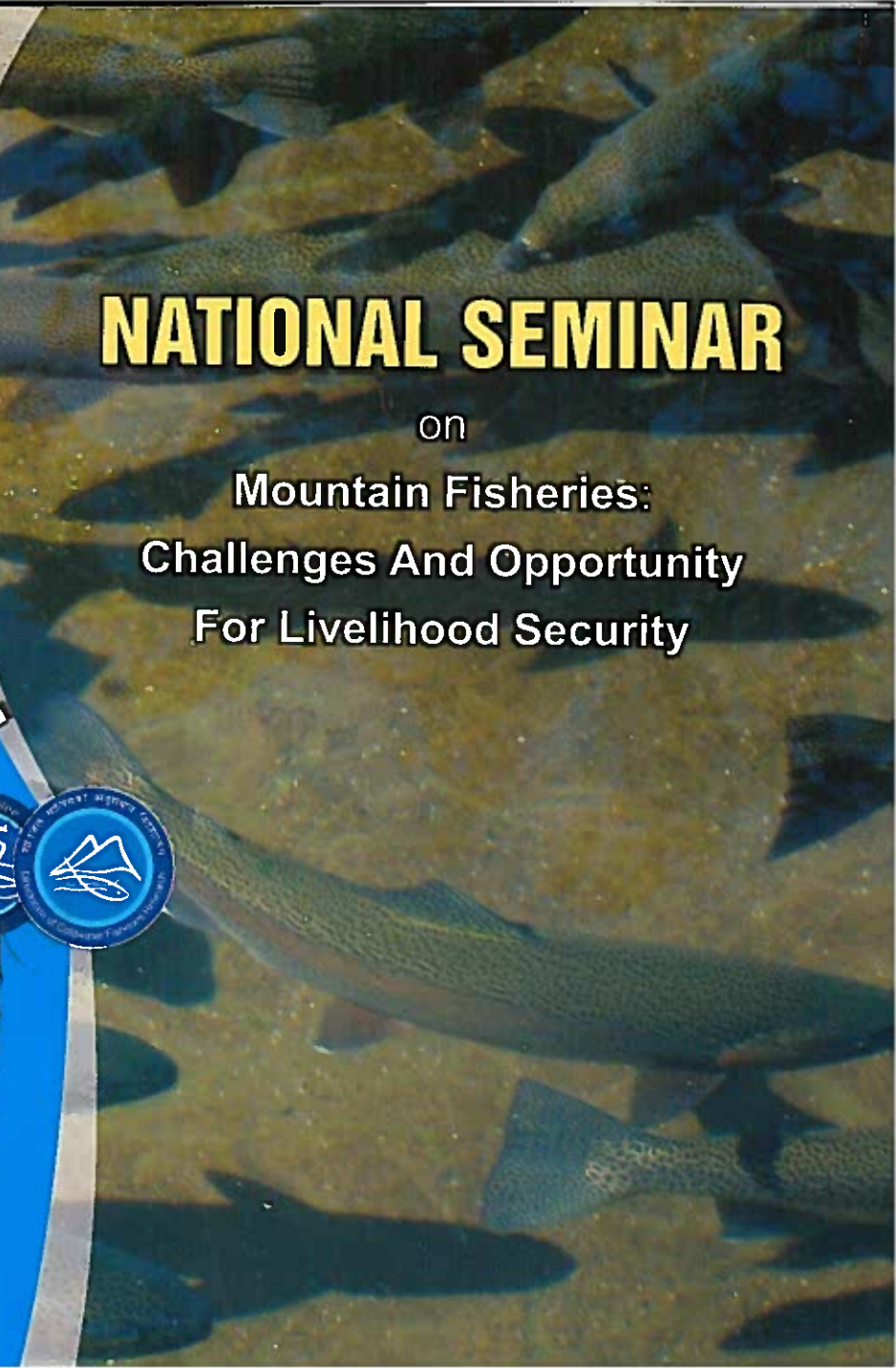
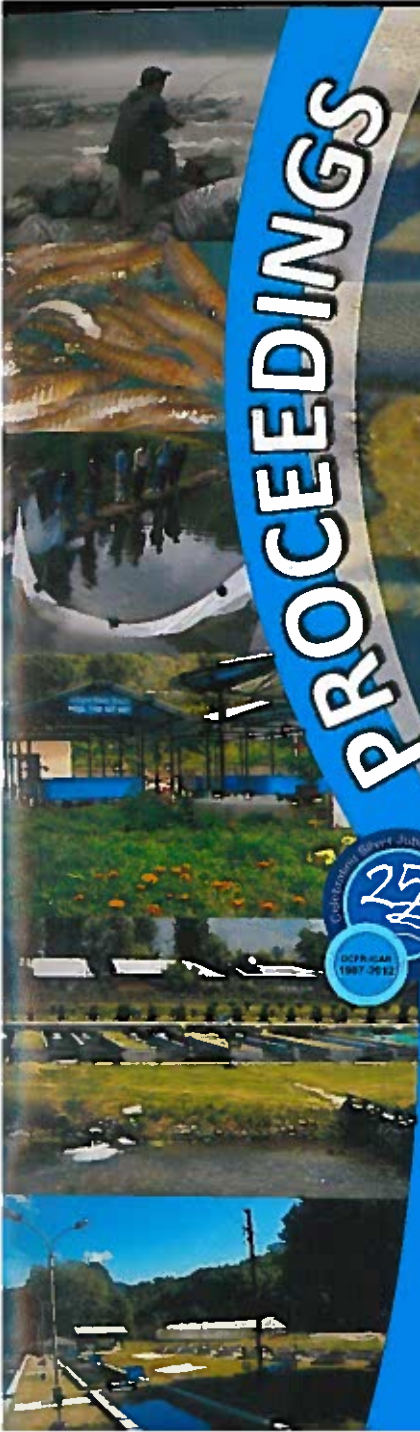


PROCEEDINGS

NATIONAL SEMINAR

on

**Mountain Fisheries:
Challenges And Opportunity
For Livelihood Security**





हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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NATIONAL SEMINAR

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Mountain Fisheries:

Challenges and Opportunity for Livelihood Security

5-6 November 2012

Proceedings

Compiled by

M. S. Akhtar

Prem Kumar

S. K. Srivastava

DCFR Proceedings of National Seminar on “Mountain Fisheries: Challenges and Opportunity for Livelihood Security” during 5-6 November 2012 on the occasion of Silver Jubilee Celebration of DCFR

Published by

Dr. A. Barat

Director

Compiled by

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National Seminar

on

Mountain Fisheries: Challenges and Opportunity for Livelihood Security

5-6 November 2012.

