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Convention & Annual General Assembly  
New Baneshwor, Kathmandu, Nepal  
30-31 January 2015

**Proceedings**

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2015

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## **PREAMBLE**

NEFIS Convention and Annual General Assembly Agenda  
Maitri Hall, Indreni Food Land, New Baneshwor  
30-31 January 2015

### **Introduction**

Modern aquaculture techniques for fish production in Nepal started with carp in the early 1950s. Public sector institutions have developed and ratified a number of technologies for the culture of carp, catfishes, and trout through research and development. While some of these technologies are meant for small farmers and medium entrepreneurs, others are intended for large-scale operations. In addition, community-based aquatic resource management that conserves local germplasm and enhances livelihoods of wetland-dependent, marginalized communities has been one of the focus areas for fisheries research, extension, education, and development. However, the aquaculture and fisheries sector in the country has faced many challenges, including resource competition, the need to increase species productivity within given ecoregions, biotechnology interface, underuse of water resources, and underdeveloped disciplines related to aquaculture.

With increasing demand for food fish from aquaculture, and growing competition for resources, such as water, land, feeds and manure, there is a trend towards intensification of aquaculture systems. Opportunities for and constraints on intensification of aquaculture systems need to be explored, with a view to providing appropriate technical guidance for sustainable intensification of food production using such systems. However, it is necessary to improve productivity by increasing our understanding and increasing inputs.

In the country, there is good potential for culturing species other than carps. These include catfish (*Pangasia* and *Clarias* spp.), trout, tilapia, sahar, silver barbs, giant freshwater prawn, and others. There is an increasing demand among consumers for high-quality, eco-friendly, and more accessible aquaculture products. Aquaculture is now considered an important player in the national economy, specifically in terms of producing high nutritional value food for human consumption and for contributing to rural income and employment through farming and related activities. The long-term viability and sustainability of aquaculture, particularly in respect to commercial farming, has now become a critical factor in aquaculture development, in view of the increasing environmental and social concerns associated with the industry.

This convention, with its theme of “Emerging Trends and Challenges in Aquaculture and Fisheries,” will serve as a venue for the sharing of knowledge and experiences on improved aquaculture and fisheries technologies and management systems to address the need for ecologically, socially, and economically sustainable aquaculture production processes that satisfy the nutrition and food security concerns of the nation.

**First NEFIS Convention and Annual General Assembly Agenda**  
**Maitri Hall, Indreni Food Land, New Baneshwor**

**30 JANUARY 2015 — DAY 1**

**INAUGURAL SESSION**  
Convener: Neeta Pradhan

- 08:30-09:00     Registration** — Kamala Gharti, Mukunda Thapa, Sarmili Karmacharya
- 09:00-09:10     Chairing of the guest**
- Chairperson: NEFIS President Prof. Dr. Madhav K. Shrestha
  - Chief guest: Mr. Gagan Thapa, Hon. Member of Constitution Assembly and President of Agriculture and Water Resource Parliament Committee
  - Special guest: Hon. Member of National Planning Commission
  - Special guest: Vice-Chancellor, Agriculture and Forestry University
  - Special guest: President, Nepal Agriculture Federation
  - Guest: Executive Director, NARC
- 09:10-9:15       Welcome address** and highlight on the objective of the convention:  
Mr. Rama Nanda Mishra, NEFIS general secretary
- 09:15-09:20     Inauguration of the convention** by lighting panas: chief guest
- 09:20-09:50     Keynote paper** on “Emerging Opportunities and Trends in Global Aquaculture/Fisheries” by Dr. Ram Bhujel, AIT, Bangkok, Thailand
- 09:50-10:10     Felicitation of eminent professional**
- Academician Mr. Krishna Gopal Rajbanshi
  - Prof. Dr. Jeevan Shrestha
- 10:10-10:20     Indira Bhusal Memorial Award distribution**  
Mr. Durga Dahal, Dahal Trading Concern
- 10:20-10:35     A few words**
- President, Nepal Agriculture Federation
  - Vice-Chancellor, Agriculture and Forestry University
  - Hon. Member of National Planning Commission
- 10:35-10:40     Remarks from chief guest**
- 10:40-10:45     Vote of thanks: NEFIS Vice President** Mr. Suresh K. Wagle
- 10:45-10:50     Remarks and closing of the inauguration:** Chairperson
- 10:50-12:30     Participation in inauguration of National Fish Festival**
- 12:30-13:30     Lunch break and poster observation**

#### **TECHNICAL SESSION I: POLICY, EMERGING TRENDS AND VALUE CHAIN**

Chairperson: Dr. Deep Bahadur Swar

Rapporteurs: Agni Nepal, Sumitra Laudari

- 13:30-13:50 Emerging Trends and Challenges in Aquaculture and Fisheries, Nepal**  
Rama Nanda Mishra
- 13:50-14:10 Trading-off Fish Diversity, Hydropower and Food Security in Nepal: New Challenges and Research Opportunities**  
Tek Bahadur Gurung, Suresh Kumar Wagle, Arun Baidya, and Agni Nepal
- 14:10-14:30 Value Chain Analysis of Carp Polyculture Systems in Chitwan District, Nepal-marketing, Economic Risk Analysis Assessment and Trade Activity**  
Rim Bahadur Thapa
- 14:30-14:50 Small Scale Fishery in Uplands of Nepal**  
Khop N. Shrestha
- 14:50-15:10 Substrate Based Carp and Small Indigenous Fish Poly Culture**  
Sunila Rai
- 15:10-15:15 Chairperson's remark**
- 15:15-15:30 Tea break**

#### **TECHNICAL SESSION II: PRODUCTION MANAGEMENT**

Chairperson: Prof. Dr. Tej Kumar Shrestha

Rapporteurs: Prabesh Kuwar, Abhilasha Jha

- 15:30-15:50 Environmentally Friendly Cage Fish Culture: A Successful Model for Livelihood of Fishers Community in Nepal**  
Jay Dev Bista, Surendra Prasad, Agni Prasad Nepal, Ram Kumar Shrestha, Md. Akbal Husen, Ram Prasad Dhakal, and Madhav Kumar Shrestha
- 15:50-16:10 Polyculture of Mixed-Sex Nile Tilapia with Pangas and Sahar**  
Madhav K. Shrestha, Jay Dev Bista, Shankar P. Dahal, and Narayan P. Pandit
- 16:10-16:40 Live Food Organisms and Their Importance in Aquaculture**  
Prabesh Singh Kunwar and Narayan Giri
- 16:40-17:00 Successful Semi-Artificial Breeding of Pond Reared Tor Mahseer, *Tor tor* and Observation on Its Initial Growth**  
Arun Prasad Baidya and Santa Kumar Shrestha
- 17:00-17:20 Status of Carp Seed Health Management in Nepal**  
D.K. Jha, Ram C. Bhujel, and Anil K. Anal
- 17:20-17:40 An Extruded Pellet Floating Feed for Trout and Carp Fish Culture**  
Raghvendra Pandey
- 17:40-17:45 Chairperson's remarks**

## 31 JANUARY 2015 — DAY 2

### **TECHNICAL SESSION III: TAXONOMY, LIMNOLOGY, PRODUCTION MANAGEMENT**

Chairperson: Dr. Ram Chandra Bhujel

Rapporteurs: Narayan Giri, KC

- 9:00-9:20      DNA Marker Based Genetic Variation of Rohu (*Labeo rohita*) Populations From Hatcheries and River of Nepal**  
Neeta Pradhan, Suresh Kumar Wagle, Jitendra Maherjan, Suraj Sapkota and Ram Rokka
- 9:20-9:40      Impact of Cross Dam on Faunal Diversity of Nepalese Fishes**  
Deep Bahadur Swar and Prabesh Singh Kunwar
- 9:40-10:00      Mercury in Fish and Fisher Folks' Body in Nepal — Calls for Urgent Action**  
Ram Charitra Sah
- 10:00-10:20      Effect of Different Feeds on Growth and Survival of Gardi (*Labeo dero*) Fry**  
Surendra Prasad, Jay D. Bista, Ram P. Dhakal, Agni P. Nepal, and Md. A. Hussien
- 10:20-10:40      Improving National Aquaculture Seed Production System in Nepal**  
Rama Nanda Mishra
- 10:40-10:45      Chairperson's remarks**

### **TECHNICAL SESSION IV: PRODUCTION MANAGEMENT**

Chairperson: Dr. Tek Bahadur Gurung

Rapporteurs: Hira Lal Bhusal, Kamala KC

- 10:45-11:05      Effect of Aeration in Pond on Oxygen Transfer and Fish Production**  
Suresh Kumar Wagle, Shiva Narayan Mehta, Abhilasha Jha, and Arjun Bahadur Thapa
- 11:05-11:25      Spawning Response of Sahar (*Tor putitora*) in Different Seasons Under Pond Reared Condition in Pokhara, Nepal**  
Jay Dev Bista, Bharat Shrestha, Ram Kumar Shrestha, Surendra Prasad, Agni Prasad Nepal, Arun Baidya, Suresh Kumar Wagle, and Tek Bahadur Gurung
- 11:25-11:45      Efficacy of An Eco-Friendly Anaesthetics Clove Oil During Simulated Transportation of Rohu (*Labeo rohita*)**  
Md. Hussain, Subodh Sarma
- 11:45-12:05      Cost-benefit Analysis Of Rainbow Trout Commercial Farms — A Case Study of Kaski District, Western Development Region, Nepal**  
Agni Prasad Nepal, Subodh Sharma, Jay Dev Bista, Surendra Prasad, Tek Bahadur Gurung, and Suresh Kumar Wagle
- 12:05-12:25      Problem assessment of red bloom fishpond**  
Ram Bhajan Mandal and N.P. Pandit

