and Kumar, R. (2015). Morphometric variation and molecular characterization of snow trout species from Kashmir valley, India. *Mitochondrial DNA*, DOI: 10.3109/19401736.2015.1101537.
- Bashir, A., Kumar, R., Bisht, B. S., Patiyal, R. S., Mir, J. I. and Singh, A. K. (2015). Molecular characterization of *Cyprinus carpio* var. *communis* and *Carassius carassius* from Kashmir. *SKUAST Journal of Research*, 17(1): 1-7.
- Belwal, K. and Pande, A. (2015). Molecular cloning, domain analysis and homology modeling of Toll-Like Receptor 3 from *Barilius bendelisis* (Ham.) *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.* DOI 10.1007/s40011-015-0677-8.
- Chandra, S., Singh, S. K., Dasgupta, S. and Sahoo, S. K. (2015). Mass specific oxygen uptake in the freshwater catfish *Wallago attu* (Bloch & Schneider, 1801). *Indian J. Fish.*, 62(3): 137-140.
- Chaturvedi, P., Dhanik, M. and Pande, A. (2015). Molecular characterization and in silico analysis of Defensin from *Tor putitora* (Hamilton). *Probiotics and Antimicrobial Protein*. DOI 10.1007/s12602-015-9197-3.
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- Inlole, N. A., Ram, R. N. and Kumar, P. (2015). Study of morphometrical changes and suspended sediments in Nanak Sagar reservoir of Uttarakhand, India, using remote sensing data & its impact on Ichthyofaunal diversity. *Eco. Env. & Cons.* 20 (Suppl.): S373-S379.
- Kamalam, B. S., Medale, F. and Panserat, S. (2016). Utilisation of dietary carbohydrates in farmed fishes: New insights on influencing factors, biological limitations and future strategies. *Aquaculture*, <http://dx.doi.org/10.1016/j.aquaculture.2016.02.007>.
- Kumar, P., Saxena, K. K., Tyagi, B. C., Joshi, K. D., Pandey, N. N., Singh, A. K. (2015). Ichthyofaunal diversity of Sarda Sagar reservoir

- in Tarai region. *J. Eco. & Occu. Health*. 15 (1&2):9-17.
- Mahanty, K. A., Ganguly, S., Sankar, T. V., Anandan, R., Chakrabarty, K., Paul, B. N., Sarma, D., Dayal, J. S., Venkateswarlu, G., Debnath, D., Mitra, T., Banerjee, S., Mathew, S., Asha, K. K., Vijayagopal, P., Sridhar, N., Chanda, S., Das, P., Das, P., Shahi, N., Akhtar, M. S., Vijayan, K. K., Sharma, A. P., Singh, S. D., Mohan, M., Meenakumari, B. and Ayyappan, S. (2015). Database on nutritional composition of food fishes from India. *Current Science*, vol. 109, no. 11.
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 - Mir, J. I., Patiyal, R. S. and Sahoo, P. K. (2015). Length-weight relationships of 10 fish species from a tributary of Ganga river basin in Uttarakhand, India. *Journal of Applied Ichthyology*, DOI: 10.1111/jai.12686.
 - Mir, J. I., Patiyal, R. S. and Sharma, N. K. (2015). Analysis of length-weight relationship of sympatric hill stream teleosts *Barilius bendelisis* (Hamilton, 1807) and *Barilius vagra* (Hamilton, 1822) from Garhwal Himalaya, India. *Journal of Applied Ichthyology*, DOI: 10.1111/jai.12688.
 - Mir, J. I., Saxena, N., Patiyal, R. S. and Sahoo, P. K. (2015). Phenotypic differentiation in *Barilius bendelisis* (Hamilton, 1807) from four rivers of the Central Indian Himalaya. *Rev. Biol. Trop.* (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 63 (1): 165-173.
 - Nilssen, K. J., Ngasainao, M. R., Sharma, J. G., Srivastava, S. K., Chandra, S., Moirangthem, K. S., Khangembam, B. K., Kumar, S. and Chakrabarty, R. (2015). Activities of digestive enzymes in relation to ingested natural food in three carp species of Himalayan River Ladhiya northern India. *Aquaculture Nutrition*, DOI .1111/ anu /123551.2015.
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 - Sahoo, P. K., Singh, L., Sharma, L., Kumar, R., Singh, V. K., Ali, S., Singh, A. K. and Barat, A. (2016). The complete mitogenome of brown trout (*Salmo trutta fario*) and its phylogeny. *Mitochondrial DNA*, DOI: 10.3109/19401736.2015.1101565
 - Sarma, D., Akhtar, M. S., Das, P., Ganesh, G., Ciji, A. and Mahanta, P. C. (2015). Observations on larval development of chocolate mahseer, *Neolissochilus hexagonolepis* (McClelland, 1839). *Indian Journal of Fisheries*, 62(1):135-138.
 - Sarma, D., Das, P., Das, P., Sanwal, S. and Akhtar, M. S. (2015). Nutritional composition of golden mahseer (*Tor putitora*) in coldwater Himalayan region of India. *SKUAST Journal of Research* 17(1): 23-28.
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- Sharma, N. K., Mir, J. I., Pandey, N. N., Singh, R., Bashir, A. and Akhtar, M. S. (2015). Length–weight relationships of six fish species from an Indus basin tributary in the Poonch region of Jammu and Kashmir, India. *Journal of Applied Ichthyology*, 31(3): 585-586.
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- Sharma, N. K., Singh, R., Gupta, M., Pandey, N. N., Tiwari, V. K. and Akhtar, M. S. (2016). Length–weight relationships of four freshwater cyprinid species from a tributary of Ganga River Basin in North India. *Journal of Applied Ichthyology*, DOI: 10.1111/jai.12998.
- Sharma, N. K., Singh, R., Pandey, N. N., Akhtar, M. S. and Mir, J. I. (2015). Length–weight relationship of two fish species from Poonch River, Western Indian Himalaya: *Glyptothorax kashmirensis* (Hora, 1923) and *Crossocheilus diplochilus* (Heckel, 1838). *Journal of Applied Ichthyology*, 31(6):1144-1145.
- Sharma, N. K., Singh, R., Pandey, N. N., Akhtar, M. S. and Mir, J. I. (2015). Threatened Fishes of The World: *Glyptothorax kashmirensis* (Hora, 1923; Siluriformes: Sisoridae) A Mini Review. *J. Fish. Livestock Prod.*, 3(147): 1-2.
- Sharma, P., Grabowski, T. B. and Reynaldo, P. (2016). Thyroid endocrine disruption and external body morphology of zebra fish. *General and Comparative Endocrinology*, 226:42-4.
- Singh, A. K., Kamalam, B. S. and Kumar, P. (2016). Charting ways to invigorate rainbow trout production in India. *Journal of Fisheries Sciences. Com*, 10(2): 25-32.
- Singh, P. J., Kumar, A., Patiyal, R. S., Pal, A., Bisht, A. K., Chandra, S., and Abidi, R. (2016). Traditional community fishing festival (Maund Mela) of Garhwal Himalaya, Uttarakhand using *Zanthoxylum armatus* (Timur). *World Journal of Fish and Marine Science* 8(9):123-128.

- Verma, R., Singh, A. K. and Kamal, J. (2015). Endocrine disrupting compounds in river Gomti: sources, detection, and effects (a review). *Proc. Zool. Soc. India* 14(1): 79-90.

12.2. Technical/Popular Articles

- Dash, P., Shyne-Anand, P. S., Panigrahi, A. and Gopal, C. (2015). Tallab me Artemia biomass uttpadan ki prathamikata. CIBA publication *Jaltarang*, vol. 1: 36-37.
- Kamalam, B. S. and Panserat, S. (2016). Carbohydrates in fish nutrition. *International Aquafeed*, March-April, pp. 20-23.
- Pandey, N. N., Ali, S. and Singh, A.K. (2016). Rainbow trout (*Oncorhynchus mykiss*) farming in India. Technical compendium, *National conference on Hill agriculture in perspective*, G. B. Pant University of Ag. & Tech. Pantnagar, pp: 341-350.
- Sandeep, K. P., Dash, P., Mandal, B., SyamaDayal, J., Kumarguru, K. P. and Ambasankar, K. (2015). Larvae palan me live feed: Ek posan pariprekhya. CIBA publication *Jaltarang*, vol. 1: 38-40.
- Sarma, D., Halder, R. S., Akhtar, M. S., Das, P. and Singh, A. K. (2016). Hatchery management and seed production of golden mahseer (*Tor putitora*): Strategies for mahseer rehabilitation in Indian Himalaya. Technical Compendium, *National Conference on Hill Agriculture in Perspective*, G. B. Pant University of Ag. & Tech. Pantnagar, pp: 368-376.
- Sarma, D., Mallik, S. K., Nabam, J., Dutta, T., Das, P. and Singh, A. K. (2015). Mountain lakes of Tawang, Arunachal Pradesh. 2015. *Fishing Chimes*, vol. 35 (6). pp. 54-58.
- Shyne-Anand, P. S., Dash P., Panigrahi A., Kumar S. and Gopal, C. (2015). Periphyton aadharit Jhinga kheti- ek tikau pradyogiki. ICAR-CIBA publication, *Jaltarang*, vol. 1: 41.
- Singh, A. K. (2016). Coldwater fisheries and aquaculture: Sustainability and food security. *National seminar on fisheries and aquaculture: Livelihood security, sustainability and*

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- Singh, A. K. (2016). Participatory approaches for conservation and propagation of hill fishery resources for livelihood support. Technical Compendium, *National Conference on Hill Agriculture in Perspective*, G. B. Pant University of Ag. & Tech. Pantnagar, pp 333-340.
- Singh, A. K. and Akhtar, M. S. (2015). Coldwater fish diversity of India and its sustainable development. *Biodiversity for sustainable development*, Souvenir, Uttar Pradesh State Biodiversity Board, pp: 97-105.
- Singh, A. K., Patiyal, R. S. and Kumar, P. (2015). Coldwater fisheries for livelihood support in high altitude area with special reference to Leh-Ladakh. *Sustaining Agriculture Productivity in ARID Ecosystem: Challenges & Opportunities*. Arid Zone Research Institute, Jodhpur. pp. 188-192.