Organized by

Directorate of Coldwater Fisheries Research

(Indian Council of Agricultural Research), Bhimtal-263136, Nainital, Uttarakhand.

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Dr. A. Barat, Principal Scientist, DCFR

Dr. Debajit Sarma, Principal Scientist, DCFR

Organizing Secretaries



A. Barat, (Director)

PREFACE

Directorate of Coldwater Fisheries Research (DCFR) entered into its new horizon after completing 25 years of struggle. During these 25 years, the Directorate came across many constraints and was able to overcome them with the active participation of scientists, technical, administrative and supportive staffs and the support of the higher authority. Now it is indeed a pleasure to see it in its full bloom. Well organized laboratories, enthusiastic researchers, supportive administration are the strong pillars which will definitely fulfill the expectation of the nation. It is a matter of pride to work in such disadvantageous area and to bring prosperity to the hill community through aquaculture. The national seminar on '*Mountain Fisheries: Challenges and Opportunity for Livelihood Security*' held during 5-6 November, 2012 has given impetus to this endeavor. The proceedings of this seminar will be firsthand information on the status, prospect and constraint of coldwater fisheries sector.

In the eve of publication of the proceedings, it is my pleasure to congratulate all the staffs of DCFR for the success of the seminar and special thanks to Dr. M. S. Akhtar, Dr. Prem Kumar and Dr. S.K. Srivastava to compile the proceedings in time.

M. S.



P. C. Mahanta, (Convener)

FOREWORD

I am immensely pleased that the Directorate of Coldwater Fisheries Research, Bhimtal has successfully organized a two day national seminar on '*Mountain Fisheries: Challenges and Opportunity for Livelihood Security*' during 5-6 November, 2012 in commemoration of its silver jubilee year. The seminar was devoted to discuss on the themes of trout production and prospects, resource assessment and conservation, diversification of aquaculture, water budgeting and management, sport fishery and eco-tourism and role of women in fisheries. Fruitful discussions were made through various interactive technical sessions during the two day seminar. I hope, the recommendations emerged out of this national seminar will strengthen the future activity of the Directorate.

I congratulate the organizers for making the seminar a grand success. Further, I do acknowledge the sincere efforts taken by Dr. M. S. Akhtar, Dr. Prem Kumar and Dr. S.K. Srivastava to bring out the proceedings of the seminar.

A handwritten signature in black ink, appearing to read 'P. C. Mahanta'.

P. C. Mahanta
(Convener)

BACKGROUND

Today, under the food security prospects of India, the fisheries sector including coldwater fisheries has sizable contribution in securing food and nutrition to growing population of the country. Although the share of coldwater fish production in the total fish production basket of the country is low, but it has a greater role in the economies of the hill states. Moreover, there is further scope for enhancing the productivity of hill fishery which needs to reformulate the road map for future strategies particularly in reference to climate change. In this direction, Directorate of Coldwater Fisheries Research (DCFR) has taken an apt step by organizing a National Seminar on “*Mountain Fisheries: Challenges and Opportunities for Livelihood Security*” on its Silver Jubilee Celebration on 5th and 6th Nov. 2012, to address some of emerging issues pertaining to the sector.

Indian mountain fishery resources are significant in terms of wide range of diversity and some of them are suitable for food, sport and ornamental value which extend from North-Western to North-Eastern Himalayan region and some parts of Western Ghats. Last few decades witnessed the devastation of traditional farming systems due to scarcity of water and the majority of young populations have been continuously migrating towards plain to earn their livelihood. The reason is that the agriculture development has its own limits in uplands due to non-availability of water.

Water resources of Himalayan regions are affected in majority of the hill states due to enormous reasons that force us to redraw the action plan for water management and conservation. In these circumstances, there should be a holistic approach which confirms the water availability throughout the year for irrigating crops as well as rearing livestock. Fish culture may be taken as an option to it and mountain fisheries may play an important role in rejuvenating the agriculture and allied endeavor that would in turn

if the fish stocks dwindle, there would be a grave threat to food security; anything that transforms the uplands would affect inhabitants by the virtue of their habitation. Hence, it is necessary to enhance, sustain and conserve the productivity of these resources.

This diverse natural resource-base, wide climatic diversity vis-à-vis altitudes are conducive to rear suitable coldwater fish species. Both vertical and horizontal expansion of aquaculture; developing domestic market for high value fish and growing interest of people in eco-tourism including angling would be the new avenues for employment. As the aquaculture practices will be growing, diversification of the candidate species will be required. Rainbow trout is considered to be a high priced and low volume fish which forms a sizable fishery in high altitude. Economically viable low input technology for mid Himalayan region has had a positive impact on employment generation in the hilly regions. There is great scope for new promising culture systems for enhancing the per unit productivity in order to upgrade the socio-economic conditions of the hill inhabitants.

Women are important stakeholder in agriculture and allied activities in hills and the development of fisheries sector greatly rely on their participation and skill development. Strategic plan may be required for the inclusion of women in fisheries development. The coming decades are expected to pose newer and greater challenges for nutritional and livelihood security. To fulfill this gap, the challenge is to develop approaches that are realistic and achievable in the context of current social, economic, environmental and political circumstances. Such approaches should not only focus on increasing production; they should focus on producing a product that is affordable, acceptable and accessible to all sectors of society.