**12:25-12:30      Chairperson's remarks**

**12:30-13:30      Lunch and poster observation**

**CLOSED SESSION: NEFIS GENERAL ASSEMBLY**

**13:30-14:15      Chairperson: NEFIS President**  
• Presentation of NEFIS progress report: General Secretary, NEFIS  
• Presentation of NEFIS financial report: Treasurer, NEFIS  
• Chairperson remark

**14:15-16:00      Election of NEFIS Executive Committee**

**16:00-16:15      Tea break**

**CLOSING SESSION: NEFIS GENERAL ASSEMBLY**

**16:15-16:20      Chairperson: NEFIS President Prof. Dr. Madhav K. Shrestha**  
Chief guest: Dr. Bharatendu Mishra, Hon. Member, NPC  
Guest: President, Nepal Agriculture Federation  
Guest: Joint Secretaries, MoAD  
Guest: Executive Director, NARC  
Guest: Director General, DoA

**16:20-16:25      Declaration of new NEFIS Executive Committee:** Commissioner

**16:25-16:30      Distribution of certificate** for NEFIS Executive Committee

**16:30-16:40      Distribution of blaze** to NEFIS member

**16:40-16:45      Presentation of recommendation** of NEFIS Convention

**16:45-17:10      A few words**  
• President, Nepal Agriculture Federation  
• Director General, DoA  
• Executive Director, NARC  
• Officiating Secretary/Joint Secretary, MoAD

**17:10-17:20      Remarks and directive:** chief guest

**17:20-17:25      Vote of thanks:** NEFIS President

**17:25-17:30      Chairperson's concluding remark and closing**

**17:30-19:30      Dinner**

## POSTER LIST

**A Morphometric Study on Asala (*Schizothorax richardsonii*) from Rivers of Nepal**

Suresh K. Wagle, Madhav K. Shrestha, Neeta Pradhan, and Anita Gautam

**Assessment of Optimum Feeding Rate on Growth and Production of Carp Polyculture in Nepal**

Sumitra Laudari

**Chhadi Fish Farming: A Modified Carp Poly Culture System for Enhancement of Pond Productivity**

Narayan Giri and Prabesh Singh Kunwar

**Comparison of Fish Growth and Yield From Different Models of Integrated Fish Farming in Chhatrephat, Nuwakot**

Abhilasha Jha, Suresh K. Wagle, Kamala Gharti, and Prem Timilsina

**Effect of Different Protein Sources in Feed on The Growth and Survival of Rainbow Trout Fry**

Gun Bahadur Gurung and Neeta Pradhan

**Integration of  $\beta$ -carbonate Enriched Orange Sweet Potato in Aquaculture for Enhanced Nutrition Accessibility by Small Fish Farmers**

Binesh Man Sakha, Madhav Kumar Shrestha, Krishna Chandra Upreti, Shailesh Gurung, and Bishwa Pokhrel

**Limnology and Aquatic Biodiversity of Trishuli-Narayani River System**

Gopal Prasad Lamsal

**Nursing Performance of Gardi (*Labeo dero*) Fry in Captive Environment**

S. Prasad, A.P.Nepal, R.K. Shrestha, R.P. Dhakal, and A. Hussain

**Observation on The Performance of Wild Jalkapur (*Pseudeutropius murius batarensis*) Fry in Ponds at Trishuli**

Kamala Gharti and Gopal Lamsal

**Pellet Fish Feed Production and Management for Intensive Aquaculture Development in Nepal**

Jay Dev Bista, Nanda Kishore Roy, Ram Kumar Shrestha, Agni Prasad Nepal, Surendra Prasad, Dev Prasad Sharma, Md. Akbal Husen, and Neeta Pradhan

**Preliminary Observations on Breeding and Fry Rearing of Pangas (*Pangasius hypophthalmus*) at Eastern Region of Terai**

Shiva Narayan Mehta, Suresh Kumar Wagle, Umita Sah, and Yukti Lal Mukhiya

**Prospects and Status of Rainbow Trout (*Oncorhynchus mykiss*) Farming in Rasuwa District**

Arjun Bahadur Thapa and Prem Timalsina

**Quality of Fresh Fish Preserved in Different Containers for Transportation**

Neeta Pradhan, Madhav Shrestha, Achyut Mishra, Suresh K. Wagle, and Prashansha Shrestha

**Small Scale Aquaculture Technology to Enhance Fish Production in Nepal: Action Research Outcomes**

M.K. Shrestha, R.N. Mishra, S.K. Wagle, S. Rai, N. Bhattarai, and L. Karki

**The Efficacy of Clove Oil as An Anesthetic for Use on Fingerling of Common Carp, *Cyprinus carpio***

Anita Gautam, Suresh K. Wagle, and Prakash Kunwar



## PRESENTATION ABSTRACTS

*In the order they appear in the agenda starting with keynote paper on page 5*

### Emerging Opportunities and Trends in Aquaculture/Fisheries Globally

**Ram C. Bhujel**

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Green revolution contributed tremendously to feed the hungry people, especially by fulfilling the energy requirements. Next challenge has been the adequate supply of high quality protein to improve health of the people. Fisheries products serve as one of the best options. Although wild catch is still the largest source, it is adequate to fulfill the increasing demand. Therefore, a lot of efforts have been made to restore or enhance wild fish stocks and their habitats worldwide providing new opportunities for the professionals. On the other hand, more efforts have been made to promote aquaculture. Starting from 1950s with only 0.5 million ton/year, aquaculture production increased tremendously reaching 70.5 million ton in 2013. By 2050, considering the demand, aquaculture has to supply over 160 million ton/year that is more than two folds of the current production. Due to some reasons development of aquaculture is patchy. Despite huge efforts, the rich countries such as USA, Japan and European countries are not able to produce enough fish. It has been a good opportunity for developing countries to supply them and earn foreign currencies. Over 80% of the seafood traded comes from the developing world, the value of which has reached over US\$200 billion annually doubling every decade. Major seafood importers are the USA (US\$19 billion), Japan (US\$15.3 billion) and European countries.

Asia has been the aquaculture hub. Out of top 10 aquaculture producing countries in the world eight are in Asia where nearly 90% of the global farmed-fish comes from Asia. China has given high priority to aquaculture and earns nearly US\$20 billion/year from seafood while those of Vietnam, Thailand and India also earn approx. US\$7-8 billion each annually. Norway is only European country, which earns over US\$10 billion by exporting mainly salmon, worldwide. Vietnam earns nearly US\$2 billion annually from *Pangasius* export. Over 40,000 farmers are engaged and produce nearly 1 million ton of *Pangasius* annually. Average pond productivity has reached over 400 ton/ha in 6 month. Over >200,000 people, especially women, get employment in its processing factories. Similarly, in Thailand, tilapia farming is widespread. Even though export is limited, local demand is huge and over 90% is sold in domestic market. About 250,000 farmers produce over 200,000 ton of tilapia per year. Realizing the great potential of aquaculture in generating income/profits, creating jobs, and improving human health, many countries of Asia, Africa and Latin America are prioritizing aquaculture development.

In Nepal, according to the report “Statistical Information on Nepalese agriculture 2013 published by the Ministry of Agricultural Development (MoAD), total meat including fish available to the people was 402,372 ton in 2013 (Table 1) i.e. 14.8 kg/person. Although fish (14.3%) contributes more protein and is increasing rapidly than chicken or goat it receives very low priority in national agenda. Presently, only about 2 kg fish is available per person/year. Fish farming is still in its infancy stage as compared to many Asian countries. Buffalo meat contributes almost half of the total animal protein intake, but mostly imported from India. Fish has the potential to replace this import of red meat. Poultry suffers from bird flue quite often that results in high demand for fish. Goat meat is more than twice in price than that of fish but most people still prefer goat

because of their traditional. However, increasing-awareness against the meat with high fat is also creating space for fish.

**Table 1.** Animal protein in Nepal in 2013

<b>Source</b>	<b>Tons</b>	<b>Per cent</b>
Buffalo	175,132	43.5%
Fish	57,520	14.3%
Goat	55,578	13.8%
Eggs	49,685	12.3%
Chicken	42,810	10.6%
Pig	18,709	4.6%
Others	2,938	0.7%
<b>Total</b>	<b>402,372</b>	<b>100%</b>

Fish farming can be easily incorporated into the existing farming systems. Rice field covers most of the country's 1,331,521 ha of irrigated land. The productivity of rice is only about 3.2 ton/ha. Helping to dig ponds utilizing less productive lands around the corners of rice plots or swampy areas could result in a good fish yield, thereby the family income. If only 20% of the irrigated rice field could be utilized to produce fish, total fish production of the country could be doubled. Presently, 90% fish farms use earth ponds and almost 99% of the ponds are in Terai. More efforts are needed to focus on mid-hills and valleys as well. Promoting more cages culture in reservoirs, lakes and community ponds is another option.

