ICAR-DCFR
NEWSLETTER
Vol 23 No. 1 Jan-June, 2022

FROM DIRECTOR'S DESK

The Himalayan belt, frequently referred to as the third pole, is endowed with amazing beauty in the form of breath-taking scenery, snow-covered mountains, pine and deodar forests, luscious freshwater springs, ice-cold rushing rivers, and beautiful lakes. It stretches from Ladakh in the West to Arunachal Pradesh in the East. Its strengths include its topography, landscapes, and rich biodiversity. Given its size, rough terrain, variety of microclimates, inaccessibility of the most regions, utilizing these resources for the rural development creates serious obstacles. Despite these difficulties, the ICAR-Directorate of Coldwater Fisheries Research (DCFR) is diligently working to give directions and answers for scientific utilization of the fisheries resources.

The directorate has made a deliberate effort to meet the research, extension, and capacity-building goals set for the organization. Along with hydro-morphometric characterization and health evaluation, fish, plankton, and periphyton diversity of the significant Himalayan rivers have been quantified. The indigenous snow trout species *S. progastus* and *S. Plagiostomus* have been successfully bred in captivity using temperature manipulation and herbal feed additives in the diets. In addition, regular breeding operations for mahseer, common carp, ornamental fish, and rainbow trout were conducted. The re-circulatory aquaculture system is quite promising in increasing rainbow trout production. Therefore, the directorate has validated a coldwater re-circulatory aquaculture facility to reduce the amount of water, used for culture operations. Further, for reducing the loss of eyed-ova during the transportation, the directorate has conducted field research to examine a few pre-shipping and shipment settings for reducing eyed ova losses. The directorate has also carried out a variety of outreach initiatives through its extension-focused programs under NEH, TSP, and SCSP. Hatcheries were created in various Himalayan states, including Menchuka, Arunachal Pradesh, and in the cold desert of Leh and Ladkah (UT) to meet the need for rainbow trout seed in the area.The directorate has also prepared a road map for the sustainable development of fisheries in UT of Leh and Laddakh. During the period, the directorate also organized various extension programmes such as field days, awareness campaigns, demonstration trips, field tours, to raise awareness among farmers. A national campaign on *Annadata Devo Bhava* and an orientation workshop on Natural Farming were also organized.

Finally, I acknowledge Dr. Himanshu Pathak, Secretary DARE and Director General, ICAR, and Dr. J K, Jena, Deputy Director General (Fisheries Sciences), for their unwavering encouragement and insightful advice. The editorial team is highly appreciated for their efforts in collating and archiving the directorate's scientific accomplishments.

(Pramod Kumar Pandey)
Director

Fisheries Resource Management

Evaluation of the vertical accuracy of multi-source digital elevation models in the Himalayan river basin

In order to conduct hydrological research activities, a basic grasp of topography is required, and in the modern world, remote sensing equipment is essential. It is essential to select the optimal DEM by taking the objective, level of precision required, and scope of each study into consideration because the quality of the used DEMs directly influences subsequent calculations and hydrological modelling. One of the main issues with RS DEMs is the error in computing the absolute height, which has an impact on how well the morphometric features of the terrain are simulated. There are many comparative studies of the errors in estimating the absolute heights of different DEMs, but it is more difficult to compare data from different studies because different versions of the elevation models are being compared, different landscapes and land covers, as well as different methodologies for estimating vertical errors. With this background, the present study was envisaged to compare ASTER-DEM (Advanced Spaceborne Thermal Emission and Reflection Radiometer), SRTM-DEM (Shuttle Radar Topography Mission) and CARTOSAT DEM with respect to the ground control points taken at different elevations of the Lohawati basin, Champawat, Uttarakhand.

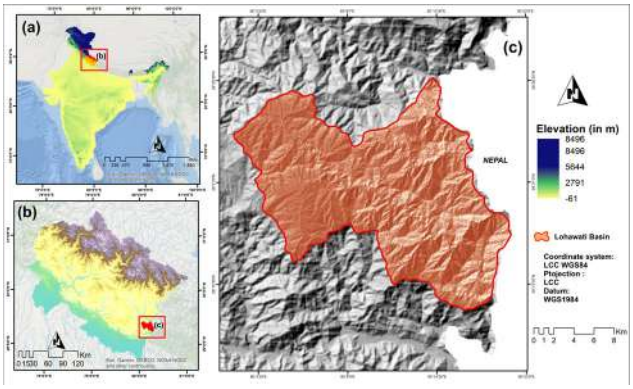


Fig. Location and geographical setting of the Lohawati basin, North western Himalaya, India.

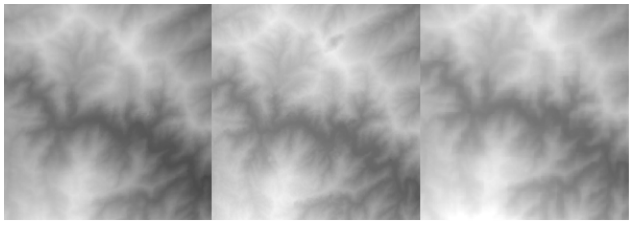


Fig. Representative grids of SRTM CARTOSAT and ASTER DEMS

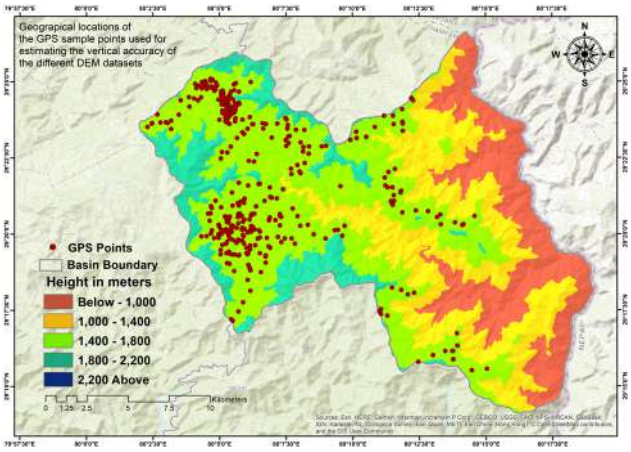
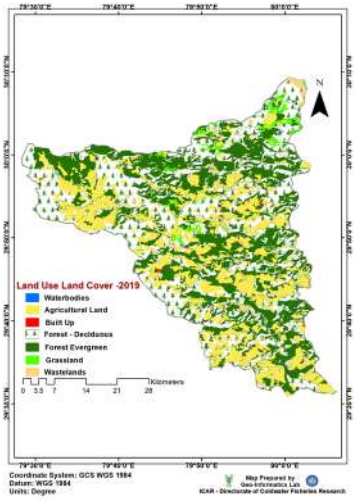