12.3. Book Chapters/Training Manuals/Bulletins

- Baruah, D., Halder, R. S., Dash, P. and Mallik, S. K. (2015). Fish farming techniques for mid-altitude Himalayan regions. *Training manual*, ICAR-DCFR, Bhimtal. pp. 1-40.
- Baruah, D., Tandel, R. S., Patiyal, R. S., Tripathi, A. N. and Nainwal, G. C. (2016). Livelihood support to the hill tribes through integrated fish farming. *Training manual*, ICAR-DCFR, Bhimtal. pp. 1-56.
- Chandra, S., Giri, A. K., Patiyal, R. S. and Mallik, S. K. (2016). Fish farming in hills (Parvateeye kshatrio mei machhlei palan). *Training manual*, ICAR-DCFR, Champawat. pp. 1-71.
- Giri, A. K., Gupta, S. K. and Chandra, S. (2016). Up scaling of aquatic ecosystems through cascade of straining arrangements. In: Gupta, S. K. and Bharti, P. K. (Eds.), *Sustainable aquaculture management*. Discovery Publishing House, New Delhi, pp: 186-223.
- Pande, A. and Saxena, A. (2015). Vaccines for fish diseases. In: Mallik, Y. S., Sagar, P., Dhama,

- K. and Singh, R. K. (Eds.), *Current trends and future research challenges in vaccines and adjuvants*. ICAR-Indian Veterinary Research Institute, Izatnagar.
- Pandey, N. N. and Ali, S. (2015). Rainbow trout farming in India: R & D perspectives. *Bulletin No. 23*, ICAR-DCFR, Bhimtal, India. pp. 1-28.
 - Patiyal, R. S., Kumar, P. and Zaidi, S. G. S. (2016). Matsaya prasanskaran evem mulya sanvardhan evem sajavati machileyo ka palan. ICAR-DCFR, Bhimtal, India. pp. 1-27.
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 - Shahi, N. and Mallik, S. K. (2015). Aerolysin gene as genetic marker for the rapid identification of haemolytic *Aeromonas hydrophila*. In: Jha, P. (Ed.) *Biodiversity, conservation and sustainable development*. New Academic Publishers, New Delhi, pp: 175-187.
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- #### 12.4. Abstracts
- Akhtar, M. S., Ciji, A., Rajesh, M., Sarma, D. and Singh, A. K. (2015). Comparative analysis manifests probable factors underlying reproductive dysfunction of endangered female golden mahseer in captivity. *National symposium on comparative endocrinology and reproductive biology*, 1-3 October 2015, Visva-Bharti, Kolkata, India.
 - Akhtar, M. S., Sarma, D., Pandey, N. N., Mallik, S. K., Kumar, S. and Singh, A. K. (2015). Density dependent growth, survival and lactate dehydrogenase activity of golden mahseer fry reared in floating cages. *5th International symposium in cage aquaculture in Asia*, 25-28 November 2015, Kochi, India.
 - Ali, S., Pandey, N. N., Dash, P., Haldar, R. S., Kumar, S. and Singh, A. K. (2016). Length weight analysis and condition factor for the *Raimas bola* collected from Kosi river. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
 - Barat, A., Sahoo, P. K., Kumar, R., Ali, S. and Singh, A. K. (2016). Genomic study in coldwater fishes of mid and high altitude Himalaya. *2nd International Symposium on Genomics in Aquaculture*, 28-30 January 2016, ICAR-CIFA, Bhubaneswar.
 - Chauhan, A., Saxena, A. and Pande, A. (2015). Current trends and research challenges in fish vaccines. *National workshop on current trend and future research challenges in vaccine and adjuvants*, 19-20 November 2015, ICAR-IVRI, Izatnagar..
 - Kumar, P., Pandey, N. N. and Singh, A. K. (2016). Suitable site selection for aquaculture development in west Sikkim, India: a GIS based approach. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
 - Kumar, P., Pandey, N. N., Patiyal, R. S. and Singh, A. K. (2016). Prospects of Low Density Poly Ethylene (LDPE) film lined ponds in upland aquaculture for livelihood security in mid hills. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
 - Pandey, N. N., Akhtar, M. S., Gupta, M., Kumar, N. and Singh, A. K. (2016). Development of larval feed of *L. dyocheilus* for better growth and survival. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
 - Pandey, N. N., Haldar, R. S., Ali, S., Kumar, P., Patiyal, R. S., Gupta, M. Kumar, S. and Singh,

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- Pandey, N. N., Kamalam, B. S., Gupta, M. and Singh, A. K. (2016). Fish and poultry offal based farm made feed for rainbow trout: Participatory field evaluation in Sikkim and Himachal Pradesh. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
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 - Patiyal, R. S. (2016). Prospects of ornamental fish culture in mid-hill region of Uttarakhand for livelihood security. *National conference on hill agriculture in perspective*, 26-28 February 2016, GBPUAT, Pantnagar.
 - Sarma, D., Kushwaha, S., Joshi, V., Das, P., Alexander, C., Sharma, P. and Akhtar, M. S. (2016). Proximate composition including mineral, total cholesterol and fatty acid profile of Himalayan snow trout (*Schizothorax spp.*). *National seminar on fisheries and aquaculture: Livelihood security, sustainability and conservation*, 21-22 January 2016, College of Fisheries, Tripura.
 - Shahi, N., Thakuria, D., Singh, A. K. and Sarma, D. (2015). Kisspeptin-1 (*kiss1*) and kisspeptin-1 receptor (*kiss1r*) genes in golden mahseer (*Tor putitora*): Cloning, characterization and structural analysis. *National symposium on comparative endocrinology and reproductive biology*, 1-3 October 2015, Visva-Bharati, Kolkata.
 - Sharma, L., Singh, S., Kumar, R., Sahoo, P. K. and Barat, A. (2016). The complete mitogenome of chocolate mahseer (*Neolissochilus hexagonolepis*). *2nd International Symposium on Genomics in Aquaculture*, 28-30 January 2016, ICAR-CIFA, Bhubaneswar.
 - Sharma, P., Akhtar, M. S., Singh, A. K., Das, P. and Sarma, D. (2016). Histo-morphological changes in digestive tract of golden mahseer (*Tor putitora*) during different developmental stages. *National seminar on fisheries and aquaculture: Livelihood security, sustainability and conservation*, 21-22 January 2016, Tripura.
 - Singh, L., Kumar, R., Siva, C., Sahoo, P. K. and Barat, A. (2016). Phylogenetic relationship and molecular identification of snow trout species using complete mitogenomes. *2nd International Symposium on Genomics in Aquaculture*, 28-30 January 2016, ICAR-CIFA, Bhubaneswar.
 - Zsuzsanna, M., Ljubobratovic, U., Shahi, N., Zoltán, H. and Galina, J. (2016). Effect of transportation stress on pike-perch fingerlings. *Young researchers conference*, 3-4 March 2016, Gödöllő, NAIK-MBK, Hungary.

12.5. GenBank Submissions

- Barat, A., *et al.* Paired end raw reads of 9 samples of transcriptome sequencing of *Tor putitora* (Spleen, SRS 751988; Liver, SRS 751990; Gill, SRS 752730; Kidney, SRS 752732; Muscle, SRS 754198; Brain, SRS 783069; TPAH_C, SRS 1117943; TPAH_T1, SRS 1143332; TPAH_T2, SRS 1152837).
- Ciji, A., Rajesh, M., Akhtar, M. S., Kamalam, B. S., Sharma, P., Dash, P. and Singh, A. K. *Schizothorax richardsonii cyp19a* (aromatase gonad type) mRNA partial cds (KU715837).
- Ciji, A., Rajesh, M., Akhtar, M. S., Kamalam, B. S., Sharma, P., Dash, P. and Singh, A. K. *Schizothorax richardsonii cyp19b* (aromatase brain type) mRNA partial cds (KU715838).
- Rajesh, M., Akhtar, M. S., Ciji, A., Kamalam, B. S. and Singh, A. K. *Tor putitora* beta actin mRNA partial cds (KU714644).
- Rajesh, M., Akhtar, M. S., Ciji, A., Kamalam, B. S. and Singh, A. K. *Tor putitora* elongation factor 1- alpha mRNA partial cds (KU714645).
- Rajesh, M., Akhtar, M. S., Ciji, A., Sarma, D. and Singh, A. K. *Tor putitora cyp19b* (aromatase brain type) mRNA partial cds (KU714647).

- Rajesh, M., Akhtar, M. S., Ciji, A., Sarma, D. and Singh, A. K. *Tor putitora cyp19a* (aromatase gonad type) mRNA partial cds (KU714646).
- Rajesh, M., Akhtar, M. S., Kamalam, B. S., Ciji, A., Sharma, P. and Singh, A. K. *Schizothorax richardsonii* elongation factor 1- alpha mRNA partial cds (KU715836).
- Rajesh, M., Akhtar, M. S., Kamalam, B. S., Ciji, A., Sharma, P. and Singh, A. K. *Schizothorax richardsonii* beta actin mRNA partial cds (KU715835).
- Sahoo, P. K., Goel, C., Kumar, R., Dhama, N., Ali, S., Sarma, D., Nanda, P. and Barat, A. Whole mitochondrial genome sequence of chocolate mahseer (KU 553349)
- Sahoo, P. K., Singh, L., Sharma, L., Kumar, R., Singh, V. K., Ali, S., Singh, A. K. and Barat, A. Whole mitochondrial genome sequence of brown trout (KT 633607)
- Saxena, A., Chauhan, A. and Pande, A. *Schizothorax richardsonii* interferon- inducible Mx protein mRNA, partial cds (KU529282)
- Shahi, N., Pandey, J. and Sharma, P. *Tor putitora* beta-actin mRNA, partial cds from brain (KT966391).
- Shahi, N., Singh, A. K. and Thakuria, D. Golden mahseer, *Tor putitora* Kisspeptin2 mRNA, complete cds (KX024449).
- Shahi, N., Singh, A. K., Mallik, S. K., Thakuria, D. and Sarma, D. Golden mahseer, *Tor putitora* Kisspeptin 1 receptor (GPR54) mRNA, complete cds (KP748255).

PARTICIPATION IN CONFERENCE/ SYMPOSIA/WORKSHOP/MEETING

13.1. Participation in Conference/ Symposia/Workshop

- A. K. Singh attended the International conference on 'Climate Change and Sustainability' organized by AEB at Mumbai on 21-22 December 2015.
- A. K. Singh participated in the workshop on 'Biodiversity for Sustainable Development' organized by the Uttar Pradesh State Biodiversity Board, Lucknow on 22 May 2015.
- A. K. Singh participated in the workshop on 'Mahseer fisheries: Conservation strategies and way forward' organized by ICAR-CIFE in collaboration with Tata Power Company Ltd. at Lonavala during 21-22 August 2015, chaired a session and delivered a presentation.
- A. K. Singh, A. Barat and R. S. Haldar attended the 2nd International symposium on 'Genomics in Aquaculture' held at ICAR-CIFA, Bhubaneswar during 28-30 January 2016. Dr. Singh was a guest of honour in the inauguration and chaired a technical session.
- A. K. Singh, P. Kumar and M. S. Akhtar attended the 5th International symposium on 'Cage Aquaculture in Asia' organized by Asian Fisheries Society and AFSIB in collaboration with ICAR-CMFRI at Kochi during 25-28 November 2015.
- A. K. Singh and P. Kumar participated in the project launch workshop of National Mission for Sustaining Himalayan Ecosystem at ICAR Headquarters, New Delhi on 13 May 2015.
- A. K. Singh, N. Shahi and M. S. Akhtar attended the National symposium on 'Comparative Endocrinology and Reproductive Biology' (CERB 2015) held at Vishwa Bharti University, Kolkata during 1-3 October 2015.
- A. K. Singh, D. Sarma and P. Sharma participated in the National seminar on 'Aquaculture in the north-east region: realities, potential and challenges' organized by St. Anthony's College in collaboration with the Dept. of Fisheries, Govt. of Meghalaya at Shillong on 25-26 August 2015. Dr. Singh chaired a session and delivered a presentation.
- A. K. Singh and R. S. Haldar attended the 26th All India Congress of Zoology and International symposium on 'Innovation in animal sciences for food security, health security and livelihood' organised by Babasaheb Bhimrao Ambedkar University in collaboration with Zoological Society of India at Lucknow during 29-31 October 2015. Dr. Singh chaired a technical session and delivered an invited talk.
- A. K. Singh and R. S. Haldar attended the National seminar on 'Aquaculture and fisheries: Livelihood security, sustainability and conservation' organized by NESFA and AFSIB in collaboration with CAU, Imphal at College of Fisheries, Lembucherra during 21-22 January 2016. Dr. Singh chaired a technical session and delivered an invited talk.
- A. K. Singh, D. Sarma, N. N. Pandey, P. Kumar, R. S. Patiyal, S. Chandra, S. G. S. Zaidi, M. S. Akhtar, D. Thakuria, B. S. Kamalam, Rajesh,

M., R. S. Tandel, P. Sharma, P. Dash and Siva, C. participated in the National conference on 'Hill Agriculture in Perspective' held at GBPUAT, Pantnagar during 26-28 February 2016. Dr. Singh was the convener of the session on hill fisheries and aquaculture and delivered the key note address.