According to the MoAD data, total aquatic animal import has reached NRs 670 million (67 crore) per year, out of which over 70% is whole frozen fish from India whereas export value is only NRs. 3 million. In order to compensate the huge deficit, more concerted efforts, and more support packages are needed to engage people, especially the young entrepreneurs in farming fish. A lot of cases have shown fish farming has been one of the best options in terms of generating income and utilizing available resources such as land, labor and water.

### **Emerging Trends and Challenges in Aquaculture and Fisheries, Nepal**

**Ramanand Mishra**

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Nepal is nutritionally deficient country particularly in the supply of animal protein. To provide adequate nutrition and quality food to its people the supply of animal protein has to be doubled. Fish being cheapest and best source of animal protein and the country having vast water resources fish is likely to bridge these gaps. Aquaculture is one of the fastest-growing economic and food production sector, providing high-protein food, income and employment. It has the potential to contribute significantly to food security, valuable nutritional input, livelihood development and poverty alleviation. The growth rate of Aquaculture sector is 8.4%; however the total growth rate of fisheries sector is only 5.11%. In addition, nearly 3% of the population is benefitted by fisheries and aquaculture activity contributing 0.93% in National GDP and 2.61% in Agriculture GDP. Aquaculture is limited to less than 2% of the available water resource and thus, having high potential for expansion and there is growing demand for fish particularly after the outbreak of bird flu and swine flu. Although, fish production in the country has reached 64900 mt in 2013/14 with more than 15-fold increment in 30 years. Aquaculture has a short history but has grown tremendously contributing nearly 67% in the total fish production of the country. Still, per capita

production is very low resulting in significant amount of fish import. In addition, there is a regional as well as physiographic imbalance in fish production and lacks proper distribution mechanism. Even though, there is a great potential for further growth of aquaculture in the country but, such a growth has to be obtained through improvements in technologies and resource use, intensification, integration of aquaculture with other farming activities, and development of additional areas for aquaculture.

The greatest challenge for inland fisheries in Nepal is environmental degradation. Aquatic pollution, destruction of fish habitats, water abstraction and impacts on aquatic biodiversity are all increasing. These trends must be reversed. Similarly, the potential for further growth of aquaculture is promising. However, aquaculture is facing significant challenges like ;meeting growing demands for seed, feed and fertilizers, in terms of quantities and quality; reducing production losses through improvement in water quality and fish health management; successful integration of aquaculture with other farming activities, and promotion of small-scale low-cost aquaculture in support of rural development; improvements in environmental management including reduction of environmental impacts and avoidance of risks to biodiversity through better site selection, appropriate use of technologies, including biotechnologies, and more efficient resource use and farm management; and assurance of food safety and quality of products.

### **Trading-off Fish Diversity, Hydropower and Food Security in Nepal: New Challenges and Research Opportunities**

**Tek Bahadur Gurung, Suresh Kumar Wagle, Arun Baidya, Agni Nepal**  
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This paper aims to elucidate interrelationship and possible trade-off among fish diversity, hydropower and food security for sustainable development. Nepal has three major river systems the Koshi, the Narayani, and the Karnali well known for enriched aquatic biodiversity including that of 229 fish species in hilly rivers; and adjacent flood plains of southern terai suitable for grain production. The river systems play important roles in ensuring fish biodiversity, hydropower and food security from sloppy gradients in hills to southern plains of Nepal. To meet the energy security, rivers in the mid hills have been proposed for several hydropower developments. Since the present level of food security is not adequate, therefore, cereals productions have been prioritized in southern plains with more intensive farming approaches focusing on diversion of river waters for irrigation along with the use of inorganic fertilizers, pesticides. Food and hydropower security have always the prime priority of national agenda for multiple approaches of economic development. As a result numbers of hydropower dams for electricity generation in hill and irrigation networks in southern plains focusing on energy and food security are under operation. In these scenarios, both rivers and wetlands would be regulated, earlier serving as the “bank in water” for “poorest of the poor.” However, these activities create trade-offs with the fish biodiversity and yields upon which several communities depend substantially. The rivers that flow down to south sustains fish yield (lowly estimated in year 2011-12) of about 21.5 thousand Metric ton employing about 0.6 million people dominating by women. The fish yield values annually worth US\$51 million at first sale sustaining livelihoods and food security of millions poor. Fish, snails and crabs are the easiest animal based nutritious foods available to poor suggesting its significance to food security.

However, upcoming dams and irrigation alterations in rivers might hindered fish yield and endangered fish biodiversity in hills as well as in southern wetlands. The agricultural intensifications would impact flood plains fish most of which are already vulnerable due to eutrophication and agrochemical use. As evidence many native fish, crab, shrimp and snail have been disappeared from rice field and flood plains functioning earlier as shelter, breeding grounds and nurseries due to rampant use of pesticides posing threat to fish stocks in Nepal. It is outlined that such a change definitely challenges the fish diversity in rivers, wetlands and paddy fields including other habitats. In recent practices fish hatchery subsidized by hydropower institutions has been operated to compensate the fish stock up and downstream of regulated rivers. It is supported that trade-offs between hydropower security and fish resources in rivers should be balanced by fish as well as hydropower friendly programs. Likewise in southern flood plains endangered fishes are proposed to conserve by innovative means along with fish friendly approaches such as promotion of environment friendly rice-fish integration and operating hatcheries of native fishes with additional research and developmental activities to support food and nutritional security for reducing catastrophic results. It is argued such integrated approaches water supply should be ensured to fisheries research and development facilities.

### **Value Chain Analysis of Carp Polyculture Systems in Chitwan District, Nepal-marketing, Economic Risk Analysis Assessment and Trade Activity**

**Rim Bahadur Thapa**

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Chitwan district is famous as a major fish pocket area in Nepal. The study was carried out in 2013 to explore the value chain of Carp fish in Chitwan district. For this study, VDCs namely were Gitanagar, Madikalyanpur, Gunjanagar, Kathar, Khairahani, Kumroj, Patihani, Piple and Saradhanagar for the fish farmer, Madikalyanpur, Narayanghat, Gitanagar, Patayani, Parsa, Ratnagar(tadi) and Bharatpur municipality (hakim chock, Chitwan farm house, narayanghat mandi and namuna jiudo thatha taja machha pasal) for fish seller and Bhandara, Kathar, Ratnagar, Madikalyanpur and Gunjanagar for fish seed producer, purposively selected for the study based on the area coverage, production, number of growers and access to road facilities. For this, 121 table fish growers, 35 fish sellers and 8 seed producers were interviewed for getting information on marketing and value chain study. 91.3 percent of the fish sellers were retailer that plays a main role in Chitwan district market. Similarly 7.7 percent and only 1 percent were fish farmer acting as fish seller and intermediaries respectively. The average variable cost for production of fish per hectare was Rs 311422. The majority of the fish producers 88.42% sold their produce at farm gate where as only few producers 6.63% sold their produce directly to the market. Only 4.95% producers sold part of the production in the market and remaining part from the farm gate. Mean production of the fish was 4.66 Mt/hect in Chitwan district. The local consumers were consuming 80.00 percent of the total production of fish. Only 14 percent of the remaining product exported to other district namely Pokhara, Malekhu (Dhading) and Kathmandu valley. The average farm gate price per kg of carp fish was NRs 158.57. The average selling price of retailers was NRs 228.10. The price spread was NRs 69.53 per kg. The marketing efficiency of this chain was 183 percent. Similarly, the producer's share on consumer was 69.51 percent. The benefit cost was 2.41. The average gross margin from the fish production was NRs. 476598 per hectare and NRs. 103.60 per kg of fish. Gross margin and high B/C ratio received by the Carp growers showed that the carp business is profitable in the production point. The retailers were the main intermediary actors in the carp value chain of Chitwan district. They were the main actors

for interselling of carp within the district. Most of the fish is consumed within the Chitwan district. Due to the establishment of organisation Chitwan Matsay Bebasai Sang, the farm gate price of the fish fixed in whole Chitwan district, so the producers are always getting high profit from the business. The farm gate price of the Carp fish was very high as compared to retail price. Marketing efficiency of the fish business is high so its marketing is feasible in Chitwan district.

### **Small Scale Fishery in Uplands of Nepal**

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More than two third of the total population of Nepal, with majority of indigenous people living in the uplands, suffer from malnutrition, In fact these communities are living in destitute and extreme poverty. They have no good lands and water being the scarcest resources for them. There are no jobs available and members of the tribe barely scrap by on subsistence farming in the hill slopes.

The hills and mountains are a major source of water in Nepal. The water resources appear in a diverse form and support a diverse fish fauna. Though, fish is said to be the cheapest source of protein, it rarely reaches the tables of uplands people, because of the low advancement made in the upland fish farming technology.

Realizing the benefits of small-scale fishery, which can make up an important contribution to nutrition, food security, sustainable livelihoods and poverty alleviation of the upland dwellers, MDI Nepal, initiated some innovations on upland fishery in Makawanpur and Udaypur districts of Nepal and added fishery component as one of its important intervention along with other activities so far. During this period, a number of fishery ponds have been constructed in areas where projects are launched.