With an aim to fulfill the above gaps and to prepare a road map for the future strategies to be undertaken to mitigate, enhance and sustain the productivity for nutritional and livelihood security in hills under adverse climatic challenges, the Directorate organized the seminar with following objectives:

Objectives of the seminar

- To address the issues, challenges and opportunities in hill fisheries
- To draw action plans for enhancing the productivity in upland waters for

the exhibition. Dr. B. Meenakumari, DDG (FY) ICAR, New Delhi presided over the inaugural session. The Chief Guest of the inaugural session was Dr. K.L. Sehgal. Dr. A.P. Sharma, Director, CIFRI, Barrackpore; Dr. P. Jayasankar, Director, CIFA, Bhubaneswar and Dr. B. Pattanaik, Director, PDFMD, Mukteshwar were the guests of honour. At the very outset Dr. P.C. Mahanta, Director and Convener welcomed the guests and explained the importance of coldwater fisheries and genesis of the Directorate and its progress during last 25 years. Dr. A.P. Sharma, Dr. P. Jayasankar and Dr. B. Pattanaik also expressed their views and appreciated the contribution of DCFR in coldwater fisheries sector and threw light on the future responsibility of Directorate. The retired personnel of the Directorate were felicitated on this august occasion.

Following publications were released on the occasion:

- Souvenir cum Abstract Book released by Dr. B. Meenakumari
- 25 years of DCFR released by Dr. SAH Abidi
- Silver Jubilee Compendium released by Dr. S.D. Tripathi
- Research Publications (2007-2012) released by Dr. A.P Sharma
- 25 years of Research: A Bibliography released by Dr. M. Y. Kamal
- Bulletin on Coldwater Fish Diseases released by Dr. P. Jayasankar
- Him Jyoti (Hindi Magazine) released by Dr. Dilip Kumar
- Bulletin on Mahseer released by Dr. V.V. Sugunan
- Extension leaflets released by Dr. S.C. Dey

The Coldwater Fisheries Society of India was launched by Dr. S.P. Ayyar, Former Director, CIFRI.

Dr. B. Meenakumari felicitated the eminent Scientists such as Dr. SAH Abidi, Former member ASRB, Dr. S.D. Tripathi, Former Director, CIFE, Dr. M. Y. Kamal, former VC, SKUAS&T (K), Dr. Dilip Kumar, Former Director, CIFE, Prof. S.C. Dey, Former Professor, Guwahati University and Dr. S.P. Ayyar, Former Director, CIFRI.

Dr. P.C. Mahanta felicitated the Scientists such as Dr. A.P Sharma, Director, CIFRI, Dr. Madan Mohan, ADG (MFy), Dr. P. Jayasankar, Director, CIFA, Dr. V.V. Sugunan, Former ADG (IFy), Dr. N. Sarangi, Former Director, CIFA, Dr. M. L. Bhowmick,

Chairperson, Dr. B. Meenakumari addressed the gathering and pointed out that the Directorate has developed sufficient infrastructure in order to develop and disseminate location, situation and system specific technologies. She also stressed on the changing climate that has posed new challenges and the mountain region is going to be affected adversely that can be addressed by developing holistic models for aquaculture which can mitigate the water scarcity. She also appraised for DCFR developing a model of integrated fish farming using polytanks in mid hill regions.

The Chief Guest, Dr. K.L. Sehgal stressed over the conservation of germplasm in the natural water bodies in his speech. He believed that the issue of climate change needs to be addressed through proper appraisal and monitoring.

Dr. A. Barat, Principal Scientist, DCFR offered vote of thanks.

Silver Jubilee Lecture

Dr. P. C. Mahanta, Director, in a special session, delivered the Silver Jubilee lecture highlighting the contributions made by DCFR in research and development of coldwater fisheries sector in India during last 25 years. He emphasized that the coldwater fisheries have a great potential in generating rural income and providing food security to the upland rural community of India. The coldwater sector is bestowed with special water resources with immense fisheries prospects and a great reservoir of biodiversity that can be tapped for food and nutritional security. In this direction, the Directorate at Bhimtal has started the research and developmental activities in the hill states of the country since its inception on 24th September, 1987. The Directorate is on its glorious path of virtually actualizing its vision by imparting quality research in sustainable coldwater fisheries production, management and conservation. The basic and applied research on partnership mode is being carried out with the different state fisheries departments, universities & institutes, NGOs, KVKs, farmers and other stakeholders in Jammu & Kashmir, Himachal Pradesh, Sikkim, Arunachal Pradesh, Manipur, Nagaland, Mizoram, Meghalaya, Assam and Uttarakhand for sustainable utilization of mountain fishery resources.

He also revealed that DCFR is instrumental in conducting research on breeding and culture techniques of commercially important coldwater fishes and their conservation.

of three new species namely *Neolissochilus hexagonolepis*, *Labeo dyocheilus*, *Labeo dero*, *Semiplotus semiplotus* and *Osteobrama belangeri* are under experimental trial which is an initiative to have new candidate species for diversified aquaculture in hill region. A new model of carp culture has been developed using polythene lining tank for fish culture. Efforts are also being made to popularize this model for livelihood security in mid-hills. Various grow out feed formulations for different coldwater species have been developed. Species characterization & population genetic studies using molecular genetic tools have been initiated which will ultimately help in marker assisted selective breeding programme in future besides contributing to the molecular database of coldwater fishes. Moreover, species specific marker is being developed using RAPD, mtDNA and microsatellite markers for *Schizothorax* and mahseer.

He also informed that in order to have an effective disease reporting and surveillance system, the Directorate has initiated a programme to investigate fish pathogens that may pose threat to coldwater fishery. GIS based Decision Support System (DSS) for coldwater aquaculture site suitability has been developed by the Directorate on pilot scale.

Finally, he thanked all the scientists and staffs of DCFR for their concerted efforts in bringing the coldwater fisheries sector to newer horizons. The Directorate is still progressing towards achieving its goal for enhancement of fish production and also providing livelihood security to the people of coldwater region.

Following the Silver Jubilee special lecture, six technical sessions were held corresponding to the thematic areas such as Resource Assessment, Aquaculture, Biotechnology and Fish Health, Water Management and conservation, Sport Fisheries and Eco-tourism and Gender issues.