Fig. Geographical locations of the GPS sample points used for estimating the vertical accuracy of the different DEM datasets

The data from multiple RS systems (SRTM, ASTRE and CARTOSAT) were selected as the primary source for a comparison analysis in the study area, with geographic coordinates 29°26''30''N; 80°3'30''E to 29°15'30''N 80°20'0''E. The GCPs were acquired using a GPS (Trimble Juno T41/5 with an accuracy of ± 8 m), and 400 of these GCPs were gathered from the study region. The SRTM performed better than the ASTER and CARTOSAT DEMs in terms of overall vertical accuracy, as measured by Mean Absolute Error (MAE), Mean Bias Error (MBE), Root Mean Square Error (RMSE), Normalized Root Mean Square Error (NRMSE), Relative Root Mean Square Error (RRMSE), and Nash-Sutcliffe Efficiency (NSE). Overall, ASTER and CARTOSAT DEMs underestimated GPS site heights, while SRTM DEM overestimated them. All DEMS were substantially compliant with GCPs, according to NSE.

Ichthyofaunal diversity and health assessment of Central Himalayan River Saryu, Uttarakhand

Field sampling was carried out at six different locations of the river Saryu (viz. Kapkot, Bageshwar, Seraghat, Panar, Ghat and Rameshwar) during the months of January 2022 and June 2022 for recording and collection of piscines and hydrobiological data. Total of fifteen species of fishes



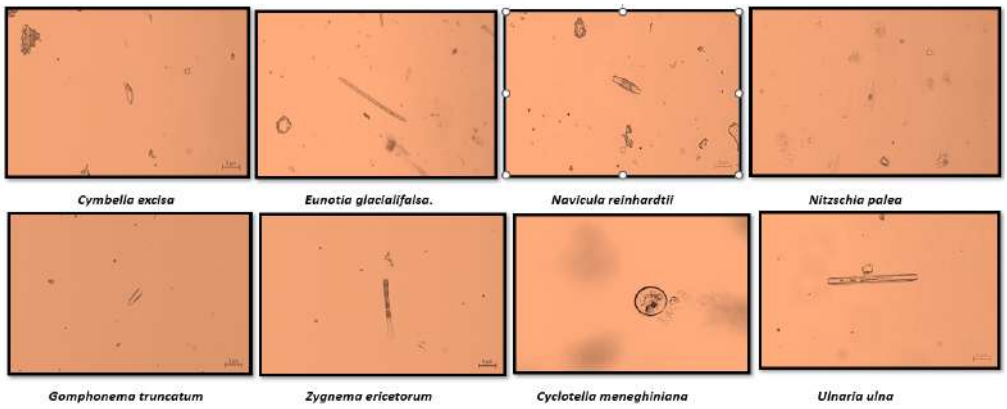


Fig.: phytoplankton diversity in River Saryu

belonging to nine genera were collected/identified from River Saryu. Maximum fish diversity was recorded at Pancheswar where Saryu meets Kali river, while minimum at Kapkot which was highest point and nearest to the origin of Saryu river. Maximum fish abundance was recorded at Seraghat, while minimum was recorded at Kapkot. A total of 30 phytoplankton species were identified and their density was found in the range of 181-1127 cell/litre with maximum density at Seraghat and minimum at Kapkot and maximum diversity was at Pancheshwar while minimum was at Kapkot. Minimum abundance of phytoplankton was recorded in monsoon due to high turbidity and higher flow rate while maximum abundance was in pre-monsoon due to lower velocity of water.

Habitat assessment in River Saryu was carried out based on location of sampling stations, weather conditions, stream characterization, watershed features, riparian vegetation, in stream features, in stream sediment and substrate features, physicochemical characteristics of water, phytoplankton, periphyton and zooplankton diversity & distribution.

Assessment of health status and influence of hydrobiological variations on fish assemblages' pattern in River Ladhiya Central Himalayas, Uttarakhand

Field sampling was carried out at six different locations of the River Ladhiya (Sunnegaon, Sunnkot, Reetha Sahib, Belkhet, Chalthi and Chukka) during the study period for recording and collection of species and hydrobiological data. Different physico-chemical characteristics of water samples were analysed. For assessing the health of river, water quality index was standardised for river Ladhiya based on the methodology developed by Brown et al, 1972. Based on this assessment, it was found out that river water varied from being of good quality at its source which degraded to poor quality in the middle and again restored back to good quality towards its mouth. This might beprobably because of more habitation and agricultural activities going on in the catchment of middle stretch of the river. Plankton were also identified and estimated at sampling sites.

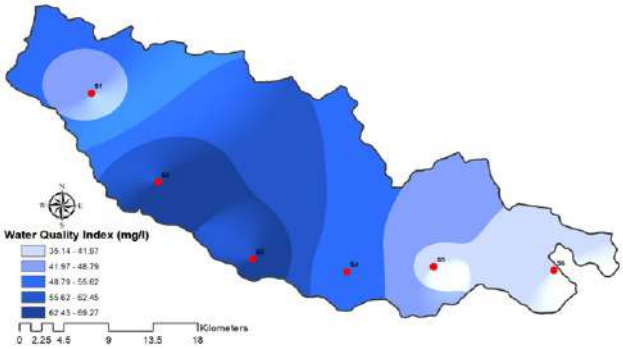


Fig.: Water Quality Index for River Ladhiya

Aquaculture

Successful breeding of *S. progastus* and *S. plagiostomus* in captivity

A successful breeding protocol was developed under captive condition with herbal feed additives in the diets and thermal manipulation. Brood stock of both the species were observed for general biology, gonadosomatic index (GSI) and breeding behaviour. Brooders showed maturity at the age of three years. The fertilised eggs were sticky, orange for both species with a size ranging between 3.2-3.8 mm in *S. plagiostomus*, while 2.9-3.6 mm in *S. progastus*. Hatching takes place within 11-18 days at water