Looking over the successful results of the CARP-SIS project implemented by IAAS in Kathar VDC of Chitwan district in Nepal, MDI attempted to expand this successful initiatives in adjoining district Makawanpur targeting indigenous rural communities, i.e., Tamang and Chepang. With little financial support from UNDP GEF Small Grants Programme of Nepal (US\$28,000), the project was extended in few VDCs of northwest Makawanpur (Manahari, Handikhola, Raksirang, Kalikatar and Kankada) within the catchments of East Rapti river basin located at the foothills of Chure and Mahabharat hill range beginning from December 2012. Over the years, 123 ponds have been constructed and its beneficiaries have successfully harvested carp and SIS worth of 1 million (4279 kg) till this reporting period. There are now 121 households actively involved in promoting this technology. Altogether, 37 SIS species (D.K.Jha 2012) have been identified with abundance of Poithi (*Puntius chola*) rich in calcium content. Encouraging with this successful results, many communities particularly from ethnic origin (Tamang and Chepang) are attracted and replicated the similar system throughout the project area. The size of ponds varies from minimum 100 m<sup>2</sup> to as big as 300 m<sup>2</sup>.

## **Substrate Based Carp and Small Indigenous Fish Polyculture**

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Polyculture of carp and small indigenous species fish (SIS) in household ponds has been effective to small scale farmers in terms of income generation and nutrient supply to family. Adding substrates to the carp and small fish pond increases carp production further. A research carried out in farmers ponds in Chitwan District showed that total fish production was 19% higher in carp+SIS+substrate (67.0 kg/100 m<sup>2</sup>/y) ponds than carp+SIS polyculture (56.4 kg/100 m<sup>2</sup>/y) and carp polyculture (56.0 kg/100 m<sup>2</sup>/y) ponds. Higher production in carp+SIS+substrate system might be due to nutrient rich food "periphyton" supplied by bamboo substrates. Farmers who adopted carp+SIS+substrate farming earned higher income (Rs. 9915/100 m<sup>2</sup>/270 days) than those who adopted carp+SIS polyculture (Rs. 8353/100 m<sup>2</sup>/270 days) and carp polyculture (Rs. 7877/100 m<sup>2</sup>/270 days) corresponding to higher production. Fish consumption was more than 50% higher in carp+SIS+substrate adopted households (32.8 kg/household/270 days) than carp+SIS polyculture (21.1 kg/household/270 days) and carp polyculture adopted households (21.5 kg/household/270 days). Two verification trails both on station and on farm are ongoing.

## **Environment Friendly Cage Fish Culture: A Successful Model for Livelihood of Fishers Community in Nepal**

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This manuscript presents current status and future scope of environment friendly small-scale cage fish culture in Nepal, which is practiced mainly with plankton feeder fish, such as bighead carp (*Aristichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*), in floating cages. The most important characteristic of this type of fish culture is subsisting on natural food in water column of the lakes and reservoirs. It is popular among traditional Jalari families of fisher community living around lakes of Pokhara valley and the families displaced by construction of hydropower dam in Kulekhani, Makwanpur. Estimated fish production was 122 mt in Pokhara valley and 134 mt in Kulekhani reservoir from operation of approximately 30,000 m<sup>3</sup> and 81,500 m<sup>3</sup> of cages, respectively during 2008/09 (Wagle et al. 2012). Such a cage fish culture has been in operation since four decades in Pokhara and two and half decades in Kulekhani. The production rate is varied i.e. average 4.30 and 1.62 kg/m<sup>3</sup> in Pokhara and Kulekhani, respectively. The contribution of cage produced fish in national production is low (0.51%). However, its social impact is incomparable for sustaining livelihood including food security and education of the children. The cage fish culture in natural lakes in Pokhara valley and Kulekhani reservoir has been appreciated as one of the successful farming model for deprived fisher communities and the displaced people by hydropower damming. Inclusion of Grass carp (*Ctenopharyngodon idella*), a herbivorous species could utilize aquatic plants, which shows fast grow and fetches relatively high market price, enhance cage productivity (8.4 kg/m<sup>3</sup>). Besides, removal of grass also helps to improve the ecosystem of water bodies. Cage culture practice is most potential for upcoming reservoirs in the country.

## Polyculture of Mixed-sex Nile Tilapia with Pangas and Sahar

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Polyculture of mixed-sex Nile tilapia with predatory fish species helps to control the Nile tilapia recruits and increase production. An experiment was conducted in 9 earthen ponds of 200 m<sup>2</sup> size for 150 days at the Center for Aquaculture Research and Production (CARP), Kathar, Chitwan, Nepal to assess the polyculture performance pangas and sahar with Nile tilapia. The experiment was conducted in a completely randomized design (CRD) with 3 treatments and 3 replications. The treatments were: (1) Nile tilapia monoculture @ 1 fish/m<sup>2</sup>, (2) Nile tilapia @ 1 fish/m<sup>2</sup> + pangas @ 1 fish/m<sup>2</sup> and (3) Nile tilapia @ 1 fish/m<sup>2</sup> + sahar @ 0.5 fish/m<sup>2</sup>. The stocking size of mixed-sex Nile tilapia, pangas and sahar were 23-28 g, 31-52 g and 12-24 g, respectively. Fish were fed with NIMBUS pellet feed (24.0% crude protein) at 2.0% of body weight per day. No fertilizers were applied throughout the experiment. The water depth in all ponds was maintained at 1 m. Feed rations were adjusted monthly based on sampling weights. At harvest, the gross fish yield and net fish yield were significantly higher in Nile tilapia + pangas treatment (T<sub>2</sub>) than other treatments ( $p < 0.05$ ). There were no significant differences in survival and apparent food conversion ratio (AFCR) between T<sub>1</sub> and T<sub>2</sub>. The mean number and weight of Nile tilapia recruits were significantly highest in T<sub>1</sub>, intermediate in T<sub>2</sub> and lowest in T<sub>3</sub> ( $p < 0.05$ ). There were no significant differences in water temperature, pH and Secchi disk depth among treatments, whereas the dissolved oxygen was significantly lower in Nile tilapia + sahar (T<sub>3</sub>) treatment than other treatments that caused mortality of sahar. Moreover, there was flood problem in Nile tilapia + sahar treatment that affected survival data.

**Table 1.** Combined performance of Nile tilapia, Pangas and sahar in different treatments during the experimental period of 150 days. Data based on 200 m<sup>2</sup> water area. Mean values with different superscript in the same row are significantly different ( $p < 0.05$ ).

Parameter	Treatment		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Total stock weight (kg)	5.7±0.3	8.8±1.5	7.5±0.7
Total harvest weight (kg)	31.4±1.3 <sup>a</sup>	68.8±7.7 <sup>b</sup>	25.3±4.2 <sup>a</sup>
Gross fish yield (kg/ha/cycle)	1571.7±65.8 <sup>a</sup>	3440.0±383.2 <sup>b</sup>	1264.6±209.6 <sup>a</sup>
Net fish yield (kg/ha/cycle)	1288.5±53.2 <sup>a</sup>	3001.7±308.8 <sup>b</sup>	891.8±239.4 <sup>a</sup>
Gross fish yield (ton/ha/year)	3.8±0.2 <sup>a</sup>	8.3±0.9 <sup>b</sup>	3.0±0.5 <sup>a</sup>
Net fish yield (ton/ha/year)	3.1±0.1 <sup>a</sup>	7.2±0.7 <sup>b</sup>	2.1±0.6 <sup>a</sup>
Recruit weight (kg/ha/cycle)	1225±95.0 <sup>c</sup>	743.8±199.0 <sup>b</sup>	26.7±22.2 <sup>a</sup>
AFCR	2.7±0.1 <sup>a</sup>	2.1±0.0 <sup>a</sup>	6.5±1.8 <sup>b</sup>
Survival (%)	98.0±2.0 <sup>b</sup>	98.7±0.9 <sup>b</sup>	41.2±9.0 <sup>a</sup>

## **Live Food Organisms and Their Importance in Aquaculture**

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Aquaculture is an important and rapid growing industry in Nepal. Government of Nepal has implemented fish mission and area expansion program to push this industry forward. Support in mechanization and training programs have though created awareness among farmers regarding the importance of pellet feed but concept of live food is still lacking. The bottleneck of the Nepalese aquaculture industry is the quality seed. Because of very low larval survivability, which is only around 30%, increases unnecessary cost and farm space. Lack of sufficient knowledge on live food has also been attributed to hamper the industrial development of fish culture. Live food includes both phytoplankton and zooplankton that are grazed upon by fish. The phytoplanktons are primary producer and zooplanktons are primary consumers. Availability of suitable live food organisms determines the success of fish seed production. In fact, most early stages of fish larvae usually do not ingest or are not able to digest formulated feeds and require live foods that swim actively and encourage feeding response of fish larvae. Live foods are highly digestible and contain all the nutrients hence also called “living capsules of nutrition. Artificial larval feeds are no match to live food organisms in terms of acceptance, digestibility, nutritional contents and other factors. Live food organisms can nutritionally be enriched according to the requirement of species being cultured. Progress in live food enrichment techniques has further boosted importance of live food organisms in aquaculture. There are hundreds of scientific publications arguing positive impact of live food in fish. Feeding habit of fishes varies among the species but all of them require protein rich live food for their better growth, efficient breeding and survival. Considering the high importance and potential of live food, its application in various stages of fish rearing process must be encouraged to improve quality, survivability and growth for the overall success of Nepalese aquaculture industry.