Dr. A. K. Singh delivering the keynote address

- A. K. Singh, N. N. Pandey and P. Kumar participated in the National workshop on 'Development of Fisheries vis-à-vis Blue Revolution and Value Addition' organised by the Department of Fisheries, Himachal Pradesh at Bilaspur during 12-13 December 2015. Dr. Singh chaired a technical session and delivered the lead lecture.
- A. K. Singh attended the National seminar on 'Integrating agri-horticulture and allied research for food and nutritional Security in the era of global climate disruption' organized by ICAR research complex for NEH Region at Imphal, Manipur, chaired a technical session and delivered an invited talk.
- D. Baruah attended the Capacity Building Conclave organised by National Fisheries Development Board at Hyderabad during 25-26 February 2016.
- D. Baruah participated in the 3-days User's training workshop on 'ICAR KRISHI Geoportal' held at NBSS LUP, Nagpur during 28-30 March 2016.
- D. Sarma participated in the workshop on 'Competency development program for the HRD Nodal Officer of ICAR Institute' at NAARM, Hyderabad during 10-12 February 2016.
- N. N. Pandey participated in the International Angling meet organised by Trout conservation and angling association, Kullu, Himachal Pradesh during 10-11 April 2015.
- P. Kumar participated in the training cum workshop for the nodal officer of ICAR Research Data Repository for knowledge management at NASC, New Delhi during 4-5 August 2015.
- P. Kumar and R. S. Patiyal participated in the National symposium on 'Sustainable agriculture productivity in ARID ecosystem: challenges & opportunities' (SAPECO-2015) organized by Arid Zone Research Institute, Jodhpur at Leh during 19-22 August 2015.
- P. Kumar participated in the workshop for the nodal officer of ICAR Research Data Repository for knowledge management at NBSS LUP, Nagpur during 11-12 March 2016.
- R. S. Halder attended the 11th National symposium on 'Innovations in coastal agriculture -Current status and potential under changing environment' organised by ICAR-IIWM in collaboration with the Indian Society for Coastal Agricultural Research at Bhubaneswar during 14-17 January 2016.
- R. S. Patiyal participated in the 28th Hindi sammelan evam karyashala organized by Rajya bhasha evam prabandhan vikash sanshta at Kodaikanal during 14-16 May 2015.
- R. S. Patiyal participated in the National symposium on 'Sustainable mountain development summit-IV' at Itanagar, Arunachal Pradesh during 7-9 October 2015.
- R. S. Tandel participated in the National workshop on 'Antibiotic residue analysis in aquaculture environments' under the All India Network Project on Fish Health at ICAR-CIFT, Kochi during 11-12 February 2016 and presented the work progress of ICAR-DCFR for the year 2015-16.

- S. Ali participated in the workshop on 'Providing technological support, extension and demonstration services to farmers-Western Himalayan region (HP, J&K and hills of Uttarakhand)' at SKUAS&T, Jammu on 4 November 2015.
- S. Ali participated in the workshop on 'Vulnerability analysis' under DST project National Mission for Sustaining Himalayan Ecosystem at ICAR- IISWC, Dehradun during 17-18 November 2015.

13.2. Participation in Meeting

- A. K. Singh participated in the 18th meeting of the committee on introduction of exotic aquatic organisms into Indian waters, convened by Joint Secretary (Fisheries) at Krishi Bhawan, New Delhi on 22 February 2016.
- A. K. Singh participated in the 9th meeting of the advisory committee and the selection committee meeting at GBPUA&T, Pantnagar on 17 May 2015.
- A. K. Singh attended the Fisheries Divisional meeting held at the ICAR headquarters, New Delhi on 14 May 2015.
- A. K. Singh attended the interaction meeting of Directors' of ICAR Institutes and Vice Chancellors' of State Agricultural Universities on 23-24 January 2016.
- A. K. Singh and P. Kumar participated in the mid-term Regional Committee meeting held at GBPUA&T, Pantnagar on 3 June 2015.
- A. K. Singh and R. S. Patiyal attended the 21st Pt. G. B. memorial lecture and annual day meeting of G. B. Pant Institute of Himalayan Environment & Development at Kosi Katarmal, Almora on 10 September 2015.
- A. K. Singh, N. N. Pandey and P. Kumar participated in the high level meeting called by the Secretary, DARE & DG, ICAR at Nanak Sagar reservoir, Uttarakhand on 22 October 2015.
- N. N. Pandey and P. Kumar attended the review meeting on the cumulative impact assessment

on Sutlej Basin at MOEF & CC, New Delhi on 8 February 2016.

- N. N. Pandey attended the 11th meeting of Fish Farmer's Development Agency (FFDA) governing body of Uttarakhand state on 18 January 2016.
- P. Kumar and S. Ali participated in the National Mission for Sustaining the Himalayan Ecosystem project meeting organised at ICAR-VPKAS, Almora on 1 December 2015.
- P. Kumar participated in the vigilance officer's meeting held at ICAR headquarters, New Delhi on 6 July 2015.
- S. Ali attended the meeting cum workshop on various issues of fisheries development in Uttarakhand, organized by State Fisheries Department at Dehradun during 8 January 2016.
- S. Ali participated in the meeting for finalization of Institutional consultancy report on Sutlej basin at ICFRE, Dehradun during 12-13 May 2015.
- S. Chandra and A. K. Giri participated in the Kisan Gosti meeting held at ICAR-KVK, Lohaghat on 19 March 2016.

13.3. Lectures/Talks delivered

- A. Barat delivered an oral presentation on 'Genomic study in coldwater fishes of mid and high altitude Himalaya' in the 2nd International Symposium on 'Genomics in aquaculture' at ICAR-CIFA, Bhubaneswar during 28-30 January 2016.
- A. K. Giri delivered four lectures on 'Economically important coldwater fish species', 'Selection of sites for construction of coldwater fish farms', 'Rainbow trout culture' and 'Culture and breeding of improved common carp' in the NFDB sponsored training programme on 'Fish farming in hills' at Toli, Champawat during 9-13 March 2016.
- A. K. Giri delivered two lectures on 'Rainbow trout breeding and seed production technologies' and 'Management of health

- issues in rainbow trout' during the 'Jai Kisan Jai Vigyan' week organised by DCFR field centre at Champawat on 29 December 2015.
- A. K. Singh delivered a lead lecture on 'Participatory approaches and conservation of hill fishery resources for livelihood support' in the National conference on 'Hill Agriculture in Perspective' held at GBPUAT, Pantnagar during 26-28 February 2016.
 - A. Pande delivered a talk on 'Health management in rainbow trout: an Indian perspective' in the DBT sponsored National consultation on 'Rainbow trout farming: prospects and challenges for strategic development' organised by ICAR-DCFR at Bhimtal during 20-21 September 2015.
 - A. Pande delivered a talk on 'Trends in fish vaccines' in the National workshop on 'Current trend and future research challenges in vaccine and adjuvants' held at ICAR-IVRI, Izatnagar during 19-20 November 2015.
 - B. S. Kamalam delivered a lecture on 'Rainbow trout farming across the globe: a case scenario' in the DBT sponsored National consultation on 'Rainbow trout farming: prospects and challenges for strategic development' organised by ICAR-DCFR at Bhimtal during 20-21 September 2015.
 - B. S. Kamalam delivered a talk on 'Intellectual Property Rights: basics and examples' in the Intellectual Property Rights day programme organized at ICAR-DCFR, Bhimtal on 28 April 2015.
 - D. Baruah delivered three lectures on 'Design and construction of aquaculture ponds in hill regions', 'Composite carp culture technology for foothill and mid altitude regions' and 'Nursery and rearing pond management of carp seeds for income generation' in the NFDB sponsored training programme on 'Techniques for fish farming in mid-altitude fish pond of Donglok and Chug village, Dirang, West Kameng district in Arunachal Pradesh' during 1-5 December 2015.
 - D. Baruah delivered two lectures on 'Fish seed production and hatchery management' and 'Diversified fish culture in hill regions' in the NFDB sponsored training programme on 'Three pronged fish farming technique for development of coldwater fisheries in Meghalaya' during 18-22 January 2016.
 - D. Baruah delivered two lectures on 'Good management practices in hill aquaculture' and 'Mahseers in India' in the NFDB sponsored training programme on 'Hatchery management practices for seed production of golden and chocolate mahseer' at Chatlang, Mizoram during 24-28 January 2016.
 - D. Baruah delivered three lectures on 'Endemic fishes of north-east India and their importance', 'Fish culture in high altitude rice environments' and 'Integrated fish farming technology' in the TSP training on 'Livelihood support to the hill tribes through integrated fish farming' at Hapoli and Yachuli of Lower Subansiri district of Arunachal Pradesh during 5-8 March 2016.
 - D. Sarma delivered a talk on 'Rainbow trout as a health food' in the DBT sponsored National consultation on 'Rainbow trout farming: prospects and challenges for strategic development' organised by ICAR-DCFR at Bhimtal during 20-21 September 2015.
 - D. Sarma delivered a theme presentation on 'Coldwater endemic fishes of north-eastern Himalaya' in the National workshop on 'Coldwater endemic fishes of north-eastern Himalaya: Avenues and challenges' organised by ICAR-DCFR in collaboration with the Dept. of Fisheries, Govt. of Sikkim at Gangtok during 5-6 November 2015.
 - D. Sarma delivered an invited talk on 'Hatchery management and seed production of golden mahseer (*Tor putitora*): Strategies for mahseer rehabilitation in Indian Himalaya' in the National conference on 'Hill Agriculture in Perspective' held at GBPUAT, Pantnagar during 26-28 February 2016.