Fig.: S. plagiostomus

temperature of 18-21°C. Fecundity was recorded in the range of 14,000-18,000 per kg body weight in *S. plagiostomus*, while 18,000-20,000 per kg body weight in *S. progastus*. The hatching rate was higher (>80%) during the month of September than in March (< 56%). Sexual dimorphism was observed with the presence of nuptial organs and size of the basal sheath scale. Mature males develop tubercles on either side of the snout, faint yellow colour of the body, and reddish colour of fins. *S. plagiostomus* was easier to breed than *S. progastus* at water temperature 15-20°C. 1.0 % dietary supplementation consisting a blend of ashwagandha (*Withania somnifera*) root powder, dried powder of garlic (*Allium sativum*) is beneficial for gonadal maturity of females. Dry stripping method was applied for spawning. Success in voluntary spawning was achieved with inducing hormone application. Breeding of both the species is feasible in captive condition and produced seed would be useful for wild population enhancement.

Fig.: Voluntary spawning of S. plagiostomus in captivity

Optimization of intensive production of rainbow trout in RAS

Under ICAR-NICRA project, continuous efforts are being made to optimize the culture conditions for achieving higher unit productivity of rainbow trout in RAS. Presently, water use per kilogram fish production in our RAS has been reduced by hundred-fold (~700 L per kg fish) and culture duration has been reduced to 5-6 months. This is possible under optimal rearing conditions due to faster growth rates and efficient feed conversion. Production cost per kg of trout was estimated to be around Rs. 250 which includes cost of feeding (Rs.150/kg); energy (Rs. 90/kg); seed and chemicals (Rs. 27000/crop cycle). In the current production cycle (November2021 to May2022), a different production approach was followed to produce large sized table fishes with lesser stocking and higher system hydraulic retention time to maintain important water quality parameters in the optimal range and to reduce the addition of alkalinity (sodium bicarbonate). The tested approach resulted in better water quality parameters in terms of temperature, turbidity, alkalinity and TSS; and growth rates where faster than the previous production cycle. During the reporting period between January to June 2022, a revenue of Rs. 2,05,180 was simultaneously generated through retail selling of market-sized rainbow trout from the pilot scale RAS facility.

Fig. Grow-out phase of rainbow trout production in the pilot-scale RAS facility, ICAR-DCFR, Bhimtal

Optimization of rainbow trout eyed ova shipment conditions

In India, there are specialized rainbow trout brood fish farms and breeding units, from where eyed ova are shipped to geographically distant farms and hatchery facilities across the country. But, often, there is an occurrence of huge losses due to poor shipment conditions. Therefore, under our tribal sub-plan programme, we carried out a field study to test few pre-shipment and shipment conditions for minimizing eyed ova losses. Critical factors such as eyed ova loading density (0.6, 0.8, 1 and 1.2 ml per cm^3), post-fertilization time of shipment (240 *vs.* 250-degree days) and acclimation to ice-cold temperature before packing (tempered *vs.* not tempered) were evaluated based on eyed ova losses at the time of receipt and cumulative losses up to 96 hours post-receipt (until the onset of hatching). Eyed ova for this study were obtained from an age group female and male rainbow trout that were more than four years, bred and incubated at ICAR-DCFR experimental fish

Fig. Rainbow trout eyed ova shipment receipt and checking at the destination, Leh

farm, Champawat, Uttarakhand. The eyed ova were measured by volumetric displacement, packed in trays, kept in an insulated box between layers of crushed ice and shipped in iced condition (< 2°C) to Leh, Ladakh (a high-altitude cold arid region) by road and air. The total distance covered and duration taken was 1500 km and 24 h, respectively. Out of the 86,000 eyed ova shipped, shipment loss at the time of receipt was 5.1% and cumulative 96 hours post-shipment loss was 4.1%. Concerning shipment conditions, 5 eyed ova per cm^3 loading density had minimum loss on-receipt and 96 hours post-receipt. Whereas, the post-fertilization time of 250-degree days and tempering was found to improve the cumulative post-receipt survival.

Molecular Genetics & Biotechnology

Characterization of housekeeping genes in *Tor putitora*

Housekeeping genes (HKGs) are thought to be consistently expressed across cell types because they are mainly required for cellular maintenance. These genes have been identified as having distinct evolutionary and genomic characteristics, as markers of organismal health, and as a benchmark for gene expression experiments. Quantitative real-time reverse transcription-polymerase chain reaction (qRT-PCR) is widely used in gene expression analysis and a successful qRT-PCR depends on accurate transcript normalization via the selection of suitable housekeeping gene. The potentials of five HKGs (*gapdh*, *b2m*, *tbp*, *ef1a*, and *18s)* for qRT-PCR data normalization in three different tissues (liver, muscle, and gill) of male and female golden mahseer was evaluated.

The expression levels of the HKGs were then compared and analyzed with Δct, NormFinder, BestKeeper, geNorm and RefFinder algorithms. The results showed that, the tested genes exhibited sex and tissue-specific expressions to various degrees, with *ef1a* and *gapdh* were found as the most stable reference genes in the gills of male and female respectively. While *tbp* and *ef1a* were found as the most stable genes for liver tissue of male and female respectively. However, *b2m* was the most stable gene for muscle tissues of both the sexes. It was evident that all the tested genes varied in expression levels in sex and tissue dependent manners and no single gene was identified as HKG across all tissue types. Further analysis combining all three tissues of both the sexes showed *tbp* as the most stable reference genes. These results indicate that for qRT-PCR analysis of gene expression in golden mahseer as a function of sex, the choice of HKGs should be made according to tissue type.

Computational prediction and designing of novel cell penetrating peptides for gene delivery

A total eight novel CPPs have been predicted from fish viral proteins. These CPPs have been predicted using **Cell PPD** and **C2Pred** web servers. One of the predicted CPP from along with NLS (Nuclear localization signal) was used to design a novel chimeric CPP. It contains both hydrophilic and hydrobhobic amino acids required for successful translocation inside the cells. Also, an endosomolytic peptide linker has been introduced in between hydrophilic and hydrophobic domain in order to accelerate the endosomal escape properties of the chimeric peptide. The designed chimeric peptide further checked using **Cell PPD** and **C2Pred** web servers for its cell penetrating ability. The designed cell penetrating peptide showed promising results for its gene carrying capacity inside fish cells and the results were comparable with that of commercially available lipofectamine transfection reagent.