## **Successful Semi-artificial Breeding of Pond Reared Tor Mahseer, *Tor tor* and Observation on its Initial Growth**

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Tor mahseer, *Tor tor*, is a large endangered riverine and an attractive sport fish with high food value. Wild fingerlings of *T. tor* were collected from Kali Gandaki River and reared in a control system for more than 12 years. Brood fish of *T. tor* and golden mahseer, *T. putitora* were stocked at the rate of about 3 Mt/ha in a 0.03 ha size concrete pond with earthen bottom with regular supply of fresh water at Kali Gandaki Fish Hatchery, Beltari, Syangja. A female fish (5.1 kg, 77 cm TL) stripped eggs (250 g, 46 eggs/g) successfully for the first time in Nepal on 29<sup>th</sup> September 2014, and fertilized with milt using dry fertilization method. The mean weight of newly ovulated eggs was 21 mg, which was bigger than those of *T. putitora* (12 mg; stripped at the same time). The eggs were hatched from 84 h to 108 h after fertilization at 22-24°C water temperature. The fertilization and hatching rates were 95% and 90%, respectively; and produced 9,800 larvae. The mean weight of juveniles with the age of 14 dAH (days after hatching), 45 dAH, 75 dAH and 105 dAH were 25 mg, 109 mg, 194 mg (26 mm TL) and 221 mg (28 mm TL), respectively; which were larger than the juveniles of 14 dAH (17 mg), 45 dAH (68mg), 75 dAH (136 mg, 24 mm TL) and 105 dAH (172 mg, 26 mm) of *T. putitora* (hatched on the same day). This preliminary study



shows that there are possibilities of mass seed production of *T. tor*, and this fish could be a potential candidate for the development of an open water fishery as well as aquaculture.

### **Status of Carp Seed Health Management in Nepal**

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Availability of quality seed of the desired species in adequate quantity is one of the most important factors for a sustainable fish farming. Most fish hatcheries often encounter high mortality and low quality of seed (fry and fingerlings). A study was conducted to understand the problems, especially juvenile mortality, and issues of health management in private fish hatcheries in Terai and Inner Terai of Nepal. The average survival of hatchlings were 28.1%, 22.2%, 26.83%, 23.3% and 26.7% recorded in eastern, central, western, mid-western and far western development regions respectively. Hatcheries of central region have great variation in survival of hatchlings ranging from 10 to 35%. Twenty one percent owners reported only 10-15% survival while 36.8%, 21%, 10.5% and 10.5% owners experienced 16-20%, 21-25%, 26-30% and 31-35% survival respectively. Almost all hatcheries reported of asphyxiation, predatory aquatic insects, frogs, water snakes and piscivorous birds faced during juvenile nursing. More than one-third (35%) owners reported the problem of Trichodina while 10% faced white and black spot disease, 15% owner reported Scoliosis mostly in silver and bighead carps. Sometimes fish lice also posed great problems. Seventy percent owners claimed that they don't have proper knowledge and practical hands-on skill for the management of their hatcheries. They pointed out that lack of suitable feed for juvenile is another big challenge. Overall hatchery and bloodstock as well as juvenile health management should be given high priority in order to maintain adequate supply and also ensure high quality of seed.

### **An Extruded Pellet floating Feed for Trout and Carp Fish Culture**

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The extruded floating pellet feed is the nutritionally balanced fish feed. It floats on water surface and directly fed by the fish. Mainly feed feeder like to feed this feed. There is no wastage during feeding process in fish ponds. Due to more consumption of this balanced floating feed the growth of fish is sooner compared to fed by rational feed (rice bran and mustard oil cake.) There is approximately 15%-20% of feed wastage during the feeding process of rational old type of feeding to fish. There are private feed industries who are making extruded floating pellet feed in technical supervision of International and National Fisheries Experts in Nepal. There is more demand of Trout and Carp floating feed in the country. Trout growers have feed compulsorily pellet feed due to raceways cleanliness. The quality feed can only increase the fish productivity. There need to use floating pellet feed at wide range at village level. The fish growers are not fully aware with floating pellet feed. The use of floating Pellet feed increase fish productivity as well as improves the water quality. To meet the large scale fresh and live fish demand is only possible by use of Floating Pellet feed. The annual 16,000 kg fish import from India could be easily

replaced by the national fish production by using the latest fish culture practices in Nepal. At present floating pellet feed is getting popularity due to quality and lower FCR compared to Rice bran and mustard oil cake. The floating pellet feed producer/ industries have to be very careful about the ingredients what they mix during the formulation of feed.

Good quality and fresh feed ingredients, vitamins; minerals are the key for extruded floating pellet feed making. Many commercial fish farmers are avoiding the use of rice bran and mustards oilcake which is old practice at village level for carp growers. The commercial fish farmers can't take risk to produce carp fish by use of Mustards oil cake and rice bran in 3-4 FCR, whereas the extruded floating pellet feed FCR is 1.4-1.5.

Now there is requirement for tilapia and *Pangasius* feed is increasing for the commercial growers. The increasing the fish culture at large scale in Chitwan, Bara, Parsa, Rupandehi, Kapilvastu, Morang, districts can provide millions of tons of Fish in market if growers use Extruded pellet feed. But the main ingredient for feed making are the soya, fish meal which increases the production cost of feed, its big challenge for growers as well as for feed producers. Fish farmers are in confusion to decide about the use of floating pellet feed due to high cost of pellet feed and lack of knowledge of the proper fish species species and size of the fingerlings stocking. This is the time of blue revolution. High investment in fish culture has been done by the private sector.

#### **DNA Marker Based Genetic Variation of Rohu (*Labeo rohita*) Populations from Hatcheries and River of Nepal**

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Rohu, *Labeo rohita*, is a major indigenous aquaculture fish species of Nepal and its aquaculture practices has shift the supply of seed from river collected spawn to hatchery produced seed. Genetic degradation might be a consequence of products of hatchery due to repeated breeding with a limited number of effective parents ( $N_e$ ) to keep the production costs to a minimum. In order to quantify genetic variability among hatchery stocks and wild population for the establishment of base population, which would enable future selective breeding program, molecular marker (microsatellites DNA) was applied to rohu for the genetic assessment. Six polymorphic microsatellites were used to study genetic variation within and between populations of rohu from the five hatcheries and a river of Nepal. Allelic diversity was high ( $3.17 \pm 1.17/\text{locus}$ ) in hatchery stock of Geta, Kailali and hatchery stock of Tarahara had significantly lower ( $P < 0.05$ ) number of alleles per locus ( $2.66 \pm 0.52$ ). The observed ( $H_o$ ) and expected ( $H_e$ ) heterozygosity ranged from 0.10 to 0.18 and from 0.34 to 0.50, respectively and the differences are not significant ( $P > 0.05$ ) amongst the studied populations.  $F_{st}$  (0.2012) did show significantly population differentiation among the hatchery populations of rohu. Genetic distance among rohu populations fall above the conspecific taxa indicating the populations are congeneric which could be the result of low number of loci used in this study.

## Impact of Cross Dam on Faunal Diversity of Nepalese Fishes

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The present study is based on field visits, observations, interviewing local communities, sampling aquatic organisms, water quality analysis, secondary data collection, consultation with biodiversity experts and thorough literature reviews. The study recorded 220 cross dams at different phases of development at different locations in the river basis of the country. Comparative study of environmental impacts and effectiveness of mitigation measures in 13 cross dam projects were carried out, the result of which shows that all the dammed rivers are inhabited by *Tor putitora*, *Bagarius spp*, *Clupisoma garua*, *Anguilla bengalensis*, which are long distance migratory fishes. Of these four species, *Tor putitora* and *Bagarius spp* are listed under IUCN Red List as “endangered” and “near threatened species”, respectively. Similarly, several short distance species such as *Schizothorax richardsonii*, *Puntius chelynoides*, *Tor tor* and *Neolissochilus hexagonolepis* were also recorded in most of the rivers. Among these species, *Schizothorax richardsonii* is “vulnerable” as per the IUCN Red List and the *Neolissochilus hexagonolepis* is “near threatened.” It has been clearly indicated that population is adversely affected by the formation of cross dams, which is worth researching for estimating the percentage of reduction, confirming reasons and developing more appropriate mitigation measures through a comprehensive future study. It should also be taken into consideration that population depletion of fishes is not solely caused by dam. Other abiotic and biotic factors have also played role in the reduction of their population.

An attempt was made to map the integrated route of short and long distance migratory fishes in Nepalese rivers and found that the location of dams are not selected in reference to the cumulative impact on fish migratory routes. A map was prepared to project the migratory routes of two long distance migratory fishes *Tor putitora* and *Anguilla bengalensis*.