- D. Sarma delivered an invited talk on 'Mahseer resources, breeding, conservation, policy and issues in north-east India' in the National seminar on 'Aquaculture in the north-east region: realities, potential and challenges' organized by St. Anthony's College in collaboration with the Dept. of Fisheries, Meghalaya at Shillong on 25-26 August 2015.
- D. Sarma delivered an invited talk on 'Migration of mahseer' in the event commemorating 'World Fish Migration Day' at ABACA, Nameri, Assam during 16 May 2015.
- D. Sarma delivered an oral presentation on 'Fatty acid, proximate and mineral composition of snow trout of India' in the National seminar on 'Aquaculture and fisheries: Livelihood security, sustainability and conservation' organized by NESFA, AFSIB and CAU, Imphal at College of Fisheries, Lembucherra during 21-22 January 2016.
- M. S. Akhtar delivered a lecture on 'Coldwater fish nutrition and reproductive dysfunction in golden mahseer' in the National workshop on 'Coldwater endemic fishes of north-eastern Himalaya: avenues and challenges' organised by ICAR-DCFR in collaboration with the Dept. of Fisheries, Govt. of Sikkim at Gangtok during 5-6 November 2015.
- M. S. Akhtar delivered an oral presentation on 'Comparative analysis manifests probable factors underlying reproductive dysfunction of endangered female golden mahseer in captivity' in the National symposium on 'Comparative endocrinology and reproductive biology' at Vishwa Bharti University, Kolkata during 1-3 October 2015.
- M. S. Akhtar presented a paper on 'Density dependent growth, survival and lactate dehydrogenase activity of golden mahseer fry reared in floating cages' in the '5th International symposium in cage aquaculture in Asia' at Kochi during 25-28 November 2015.
- N. N. Pandey delivered a lecture on 'Endemic fish: *Labeo dyocheilus*, *Labeo dero* and *Chagunius chagunia* as candidate species for hill aquaculture' in the National workshop on 'Coldwater endemic fishes of north-eastern Himalaya: avenues and challenges' organised by ICAR-DCFR in collaboration with the Dept. of Fisheries, Govt. of Sikkim at Gangtok during 5-6 November 2015.
- N. N. Pandey delivered a lecture on 'Nutrition and feeding of coldwater cultivable fish species' in the NFDB sponsored training programme on 'Fish farming in hills' conducted by ICAR-DCFR field centre at Champawat during 9-13 March 2016.
- N. N. Pandey delivered a theme lecture on 'Management practices in rainbow trout farming' in the DBT sponsored National consultation on 'Rainbow trout farming: prospects and challenges for strategic development' organised by ICAR-DCFR at Bhimtal during 20-21 September 2015.
- N. N. Pandey delivered an oral presentation on 'Rainbow trout farming in India' in the National conference on 'Hill Agriculture in Perspective' held at GBPUAT, Pantnagar during 26-28 February 2016.
- N. N. Pandey delivered three guest lectures on 'Rainbow trout farming', 'Candidate species of coldwater aquaculture' and 'Overview of coldwater aquaculture in India' at ICAR-CIFE, Mumbai during 23-25 November 2015.
- P. Dash delivered two lectures on 'Aquaculture in mid hills using poly-house and polyethylene film lined ponds' and 'Common diseases in coldwater aquaculture and fish health management' in the NFDB sponsored training programme on 'Techniques for fish farming in mid-altitude fish pond of Donglok and Chug village, Dirang, West Kameng district in Arunachal Pradesh' during 1-5 December 2015.
- P. Kumar delivered a lecture on 'GIS based selection of suitable sites for rainbow trout farming' in the DBT sponsored National consultation on 'Rainbow trout farming: prospects and challenges for strategic

- development' organised by ICAR-DCFR at Bhimtal during 20-21 September 2015.
- P. Kumar delivered an invited lecture on 'Spatial database on fisheries resources and livelihood support through fisheries' in the launch workshop of the DST sponsored project on National Mission for Sustaining the Himalayan Ecosystem at Delhi on 13 May 2015.
 - P. Kumar delivered an invited talk on 'Coldwater fisheries resource assessment and management' in the National conference on 'Hill Agriculture in Perspective' held at GBPUAT, Pantnagar during 26-28 February 2016.
 - P. Kumar delivered an oral presentation on 'Coldwater fisheries for livelihood support in high altitude area with special reference to Leh-Ladakh' in the National symposium on 'Sustainable agriculture productivity in ARID ecosystem: challenges & opportunities' organized by Arid Zone Research Institute, Jodhpur at Leh during 19-22 August 2015.
 - P. Sharma delivered an invited theme talk on 'Coldwater fish nutrition for cost effective and sustainable aquaculture' in the National Seminar on 'Aquaculture in the north-east region: realities, potential and challenges' organized by St. Anthony's College in collaboration with the Dept. of Fisheries, Meghalaya at Shillong on 25-26 August 2015.
 - R. S. Patiyal delivered a lecture on 'Ornamental fish culture for mountain region towards livelihood security' in the National symposium on 'Sustainable mountain development summit-IV' at Itanagar, Arunachal Pradesh during 7-9 October 2015.
 - R. S. Patiyal delivered a lecture on 'Shodh me hindi ka prayog' in the '28th Hindi sammelan evam karyashala' organized by Rajya bhasha evam prabandhan vikash sanshta at Kodaikanal during 14-16 May 2015.
 - R. S. Patiyal delivered two lectures on 'Matsya prasanskan evam mulya snvardhan' and 'Sajavati machaleyo ka palan' in the ICAR sponsored training program on 'Matsya prasanskan evam mulya snvardhan evam Sajavati machaleyo ka palan' organized at Condoliya, Dehradun during 1-3 March 2016.
 - R. S. Patiyal delivered two lectures on 'Parvateya shetro me sajavati machaleyo se jeeveka ki sambhavanaye' and 'Palan upyogi parvateya shetro ki pramukha matsya prajateya' in the NFDB sponsored training programme on 'Fish farming in hills' at farm school, Toli, Champawat during 9-13 March 2016.
 - R. S. Tandel delivered two lectures on 'Prevention and control of common disease in coldwater aquaculture and its management' and on 'Best management practices in integrated aquaculture' in the TSP training on 'Livelihood support to the hill tribes through integrated fish farming' at Hapoli and Yachuli of Lower Subansiri district of Arunachal Pradesh during 5-8 March 2016.
 - Rajesh, M. delivered a talk on 'Agriculture scenario 2050: a fisheries perspective' at AGRI SEARCH 2050 organized by ICAR at NASC Complex, New Delhi on 18 May 2015.
 - S. Ali delivered a talk on 'Material Transfer Agreement' in the Intellectual Property Rights day programme organized at ICAR-DCFR, Bhimtal on 28 April 2015.
 - S. Chandra delivered a lecture on 'Diseases and health issues in open water fishery' in the National workshop on 'Coldwater endemic fishes of north-eastern Himalaya: avenues and challenges' organised by ICAR-DCFR in collaboration with the Dept. of Fisheries, Govt. of Sikkim at Gangtok during 5-6 November 2015.
 - S. Chandra delivered a lecture on 'Rainbow trout seed production and farm management' during the 'Jai Kisan Jai Vigyan' week organised by ICAR-DCFR Field Centre at Champawat on 29 December 2015.
 - S. Chandra delivered a talk on 'Fish health management in coldwater aquaculture systems'

- in the awareness programme organised by ICAR-DCFR field centre at farm school, Toli, Champawat on 12 January 2016.
- S. Chandra delivered an invited talk on 'Coldwater fish farming for livelihood and income generation' in the Kisan Mela and Kisan Gosti at KVK Lohaghat on 19 March 2016.
 - S. Chandra delivered three lectures on 'Breeding and seed production techniques of rainbow trout', 'Health management in trout and carp farms' and 'Bio-security measures in fish farms' in the NFDB sponsored training programme on 'Fish farming in hills' at farm school, Toli, Champawat during 9-13 March 2016.

LIBRARY & INFORMATION SERVICES

The library and documentation unit of the Directorate serves as a repository of scientific and technical literature and it provides up-to-date information in the field of fisheries, aquaculture and allied aspects. Primarily, the library renders services to all the scientists, staffs and research scholars of the Directorate. Nevertheless, it also serves visiting researchers and others who are interested in scientific literature on coldwater fisheries and allied subjects.

During the year 2015-16, the Directorate subscribed 13 online International journals, 8 Indian journals and procured 410 scientific books. Some of the notable journals subscribed were Reviews in Aquaculture, Fish and Fisheries, Aquaculture Research, Journal of Fish Biology, Journal of Fish Diseases, Aquaculture Nutrition, Mitochondrial DNA and Current Science. All the articles of the 13 subscribed online journals were downloaded and soft copies were added to the e-inventory of the library which has more than 35000 articles. For selecting and procuring new text books to enrich the library, a book exhibition was arranged at the headquarters in Bhimtal during 23-24 September 2015, where 6 publishers/suppliers participated. As such, the current holding of the library includes 5761 books, 1693 volumes of foreign journals, 536 volumes of Indian journals and 8000 other publications. The library also facilitates the provision



Exhibition of scientific books at ICAR-DCFR, Bhimtal

of access to online publications and articles of many international and national journals through www.cera.jccc.in.

Library automation

Various activities of the library such as cataloguing and retrieval have been computerized using TLS software. The records of books, journals, bulletins and other documents have been entered in the database. Barcoding of books and periodicals is actively being done. Digitization work of the Directorate's publications is also in progress.

Information services

The library is continuing its efforts in collection, processing and dissemination of scientific and technical information to the potential end-users and stakeholders. As part of the inter-institutional information exchange, the library sends the Directorate's annual report, special publications and technical bulletins published from time to time to about 250 organizations, institutions and fishery agencies.

Reprography services

The library maintains an active reprography services by reproducing departmental publications and distributing photocopies to the scientists, research scholars as well as other research organizations, as and when required or requested.

Documentation section

The documentation section of the library is entrusted with the responsibility concerning publications such as scientific bulletins, brochures, pamphlets, annual reports and newsletters. During the period of 2015-2016, the section facilitated the publication of two annual reports 2014-15 (Hindi and English), two bulletins, leaflets and two newsletters.

DISTINGUISHED VISITORS

- Sh. Aditya Kumar Joshi, Joint Secretary, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare, Govt. of India, New Delhi.
- Dr. N. K. Krishna Kumar, Deputy Director General (Horticulture), ICAR, New Delhi.



Sh. Aditya Kumar Joshi and other dignitaries at ICAR-DCFR farm unit at Bhimtal



Dr. N.K. Krishna Kumar visiting the laboratories at ICAR-DCFR, Bhimtal

- Dr. Mangala Rai, Vice-Chancellor, GB Pant University of Agriculture & Technology and former Director General, ICAR.
- Dr. Saroj Kumar, Special Secretary, Ministry of Home Affairs, Govt. of Uttar Pradesh



Dr. Mangala Rai visiting the farm facilities at ICAR-DCFR, Champawat



Dr. Saroj Kumar visiting the farm facilities at ICAR-DCFR, Bhimtal

- Dr. B. Meena Kumari, former Deputy Director General (Fisheries), ICAR.
- Dr. A. S. Ninawe, Advisor, Department of Biotechnology, New Delhi.

- Dr. Nawab Ali, former Deputy Director General (Engineering), ICAR.