Fish without water: *In vitro* meat

A cell line from snow trout muscles was developed. The cell line was named as SRM-1 and characterised in collaboration with ICAR-NBFGR, Lucknow. It was authenticated and deposited in National Repository of Fish Cell lines, ICAR-NBFGR Lucknow with accession number NRFC079.

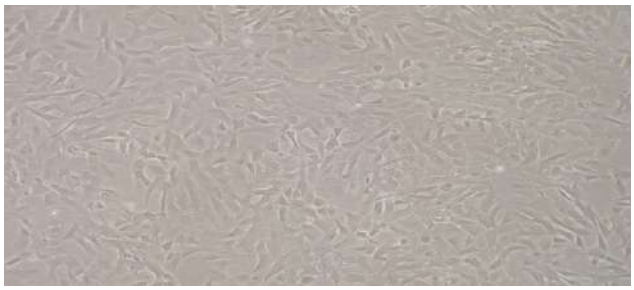


Fig: Cell line from snow trout muscle (SRM-1, Accession No. NRFC079)

Characterization and transcriptional regulation of thermal adaptation biomarkers (*stip1*, *hyou1* and *dnajc16*) in rainbow trout

Under ICAR-NICRA project, we have characterized three potentially novel biomarkers of thermal adaptation in rainbow trout, namely stress induced phosphoprotein (*stip1*), hypoxia up-regulated protein (*hyou1*) and heat shock protein 40 family member C16 (*dnajc16*). We have also elucidated their transcriptional regulation in gill during the course of high temperature acclimation, alongside established biomarkers of cellular stress response in salmonids.

The full-length mRNA of *stip1* and *hyou1* were 3096 bp and 3421 bp long, with 1632 and 3063 bp ORF region, encoding a putative protein of 544 and 1020 amino acids, respectively. Whereas, the amplified *dnajc16* fragment was 2528 bp long, with a partial ORF of 2356 bp that encoded 785 amino acids. Phylogenetically, the deduced protein sequences of stip1, hyou1 and dnajc16 clustered closely with other salmonids. Concerning their expression before (T0) and during the time-course (days) of high temperature (22°C) acclimation (T1, T3, T7, T15 and T30), the gill mRNA levels of *stip1*, *hyou1* and *dnajc16* were uniformly up regulated at T1, after the high-temperature transition. With prolonged exposure, transcripts of *hyou1* and *dnajc16* were elevated again at T15 and T30. A similar acute and chronic up regulation was observed for *hspbp1*, *hsp90b*, *gr1*, *junb*, *hif1a*, *gpx* and *tlr5*. Whereas, the expression of *hsc70*, *hspa5*, *gst* and *tnfa* was similar to that of *stip1* (elevated only at T1). Overall, molecular characterization of the structure and transcriptional regulation of *stip1*, *hyou1* and *dnajc16*, concurrently with their potential regulatory interactions has improved our understanding about thermal adaptation and tolerance in rainbow trout.

Fish Health management

Species specific PCR targeting ITS 2 region for detection of *S. parasitica*

Internal transcribed spacer (ITS) region is the DNA located between the small-subunit ribosomal RNA and the large-subunit ribosomal RNA coding genes. In eukaryotes, ITS region consists of ITS1 and ITS2 separated by 5.8S rRNA genes. The ITS region is the preferred DNA barcode in fungi because it is easy to detect even in a small quantities of DNA and it has high degree of variation between closely related species. Amplification and sequencing of ITS region is a common practice for species identification in *Saprolegnia*. In the ITS region, ITS2 exhibit high inter-species divergence and has been demonstrated as a suitable marker for taxonomic classification and phylogenetic reconstructions in eukaryotes. Based on the highly variable sequence of ITS2 region, a *S. parasitica* specific PCR protocol has been developed. The protocol uses universal primer, ITS1 along with species specific primer, TC27R. PCR amplification using these two primers resulted in amplicon of 620 bp approximately in *S. parasitica* only. No amplification was observed in other *Saprolegnia* species in this protocol. Therefore, the developed PCR protocol may be used for sequencing free molecular identification of *S. parasitica*.

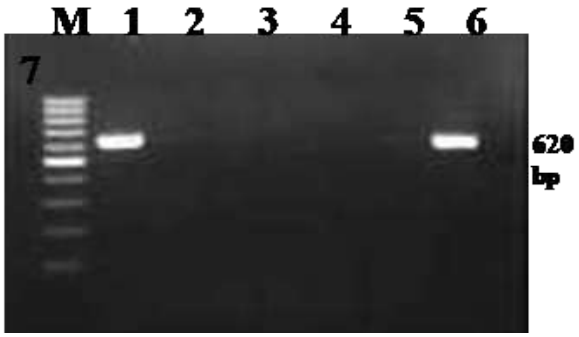


Fig: Gel electrophoresis of PCR products by the developed S. parasitica specific PCR.

Lane: M-100 bp DNA ladder, 1-S. parasitica, 2-S. australis, 3-S. diclina, 4-S. aenigmatica, 5-S. asterophora, 6- S. australis, 7-S. parasitica.

Fish Nutrition and Feed Development

Development and validation of high-performance rainbow trout grower feed

Through a series of experiments and field evaluation studies, ICAR-DCFR has developed and validated a high-performance rainbow trout grower feed formulation which consistently delivers a feed conversion efficiency of 0.9 to 1.1. The ingredient-nutritional composition and physical properties of the feed are designed to enhance palatability, digestibility and nutrient retention, while minimizing feed wastage. The salient features of the feed are the promotion of fast growth (>30% growth as compared to available feeds); optimal feed to weight gain conversion (FCR of 0.9-1.1); shortening of culture duration to achieve portion sized fish (from 12-18 months to 9-12 months); improved flesh quality (in terms of carcass yield and organoleptic properties); increased unit productivity and profit margins (>40%); and lower water foot print (<35%). Indicative feeding schedule matched to this trout feed have also been developed to suit varying environmental / operational scenarios. This feed research and development was carried out in collaboration with Growel Feeds Ltd., Andhra Pradesh.