The study has recommended upgrading the existing aquatic animal protection policy and act of the government. The government should update almost two decades old environmental policy and regulation to make cumulative impact assessment a mandatory requirement of IEE and EIA studies. The regulation should also reverse the waiver of EIA for hydropower projects up to 50 MW capacity, and rather peg this with significance of impact. The study also recommends that Strategic Environmental Assessment (SEA) should be carried out for the important and relevant national policy, plan and programs including hydropower and irrigation policies and master plan, and IWRM policy. The study has also recommended establishing a National Aquatic Biodiversity Sub-Committee under the framework of National Biodiversity Conservation Committee for achieving collective support of all stakeholders supporting the government in policy making, and conducting independent monitoring of compliance in projects under construction or operation. An effective regional cooperation mechanism between Nepal, India and Bangladesh should be established to collectively conserve the valuable and threatened aquatic fauna by ensuring their trans-boundary movement for food and reproduction during their lifecycle. The study finally recommends for a follow up comprehensive study of aquatic biodiversity to establish a national level database, and develop measures so that a balance can be drawn between development projects and conservation of aquatic biodiversity.

## Mercury in Fish and Fisher Folks' Body in Nepal, Calls for Urgent Action

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Mercury (Hg) is a global pollutant. Methyl mercury primarily gets into the human body through the consumptions of contaminated fish and uses of other mercury based products. Large mercury, mercury based equipment and products imported and used in Nepal have become sources of dietary and occupational exposure among fisher folks, general public including child bearing age female and children, and ultimately loaded heavy pollution to the environment, especially to the aquatic ecosystems in Nepal. This paper aims to share new findings of mercury bio-monitoring in fishes, depending fisher folks and fish consuming female of child bearing age, raise awareness, identify specific hot spots, populations at risk of exposure especially fisher folks around the aquatic ecosystems of Nepal.

As a part of global campaign, CEPHED carried out bio-monitoring of fish and human hair about the presence of mercury in them. For study of Hg concentration in Fish and Human body all together 15 Fisher Folk's hair samples and 19 fish samples (15 from Phewa Lake and 4 from Kalimati, Kathmandu) were collected and tested for total mercury. The fish samples include six fish species namely; Tilapia (*Oreochromis niloticus*), Thulo Bhitte (*Puntius titus*), African Magur (*Clarias gariepinus*), Sahar (*Tor putitora*), Silver carp (*Hypophthalmichthys molitrix*) and Rohu (*Labeo rohita*). Similarly, 15 hair samples were collected from the Fisher's Folks of Khapaudi, Sarangkot, VDC-2, Kaski were included in the study.

The collected human hair samples and fish samples were tested at Biodiversity Research Institute (BRI), USA for total mercury using DMA-80. The DMA-80 is a direct mercury analyzer manufactured by Milestone. The bio monitoring of mercury in Fish found in Phewa Lake and depending Fisher folk's body in their hairs samples found to have mercury contamination in them. One-hundred percent of fish samples (15-Pokhara and 4-Kathmandu) contain mercury ranges from 0.003 to 0.242 ppm, all below US EPA reference doses (0.22 ppm) except 1 (5.26%). One-hundred percent of fisher folks' hair samples contain mercury ranges from 0.345 to 1.719 ppm. 53.3% of hair samples of fisher folk (8 out of 15) contain mercury higher than reference dose of 1 ppm of mercury is shocking and alarming results and urgent calls for actions from all concerned especially the government (CEPHED, IPEN and BRI 2012). Another bio-monitoring study of mercury in the 20 female of child bearing age from different part of Nepal but currently residing in Kathmandu Valley, mercury contamination in them were ranges from 0.11 to 1 ppm (CEPHED and ZMWG 2013).

This studies confirmed mercury contamination in fish and depending fisher folks and other fish consuming child-bearing age of female in Nepal. Though the current level of mercury contamination in fishes is not alarming but level among Fisher Folks and other human hair is increasingly alarming but high possibility of increased and repeated sources of mercury in fish and fish item are proved to be sources of mercury exposure to peoples and high toxic mercury load to surrounding environment calls for urgent action by all and especially the professional associations and Government of Nepal. Early ratification of Minamata Convention on Mercury thus protection and preservation of public health and aquatic ecosystems in Nepal will be the first priority.

## **Effect of Different Feeds on Growth and Survival of Gardi (*Labeo dero*) Fry**

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Gardi (*Labeo dero*) is a native fish species that is relatively easy to breed and rear, thus considered to be suitable for aquaculture. Fry rearing is one of the important phase and aims at obtaining high growth and survival for production of fingerlings required for stocking into grow out ponds as well as rehabilitation in natural habitat. Past study had showed gardi could accept artificial food in captivity however, specific studies on different composition of feed and dietary evaluation is limited. Therefore, this study was carried out to evaluate the effect of three different formulated feeds on growth and survival of gardi fry for farming in pond and other aquaculture systems.

The experiment was conducted in 2 m<sup>2</sup> size hapa (2m x 2m) fixed in pond. Fry (mean body weight 0.01±0.01 g to 0.03±0.01 g) were stocked at 200 no per hapa (10,00,000 no/ha) with two replicates per treatment. Three different formulated diets (micro feed, powdered milk with egg and soya milk) were provided adlibitum to fry over a period of 45 days. Water temperature in ponds ranged from 29.0 to 30.0 °C during study period. Survival was greater than 64 % in all treatment with no significant differences ( $p>0.05$ ) observed among treatments. There were also no differences ( $p>0.05$ ) in relative growth rate (RGR 2.10 g -2.23%) of the fish among treatments. Significantly highest ( $p<0.01$ ) body weight gain were observed with fry fed with micro feed (0.523±0.080 g) followed by powdered milk with egg (0.400±0.029 g) and soya milk (0.330±0.034 g). The result suggested that there was an apparent effect of different diets at the level tested on body weight gain but gardi fry prefer micro feed containing high protein preferably of more animal origin in early stage.

## **Improving National Aquaculture Seed Production System in Nepal**

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Nepal being land locked has only fresh water aquaculture and aquaculture contributed 63% in national production last year. Aquaculture is limited to pisci-culture. Pond aquaculture is the major culture system contributing nearly 90% in aquaculture production. Poly-culture of carp is major aquaculture practice in ponds. Carp contribute more than 95% in total aquaculture production in Nepal of which 70% is contributed by exotic species. Seed supply was responsibility of Government in the initial stage. Insufficiency in seed production at government hatcheries led to import of carp seed from India through vendors and fish seed traders. However, with Government support program establishment of private hatcheries in the country has changed the scenario and country can boost of being self sufficient in carp seeds. There are 54 private and 14 public hatcheries. In addition, there are around 222 private fish nurseries and 20 commercial fish traders. Private sector contributed nearly 81% in the carp seed supply in the year 2012–13. However, there is a regional imbalance in the distribution of hatcheries as a result there is surplus and deficit regions. Recently, Government has encouraged establishment of hatcheries in the deficit region with financial support. Moreover, Government has also encouraged establishment

of private nurseries for easy accessibility for carp seeds to farmers. Carp breeding program continues with the stock introduced in Sixties and Seventies and seed supply is entirely dependent on the hatchery production. The fish breeding program had ignored the genetic aspect resulting in stock degradation. Thus, the major concern for carp seed at present is not the quantity but quality. Quality concerns were shown by farmers and the issue was recognized by the Government and works were initiated with two year TCP (2011–12) support from FAO to improve the carp seed quality. TCP helped in establishment of national regulatory system for managing and monitoring fish seed production and establishment of well structured national fish seed production system. Similarly, it helped in Improving genetic quality of existing broodstock of major carp species and strengthened human resource base in the field of fish genetics and seed production. The initiative to improve the genetic quality of brood stock was through introduction and maintenance of fresh germplasm from the place of origin, selective breeding, cross breeding, use of cryomilt and other methods of stock improvement. Similarly, to regulate the seed quality fish seed acts and regulations are drafted. Fish seed production and distribution system was developed to ensure both quality as well as quantity of the carp seeds. Registration of hatcheries and nurseries, seed certification, and effective quarantine measures were considered essential to ensure seed quality. However, the foundation has been laid and works initiated but needs special attention in order to insure quality seed production and distribution in adequate quantity in the future.

### **Effect of Aeration in Pond on Oxygen Transfer and Fish Production**

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The effect of two propeller paddle wheel aerator (0.75 KVA) on diurnal oxygen fluctuation, and growth and production of carp under polyculture fish farming in pond was carried out at Regional Agriculture Research Station, Tarahara. Fingerlings of common carp, silver carp, bighead carp and grass carp with an average weight of 53 g were stocked at two density 15,000 and 20,000/ha for aerated and unaerated conditions. Paddle wheel aerator was found effective to transfer oxygen by 2.2 to 3.4 mg/L and 0.7 mg/L in pond bottom and surface, respectively, after 2 hours of aeration at dawn. Diurnal and seasonal dissolve oxygen was high in aerated ponds. Survival of fish at harvest between aerated and unaerated ponds was not significantly different ( $p>0.05$ ). Pond aeration has resulted in 7,935 kg/ha and 5,466 kg/ha net fish production which was 27.1% and 26.4% more fish production than in unaerated ponds, respectively, at 15,000/ha and 20,000 fish/ha stocking density. Mean feed conversion ratio (FCR) was 15.9% lower in aerated ponds compared to mean FCR of 2.68 kg in unaerated ponds. Net profit generated by aeration for polyculture fish farming in pond was 64.6% and 82.5% over the unaerated ponds at fish stocking density of 15,000 and 20,000/ha, respectively. Further research on timing and amount of aeration at various initial fish biomass with species combination in pond and feed management has been suggested to maximize profitability from aerated pond.