Dr. Nawab Ali visiting the mahseer hatchery complex, Bhimtal

- Dr. B. Mohan Kumar, Assistant Director General (NRM), ICAR, New Delhi.
- Dr. S. D. Singh, Assistant Director General (Inland Fisheries), ICAR, New Delhi.
- Dr. B. S. Bisht, Director, Birla Institute of Applied Sciences, Bhimtal and former Vice-Chancellor, GBPUAT, Pantnagar.
- Dr. A. Pattanayak, Director, ICAR-VPKAS, Almora.
- Dr. P. K. Misra, Director, ICAR-IISWC, Dehradun.
- Dr. Jai Gopal, Director, ICAR-DOGR, Pune.
- Dr. P. P. Dhyani, Director, GBPIHED, Almora.
- Sh. Gurucharan Singh, Director of Fisheries, Govt. of Himachal Pradesh.
- Sh. I. P. Chetri, Director of Fisheries, Govt. of Sikkim.
- Dr. K. K. Vass, former Director, ICAR-DCFR and ICAR-CIFRI, Barrackpore.
- Dr. P. C. Mahanta, former Director, ICAR-DCFR, Bhimtal.
- Dr. N. P. Melkania, former Director, IGFRI, Jhansi.
- Dr. A. P. Sharma, former Director, ICAR-CIFRI, Kolkata.
- Dr. J. R. Dhanze, former Dean, College of Fisheries, CAU, Tripura.
- Dr. V. K. Choudhary, Project Director, Agriculture Technology Management Agency, Mandi, Himachal Pradesh.
- Sh. B.A. Bhatt, Chief Project Officer, Trout Fish Farming Centre, Kokernag.
- Sh. S. Pradhan, Additional Director of Fisheries, Govt. of Sikkim.
- Dr. B. P. Madhwal, Deputy Director of Fisheries, Govt. of Uttarakhand.
- Dr. R. C. Pokhariyal, Deputy Director of Fisheries, Govt. of Uttarakhand.
- Er. R. Kulasekaran, Executive Board Member, Tamil Nadu Fisheries University.
- Sh. B. S. Yarki, Progressive trout entrepreneur, Himachal Pradesh.
- Dr. M. P. S. Kohli, former Dean (Academics), ICAR-CIFE, Mumbai.
- Dr. S. N. Mohanty, former Principal Scientist & HOD, ICAR-CIFA, Bhubaneswar.
- Dr. H. S. Raina, former Principal Scientist, ICAR-DCFR, Bhimtal.
- Dr. B. C. Tyagi, former Principal Scientist, ICAR-DCFR, Bhimtal.
- Dr. K. D. Joshi, Principal Scientist & In-charge, ICAR-CIFRI, Allahabad.
- Dr. B. L. Attri, Principal Scientist & In-charge, ICAR-CITH, Mukteswar.
- Dr. A. B. Pandey, Principal Scientist & In-charge, ICAR-IVRI, Mukteswar.
- Dr. S. K. Verma, Principal Scientist & In-charge, ICAR-NBPGR, Bhowali.

IMPORTANT COMMITTEES

16.1. Members of Research Advisory Committee

Dr. J. R. Dhanze, Ex-Dean, College of Fisheries, Lembucherra, Agartala – 799 210, Tripura.	Chairman
Dr. H. S. Raina, Ex-Principal Scientist (ICAR-DCFR) Shiv Ram Enclave, Post Office - Sidhra, Jammu - 180 019, Jammu & Kashmir.	Member
Shri B. A. Bhatt, Chief Project Officer, Trout Fish Farming Centre, Kokernag, Distt. Anantnag – 192 101, Kashmir, Jammu & Kashmir.	Member
Dr. Sunit K. Singh, Associate Professor (Mol. Immunology), Molecular Biology Unit, Institute of Medical Sciences, Banaras Hindu University, Varanasi – 221 005, Uttar Pradesh.	Member
Dr. S. N. Mohanty, Ex-Principal Scientist (ICAR-CIFA), A4/21, Indira Gandhi Coop. Housing Society, Post - Shishupal Garh, Bhubaneswar – 751 002, Odisha.	Member
Shri Balbir Singh Yarki, Mohalla: Jarad Ghutti Colony, P.O. Shamshi, Tehsil & District Kullu – 175 126, Himachal Pradesh.	Member
Dr. S. Raizada, ADG (Inland Fisheries), ICAR, New Delhi.	Member
Dr. Amit Pande, ICAR National Fellow, ICAR- DCFR, Bhimtal.	Member Secretary

16.2. Members of Institute Management Committee

Dr. A. K. Singh, Director, ICAR-DCFR, Bhimtal.	Chairman
Dr. S. Raizada, Asstt. Director General (I. Fy.), ICAR, KAB II, New Delhi.	Member
Shri G. B. Oli, Secretary & Director of Fisheries, Govt. of Uttarakhand, Secretariat, Subhash Road, Dehradun, Uttarakhand.	Member
Dr. R. K. Dogra, Director, Directorate of Fisheries, Govt. of Jammu & Kashmir, Nowabad Canal Road, Jammu.	Member
Dr. R. S. Chauhan, Head of Department (Aquaculture) College of Fisheries, GBPUAT, Pantnagar.	Member
Dr. A. B. Pandey, Principal Scientist & Head, ICAR-IVRI Station, Mukteshwar.	Member
Dr. B. L. Attri, Principal Scientist & In-charge, CITH Regional Station, Mukteswar.	Member
Dr. J. K. Bisht, Principal Scientist, ICAR-VPKAS, Almora.	Member

Dr. S. K. Verma, Principal Scientist & Head, NBPGR Regional Station - Bhowali.	Member
Shri Kunal Kalia, F&AO, ICAR, New Delhi.	Member
Shri Vipin Pandey, M/s Shilpi Photo studio, Haldwani.	Member
Shri Pradeep Bisht, 416, Hiranage, Haldwani.	Member
Shri Y. S. Dhanik, Admin. Officer, ICAR-DCFR, Bhimtal.	Member Secretary

16.3. Members of Project Monitoring & Evaluation Cell

Dr. P. K. Sahoo, Principal Scientist, ICAR-DCFR, Bhimtal.	Officer In-charge
Dr. S. Ali, Scientist, ICAR-DCFR, Bhimtal.	Member
Smt. Pragyan Dash, Scientist, ICAR-DCFR, Bhimtal.	Member
Sh. Vijoy K. Singh, Sr. Technical Assistant, ICAR-DCFR, Bhimtal.	Technical support
Sh. A. K. Saxena, Sr. Technical Assistant, ICAR-DCFR, Bhimtal.	Technical support
Smt. Susheela Tewari, PS to Director, ICAR-DCFR, Bhimtal.	Secretarial assistance

16.4. Members of Project Monitoring & Evaluation Committee

Dr. A. K. Singh, Director, ICAR-DCFR, Bhimtal.	Chairman
Dr. A. Barat, Principal Scientist & In-charge, Molecular Genetics & Breeding, ICAR-DCFR, Bhimtal.	Member
Dr. D. Sarma, Principal Scientist & In-charge, Resource Assessment & Extension, ICAR-DCFR, Bhimtal.	Member
Dr. N. N. Pandey, Principal Scientist & In-charge, Aquaculture and Nutrition, ICAR-DCFR, Bhimtal.	Member
Dr. Prem Kumar, Senior Scientist & In-charge, AKMU & GIS, ICAR-DCFR, Bhimtal.	Member
Dr. P. K. Sahoo, Principal Scientist & In-charge, PME cell, ICAR-DCFR, Bhimtal.	Member Secretary

16.5. Members of Institute Technology Management Committee

Dr. A. K. Singh, Director, ICAR-DCFR, Bhimtal.	Chairman
Dr. A. Barat, Principal Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. P. K. Sahoo, Principal Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. Laxmi Kant, Principal Scientist, ICAR-VPKAS, Almora.	Member
Dr. Prem Kumar, Senior Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. S. Ali, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. M. S. Akhtar, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. R. S. Patiyal, Senior Scientist, ICAR-DCFR, Bhimtal.	Member Secretary

16.6. Members of Agricultural Knowledge Management Unit

Dr. Prem Kumar, Senior Scientist, ICAR-DCFR, Bhimtal.	Officer In-charge
Sh. S. K. Mallik, Scientist, ICAR-DCFR, Bhimtal.	Member
Dr. M. S. Akhtar, Scientist, ICAR-DCFR, Bhimtal.	Member
Sh. A. K. Saxena, Sr. Technical Assistant, ICAR-DCFR, Bhimtal.	Technical support

16.7. Members of Result Framework Documentation

Dr. P. K. Sahoo, Principal Scientist, ICAR-DCFR, Bhimtal.	Nodal Officer
Dr. S. Ali, Scientist, ICAR-DCFR, Bhimtal.	Co-Nodal Officer

16.8. HYPM, PERMISNET, PIMS, MIS & FMS

Dr. Prem Kumar, Senior Scientist, ICAR-DCFR, Bhimtal.	Nodal Officer
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16.9. Library Advisory Committee

Dr. D. Sarma, Principal Scientist, ICAR-DCFR, Bhimtal.	Chairman
Dr. S. Ali, Scientist, ICAR-DCFR, Bhimtal.	Member
Sh. Y. S. Dhanik, Admin. Officer, ICAR-DCFR, Bhimtal.	Member
Sh. B. C. Pandey, Asstt. Fin. & Acc. Officer, ICAR-DCFR, Bhimtal.	Member
Dr. M. S. Akhtar, Scientist, ICAR-DCFR, Bhimtal.	Member Secretary

16.10. Institute Joint Staff Council

Official side	
Dr. A. K. Singh, Director	Chairman
Dr. A. Barat, Principal Scientist	Member
Dr. Suresh Chandra, Senior Scientist	Member
Sh. Y. S. Dhanik, Admin. Officer	Member
Sh. B. C. Pandey, Asstt. Fin. & Acc. Officer	Member
Smt. Khilawati Rawat, Asstt. Admin. Officer	Member Secretary
Staff side	
Sh. P. C. Tewari, Admin. Assistant	CJSC Member
Sh. J. C. Bhandari, Admin. Assistant	Member
Sh. R. K. Arya, Technical Assistant	Member
Sh. Manoj Kumar, Skilled supporting staff	Member
Sh. Mangla Prasad, Skilled supporting staff	Member
Sh. T. M. Sharma, Technical Assistant	Member Secretary

16.11. Institute Biosafety Committee

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

STAFF NEWS

17.1. Joining

The scientific cadre strength of the Directorate was enhanced by the joining of the following scientist through promotion, transfer or recruitment during the reporting period April 2015 to March 2016.

Dr. S. G. S. Zaidi, Senior Scientist (Aquaculture) joined on 28th September 2015.

Dr. Deepjyoti Baruah, Senior Scientist (Fish and Fisheries) joined on 16th October 2015.

Dr. Khangembam Victoria Chanu, Scientist (Biochemistry-Animal Science) joined on 14th March 2016.

Dr. Prakash Sharma, Scientist (Fish Nutrition) joined on 9th April 2015.

Smt. Pragyan Dash, Scientist (Aquaculture) joined on 11th May 2015.

Sh. Siva, C., Scientist (Fish Genetics and Breeding) joined on 9th October 2015.

17.2. Promotions

Sh. Baldev Singh was promoted to the post of Sr. Technical Officer under CAS of ICAR, with effect from 1st January 2015.

Sh. Ravinder Kumar was promoted to the post of Technical Officer under CAS of ICAR, with effect from 3rd February 2015.

Sh. Gopal C. Arya was promoted to the post of Sr. Technical Assistant under CAS of ICAR, with effect from 11th November 2015.

17.3. Transfers

Dr. S. K. Srivastava, Senior Scientist was transferred to ICAR-National Bureau of Fish Genetic Resources, Lucknow, by the Council. He was relieved from the Directorate on 16th January 2016.

Dr. S. K. Gupta, Scientist was transferred to ICAR-Indian Institute of Agricultural Biotechnology, Ranchi, by the Council. He was relieved from the Directorate on 10th September 2015.