Fig. Flesh quality of rainbow trout grown with ICAR-DCFR grower feed

Activities under NEH

Establishment of trout hatchery at Mechuka, Arunachal Pradesh

A trout hatchery was established in Mechuka, Shi-Yomi District, Arunachal Pradesh for hatching five lakh eyed ova with an investment of Rs 16.9 lakh to popularize trout farming in this remote hilly region. About 2.5 lakh eyed ova was provided along with 12 kg starter feed to Mechuka. For Nuranang trout hatchery, about two lakh eyed ova were provided and fingerlings distributed among trout growers of West Kameng and Tawang Districts of Arunachal Pradesh.

Fig.: Trout hatchery at Mechuka, Shi-Yomi Dist. Arunachal Pradesh and Rainbow trout hatchlings and seed distribution

Training Programme Organized

Four training programs were organized for the development NEH region. Aspirant villages of Mabong and Karji villages selected by DoNER, in West Sikkim were explored for feasibility of fish farming. A training programme was conducted on "*Ornamental Fish Culture - a Source of Income Generation*" in Mabong while another on "*High value trout farming for Livelihood Security*" was conducted at Karji.

For DoNER aspirational villages of Lotsu and Ranthan in district Wohka, Nagaland, carp feed, hand nets and cast nets were distributed as input among the farmers besides conducting two training programmes on "*Integrated Fish Farming as a Source of Income*" at Lotsu and Ranthan in district Wohka, Nagaland The Department of Fisheries, Nagaland was assisted to procure five tons of trout feed to sustain their brood stock. Reports on different NEH activities were compiled and documented for ICAR.

Fig. Training programs at Mabong and Karji

Fig. Training and input distribution program at Sanis and Lotsu

Fig. Trout seed distribution at Shergaon, West Kameng, Arunachal Pradesh

Activities under Tribal Sub-plan (TSP)

Establishment and on-farm demonstration of first RAS based rainbow trout hatchery-nursery in Ladakh

ICAR-DCFR is intensifying efforts to develop advanced aquaculture systems and diverse aquaculture practices in the high altitudinal regions of Ladakh. For the very first time, a scientifically designed and validated rainbow trout hatchery-nursery system was established at Chuchot Shamma village, Leh, in Mr. Zabir Ahmad's farm, under the Tribal Sub-Plan scheme. Approximately 75,000 rainbow trout eyed ova was supplied from ICAR-DCFR experimental farm during January-March 2022. Under continuous monitoring and guidance from DCFR scientists, hatching and larval rearing was successfully achieved in this RAS-based rainbow trout seed facility, with the final production of more than 30,000 rainbow trout fingerlings. On 21st May 2022, Dr. J.K. Jena (DDG, Fisheries Science) inaugurated this ICAR-DCFR established rainbow trout seed production facility, in the presence of Shri Ravinder Kumar (Secretary, Department of ASH & Fisheries, Ladakh), Dr. Pramod Kumar Pandey (Director, DCFR), top fisheries officials from various hill states and farmers. The design and operation of the facility was demonstrated to the gathering by Dr. Rajesh, M. The trout fingerlings produced in the facility were distributed and stocked in the raceways of tribal farmers from Leh and Nubra valley. This RAS model was found to effectively help in overcoming the inherent climatic challenges in Ladakh, enable timely production and availability of rainbow trout seed, and promote self-reliance in rainbow trout culture in Ladakh. This entire development programme and demonstration was carried out under TSP, by Dr. R.S. Patiyal, Dr. Biju Sam Kamalam and Dr. Rajesh, M.

Fig. Visit by Dr. J.K. Jena, DDG (Fisheries Sciences) at RAS based rainbow trout hatchery at Leh

Ornamental fish rearing in aqua-garden initiated at Leh, Ladakh

ICAR-DCFR has introduced another new aquaculture practice, namely aqua-gardening with ornamental fishes for integration with eco-tourism in Ladakh. A small aqua-garden with gold fish and koi carp has been set-up in Chuchot village, Leh, during March 2022. This aqua-gardening proof-of-concept unit was inaugurated on 21st May 2022 and demonstrated to the local tribal farmers in the presence of Dr. J.K. Jena (DDG, Fisheries Science), Shri Ravinder Kumar (Secretary, Department of ASH & Fisheries, Ladakh), Dr. Pramod Kumar Pandey (Director, DCFR) and top fisheries officials from various hill states. Dr. R.S. Patiyal briefed the potential of aqua-gardening to generate alternate livelihood in Ladakh. ICAR-DCFR was encouraged to establish more aqua-gardening units in different parts of Ladakh to promote aquaculture in the high altitude cold arid regions of Ladakh. This activity was carried out under TSP, by Dr. R.S. Patiyal, Dr. Biju Sam Kamalam and Dr. Rajesh, M.

Fig. Release of ornamental fish seed by Dr. J.K. Jena, DDG (Fisheries Sciences) and other dignitaries in aqua-gardening pond at Leh

Road map for sustainable development of fisheries and aquaculture in Ladakh

ICAR-DCFR organised a brainstorming session for deliberations on the draft road map for sustainable development of fisheries and aquaculture in UT Ladakh, on 21st May 2022, at Leh. This meeting was chaired by the Hon'ble Lieutenant Governor of UT Ladakh, Shri Radha Krishna Mathur, and was attended by Dr. J. K. Jena (DDG,Fisheries Science); Shri Ravinder Kumar (Secretary, Department of ASH