Technical session I : Resource Assessment and Management

Chairman : Dr. M. Y. Kamal

Co-Chairmen : Dr. V.V. Sugunan & Dr. A. P. Sharma

1. **Dr. Prem Kumar, Senior Scientist, DCFR, Bhimtal** presented on 'Coldwater fisheries resource assessment and management of the coldwater region'

Depending upon the micro-climatic conditions of the region, such suitable patches of water bodies should be identified throughout the region and be brought under aquaculture practices. Today, the available technologies allow the culture of a number of exotic and indigenous coldwater fish species in Indian Himalayas. The most common exotic species are rainbow trout, common carp, Chinese carps while the indigenous fish are mahseers. Trout (*Oncorhynchus mykiss*) farming has tremendous scope in the Himalayan and some peninsular regions, where sufficient quantity of quality water is available. Over the years, rainbow trout farming in the states of Jammu and Kashmir and Himachal Pradesh has become an enterprise. The farming of rainbow trout on commercial scale has been made possible in the hill states of the country. The farming system demonstrated in the state run farms have generated tremendous enthusiasm among the local unemployed youth to take up farming of trout as a means of employment. With the support, motivation and technical know-how by the extension wings of the State Governments as well as by Directorate of Coldwater Fisheries Research (DCFR), Bhimtal, better farming units have come up even in the remote hill pockets of the States of Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim. DCFR, Bhimtal has also done commendable experimental work in trout culture and hatchery development. The trout hatcheries at Shergaon and Nuranang in Arunachal Pradesh and at Memenchu in Sikkim have been renovated by DCFR which are now in operation.

He emphasized that country's trout farming programmes need strengthening both in strength and scale. Against the current production of 150 t farm-reared rainbow trout annually, the production could be raised ten-fold in coming years. The success achieved in the states of Himachal Pradesh and Jammu & Kashmir in trout farming is worth emulating by other hill states for generating employment opportunities and adding fish in the food basket of people of hills.

He also informed the house that the carp culture in hills has been proven more profitable by integration of fish culture with dairy, horticulture, agriculture and paddy. Grass carp emerged as a popular species for the low-cost hill aquaculture with higher realization of profit margins. DCFR, Bhimtal has introduced the technology of Chinese carp based composite fish culture in mid Himalayan regions (800-2000 msl). The technology has been demonstrated in the States of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim. The technology has been adopted by the State Governments of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim. The technology has been adopted by the State Governments of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh and Sikkim.

kg/m² /yr (3400 to 6800 kg/ha/yr) has been harvested from the earthen ponds of Uttarakhand, Arunachal Pradesh and Manipur states. Many of the farmers have adopted the composite carp culture technique and getting additional income from fish production. Quality fish seed is a major bottleneck in expansion of the farming practices, therefore setting up of hatcheries, nursery rearing and seed transportation facilities would provide significant employment opportunities. He explained the recent initiatives taken by DCFR in species and system diversification. He also stressed upon the need of *in situ* seed rearing for fishery enhancement in coldwater lakes and reservoirs.

2. **Dr. P. Jayasankar, Director, CIFA, Bhubaneswar, Odisha** presented on 'Recent advances in freshwater fin fish aquaculture-prospects and constraints'. He presented the overview of global aquaculture production vis-s-vis aquaculture production of India. He pointed out the challenges being faced by Indian aquaculture industry and suggested various strategies for enhancement of aquaculture production. He also stressed upon the criticality of seed and feed availability and species diversification for sustainable aquaculture. He inform the audience about various technologies developed by CIFA and how the farmers and other stakeholders are getting benefitted with them. At last, suggested the action plan for aquaculture development.
3. **Dr. S. K. Das, ICAR-RC-NEHR, Umiam, Barapani, Meghalaya** presented on 'Aquaculture for rural farmers under mid altitude condition'. He explained about the requirement of fish in NEH region and discussed various aquaculture practices under mid altitude condition followed in all the states of NEH region. Suggested the strategies to be adopted for enhancement of aquaculture production and maximum utilization of fishery resources of the region. He also emphasized on the need of species diversification and biodiversity conservation. Also, informed the house about the research priorities of Fisheries Division of ICAR RC NEHR, Barapani in the 12th plan.
4. **Dr. Syama Dayal, Senior Scientist, CIBA, Chennai** presented on 'Aquaculture for nutritional security'. He discussed about the nutritional security status of India and informed the house about health benefits of fish.


Technical session III : Biotechnology and Fish Health

Chairman : Dr. N. P. Melkania

Co-Chairmen : Dr. I.J. Singh & Dr. V.S. Chandrashekhara

1. **Dr. A. Barat, Principal Scientist, DCFR, Bhimtal** delivered the theme presentation on 'Biotechnological and genetic approach in sustainable management of coldwater fisheries'. Elucidated the DCFR's initiatives in the development of genetic markers of coldwater fishes and their potential use in selective breeding programme in future. The achievement so far made at DCFR in molecular genetics are
 - Constructed a normalized cDNA library of brain tissue of *Schizothorax richardsonii* collected from high altitude Himalayan regions of Sikkim, India.
 - Isolated 1036 ESTs (Expressed Sequence Tags) from brain cDNA library.
 - Cloning and differential gene expression analysis of glycerol-3 phosphate dehydrogenase (GPDH) and C-type lectin in *S. richardsonii*
 - Estimation of glycerol (possible mechanism of cold acclimation in some coldwater fishes) and some other enzymes in *S. richardsonii* and *Berilius bendelisis*.
 - Constructed partial genomic library of *S. richardsonii* and *Garra gotyla*
 - Isolated and validated 57 microsatellite markers of *S. richardsonii* and 34 of *Garra gotyla*
 - Molecular characterization of some coldwater fish species including a new species *Schistura sp* (Cobitidae) using mitochondrial DNA markers Cytb, Cytochrome Oxidase C I and ATPase.
 - Constructed a partial genomic library enriched in microsatellite of *Schizothorax niger* and *Tor putitora*

2. **Dr. Veena Pande, Head & Coordinator, DBT, Kumaon University, Nainital, Uttarakhand** presented on 'Biotechnology and fish health'. She explained the basics of biotechnology and various biotechnological tools. She also emphasized that how best these biotechnological tools could be utilized for the diagnosis of fish diseases. Also discussed the concerns of genetically engineered organisms.