## **Spawning Response of Sahar (*Tor putitora*) in Different Seasons Under Pond Reared Condition in Pokhara, Nepal**

**Jay Dev Bista, Bharat Shrestha, Ram Kumar Shrestha, Surendra Prasad, Agni Prasad Nepal, Arun Baidya, Suresh Kumar Wagle and Tek Bahadur Gurung**

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Sahar (*Tor putitora*) formed a substantial natural fishery in the major riverine and lacustrine ecosystem of Nepal. Two species of *Tor* (*T. putitora* and *T. tor*) are inhabitant in major river systems of Nepal. Biological diversity of this species is being threatened by various anthropogenic activities. In view of the conservational value and the aquaculture potential of *T. putitora*, significant development in artificial propagation of this species has been achieved. Studies on reproductive behavior of Sahar (*Tor putitora*) reared in the ponds were conducted at Fisheries Research Centre (FRC), Pokhara from last few years to assess the seasonal reproductive behavior and spawning success rate. During September 2011 to March 2012 breeding response of Sahar was observed at Fisheries Research Centre, Pokhara where 100 female and 200 male brood fish were reared in 500 m<sup>2</sup> sized three earthen ponds separately. Without any reproductive hormone use, twenty percent female responded to spawning and only 6% female released 378 g viable eggs during autumn season (early September to early December 2011) at water temperature ranges from 19.0-23.0°C. While all the female (100%) responded to spawning and 42% female produced 2,265 g viable eggs during spring season (late February to late March 2012) at 20.0-24.0°C water temperature. The fertilization and hatching rate of sahar eggs ranges between 70%-95% depending on the season. Individual female mature fish can normally release eggs two times in a year. It was recorded that in all months of the year except January Sahar can release eggs under cultured condition. These results indicated that its spawning behavior is an intermittent, can breed in most of the season. Maturity of male Sahar can attain in one year even the body size less than 50 g but female fish only get maturity at the age of 3<sup>+</sup> years only. There was no post spawning brood mortality observed during hatchery operation in both season.

## **Efficacy of An Eco-friendly Anaesthetics Clove Oil During Simulated Transportation of Rohu (*Labeo rohita*)**

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The use of anaesthetics becomes essential in the transportation medium in mitigating physiological stress and reducing metabolic rates. Clove oil is a highly effective fish anaesthetic with no side effects. An experiment was conducted to study the efficacy of clove oil as an anaesthetic for the transportation and handling of rohu fry. The concentrations of clove oil tested were: 0.025ml L<sup>-1</sup>, 0.05 ml L<sup>-1</sup>, 0.075ml L<sup>-1</sup> and 0.1ml L<sup>-1</sup>. The induction time was decreased with increased concentration of clove oil. The lowest effective dose of clove oil that produced induction in 3 min or less and recovery times in 5 min found was 0.05ml L<sup>-1</sup>. The effective dose 0.005ml L<sup>-1</sup> of clove oil was found suitable for transportation of rohu advanced size fry. Mortality rate often used as the indicators of the tertiary stress was higher (14.4%) in control (without clove oil) than the sedative dose (Clove oil 0.005ml L<sup>-1</sup>) during simulated transportation of rohu fry in the packing of polyethylene plastic bag with oxygen. We concluded that clove oil is promising to be used as anaesthetics for handling and transportation in rohu (*Labeo rohita*) advanced fry.

**Cost-Benefit Analysis of Rainbow Trout Commercial Farms —  
A Case Study of Kaski District, Western Development Region, Nepal**

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Within one and half decades of its technology introduced in private sector, the rainbow trout (*Oncorhynchus mykiss*), farming has covered 22 midhill and mountainous districts with emerging demand of technology in feasible areas. Furthermore, there is a promising growth of trout farms in Western Development Region. All together 14 farms in 6 districts have been established in this region by 2014. This paper deals with the cost-benefit analysis of two commercial farms established in Kaski district, i.e., Gandaki Rainbow Trout Farm (Gandaki Farm) and Chhetradip Annapurna Trout Fish Research and Development Pvt. Ltd. (Chhetradip Farm). Case studies of both farms were carried out during December 2014. The analysis was based on feed efficiency, feed conversion ratio (FCR) and data recorded for annual operational costs expended to produce average marketable size (200 g) fish in each farm. Findings of the study indicate that it takes 9-10 months to reach 200 g at Gandaki Farm, where as 12-13 months to harvest this size at Chhetradip Farm, growing from free swimming larvae. Growth difference attributes to the water temperature and quality of feed. However, both farms are supplying a locally prepared about 35% CP containing pellet feed formulated by same type of ingredients. The result shows that it costs about NPR 520.02 and NPR 504.13 to produce one kilogram of trout at Gandaki Farm and Chhetradip Farm, respectively. The opportunity cost such as household labour and interest of operational cost has not been included in analysis. The feed efficiency and FCR remained 45.7% and 1:2.2, respectively at Gandaki Farm and 40.0% and 1:2.5, respectively at Chhetradip Farm. The rate of return on operational cost remained significantly higher ( $p>0.05$ ) at Chhetradip Farm (NRS 40.86) than Gandaki Farm (35.82). Improvement in issues related to supply of quality seed, feed, health management and extension system would certainly boost up the commercial trout farming in Nepal, which is one of best solutions for improving standard of living of the rural people by generating income and employment opportunities through coldwater aquaculture.

**Problem Assessment of Red Bloom Fish Pond**

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Red-blooming in fishpond has becoming a common problem in Nepal. The red-bloom concentrate as a scum at the water surface, which gives unpleasant look, inhibit photosynthesis and cause water quality problems such as depletion of dissolved oxygen, and low fertilizer response of green-algae. A study was conducted in three different sites of Chitwan district, based on field survey and water quality monitoring, to find out the status and causes of red-blooming in fishpond. Physical, chemical and biological parameters of red-bloomed and normal pond water were monitored in four different seasons. Severe red-blooming in fishponds was observed in the Southern part of Chitwan compared to other parts, where water was more stagnant, un-drainable and came from under-ground source. Water quality analysis showed that the total phosphorous and total nitrogen contents were significantly higher in red-bloomed fishpond than normal



fishpond. In red-bloomed fishpond, the red algae *Euglena sanguinea* dominated over other phytoplankton species. The present study showed that the red-blooming in fishpond might be caused by the red algae *Euglena sanguinea*, which is more common in organic-loaded and stagnant water.

## POSTER ABSTRACTS

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### **A Morphometric Study on Asala (*Schizothorax richardsonii*) from Rivers of Nepal**

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Asala or snow trout (*Schizothorax richardsonii*, Cyprinidae), one of highly valued freshwater fish of Transhimalayan regions, is distributed in upper reaches of all major river systems of Nepal. It has been hypothesized that differences between habitats (e.g. flow regime, foraging opportunities) might create selective pressures resulting in morphological divergence between intraspecific populations. Morphometric diversification between five river populations of asala (Sabha Khola, Melamchi River, Tadi River, Phalakhu Khola and Khudi River) was examined to identify intraspecific unit for enabling better management and perpetuation of the resources. Significant differences were observed in 17 measured morphometric characters of 180 specimens among the five populations. Multivariate analysis of variance (Wilks' test) indicated a significant difference for mean vectors of morphometric measurements ( $\lambda = 0.0104$   $F_{68,598} = 19.376$ ,  $p < 0.001$ ) among populations. The first discriminant function (DF) accounted for 88.2% and the second DF accounted for 7.3% of the among-group variability. Plotting of principal component factors and DFs of morphometric measurements revealed high isolation of the stocks. The analysis showed that most of the shape variation among these populations occurs in the head region, body depth and fin length. The characters that best discriminated the river populations of asala were associated with locomotion patterns and foraging behavior of fish. The asala may be phenotypically plastic in response to the environmental conditions of the habitat of each population.

### **Assessment of Optimum Feeding Rate on Growth and Production of Carp Polyculture in Nepal**

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Polyculture of carps was done in fertilized earthen ponds to identify appropriate feeding rates. The present work was conducted at Central Fisheries Building, Balaju, Kathmandu, Nepal to assess the growth performance and production of common carp, silver carp, bighead carp and grass carp polyculture during 28 August 2013 to 5 January 2014 for 128 days. The experiment was carried out in 3 earthen ponds, which are partitioned into 12 experimental units by nylon net with size of 129-138.7m<sup>2</sup>. The experiment consisted of four treatments with three replications in Completely Randomized Design (CRD). Treatments were: feed at 2% of fish body weight (T1), feed at 3% of fish body weight (T2), feed at 4% of fish body weight (T3) and No feeding (control) (T4). Common carp, silver carp, bighead carp and grass carp were stocked at the ratio of 40:30:15:15 with combined stocking density of 1.5 fish/m<sup>2</sup>. Ponds were fertilized by urea and diammonium phosphate to provide 0.15g N/m<sup>2</sup>/day and 0.05 g P/m<sup>2</sup>/day (3:1 N: P ratio) in fortnightly interval. Fish were fed daily between 9 and 10 a.m., with a locally made pelleted feed

(22% crude protein) six days a week. Feed rations were adjusted monthly based on sampling weights. Water temperature, dissolved oxygen, pH and sechi disc visibility ranged from 15.1-27.6°C, 2.2-5.9 mg/L, 6.8-7.6 and 17.3-25 cm respectively. The overall mean survival rate for all species ranged from 87% to 92.6 %. Total fish production ton/ha/year was 2.66, 3.69, 3.61 and 1.98 in T1, T2, T3 and T4 respectively. The rate of return was 342.1% in T1, 368.2% in T2, 198.1% in T3 and 3,045.2%. Total net yield (ton/ha/year) was significantly higher ( $p<0.05$ ) in T2 (3.69) than T1 (2.66) and T4 (1.98) where as T2 (3.69) and T3 (3.61) are statistically similar ( $p>0.05$ ). Feed conversion ratio was 1.18, 1.16 and 1.85 in T1, T2 and T3 respectively. Overall growth and production performance of all carps were very encouraging in total production. Thus, among the four different feeding levels, T2 (3% feeding rate) treatment showed optimum rate for better growth and production of carps.