PERSONNEL

Staff list as on 31.03. 2016

18.1. Research Management		
	Dr. A. K. Singh	Director
18.2. Scientific Staff		
1.	Dr. P. K. Sahoo	Principal Scientist (Fish & Fishery Science)
2.	Dr. Ashoktaru Barat	Principal Scientist (Fish Genetics & Breeding)
3.	Dr. Debajit Sarma	Principal Scientist (Fish & Fishery Science)
4.	Dr. Amit Pande	ICAR National Fellow (Biotechnology-Animal science)
5.	Dr. Nityanand Pandey	Principal Scientist (Aquaculture)
6.	Dr. Prem Kumar	Senior Scientist (Fish & Fishery Science)
7.	Dr. Suresh Chandra	Senior Scientist (Fish Pathology)
8.	Dr. R. S. Patiyal	Senior Scientist (Fish Genetics & Breeding)
9.	Dr. S. G. S. Zaidi	Senior Scientist (Aquaculture)
10.	Dr. Deepjyoti Baruah	Senior Scientist (Fish & Fishery Science)
11.	Sh. Sumanta Kumar Mallik	Scientist (Aquaculture)
12.	Dr. Shah Nawaz Ali	Scientist (Aquaculture)
13.	Dr. Neetu Shahi	Scientist (Biotechnology-Animal Science)
14.	Dr. Md. Shahbaz Akhtar	Scientist (Fish & Fishery Science)
15.	Dr. Dimpal Thakuria	Scientist (Biochemistry-Animal science)
16.	Dr. Kh. Victoria Chanu	Scientist (Biochemistry-Animal science)
17.	Dr. Biju Sam Kamalam J	Scientist (Fish Nutrition)
18.	Dr. Ciji Alexander	Scientist (Fish Nutrition)
19.	Sh. Rajesh M	Scientist (Fish Nutrition)
20.	Sh. Tandel Riteshkumar Shantilal	Scientist (Fish Health)
21.	Sh. Abhay Kumar Giri	Scientist (Aquaculture)
22.	Smt. Pragyan Dash	Scientist (Aquaculture)
23.	Dr. Prakash Sharma	Scientist (Fish Nutrition)
24.	Sh. Siva C	Scientist (Fish Genetics & Breeding)
18.3. Technical Staff		
1.	Dr. R. S. Haldar	Asstt. Chief Technical Officer
2.	Sh. Amit Kumar Joshi	Sr. Technical Officer

3.	Sh. Baldev Singh	Sr. Technical Officer
4.	Sh. Santosh Kumar	Technical Officer
5.	Sh. Ravinder Kumar	Technical Officer
6.	Sh. Vijoy Kumar Singh	Sr. Technical Assistant
7.	Sh. Amit Kumar Saxena	Sr. Technical Assistant
8.	Sh. Gopal C. Arya	Sr. Technical Assistant
9.	Sh. Hansa Dutt	Technical Assistant
10.	Sh. T. M. Sharma	Technical Assistant
11.	Sh. R. K. Arya	Technical Assistant
12.	Sh. Partha Das	Sr. Technician
13.	Sh. Manoj Kumar Yadav	Driver (Sr. Technician)
18.4. Administrative Staff		
1.	Sh. Y. S. Dhanik	Admn. Officer
2.	Sh. Harish Ram	Asstt. Admn. Officer
3..	Sh. B. C. Pandey	Asstt. Fin. & Acc. Officer
4.	Smt. Khilawati Rawat	Asstt. Admn. Officer
5.	Smt. Susheela Tewari	Private Secretary
6.	Sh. P. C. Tewari	Assistant
7.	Sh. J. C. Bhandari	Assistant
8.	Sh. Arun Khulbe	Assistant
9.	Sh. Ankesh Kumar Sinha	Assistant
10.	Sh. Pratap Singh Bisht	UDC
11.	Smt. Munni Bhakt	UDC
12.	Sh. Hansa Singh Bhandari	LDC
18.5. Skilled Supporting Staff		
1.	Sh. Ravinder Kumar	Skilled Supporting Staff
2.	Sh. Om Raj	-do-
3.	Sh. Sunder Lal	-do-
4.	Sh. Pooran Chandra	-do-
5.	Sh. Manoj Kumar	-do-
6.	Sh. Kuldeep Kumar	-do-
7.	Sh. Bholu Dutt Mouni	-do-
8.	Sh. Dharam Singh	-do-
9.	Smt. Basanti Devi	-do-
10.	Sh. Mangla Prasad	-do-
11.	Sh. Sushil Kumar	-do-

Annexure 1



Results Framework Document (RFD)

ICAR-Directorate of Coldwater Fisheries Research

(2015-2016)

Address:

Anusandhan Bhavan, Industrial Area
Bhimtal -263136 (Uttarakhand)

Website:

<http://www.dcf.res.in>

Section 1:

Vision

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

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.

Objectives

1. Development of protocols for sustainable management of coldwater aquatic resources
2. Development of technologies for productivity and production enhancement from coldwater aquaculture

3. Transfer of technologies, training and farmer adoption

Functions

To counteract the effect of unregulated developmental activities in fragile ecosystem of Himalayan region, judicious and scientific management of aquatic ecosystem by bridging the gap between actual fish yield and production potential can lead to the sustainable coldwater fishery resources which in turn would accelerate the economy of the region. To achieve the goal it is necessary to harness fish for food, sports and livelihood security of hill communities through assessment, generation, refinement and adoption of appropriate technologies and manpower development in the sector.

Section 2: Inter se priorities among Key Objectives, Success Indicators and Targets

Sl. No.	Objective (S)	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value				
							Excellent 100 %	Very Good 90%	Good 80%	Fair 70%	Poor 60%
1.	Development of technologies for productivity and production enhancement from coldwater aquaculture	35	Enhancement of production	Broodstock (rainbow trout, mahseer, carp) developed	Number of broodstock	8	350	300	250	200	150
				Seed production for cold water fish species (rainbow trout, mahseer, carp)	Number (in lakhs)	8	13.5	12.5	11.5	10.5	9.5
				New species and practices evaluated	Number	4	3	2.5	2.0	1.5	1
				Species specific nutrient requirement and feed preparation evaluated	Number	3	3	2.5	2.0	1.5	1
				Disease surveillance undertaken	Number of farms	6	6	5	3	2	1
				Number of pathogen	6	7	6	5	4		
2.	Development of protocols for sustainable management of coldwater aquatic resources	33	Resource assessment and exploration	Number of explorations and surveys carried out	Number	8	9	8	7	6	5
				Development of molecular markers of important coldwater fishes	Number	7	70	65	60	55	50
				GIS based resources map developed	number	7	4	3	2	1	0
				Nutrient profiling of coldwater species	number	5	6	5	4	3	2
				Management of depleting fishery resources							

Sl. No.	Objective (S)	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value				
							Excellent 100 %	Very Good 90%	Good 80%	Fair 70%	Poor 60%
3.	Transfer of technologies, training and farmer adoption	12	Training, Extension and farmer adoption in coldwater sector	Training for skill up gradation programmes conducted	Number of trainees	6	225	200	175	150	125
				Farmers adopted	Number	3	30	25	20	15	10
				Exhibitions/farmers meet organized/ participated	Number	3	8	6	4	2	1
	Publication/Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research article published	Number	3	7	6	5	4	3
				Timely publication of the Institute Annual Report(2014-2015)	Date	2	30/06/2015	02/07/2015	04/07/2015	07/07/2015	09/07/2015
				Utilization of released plan fund	%	2	98	96	94	92	90
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD 2015-2016 for approval	On-time submission	Date	2	May 15, 2015	May 16, 2015	May 19, 2015	May 20, 2015	May 21, 2015
				Timely submission of Results for 2014-2015	Date	1	May 1, 2015	May 2, 2015	May 5, 2015	May 6, 2015	May 7, 2015
				Rating from Independent Audit of Implementation of Citizens / Client's Charter (CCC)	%	2	100	95	90	85	80

Sl. No.	Objective (S)	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80
	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	01.11.2015	02.11.2015	03.11.2015	04.11.2015	05.11.2015
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risks of corruption (MSC)	% of implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for implementation of ISO 9001	% of implementation	%	2	100	95	90	85	80
			Implementation of agreed milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	90	80	70	60

Section 3: Trend Values of the Success Indicators

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual value for FY 2013-14	Actual value for FY 2014-15	Target value for FY 2015-16	Projected value for FY 2016-17	Projected value for FY 2017-18		
1	Development of technologies for productivity and production enhancement from coldwater aquaculture	Enhancement of production	Broodstock (rainbow trout, mahseer, carp) developed	Number of broodstock	3*	309	350	375	400		
			Seed production for cold water fish species (rainbow trout, mahseer, carp)	Number (in lakhs)	10	13.06	13.5	14	14.5		
			New species and practices evaluated	Number	2	3	3	3	3		
			Species specific nutrient requirement and feed preparation evaluated	Number	-	-	3	2	1		
			Disease surveillance programme	Number	3	5	6	7	8		
			Fish health management	Identification & characterization of fish pathogens in coldwater fish species	Number of pathogen	6	7	8	9	10	
				Number of explorations and surveys carried out	Number	6	8	9	10	11	
				Resource assessment and exploration	Development of molecular markers of important coldwater fishes	Number	55	65	70	75	80
			2	Development of protocols for sustainable management of natural aquatic resources	Resource assessment and exploration	Development of molecular markers of important coldwater fishes	Number	55	65	70	75

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual value for FY 2013-14	Actual value for FY 2014-15	Target value for FY 2015-16	Projected value for FY 2016-17	Projected value for FY 2017-18
		Management of depleting fishery resources	GIS based resources map developed	Date	2	2	3	4	5
			Seed ranching programme taken up	Number	3	4	5	6	7
3	Transfer of technologies, training and farmer adoption	Training, extension and farmer adoption in coldwater sector	Training for skill up gradation programmes conducted	Number of trainees	173	212	225	250	275
			Farmers adopted	Number	20	26	30	35	40
			Exhibitions/farmers meet organized/ participated	Number	4	8	4	5	6
	Publication/ Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research article published	Number	4	6	8	10	12
		Timely publication of the Institute Annual Report (2014-2015)	Annual Report published	Date	-	June 21, 2014	July 2 2015	-	-
	Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	-	99.8	-	-	-
	Efficient Functioning of the RFD System	Timely submission of Draft RFD 2015-2016 for approval	On-time submission	Date	May 14, 2013	May 16, 2014	May 15, 2015	-	-
		Timely submission of Results for 2014-2015	On-time submission	Date	April 5, 2014	May 2, 2015	May 2, 2016	-	-

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual value for FY 2013-14	Actual value for FY 2014-15	Target value for FY 2015-16	Projected value for FY 2016-1	Projected value for FY 2017-18
	Enhanced Transparency / Improved Service Delivery of Ministry/ Department	Rating from Independent Audit of Implementation of Citizen's / Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	-	-	-	-	-
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	-	-	-	-	-
	Administrative Reforms	Update organizational strategy to align with revised priorities	Date	Date	-	-	-	-	-
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risks of corruption (MSC)	% of implementation	%	-	-	-	-	-
		Implementation of agreed milestones for implementation of ISO 9001	% of implementation	%	-	-	-	-	-
		Implementation of agreed milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	-	-	-	-	-

* In previous year number of species was indicated

Section 4(a): Acronyms

No.	Acronym	Description
1.	GIS	Geographical Information System
2.	SAUs	State Agricultural Universities
3.	KVKs	Krishi Vigyan Kendras
4.	NGOs	Non-Governmental Organizations

Section 4(b): Description and definition of success indicators and proposed measurement methodology

Sl. No.	Success Indicator	Description	Definition	Measurement	General Comments
1.	Broodstock for cold water fish species (rainbow trout, mahseer, carp) developed	Brood stock development is the primary key for artificial propagation in order to enhance the production in culture system	Raising the brood stock for quality seed production	Number of brood stock developed for breeding	The institute has taken programme on location specific brood stock development
2.	Seed production for cold water fish species (rainbow trout, mahseer, carp)	Mass scale seed production is required to enhance the fish production	Production of fish seed through induced breeding	Seed production	Required for sustainable aquaculture
3.	New species and practices evaluated	Suitable species and culture practices under different conditions are required	Species and culture practices as per the local condition	Species and Culture practice suggested and advocated	Required for the local condition
4.	Species specific nutrient requirement and feed preparation evaluated	Species specific nutritional requirement is essential for feed preparation	Species specific nutritional requirement for feed preparation.	Species specific nutritional requirement and feed preparation evaluated and advocated	Availability of feed for indigenous coldwater species is one of the major constraints in coldwater aquaculture
5.	Disease surveillance undertaken	Disease surveillance is a process of monitoring and reporting important fish diseases for the health of aquaculture production	Disease surveillance is listing, profiling and monitoring of health of aquaculture species and environment	Number of farms surveyed country wide	Need based programme for fish farmers