CIFABROOD

A Proven Broodstock Feed for Indian Major Carps

Reduced breeding and seed production of carps has been taken up as commercial enterprise activity particularly in West Bengal and Andhra Pradesh, Tripura, the majority of carp seed in terms of quantity is no more a problem, but quality of seed still remains a hindrance for carp culture. Adequate nutrition and feeding of the broodstock is required to ensure quality of the stockable seed. "CIFABROOD" developed after a decade of research and validated through repeated field trials is a quality carp broodstock feed.

Saltion Features

- Readily accepted by carp broods, catfishes and water stables
- Adequately nutrient rich
- Promotes rapid gonadal growth and maturation
- Improves breeding response
- Ensures higher production of viable egg and sperm

- Remarkably improves hatching performance
- Promotes higher recovery of quality seed
- Ensures better survival and rapid growth during nursery rearing
- Enhances spent fish recovery
- Suitable for multiple repeated breeding in carp
- Seasonally stable and validated through repeated field trials

Feed Profile

Ingredients

1. Rice bran
2. Groundnut oil cake
3. Fish meal
4. Soyabean meal
5. Vegetable oil
6. Fish oil
7. Various mineral premix

Nutrient level (on dry matter basis):

1. Crude protein (%)	21.5
2. Total Lipid (%)	11.7
3. Gross energy (Kcal/kg)	1.0

Feed Form

Provided in pellet (2-5 mm dia) or in the form of coarse slough

How to Feed ?

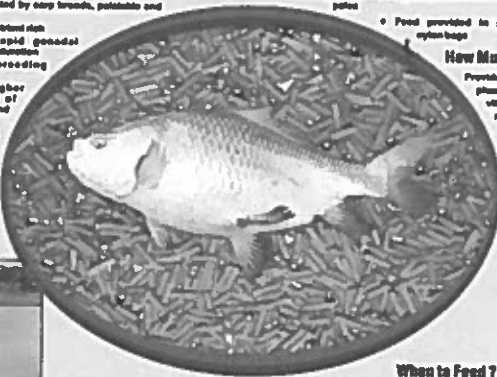
- Feeding in basket or tray suspended from long bamboo poles
- Feed provided in perforated nylon bags


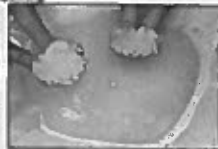
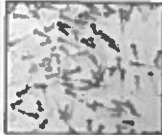
How Much to Feed ?

Provided @ 3-6% of body weight during vitellogenic phase. Reduced to 2% of body weight during post-vitellogenic phase. Spent brood to be fed at the rate of 2% of body weight in case of repeated

When to Feed ?

Twice a day at 6 hours interval preferably during daytime



Quality carp seed production can be assured with the recommended application of "CIFABROOD"

4. **Dr. Amit Pande, Senior Scientist, DCFR, Bhimtal** delivered the presentation on 'Fish health management of coldwater fisheries'. He explained the DCFR's scientific initiatives taken in coldwater fish disease management. In his presentation, he has shown the sample collection from high altitude difficult areas like Kargil, Drass of Leh Ladakh, Himachal Pradesh, Uttarakhand and the North Eastern hill states. He has screened the samples for detection of viral infection and informed the house that till today there was no great hazard of viral diseases in coldwater sector. However, he suggested to remain prepared for facing the challenges of fish health management and stressed upon the need of the establishment of disease and surveillance system for coldwater fisheries.

5. **Dr. M. Samanta, Senior Scientist, CIFA, Bhubaneswar, Odisha** presented on "Toll-like receptor (TLR)-2 in *Labeo rohita*: 3D-structure and innate immune signaling cascades". He informed the house why TLR are important in fish and described the evolution of immune system in fish. He explained his experimental results of

Poster Session

A poster session was organized wherein a number of posters on various thematic subjects were displayed. Dr. K.D. Joshi, HOD, CIFRI, Allahabad and Dr. Anju Aggarwal, Head, Dept. of Biotechnology, Kumaon University were referees for evaluating posters and basing on their evaluation, three best posters were selected.

Technical session IV : Water Management and Conservation

Chairman : Dr. S.A.H. Abidi

Co-Chairmen : Dr. Madan Mohan & Dr. A.K. Srivastava

1. Dr. N. N. Pandey, Senior Scientist, DCFR, Bhimtal delivered the theme presentation on 'Water conservation for livelihood security in hills'. He explain the prime importance of water and its conservation. Informed the house about the total availability of usable water for aquaculture in lakes, reservoirs, rivers and streams. The situation of water scarcity or diminishing water availability in the coldwater lakes and streams was also explained. He briefed some of the statistics on water as 97% of the entire water is saline and 3% is fresh water (rivers, reservoirs, lakes and ground water). 0.008% of all water (1% of total fresh water) is accessible for direct human use. Surface and ground water play major role in agriculture, hydropower generation, livestock, fish production and other human use. Agriculture is the largest user of this water. More than 75 % of the rainfall occurs during June-September while the remaining is received during the remaining eight months. More than 90 % of the annual runoff in peninsular rivers and 80 % in the Himalayan rivers occurs between June and September (4 months).

He also stressed on the issue of ground water table depleting. The water table data of the 44 out of 64 hydrograph stations in Kerala showed an overall trend of water table depletion. This depletion was noted as 8.17 m drop in the water table during the one-year period. In South-West Delhi, the maximum decline has been noted in the Ramakrishnapuram area where the water table has fallen by 4.1 meters below ground level (m.bgl). According to experts, almost all the cities in the country, including Patna, are facing rapid depletion of their water tables due to over

He also pointed out the major issues related to hills that there is marked water shortage during the summer in the streams of hills, which limits the production cycle and farm activities. The area is seen as dry in summer months because the unimodal rainfall pattern limits water availability in tributaries & rivulets. Vast amount of water is lost through seepage, especially where the soil is gravelly and porous. Various water resources of Himalayan regions are affected due to global warming and anthropogenic activities that remained many streams dry. The land holding in the hill area is smaller (700-900m²) as compared to the national average (1370 m²). The farmers in the hill region have integrated type of farming pattern. Fish can serve as an additional source of income if integrated with the water conservation and water harvesting programme.