& Fisheries, Ladakh); Dr. Pramod Kumar Pandey (Director, ICAR-DCFR); Dr. Md. Raza (Director, Department of ASH & Fisheries,Ladakh); Director of Fisheries Departments from Himachal Pradesh, Sikkim and Meghalaya; representatives from Jammu & Kashmir, Manipur and Arunachal Pradesh; scientists from ICAR-DCFR and fisheries officials of UT Ladakh. During this meeting, Shri R.K. Mathur appreciated the sincere efforts of ICAR-DCFR and emphasized on strong linkage of the UT administration with ICAR-DCFR for conducting a baseline survey of the aquatic resources / biodiversity and research on best aquaculture practices. He also mentioned the need to develop entrepreneurship models and offer flexible central schemes according to local needs. In his address, Dr. J.K. Jena pointed out the necessity to strike a balance between enhancing aquaculture production and conservation of aquatic biodiversity, engage all stakeholders and undertake long-term continuous efforts. Prior to that, Dr. Pramod Kumar Pandey set the context and outlined the present status, target domains and scope for fisheries and aquaculture development in Ladakh. This was followed by a detailed presentation of the road map, challenges and action plan by Dr. Biju Sam Kamalam. The officials of UT Ladakh and various hill states actively participated in the ensuing deliberations and shared their valuable experiences and remarks on sustainable efforts for fisheries and aquaculture development. Moreover, on this occasion, ICAR-DCFR signed a memorandum of understanding with the Department of ASH & Fisheries for technology transfer, scientific hand-holding and human resource development. This programme was coordinated by Dr. R.S. Patiyal, Dr. Nityanand Pandey, Dr. Biju Sam Kamalam and Dr. Rajesh, M.

Fig. The Signing of MoU between ICAR-DCFR and the Department of Fisheries, Ladakh.

TSP farmers' training programmes organised at Leh and Kargil

Training on Re-circulating Aquaculture System (RAS) based rainbow trout hatchery and nursery management in high altitude'

On 5th March 2022, a training cum demonstration programme on 'Recirculating Aquaculture System (RAS) based rainbow trout hatchery and nursery management in high altitude' was organised by ICAR-DCFR at Mr. Zabir Ahmad's farm, in collaboration with the Department of Fisheries, Leh. During the training, DCFR scientists provided a demonstration of the RAS hatchery-nursery facility and explained critical aspects of hatchery/farm operation, feed management, water quality monitoring, record-keeping and health management to the 25 participants. The Secretary, ASH & Fisheries, Mr. Ravinder Kumar (IAS) graced the occasion as the Chief Guest, distributed DCFR's water quality testing kits and record keeping notebooks to farmers and appreciated the continuous efforts of DCFR. Along with the Secretary, Dr. Stanzin Thakchos (OSD to Secy., ASH & Fisheries), Mr. Md. Amin Lone (ADF, Leh), fisheries department officials and fish farmers participated in the training.

Training on Best management practices for rainbow trout farming in high altitude' and feed distribution programme at Kargil

On 6th March 2022, another training on 'Best management practices for rainbow trout farming in high altitude' and feed distribution programme was organised by ICAR-DCFR at Kachan Government Trout Farm, Kargil, in collaboration with the Department of Fisheries, Kargil. The training was attended by 22 farmers, Mr. Murtaza Ali (ADF, Kargil) and 10 fisheries department officials from

Kargil and Drass. DCFR scientists explained various important aspects of rainbow trout farm management to the trainees and practically demonstrated water flow rate measurement, biomass estimation, feeding and water quality monitoring. Under the Tribal Sub-Plan scheme, 5000 kg of rainbow trout feed (developed by ICAR-DCFR) was distributed to 20 farmers in Kargil and Drass; and another 3000 kg of this feed has been distributed to 11 farmers in Leh and Nubra, to support one production cycle. For regular monitoring of the on-farm feed performance and farm management, record keeping note books were provided to all the feed recipient farmers and fisheries officials of Government farms in Leh and Kargil. The above training programmes were coordinated by Dr. R. S. Patiyal, Dr. Biju Sam Kamalam and Dr. Rajesh M.

Activities under Scheduled Caste Sub-plan (SCSP)

Rainbow trout fingerlings were stocked in the demonstration raceway of Mr. Rakesh at Losgyani village. Technical know- how and complete package of practice was provided to the farmer. Average size of the growing stock was achieved as 180 g in four months rearing period. This is a successful demonstration of rainbow trout farming in mid hill region of the Uttarakhand. Fishing nets were provided to the farmers of Harinagar and Ghati gaad area of Nainital district. Training programmes on rainbow trout farming and integrated fish farming were organized at village Harinagar and Losgyani.

Activities at Experimental Fish Farm, ICAR-DCFR, Champawat

Rainbow trout breeding

From January to March 2022, breeding and seed production of rainbow trout was carried out at the farms. A record yield of about 15,00,000 eggs was produced from 1000-1200 brooders. Around 12,37,000 eyed ova, were supplied to Munsiyari (Uttarakhand), Leh (Ladakh), Sikkim, Arunachal Pradesh and DCFR Mahaseer Hatchery, Bhimtal from Experimental Fish Farm, ICAR-DCFR, Champawat.

Fig. Rainbow trout breeding and eyed ova transportation

Fig. Stocking of rainbow trout in farmers raceways and distribution of input materials under SCSP

Common carp and ornamental fish breeding

In the mid-Himalayan region, the common carp (*Cyprinus carpio*) is a significant potential fish that can be employed to enhance production. Due to its superior growth and low maintenance requirements, it is popularly farmed in the central and lesser Himalayan region, either alone or in polyculture systems, in cemented as well as earthen tanks or ponds. Around 60000–70000 of 15 dph larvae were produced during the breeding and seed production of enhanced common carp conducted in the month of May–June 2022 at EFF, ICAR-DCFR, Champawat. Goldfish and Koi carp breeding was also carried out and about 10000 fingerlings were produced.

Fig. Common carp and other ornamental fish breeding at Experimental Fish Farm, ICAR-DCFR, Champawat

Fish seed distribution

The farm's distribution of fish seeds is a significant outreach endeavour. The Directorate's various farmer-focused awareness and training programmes included the distribution of fish seed as part of this operation. During the reporting period, about 3325 of rainbow trout fingerlings and 500 common carp fingerlings were distributed to the fish farmers from EFF Champawat.

Fig. Fish seed distribution to farmers

Fish sale

Farm-raised rainbow trout (table size weight: 1285.62 kg) were sold and a revenue of Rs.7,71,375.00 (Rs. Seven lakh Seventy one thousand three hundred seventy five only)was generated. About 112500 advanced fingerlings of rainbow trout were sold to generate a revenue of Rs 5,54,800/- (Rs. five lakh fifty

Fig. Selling of farm raised rainbow trout at EFF, Champawat

four thousand eight hundred only). Farm raised koi carp and Gold fish were also sold and to generate a revenue of around Rs. 9,500 (Rs. Nine thousand five hundred only) from the sale of 582 fish and 1,50,000 (Rs. One lakh fifty thousand only) respectively from 3000 fish. Farm raised common carp were also sold.