Sl. No.	Success Indicator	Description	Definition	Measurement	General Comments
6.	Identification & characterization of fish pathogens in coldwater fish species	Preventive measure for aquaculture production	It is protective mechanism to identify fish pathogens	Number of pathogens identified	Required to develop fish health management programme
7.	Number of explorations and surveys carried out	Explorations are the prerequisite of assessment and management of the coldwater water bodies	It is a process of assessing the temporal status of natural water bodies	Quantification of resources and fish faunal diversity	Explorations of the water bodies is routine work of the institute
8.	Development of molecular markers of important coldwater fishes	Molecular markers may help in stock improvement programme	It is a molecular tool for characterization of species	Number of markers developed for different coldwater fish species	Genetic resource database for coldwater fish species
9.	GIS based resources map developed	Characterization of different water bodies in coldwater region	GIS is powerful tool to assess the fishery resources	Number of database developed	The map can be used for suitable site selection for aquaculture in coldwater region
10.	Nutrient profiling of coldwater species	Estimation of nutrients available in coldwater species	Proximate composition of fish and availability of different types of nutrients available in coldwater fishes	Number of coldwater species assessed for nutrient profiling	Fish is an integral part of human diet and it can fulfill the protein and other nutrient requirements
11.	Seed ranching programme taken up	Due to inherent reasons the indigenous fish stocks are depleting in natural water bodies that can be counter acted with seed ranching programme	It is the process of rejuvenating the natural stocks	Number of ranching programme taken up	Farm raised fish seeds are ranched in nature for maintaining fish stock
12.	Training for skill up gradation programmes conducted	Human resource development	Skill development of different stake holders	Number of trainees	Popularization of developed technology
13.	Farmers adopted	Adoption of farmers for transferring technical know-how for aquaculture practices	Adoption is a process which is required to support and develop farmers for increasing aquaculture production	Number of farmers adopted	The institute has initiated farmers oriented programme for popularization of aquaculture in hills
14.	Exhibitions/farmers meet organized/ participated	Display of important technology and interaction with farmers	It is a method of extension for dissemination of technology and technical know-how	Numbers of exhibitions organized/ participated	The institute participate in different exhibitions/farmers meet on regular basis

Section 5: Specific performance requirement from other departments that is critical for delivering agreed results

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this organization	What happens if your requirement is not met
NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL

Section 6: Outcome/impact of Department/Ministry

Sl. No.	Outcome/ Impact	Jointly responsible for influencing this outcome/impact with the following organization/ department(s)/ministry(ies)	Success indicator	Unit	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018
1.	Aquatic resources assessed and explored	Ministry of Agriculture, SAUs, Ministry of Environment & Forest, State Fisheries Department, KVKs, NGOs	Aquatic resources explored	Number	6	8	9	10	11
2.	Productivity and production of coldwater aquaculture increased	Ministry of Agriculture, SAUs, Ministry of Environment & Forest, State Fisheries Department, KVKs, NGOs	Seed production for coldwater fishes	Number (in lakhs)	10	13.06	13.5	14	14.5
3.	Trained man power available	State Department of Fisheries, KVKs and Private sector, Hydro-electric projects	Training and skill up gradation	Number of trainees	173	212	225	250	275
			Farmers adopted	Number of farmers	20	26	30	35	40



कार्यकारी सारांश

भा.कृ.अनु.परि.—शी.मा.अनु. निदेशालय के अधिदेश में व्यापक अनुसंधान गतिविधियों, तकनीकी हस्तान्तरण आदि के माध्यम से भारत के पर्वतीय क्षेत्रों के शीतजल मात्स्यिकी उत्पादन में वृद्धि करना एवं संसाधनों का उचित प्रबन्धन करना आदि को लक्षित किया गया है। इसी क्रम में वर्ष 2015–16 की अवधि में निदेशालय द्वारा की गई अनुसंधान – गतिविधियों का सार निम्नवत् है:

संसाधन मूल्यांकन एवं प्रबन्धन

- चुनिन्दा हिमालयी जलस्रोतों में परिस्थितिकी तंत्र के मूल्यांकन एवं जल-संसाधनों के मानचित्रण की परियोजना के अन्तर्गत पश्चिमी रामगंगा एवं कोसी नदी की जल-जैविकी, जलीय-जीवों की जैव विविधता तथा वास स्थलों के स्तर का सावधानीपूर्वक अन्वेषण किया गया। पश्चिमी रामगंगा नदी के क्षेत्र पर मछली की मात्रा, विपुलता आदि पर किए गए अन्वेषण से पता चलता है कि इस नदी के मत्स्य जैव विविधता की स्थिति बहुत कम है।
- केन्द्रीय एवं उत्तर-पूर्व हिमालयी क्षेत्रों में झील परिस्थितिकी की पौषणिक गतिशीलता एवं चुनिन्दा पर्वतीय झीलों की ईको-जैविकी को जानने के लिए लक्ष्य निर्धारित किए गए। पहली बार अरुणांचल प्रदेश एवं सिक्किम की ऊंचाई वाले क्षेत्रों में स्थित कुछ झीलों से जल-जैविकी सूचनाएँ एकत्रित की गयी।
- इसके अतिरिक्त हिमांचल प्रदेश एवं जम्मू एवं कश्मीर के प्राकृतिक जल संसाधनों (नदी, झील एवं जलाशय) एवं पश्चिमी हिमांचल के शीतजल संसाधनों का एक स्थानिक डाटाबेस तैयार किया गया तथा उनको आंकड़ाबद्ध किया। इस हेतु उपग्रहों से सूचनाएँ एकत्रित की गयी और सर्वेक्षण कार्य किया।
- निदेशालय, चुनिन्दा हिमालयी क्षेत्रों में शीतजल मत्स्य पालन के सतत् विकास पर अनुसंधान एवं पारिस्थितिकी तंत्र की निगरानी तथा हिमालय की पारिस्थिति तंत्र को बनाए रखने के साथ एक राष्ट्रीय मिशन में कार्य कर रहा है।
- निदेशालय, भीमताल और चम्पावत केन्द्र में प्रमुख स्थानीय शीतजल मत्स्य प्रजातियों के जननद्रव्य के भण्डारण के साथ-साथ गंगा बेसिन की फिन-फिशोज के लिए जननद्रव्य केन्द्र को विकसित करने के कार्य हेतु एक राष्ट्रीय नेटवर्क से भी जुड़ा हुआ है।

जलकृषि पर आधारित अनुसंधान एवं विकास

- पर्वतीय मात्स्यिकी के विकास हेतु प्रजातियों के विविधिकरण के लिए एक कार्यक्रम के अन्तर्गत खाद्य मछलियों का पूर्णतः देशीकरण करने हेतु लक्ष्य निर्धारित किया गया। इस सम्बन्ध में तालाबों में लेबियों पंगुसिया का प्रजनन तथा अन्य प्रजाति राइमसबोला का चयन किया गया। चाइनीज कार्प के साथ बेंगाना देवदेवी एवं ओस्टीयोब्रामा बेलंगारी के मिश्रित पालन की सम्भावना पर प्रक्षेत्र-परीक्षणों के आधार पर आर्थिक लाभ का सुझाव दिया गया।
- बीज उत्पादन हेतु प्राकृतिक जल स्रोतों से एकत्रित की गयी मादा मछलियों पर निर्भरता को कम करने के लिए तालाबों में सुनहरी महाशीर के जननांगों की परिपक्वता हेतु फोटो थर्मल सम्बन्धी प्रयोगात्मक प्रयास किए गए तथा प्रजनन हारमोन्स स्तर में उत्प्रेरित फोटोपीरियड के परिवर्तनों को अंकित किया गया और एरोमांटेज इन्कोडिंग जीन्स को आंशिक रूप से वर्गीकृत किया गया।
- किसपेटीन 1 के पूरी लम्बाई वाले cDNA किसपेटीन 1 रिसेप्टर तथा सुनहरी महाशीर के किसपेटीन 2 का क्लोन कर उनको वर्गीकृत किया तथा KISS 1 और KISS 1' पेपटाइड्स के संरचनात्मक विश्लेषण का शारीरिक अध्ययन किया गया।
- शाइजोथोरेक्स रिचार्डसोनी की वृद्धि एवं परिपक्वता पोषक तत्वों के नियमन तथा शारीरिक तंत्र को समझने के लिए एक व्यापक परियोजना आरम्भ की गयी है।
- प्राकृतिक जलस्रोतों से एकत्रित की गयी स्नोट्राउट को तालाबों में रख कर सावधानीपूर्वक उनका अनुकूलन किया और शारीरिक क्रिया के विकास पर पोषकीय स्तर की व्याख्या की गयी, इसके साथ ही फार्म में पाले-पोषे गए प्रजनकों से प्रजनन कराया गया।
- स्नो ट्राउट की छः विभिन्न प्रजातियों के जैव रासायनिक मिश्रण, वसीय अम्ल स्तर, कौलेस्ट्रॉल, ट्राइग्लिसराइड एवं खनिजों का मानव उपयोग के लिए एक आहार के घटक के रूप में उनकी पौषणिक महत्ता का निर्धारण किया गया।
- आहार विकास सम्बन्धी आउटरीच गतिविधियों के अन्तर्गत रेन्बो ट्राउट के लिए मूल्यवर्धित दो शुरुआती खुराकों (आहार) का विकास किया गया और प्रयोगात्मक

रूप में पाया गया कि यह आहार वाणिज्यिक रूप से सफल है।

- ◆ महत्वपूर्ण शीतजल मछलियों जैसे रेन्बो ट्राउट (2.34 लाख डिम्बनेत्र), परिष्कृत हंगेरियन कॉमन कार्प (1.3 लाख जीरा), सुनहरी महाशीर (45000 अंगुलिकाएँ), माइनर कार्प (3 लाख जीरा), तथा सजावटी मछलियों का सफलतापूर्वक प्रजनन एवं बीज उत्पादन किया गया, साथ ही सुनहरी महाशीर, कामन कार्प एवं रेन्बो ट्राउट की बिक्री से 2.26 लाख का राजस्व प्राप्त किया।