He suggested some strategies to be adopted to address the water issues in hill aquaculture. They are: development of species specific model of water recirculatory system for aquaculture practice in hills; watershed based fish farming system; water conservation through polytanks and their use for aquaculture and irrigation in hills; water resource assessment and aquaculture site selection in hills through GIS and remote sensing and cage culture in open water.

Also revealed the DCFR's initiatives taken in the area of water conservation and informed the house about the low cost grit filter developed by DCFR and fish culture technology in poly-tanks. He suggested the various strategies for coldwater fish culture like water recirculatory system for trout culture in view of conserving water.

2. **Dr. V. V. Sugunan, Former ADG (I. Fy), ICAR, New Delhi** in his deliberation on 'Water management and conservation' explained the global water availability and the situation of global water crisis. The conflicting interests of water use among crop production, power generation, industries and drinking water have also been explained. He elucidated the strategies for improvement in water productivity through non-consumptive water use, ecosystem conservation and yield improvement in culture systems and also, stressed upon the need of the management of water bodies for sustainable fisheries development. The water consumption by fisheries vis-à-vis crops has also been highlighted.

Food Crop/Production System	Water Requirement (L/kg)
Beef	10,000
Capture fisheries & culture-based fisheries	Nil
Extensive pond culture without feeding in static ponds	0-200
Moderately intensive culture in ponds	3 000 – 5 000
Penaeid shrimp; semi-intensive ponds	11 000-21 430
Penaeid shrimp; intensive ponds	29 000-43 000
Penaeid shrimp; intensive raceways	55 125
Trout; raceways	210 000
Salmonids; ponds/tanks	252 000
Carp; intensive raceways	740 000
Salmonids; cages	2 260 000

The issues in degradation of water bodies, threats of climate change, pollution etc has also been covered. Finally summarised that water requirements for aquaculture and fisheries vary and depend on the culture systems, species and intensity of operations. In certain cases, it takes lesser water than animal production systems and even crop production. There is need to allow environmental flows to achieve sustainable water use for fisheries and aquaculture.

3. **Dr. J. T. Gargen, Former Scientist, Wadia Institute of Himalayan Geology, Dehradun** presented on 'Potential impact of climate change on water reserves of cold regions of Himalaya' and explained about the various forms of Himalayan water reserves in the forms of glaciers, lakes, permafrosts and seasonal ground freezing. Impacts of climate change on Himalayan glaciers are decrease of glacier mass balance, recession of glaciers, increase in erosion of de-glaciated zones, development of glacial lakes, change in weathering pattern of bedrock especially if glacier is overlying a mineralized zone leading to change in the hydro chemistry of melt water and melting of permafrost. Stressed that mountain regions are particularly vulnerable to climate change because warming trends are higher and the impacts are magnified by the extreme change in altitude over small distances. Also informed that increase in water temperature as a result of climate change will alter fundamental ecological processes and the geographic distribution of aquatic species—migration to suitable habitat. Changes in seasonal patterns of precipitation and runoff will alter hydrological characteristics of aquatic ecosystems. When

bacteria, algae, fungi, protozoan and various metazoans impart a great deal of water-borne diseases. The intoxication, accumulation and pathogenicity in aquatic biota create fish aquatic pollution episodes. Diseased and intoxicated fishes along with other aquatic food animals impose scarcity of fish either due to their mass mortality or retardation in their growth and its fecundity potential. Viral diseases among fishes and other aquatic animals have not been reported too much, as bacterial, protozoic, helminthic and other parasitic diseases. The bacterial diseases of fishes are very common and may cause local lesions, necrosis and systemic infections. Some bacterial species such as *Aeromonas* sp, *Vibrio* sp. have been documented as fish pathogens. *Aeromonas hydrophila* causes red sore disease, also sometimes in combination with *Epistylis*, a peritrichous ciliate as epizootics in fishes. Besides, he gave an account of fish diseases, corresponding possible pathogen along with the environmental factor predisposing to disease. To protect fish fauna from infectious diseases, there is pressing need today to develop some immunizing techniques by adopting vaccination which can produce immunity in fish population at large scale. Persons involved in pisciculture should be given proper training for monitoring the physico-chemical characteristics of the reservoirs. For this purpose, water analysis kits should be provided at grass root levels involving districts, blocks and co-operative societies.

5. **Dr. Ashok Kumar Nayak, Senior Scientist, Directorate of Water Management, Bhubaneswar, Odisha** presented on 'Water management measures for better agricultural productivity'. Explained the importance of water in agricultural productivity and elucidated the water availability and water use pattern in Indian agriculture. Though 70% of the earth's surface is covered with water, only 1% is accessible surface freshwater. This available water resource is used for agriculture, industry and domestic use. Globally, the water utilization pattern is agriculture- 69%; industry- 23%; domestic - 8%. In Africa, agricultural utilization is 88%; industry- 5%; domestic 7%. In Asia, water utilization in agriculture is 86%; industry- 8% and domestic use is 6%. In Europe, agriculture demand is 33%; industry- 54%; domestic 13% where as in India agriculture sector uses 90%; industry- 7%; domestic 3% water. Factors posing stress on available water are high population, inappropriate agricultural practices, industrialization, urbanization, improper pricing of water,

Technical session VI : Livelihood Security and Gender Issues**Chairman : Dr. S. P. Ayyar****Co-Chairmen : Dr. Dilip Kumar & Dr. Anju Agarwal**