Fish feed Distribution

Trout feed and common carp feed were distributed to different fish farmers present in Champawat. Under SCSP fish feed distribution programme on 06.02.2022, 280 kg common carp feed was distributed to fish farmers.

Fig. Fish feed distribution programme at EFF, Chapawat

Experimental Fish Farm-ICAR-DCFR participated in Kisan Mela and Farmers meeting

The Experimental Fish Farm of ICAR-DCFR put an exhibition stall to display all available products and fish farming technologies at one-day Kishan Mela and Farmers' meeting organized by Krishi Vigyan Kendra, Lohaghat on April 26, 2022. Experimental Fish Farm, Champawat gave information about contemporary techniques of aquaculture and value added fish mince products. Farmers enthusiastically and inquisitively interacted and learned various aspects of Coldwater Fisheries. Mr. Kishor Kunal, scientist, Mr. Hansa Datt, Technical Officier and Mr. Bhola Dutt, SSS participated in this event.

Fig. EFF, Champawat stall at Kisan mela

Farm advisories and field days

Farm advisory on "Health management of carps in mid hills" was conducted on 20th April 2022 at Village Mudiyani, Champawat. Mr. Kishor Kunal, Mr. Hansa Dutt and Mr. Bhola Dutt conducted and coordinated the program.

- Farm advisory on "Water quality management of carp ponds" was conducted on 23th May 2022 at Village Dudhpokhara, Champawat. Mr. Kishor Kunal, Mr. Hansa Dutt and Mr. Omraj conducted and coordinated the program.
- Farm advisory on "Health management of carps in mid hills" was conducted on 28thJune 2022 at Village Chaikuni Bora, Champawat. Mr. Kishor Kunal, Mrs. Garima, Mr. Hansa Dutt and Mr. Omraj conducted and coordinated the program
- Field day on "Pond preparation and seed stocking for carp culture" was conducted on 18th July 2022 at Village Mudiyani, Champawat. Mr. Kishor Kunal, Mrs. Garima, Mr. Hansa Dutt and Mr. Bhola Dutt conducted and coordinated the program
- Farm advisory on "Health management of fishes" was conducted on 10thAug, 2022 at Village Shaktipur Bunga, Champawat. Mr. Kishor Kunal, Mrs. Garimaand Mr. Omraj conducted and coordinated the program
- Farm advisory on "Brood stock management of Common carp" was conducted on 12th Aug, 2022 at Village Chaikuni, Champawat. Mr. Kishor Kunal, Mrs. Garima, Mr. Hansa Dutt and Mr. Omraj conducted and coordinated the program

Awareness programme organized

- One day awareness programme cum field day on "Pond preparation and seed stocking" was conducted on 7th Jan, 2022 at Village Mudiyani, Champawat, Mr. Kishor Kunal and Mr. Bhola Datt conducted and coordinated the program.
- One day awareness programme cum field day on "Soil and water quality analysis of fish ponds" was conducted on 5th Feb, 2022 at Village Chaikuni bora, Champawat, Mr. Kishor Kunal and Mr. Omraj conducted and coordinated the program.
- One day awareness programme cum field day on "Feed Management of carps in mid hills" was conducted on 7th March, 2022 at Village Shaktipur Bunga, Champawat, Mr. Kishor Kunal, Mr. Omraj and Mr. Bhola Datt conducted and coordinated the program.

- One day awareness programme cum field day on "Poly-culture of carps in mid hills" was conducted on 22nd April, 2022 at Village Chaikuni Bora, Champawat, Mr. Kishor Kunal, Mr. Hansa Datt and Mrs. Basanti Devi conducted and coordinated the program.
- One day awareness cum demonstration programme on "Preparation of carp feed using locally available ingredients" was conducted on 20th May, 2022 at Village Shaktipur Bunga, Champawat, Mr. Kishor Kunal, Mr. Hansa Datt and Mr. Bhola Datt conducted and coordinated the program.
- One day awareness cum cum Field Day on "Food and feeding habits of carps" was conducted on 24th June, 2022 at Village Mudiyani, Champawat, Mr. Kishor Kunal , Mrs. Garima, Mr. Hansa Datt and Mr. Bhola Datt conducted and coordinated the program.

Events, Training and Meetings organized

Celebration of Republic Day

The 73rd Republic Day was celebrated with flag hoisting ceremony attended by all Scientists and staff of the Directorate. Dr. Parmod Kumar Pandey, Director, ICAR-DCFR unfurled the national flag and saluted the patriots who fought for our freedom besides the importance of 26th January. In his address to the staff of DCFR, he laid stress upon working in harmony and putting up the best for the progress of the organization and the country. Likewise, the Republic Day was celebrated at Experimental Fish Farm, Champawat with great fervour. Mr Kishor Kunal, Scientist and Officer Incharge, EFF, hoisted the national flag. Scientists and staff of the centre also expressed their pride for being the part of such a glorious occasion.

Fig. Republic Day celebration at ICAR-DCFR, Bhimtal

Workshop on Natural farming cum Kisan Mela

The ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, organised an orientation workshop on Natural farming cum Kisan Mela on 23rd March 2022. Dr. Pramod Kumar Pandey, Director, ICAR-DCFR, highlighted the importance of natural fish farming. The Chief Guest of the programme, Dr. W. S. Lakra, former Director & Vice-Chancellor, ICAR-CIFE, Mumbai, underlined the importance of integrated fish farming and value addition technology for doubling the farmer's income. Dr. Lakshmikant, Director ICAR-VPKAS expressed concern over groundwater depletion and suggested use of polyethylene lined ponds for storage of water and fish culture in hilly regions. The eminent aquaculture scientists and former Deans of college of Fisheries, Mangalore, Prof. K.M. Shankar and Prof. Y. Bassavaraju gave their remarks on natural fish farming and highlighted the importance of endemic fish species for diversification of hill aquaculture. Several fish farmers of the Kumaon region shared

their success stories and highlighted the profitability of the venture. On the occasion, critical farms input such as fish feed and fingerlings of different species were distributed among the farmers. The event witnessed a gathering of 186 participants, including 136 fish farmers, officials, scientists, entrepreneurs, and stake holders. The event ended with formal vote of thanks.