रोग निगरानी एवं स्वास्थ्य प्रबन्धन

- ◆ हिमांचल प्रदेश एवं सिक्किम के रेन्बो ट्राउट फार्मों में उपस्थित बैक्टीरियल-रोगमूलकों को रूपांकित कर उनको प्रयोगशाला में सुरक्षित रखा गया।
- ◆ जल-जीव रोगों पर राष्ट्रीय निगरानी कार्यक्रम के अन्तर्गत जम्मू-कश्मीर, हिमांचल प्रदेश एवं उत्तराखण्ड के 25 रेन्बो ट्राउट व कार्प फार्मों में शीतजल मत्स्य रोगों की उपस्थिति का पता लगाने हेतु सर्वेक्षण किया गया और पता चला कि उनमें पैन्क्रियाटिक नेक्रोसिस वायरस एवं वायरल हैमोरेजिक स्पैटिसीमिया वायरस की उपस्थिति नगण्य थी।
- ◆ स्नोट्राउट के एम एक्स (MX) जीन एवं एम एक्स (MX) प्रमोटर की पहचान की गयी तथा प्रथम चरण में आणविक स्तर पर उनको वर्गीकृत किया साथ ही मछली के नैदानिक नमूनों में वायरस संकेत की उपस्थिति का पता लगाने के लिए एक प्रविधि को विकसित करने का प्रयास किया गया है।
- ◆ उनके एलिजिसीडल गतिविधियों के आधार पर 10 बैक्टीरियल आइसोलेट्स की पहचान की गयी तथा उनको जीवाणु जैविक उपचार के उपाय विकसित करने के लिए वर्गीकृत किया गया जो कि मत्स्य तालाबों और जलस्रोतों में एड्रुगिनोसिया ब्लूम की वृद्धि में कमी ला सकते हैं।
- ◆ मत्स्य स्वास्थ्य पर अखिल भारतीय नेटवर्क योजना के अन्तर्गत एक्वा-ड्रग और दवाएँ, एंटीबायोटिक दवाओं व उपचारात्मक किट आदि के सम्बन्ध में 6 पर्वतीय राज्यों में लगभग 300 मत्स्य फार्मों से प्राथमिक आंकड़े एकत्रित किए गए। पर्वतीय क्षेत्रों में मत्स्य पालन में मत्स्य स्वास्थ्य प्रबन्धन के लिए आमतौर पर टेबिल साल्ट, नींबू और पोटेशियम परमैंगनेट का इस्तेमाल किया जाता है।

आणविक आनुवंशिक एवं जैव प्रौद्योगिकी योगदान

- ◆ ब्राउन ट्राउट एवं चॉकलेट महाशीर का पूर्ण मिटोजेनोम अगली पीढ़ी के अनुक्रमण के माध्यम से वर्गीकृत किया गया।
- ◆ माइटक्रॉन्ड्रियल जीन-मारकर्स के प्रयोग द्वारा भौगोलिक रूप से पृथक ब्राउन ट्राउट और चॉकलेट महाशीर के बीच आनुवंशिक अन्तर का विश्लेषण किया गया, इसके अतिरिक्त एक आंशिक जीनोमिक लाइब्रेरी निर्माण किया। पृथक एसएसआर मारकर्स का प्रयोग 11 चॉकलेट महाशीर व 5 ब्राउन ट्राउट की जीनो टाइपिंग के लिए किया गया।
- ◆ सेचिस्टुरा सिक्किमसिज की आंशिक जीनोमिक लाइब्रेरी से 3876 एस.एस.आर. युक्त श्रृंखलाएँ प्राप्त की गयी। जीनोटाइपिंग के लिए चयनित 32 लोसाई के अतिरिक्त अलग - अलग संख्या के 18 लोसाई में अत्यन्त उच्च बहुरूपता पायी गयी।
- ◆ शाइजोथोरैक्स रिचार्डसोनी के उत्तरदायी ट्रांसक्रिप्ट हीट शौक के ट्रांसक्रिप्टोन विश्लेषण से पता लगता है कि 20506 यूनीजीन्स 35 कार्य समूहों में एनोटेड थे तथा जीन उपापचयी प्रक्रियाओं के नियमन से सम्बन्धित तापीय क्षमता का एक अभिन्न भाग था।
- ◆ एरोनोमाज हाइड्रोफिलिया संक्रमण के लिए सुनहरी महाशीर का सिलिको ट्रांसक्रिप्टोन विश्लेषण इंगित करता है कि 2408 ट्रांसक्रिप्ट्स विभिन्न रूप से परिभाषित थे और अधिकतर सेलुलर प्रणाली में पुनर्गठित पाए गए।
- ◆ मछली के वायरस से एक नैनो प्रणाली विकसित करने के उद्देश्य से तीन नवीन पेप्टाइट्स की पहचान की गयी। इन नवीन पेप्टाइट्स नैनो प्रणाली का संरचनात्मक विश्लेषण किया गया और इनके संश्लेषण सम्बन्धी कार्य प्रगति पर है।

महत्वपूर्ण घटनाएँ विस्तार गतिविधियाँ एवं प्रशिक्षण

- ◆ दिनांक 20- 21 सितम्बर 2015 को निदेशालय में "रेन्बो ट्राउट" फार्मिंग में चुनौतियाँ एवं सम्भावनाओं" पर दो दिवसीय राष्ट्रीय परामर्श का आयोजन किया गया जिसमें उच्च उत्पादकता के लक्ष्य को प्राप्त करने के लिए वैज्ञानिक सुधारों, कुशल प्रबन्धन एवं कुशल प्रशासन के आधार पर एक कार्य योजना तैयार की गयी।

- ◆ निदेशालय ने हिमालयी क्षेत्र की पारिस्थितिकी तंत्र को बनाए रखने के लिए हिमालयी कृषि पर राष्ट्रीय मिशन के तहत एक कार्यशाला का आयोजन किया।
- ◆ भ्रमण एवं संचार के अन्य माध्यमों के द्वारा उत्तराखण्ड के 85 कार्प उत्पादकों तथा हिमाचल प्रदेश एवं सिक्किम के 50 रेन्बोट्राउट उत्पादकों को “मेरा गाँव मेरा गौरव” कार्यक्रम के अन्तर्गत फार्म सम्बन्धी विशिष्ट परामर्श तकनीकी सहायता उपलब्ध की गयी।
- ◆ निदेशालय के चम्पावत स्थित केन्द्र में नियमित गतिविधियों एवं कुछ विशेष अवसरों जैसे – “मत्स्य कृषक दिवस” एवं “जय किसान जय विज्ञान सप्ताह” के अवसर पर रेन्बो ट्राउट व कार्प के प्रजनन का प्रदर्शन, मत्स्य स्वास्थ्य प्रबन्धन पर जन-जागरुकता अभियान, कृषकों एवं वैज्ञानिकों के मध्य आपसी परिचर्चा आदि का आयोजन किया गया।
- ◆ एन. एफ. डी. बी. द्वारा प्रायोजित प्रौद्योगिकी उन्नयन कार्यक्रम के माध्यम से कुमाऊँ एवं गढ़वाल क्षेत्र के रेन्बो ट्राउट उत्पादन को एक लाभकारी व्यवसाय के विकल्प के रूप में प्रचारित किया गया।
- ◆ भीमताल झील में 9000 महाशीर अंगुलिकाओं एवं बैजनाथ में पाली-पोषी गयी 20000 अंगुलिकाओं को छोड़ा गया, साथ ही इनके प्राकृतिक वास स्थलों को संरक्षित एवं पुनर्विकसित किया गया।
- ◆ देश भर में किसानों एवं अन्य हितधारकों के लिए सोलह विभिन्न सम्मेलनों, सेमिनारों तथा मेलों का आयोजन किया तथा निदेशालय की अनुसंधान एवं विकास गतिविधियों का प्रदर्शन किया।
- ◆ छात्रों के विभिन्न दलों एवं किसानों ने निदेशालय के भीमताल व चम्पावत केन्द्र का भ्रमण कर सुविधाओं को देखा और वैज्ञानिकों से चर्चा की।
- ◆ टिहरी जल विद्युत विकास निगम परामर्श के अन्तर्गत, एक मत्स्य प्रबन्धन योजना विष्णुगाड़ पीपलकोटी जलविद्युत परियोजना में लागू करने के लिए तैयार की जा रही है।
- ◆ पर्वतीय मात्स्यिकी की विशिष्ट सम्भावनाओं पर मौपुन-मेघालय और चाटलैंग-मिजोरम के राज्य मत्स्य पालन विभाग के अधिकारियों के लिए एन0एफ0डी0बी0 द्वारा प्रायोजित दो प्रशिक्षण कार्यक्रम आयोजित किए गये। इसी तरह दिरांग- अरुणाचल प्रदेश और तोली उत्तराखण्ड में भी एन0एफ0डी0बी0 द्वारा मत्स्य पालकों के लिए प्रशिक्षण कार्यक्रम आयोजित किए गये।

- ◆ मानव संसाधन विकास गतिविधियों के तहत निदेशालय के वैज्ञानिक, तकनीशियनों, प्रशासनिक वर्ग के सदस्यों को अपने कौशल उन्नयन निर्माण कार्यक्रमों में भाग लेने के लिए प्रोत्साहित किया गया।

उत्तर-पूर्वी पर्वतीय योजना एवं जनजाति योजना के अन्तर्गत पहल

महत्वपूर्ण स्थानीय प्रजातियों यथा सेमिप्लोटस सेमिप्लोटस, नियोलिस्सोचिलस हैक्सागोनोलिपिज व ओस्टीयोब्रामा देबदेबी के तालाब प्रबन्धन एवं प्रजनन विकास की प्रविधियों के लिए गंगटोक (सिक्किम) में पूर्वोत्तर क्षेत्रों के लिए शीतजल की स्थानीय मछलियां: अवसर और चुनौतियां विषय पर एक कार्य-योजना तैयार करने के लिए एक राष्ट्रीय कार्यशाला आयोजित की गयी।

- ◆ रेन्बोट्राउट की खेती की विभिन्न सम्भावनाओं पर सिक्किम एवं अरुणाचल प्रदेश के मात्स्यिकी विभागों को तकनीकी एवं वित्तीय सहायता दी गयी।
- ◆ तूरा (मेघालय) एवं त्वेनसांग (नागालैण्ड) में चौकेलेट महाशीर को दो हैचरियों का निर्माण किया तथा मक्का, सिक्किम में तालाबों में सुनहरी महाशीर के पालन हेतु भी मदद की गयी। जनजाति योजना के अन्तर्गत जनजाति मत्स्य पालकों एवं महिलाओं को लिए फसलोपरान्त मूल्यवर्धन हेतु विभिन्न प्रशिक्षण कार्यक्रम आयोजित किए गये।
- ◆ जम्मू कश्मीर के लेह तथा उत्तराखण्ड के धारचूला जैसे क्षेत्रों में जहाँ पर रेन्बो-ट्राउट की खेती बिलकुल नगण्य है उन स्थलों पर रेन्बो-ट्राउट की खेती को प्रचारित-प्रसारित किया गया।
- ◆ मत्स्य पालन को अपनाएने से होने वाले आर्थिक लाभ के प्रति जनजाति कृषकों के बीच रुचि पैदा करने के लिए प्रदर्शन-कार्यक्रम आयोजित किए गये तथा अंगीकृत कृषकों को मत्स्य पालन के उपकरणों, बीज, आहार व नेट आदि वितरित किए गये।

अन्य उपलब्धियाँ

- ◆ निदेशालय को छोटे संस्थानों के वर्ग में वर्ष 2014-15 की वार्षिक पुस्तिका की श्रेणी में सर्वोत्तम पुरस्कार प्राप्त हुआ।
- ◆ इस अवधि में निदेशालय की अनुसंधान गतिविधियों राष्ट्रीय एवं अन्तरराष्ट्रीय पत्रिकाओं में प्रकाशित हुयी।

Annexure 2



ICAR-DCFR Field Centre, Champawat

An experimental fish farm of the Directorate is located at Chhirapani in Champawat district, Uttarakhand. This facility is involved in various research programmes, human resource development and extension activities. The primary research activities include breeding, seed production, culture and management of coldwater fishes such as rainbow trout, common carp and snow trout.

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