1. **Dr. (Mrs.) P.K. Sahoo, Senior Scientist, DCFR, Bhimtal** delivered the theme presentation on 'Women in fisheries'. She enlightened the status of Indian aquaculture and role of women in various activities and explained the direct and indirect involvement of women in aquaculture industry. The direct involvement of women are in post-harvest related activities viz. prawn peeling, curing, fish trading, net making, fishing in the canals, picking of clam shell, fish trading, export oriented works, small scale entrepreneurship, fish sorting, grading and processing thus making value - added products. She also informed the house that women play roles in decision making, financial management, family welfare, net making, running petty shops and mobile food supply for the workers at the landing centres and fish markets. Apart from these, women are actively involved in seaweed collection, aquaculture and coastal aquaculture. The active role of women in hill fisheries like Jhora fishery in Assam and integrated fish farming in Arunachal Pradesh was of centre of attention. At last, she suggested strategies for the welfare of women in fisheries like their involvement in each activity of fish culture starting from seed production to fish marketing, involvement in ornamental fisheries, development of women self-help groups and women co-operative societies.
2. **Dr. Dilip Kumar, Former Director, CIFE, Mumbai** presented on 'Aquaculture for livelihood security for upland communities'. He emphasized that the development must begin by looking at people – as individuals, households and groups and by understanding their capacities and potential and not just merely their problems. He also pointed out the various specific concern of coldwater aquaculture and suggested different strategies viz. integration of aquaculture into rural development framework, integrated approach with other farming practices and responsible use of aquatic bioresources – fisheries and aquaculture – for the communities and by the communities for livelihood development in uplands. He suggested technological options like harvesting and holding water – using water for aquaculture, family based integrated aquaculture in ponds; aquaculture in cages in rivers, streams and

status of women participation in brackishwater aquaculture practices and informed the house about the active role of women in mud crab farming, crab fattening, shrimp farming, ornamental fisheries etc. He also stressed upon the livelihood security options for coastal women through self-help groups and elucidated the success story of women self-help groups in crab fattening, farm made aqua feed preparation and value added fish products development for the enhancement of their livelihood. He concluded that active participation, infrastructure, support from the state government programmes, along with technical and financial support offered to the coastal poor for their livelihood, particularly through the mechanism of women self help groups have made the technology adoption a successful one and thereby creating economic, social, environmental and technical sustainability in the small scale rural aquaculture.

4. **Dr. P.K. Agrawal, Principal Scientist, VPKAS, Almora, Uttarakhand** presented on 'Enhancement of livelihood security through sustainable farming systems and related farm enterprises in NW Himalaya.' He explained the various achievements of his project in enhancing livelihood security of farmers in NW Himalayan region and elucidated the strategies adopted like enhancement in agricultural productivity and profitability, up-gradation and management of natural resource base, agro processing, value addition and improved marketing for enhancing profitability and employment opportunities and empowerment through capacity building and skill development in core and allied agricultural sectors along with employment generation for the sustainable livelihood security. He emphasized the need of translating this model for livelihood security to a large scale in uplands.

Special Session for the Students

Chairman : **Dr. S. P. Ayyar**

Co-Chairmen : **Dr. Dilip Kumar & Dr. Anju Agarwal**

A special session was organized to encourage the young research scholars in different field. There were three presentations in this session on different subjects. The Best Poster Awardees (1st, 2nd and 3rd prize) presented their full paper.

Kashmir), Badon (Himachal Pradesh), Ramnagar (Uttarakhand) and Basoli (Jammu & Kashmir) for the study. Truss morphometric analysis was carried out using 12 homologous anatomical truss landmarks as stated in the figure.

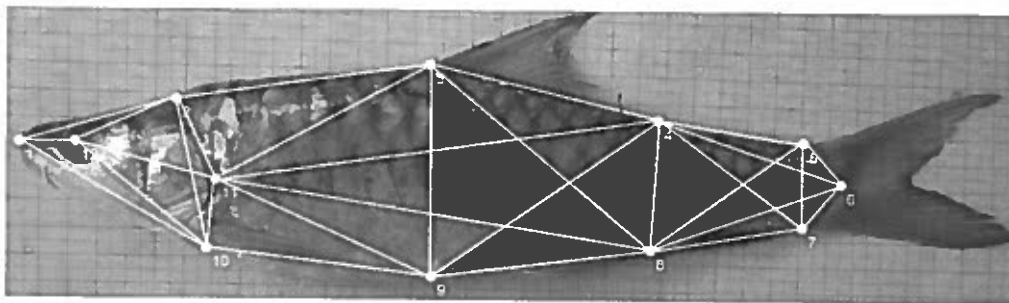
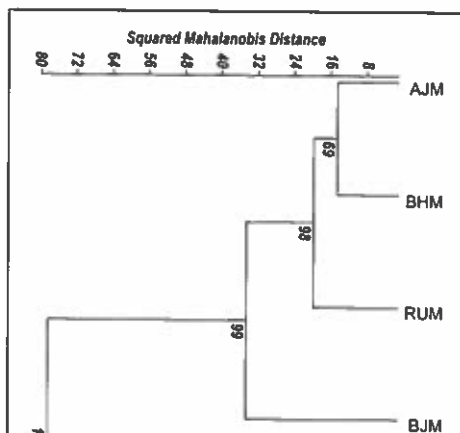


Figure 1: Digitized landmarks on Mahseer for truss analysis

Data was analyzed by principal component analysis to find out the major region contributing for morphological difference and discriminate analysis to differentiate populations morphologically. First four principal components (PC) accounted for 78.69% of the total variance. The first PC had the main loading of variable (1-12, 1-11, 1-2, 1-10, 2-12) which were mainly related to the head region while principal component 2 was mainly constructed by variable (4-6, 6-7, 4-7, 4-5, 6-8 and 5-6) which were the part of tail region of fish.

First discriminate function was accounting for 56.57% of variance and second was accounting for 30.52% of variance. Scatter plot of canonical variate analysis at 95% of concentration ellipse level visually summarized morphological distinction between population Basoli and Bhalupong from Anji, Badon and Ramnagar. Ramnagar population was also showing certain level of distinction from Anji and Badon populations with some degree of overlapping. Cluster analysis (Fig. 2) using the unweighted pair



population from rest of the stocks on morphological basis. Multivariate morphometric study revealed evidence of significant morphometric heterogeneity among 5 populations collected from different geographical locations of Indi. Findings suggested 4 phenotypically distinct populations varying in the degree of differentiation.