Research Advisory Committee (RAC) meeting

The institues RAC was held on 21-22nd March, 2022 under the chairmanship of Dr. W.S. Lakra, Former Director and Vice-Chancellor ICAR-CIFE, Mumbai. The meeting was attended by other RAC members Dr. B.P. Mohanty, ADG (I.Fy), ICAR; Dr.V.R. Chitranshi, Former ADG (I.Fy) ICAR; Dr. K.M. Shankar, Former Dean, College of Fisheries, Mangalore; Dr. Y. Bassavaraju, Professor & Head, Fisheries Research & Information Centre, Bhutanal, Bijapur, Karnataka, Dr. Pramod Kumar Pandey, Director, ICAR-DCFR, and Dr. S. Chandra, member secretary, ICAR-DCFR. The Chairman, RAC appreciated the work and progress made by the Directorate and urged the scientist to work towards making the DCFR an 'International Knowledge Center' for coldwater fisheries. The progress of on-going and externally funded projects presented by respective scientist was reviewed by the RAC and suggestions were made for any improvement or course correction.

Fig. RAC meeting at ICAR-DCFR

National Campaign on Annadata Devo Bhava (Kisan Mela)

The ICAR-Directorate of Coldwater Fisheries Research, Bhimtal, organised a National Campaign on Annadata Devo Bhava on 23-24th April, 2022 to commemorate 75 years of India's independence being observed as Azadi Ka Amrut Mahotsav. Dr. Rajendra Singh, an Indian water conservationist and environmentalist known as the "Waterman of India," graced the occasion as chief guest. He underlined the importance of natural farming and indigenous technical knowledge for sustainable development. Dr. Singh expressed concern over groundwater depletion and remarked that water is the elixir of life and necessary efforts should be made to conserve rivers and natural water bodies. Prof. Rajive Mohan Pant, Vice-Chancellor, Assam University, Silchar, urged the farmers to take up the integrated fish farming and value addition technology to double their income. Dr. Pramod Kumar Pandey, Director, ICAR-DCFR, highlighted the role of farmers in the economy of India. Several fish farmers from the Kumaon region of Uttarakhand recounted their success stories and emphasised the profitability of the venture. Critical farm inputs such as fish feed and fingerlings of various species were distributed at the event.

Fig. Inauguration of programme by lighting of lamps by dignitaries

Institute Research Committee (IRC) meeting

The 15th IRC meeting was held on 24th to 25th May 2022 at ICAR-DCFR, Bhimtal under the Chairmanship of Dr. Pramod Kumar Pandey, Director ICAR-DCFR. Scientists of the institute presented the progress of the ongoing research programmes along with concept notes on new project proposals. Discussion was also too assess the progress under NEH, TSP and SCSP besides farm activities at Experimental Fish Farm, Champawat. All the scientists of ICAR-DCFR participated in the meeting.

Fig. IRC meeting held at ICAR-DCFR

International Yoga Day Celebration

The 8th International Yoga Day was celebrated by all the staff and research scholars of the Directorate and its Experimental Field Centre, Champawat on 21st June 2022. Yoga has been beneficial in keeping the body and mind in sound health. The United Nations theme for International Day of Yoga 2022 is "**Yoga for humanity**". Yoga is universal- it can be practised anywhere, at any time, and by anyone irrespective of age, gender, culture or nationality.

Fig. International Yoga Day celebration at ICAR-DCFR

Other programmes organized

▪ Online training on Understanding the classical taxonomy of Mahseer was organized	1st February 2022
▪ National consultation cum review meeting on mahseer	16th March 2022
▪ Farewell ceremony for Shri. Syed Mohsin Ali, AF&AO on being transferred to IVRI, Barielly	11th April 2022
▪ Kisan Bhagidari, Prathmikta Hamari campaign	28th April 2022
▪ World Environment Day Celebration	6th June, 2022
Important Visitors	
▪ Director Finance, ICAR visited ICAR-DCFR	2nd May 2022
▪ Dr. C.N. Ravishankar, Director, and Dr N.P. Sahu, Jt. Director, ICAR-CIFE, Mumbai visited ICAR-DCFR	18th May 2022
▪ Dr. S.N. Oogle, NFDB Consultant visited ICAR-DCFR	21st May 2022
▪ Students from Woodbridge School, Sattal visited ICAR-DCFR	31st May 2022
▪ Students from Burdwan University visited ICAR-DCFR	7th June 2022

Fig. Glimpse of visitor at ICAR-DCFR, Bhimtal

Publications

- Rajesh, M., Kamalam, B.S., Sharma, P., Verma, V.C., Pandey, A., Dubey, M.K., Ciji, A., Akhtar, M.S., Pandey, N., Sarma, D. and Kaushik, S., 2022. Evaluation of a novel methanotroph bacteria meal grown on natural gas as fish meal substitute in rainbow trout, Oncorhynchus mykiss. Aquaculture Research, 53(6), 2159-2174.
- Gladju, J., Kamalam, B. S. and Kanagaraj, A., 2022. Applications of data mining and machine learning framework in aquaculture and fisheries: A review. Smart Agricultural Technology, 100061.

ICAR-Directorate of Coldwater Fisheries Research Bhimtal-263136, Nainital (Uttarakhand)	
Published by:	Dr. Pramod Kumar Pandey, Director, ICAR-DCFR
Editorial Committee:	Dr. Amit Pande, Dr. Shahnawaz Ali, Dr. Dimpal Thakuria, Mr. Parvaiz Ahmad Ganie
Computer Assistance:	Sh. Amit Saxena
Tel:	05942-247279;247280 Fax: 05942-247693
Email:	dcfrin@gmail.com; director.dcfr@icar.gov.in
Printed at:	M/s M. S. Printers, C-108/1 Back Side, Naraina Industrial Area, Phase I, New Delhi – 110024 (Phone: 011-45104606)