Major components loaded on DF1 were the part of head and tail region of the fish and indicated that significant morphometric change occurred due to feeding habit and swimming behavior of the fish. Bhalukpong population was sampled from Jia Bholeli River which belongs to Brahmaputra River system of Northeastern Himalayas and clear separation of this population from the rest of populations signified the major effect of geographical separation on the fish morphology. Ramnagar population also belongs to different river system (Ganga River system) but this population did not have any morphological distinction from Badon and Anji populations (Indus River system) which may be due to habitat similarity. Basoli population was also morphologically perceptible from rest of the stocks. Basoli population was sampled from catchment area of Ranjeet Sager Dam while other four populations' were collected from lotic system which signified habitat effect on morphological variation in fishes. In conjunction both geographical distance and habitat condition were supposed to be responsible for morphological variation in Golden Mahseer populations. Mr. Rohit Kumar got first prize in poster presentation.

Mrs. Puspita Das, a PhD student from Kumaon University who is pursuing her research work under the project 'Nutrient profiling and evaluation of fish as dietary component' at DCFR delivered the presentation on 'Amino acid, minerals and nutritional quality of golden mahseer (*Tor putitora*) of coldwater Himalayan region'. She emphasized that nutrient quality is very much essential to deal with the production, processing and marketing of high valued Himalayan mahseer for human consumption. However, there is paucity of information available on nutritive composition like amino acid, micro and macro minerals as well as proximate analysis of the king fish, Himalayan mahseer found in different upland streams and rivers of eastern and western Himalayan region. She informed the house that fish samples were subjected to proximate, minerals (Fe, Mn, Zn, Se, Na, K and Ca) and amino acid analysis. Higher protein level (17.29 gm/100gm) was observed during breeding season. Mahseer of Kosi river contained

and geographical location are prominent factors in making a choice for consumption of golden mahseer for benefiting the human health. Finally she concluded saying that golden mahseer could be a good source of minerals as it contains higher concentration of micro and macro minerals (potassium, calcium, iron, manganese, zinc and selenium), which helps in metabolic process of development stages and are known to be indispensable to the human beings. The size of fish, season and geographical location are the prominent factors in making a choice for consumption of coldwater fish species especially of golden mahseer for benefiting the human health. Mrs. Puspita got 2nd prize in poster presentation.

Mr. Raghvendra Singh, MFSc student from Central Institute of Fisheries Education presented on the topic entitled 'Water use optimization: Key to success of hill Aquaculture'. He explained the water is the most widely distributed substance on our planet and plays a vital role in both the environment and human life. But, now-a-days world is facing a serious problem of water crisis due to increasing population and industrialization. So, optimizing the use of water is need of the hour.

Fisheries and aquaculture contribute significantly to foods and nutrition security. The last few decades have witnessed the great advances in the productivity of the fisheries sector in India. Recent advances in aquaculture are taking the country into the threshold of fish revolutions aptly named the "Blue revolution" or "Aquaplosion". Coldwater aquaculture is also an important sector of the Indian Freshwater aquaculture.

Aquaculture systems always need huge quantity of water which is generally met with ground water and this ground water is a scare resource especially in hill states like Uttarakhand. Although the state is bestowed with lot many natural water resources comprising rivers, lakes and reservoirs which if used in a sensible and scientific manner, can bring the wonders.

In these water bodies fish culture can be practiced effectively through cage culture systems to optimize the use of natural waters. Directorate of Coldwater Fisheries Research, Bhimtal is doing pioneer work on this and rearing golden mahseer, snow trout and exotic carps in cages installed in Bhimtal lake.

Other innovative techniques like biofloc systems which run on the principle of

hydroponically. The water from fish culture unit is pumped into the plant culture unit fulfilling the requirement of water and essential nutrients to the plants as well as cleans up the water which is re-circulated to the fish culture unit. In this manner a significant amount of water can be saved. On the other side no supplementary nutrients are required for the plant growth, ultimately reducing the cost of production.

Most of the hill states of India falls in sub-temperate region which receives heavy rains during monsoon. So, rainwater harvesting in hill region can provide sufficient quantity of water for aquaculture and other practices which otherwise will be waste. Hence provision for the rainwater harvesting structures should be made for regular requirement of water specially during lean period.

In hill region the soil profile is generally comprise of rocks and stones which cause heavy seepage loss from ponds which very often demoralize the farmers to adopt the fish culture practices. Construction of polytanks can be one of the best possible, low cost solutions of this problem making aquaculture easy to adopt venture by poor farmers having limited resources.

These various ways to optimize the use of water which not only solve the problem of water scarcity but will also accelerate the pace of fish production in hill region. The thing only needed is the conversion of these techniques into technologies and awareness among the rural people to adopt them effectively. Mr. Raghvendra Singh got 3rd prize in poster presentation.

Plenary Session

6 November, 2012

Chairman : Dr. S.A.H. Abidi

Co-Chairmen : Dr. M.Y. Kamal, Dr. V.V. Sugunan, Dr. S.P. Ayyar,
Dr. Madan Mohan

Recommendations

1. Assessment of mountain aquatic resource using modern tools of geoinformatics and utilization of potential resources for aquaculture and ecotourism

4. Low cost trout feed need to be formulated using available ingredients.
5. Water conservation and management is an important area of research and development in the uplands. The emphasis need to be given in development of integrated fish culture model for need based system diversification.
6. Development of fish based location specific model of eco-tourism.
7. The declining population of some important coldwater fishes is great concern and need to be addressed though extensive conservation programme by developing breeding and seed production technologies.
8. Disease surveillance and monitoring for fish health management.
9. Establishment of location and species specific broodbank for quality seed availability.
10. The phenomenon of climate change must be carefully observed in Himalayan waters and mitigation plans to be drawn to protect upland fishery.
11. The studies on fish genomics is a pre-requisite at the hour for future genetic improvement and conservation of coldwater fishes.

The first honorary life membership of the newly registered 'Coldwater Fisheries Society of India' was awarded to the founder Director, Dr. K.L. Sehgal. The students were awarded for poster as well as presentations in special session. The seminar ended with vote of thanks offered by Dr. D. Sarma after the plenary session.

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