### **Chhadi Fish Farming, A Modified Carp Poly Culture System for Enhancement of Pond Productivity**

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Recently a study was carried out in Bara district with the purpose to find out the existing Chhadi fish production, marketing system and its role in livelihood enhancement of farmers community. The small size fish weighing 40-50 g each (mostly dominated by *Cirrhinus mrigala*) usually preferred by Cottage restaurants, consumers as a single piece recipe is commonly called as Chhadi fish. There are several benefits of Chhadi fish farming, it has short culture period and fast rate of return with the higher productivity as compare to existing carp farming. Likewise, it has well established market and supported for food and nutritional security, livelihood improvement, income and employment generation as well as import substitution.

Based on the survey report the pre-stocking management practices seems almost similar as existing carp polyculture farming. After final preparation of pond, the Chhadi fish growers do stock Naini (*Cirrhinus mrigala*) hatchling at 12,000,000/ha when rainy season starts, mostly on June and July. This stocking further supported by addition of 10% rohu (*Labeo rohita*) hatchlings. The stocked hatchlings are fed with de-oiled cake and rice bran (with equal proportion) at 60 to 75 kg/ha/day, where DAP and Urea is applied on weekly basis at 5 and 7 kg/ha respectively. The first harvest starts just after 3 months when the fish reached at marketable size (40-50 g). The next production cycle starts on November when 80% biomass of first production cycle harvested. The un-drained pond then limed at 150 kg/ha and fry of naini and rohu (naini 90%, rohu 10%) are stock at 150,000/ha. The similar cultural practices are followed in second production cycle. During culture period, the marketable fish are harvested frequently as per the demand. The third production cycle start in the same undrained pond by stocking large size fingerling (10-20 g) at 60,000/ha. Feeding, fertilization and management are done regularly and partial harvesting practices followed starts just after a month until final harvest is completed when rainy season starts. The fresh Chhadi fish are sold to the traders at NRS 160-180/kg then after they are marketed to Kathmandu, Pokhara, Narayanghat, Mugling and Malekhu. Based on the intensification and level of input application, the overall productivity has reported 12 Mt/ha from three production cycle where net benefit was found NRS 600,000/ha annually. The share of Chhadi fish on national fish production is almost 10% by producing 4,000 mt annually. Moreover, its share on fresh fish in Kathmandu market has been reported to be about 25%. High

productivity, fast return of investment and market demand makes it potential fish farming technology in Nepal.

### **Comparison of Fish Growth and Yield from Different Models of Integrated Fish Farming in Chhatrephat, Nuwakot**

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Integrated Agriculture Aquaculture (IAA) combines aquaculture with different agricultural systems into an interactive relationship to generate synergistic effects on conservation of resources and profitability. Several forms of aquaculture integration with livestock, vegetables and grass have been spontaneously practiced by farmers in small scale. In order to understand the synergy between components of IAA for economic utilization of scarce land resources and productive utilization of byproducts from agricultural activity into aquaculture, participatory research and development activities on different models of IAA have been initiated at Chhatrephat, Nuwakot. This report emphasizes the preliminary findings on the effect of pig, vegetables and grass integration with aquaculture on fish growth and yield. Mean weight of fish at harvest (432.7-380.0 g), gross (5164-4765 kg/ha) and net fish yield (4,588-5,164 kg/ha) and survival rates (77.9%-80.4%) all were significantly high ( $p < 0.05$ ) from integrated ponds compared to non-integrated pond (319.4 g, 3,536 kg/ha, 3,388 kg/ha and 69.6%, respectively). Grass carp alone contributed 58.7% and 50.9% of the total fish yield from grass-fish and vegetable-fish integration system, respectively. Bighead carp was the principal species contributed 32.3% in total fish yield from pig-fish integration. Performance of common carp was inferior among all fish species and integration models in terms of harvest weight (154.7-376.6 g), survival rate (69.6%-80.4%) and contribution to yield (8.3%-21.7%). A general conclusion may be that fish integration with livestock and agriculture crop in pond could enhance fish productivity by 35% to 47%.

### **Effect of Different Protein Sources in Feed on the Growth and Survival of Rainbow Trout Fry**

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Expensive fishmeal and shrimp remains the major dietary protein sources of the trout feed. Research effort has been expanded on evaluating the suitability of locally available ingredients of animal origin as complete or partial replacement of the fishmeal or shrimp components in trout diet. Experiments were conducted for the two consecutive years on the response of three different feed formulations viz shrimp based (conventional, 42.8% CP), silkworm pupae based (39.8% CP) and synthetic amino acid supplement in conventional feed (41.7%) on growth and survival of trout fry. Trout fry with mean individual size 0.26 g were stocked in 0.09 m<sup>3</sup> nursing cages at density of 500 fry/cage, and fed respective formulations six times per day up to satiation. Fry growth rates of 32.7 mg, 29.7 mg and 28.7 mg per day, respectively, for shrimp, silkworm pupae and synthetic amino acid were not significantly different ( $P > 0.05$ ). Differences in survival rate (67.7 to 74.8%, final weight of trout fry (2.87 to 3.22 g/fish) and yields (1.02 to 1.09 kg/cage) at

the end of three months of growing period were also not significantly different ( $P>0.05$ ) among different formulated feeds. Synthetic amino acid supplemented feed exhibited significantly ( $P<0.05$ ) lowest feed conversion ratio (FCR, 0.91) in comparison to the FCR of silkworm pupae (1.36) and conventional feed (1.40). The results of the present study and considering the cost of formulations suggested that the silkworm pupae could be used to completely replace shrimp based conventional feed in the area where it is available for the rearing of trout fry.

### **Integration of $\beta$ -carbonate Enriched Orange Sweet Potato in Aquaculture for Enhanced Nutrition Accessibility by Small Fish Farmers**

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Cultivation of elite  $\beta$ -carotene enriched orange sweet potato genotypes in the dikes of the fish ponds of the small fish farmers under the Agriculture and Nutrition Extension Project (ANEP)'s action research command areas of Rupandehi and Nawalparasi districts of Nepal were explored. The objective of the study is to evaluate the elite orange sweet potato genotypes for high yield and adoptability so that the small fish farmers, thereafter, can integrate orange sweet potatoes in their pond dikes and hence their nutrition accessibility enhanced.

Three-nodded stem cuttings of four elite orange sweet potato genotypes CIP 440015, CIP 440021, CIP 440185 and CIP 440267 along with a standard check, Japanese Red, were planted in pond dikes of fish farmers in Tareni, Patkhauri-1 and Shankarpur, Siktahan-7 of Rupandehi district and Bhatauliya, Jahada-9 and Dhanewa, Jahada-3 of Nawalparasi district. Eighty cuttings each of a genotype were planted in a farmer's pond dike, considering each village as a replication. The pooled yield data in terms of tons per hectare were analyzed in RCBD with MstatC and the raw and cooked roots were evaluated by the farmers themselves.

Harvesting of sweet potato plants about six months after planting revealed that CIP 440021 yielded highest marketable storage roots (50 t/ha,  $p<0.001$ ). After harvesting, evaluation of sweet potato storage roots revealed that appearance of CIP 440185 (57%), skin color of CIP 440015 (77%), raw flesh color of CIP 440267 (67%), and cooked flesh color of all orange sweet potatoes were liked by most of the farmers ( $>52\%$ ). Raw taste of CIP 440267 was highly appreciated (81%) followed by CIP 440185 (57%) and CIP 440021 (53%), following the similar trend in cooked taste and texture. Based on these findings, CIP 440021 and CIP 440267 were recommended for the cultivation in the fish pond dikes of Rupandehi and Nawalparasi districts.

## **Limnology and Aquatic Biodiversity of Trishuli-Narayani River System**

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Limnological and aquatic biodiversity of Trishuli-Narayani River system was carried out from headway of Trishuli River (Rashuwa Gadhi, 2400 msl) to confluence of Kali Gandaki and Narayani River (Devghat Chitwan, 84 msl) during September 2012 to April 2013. Water temperature was low (9.3 °C) in upper reaches of Trishuli River and gradually increased to 29.6 °C in confluence of Kali Gandaki and Narayani River. Water pH varied between 6.5-8.2, conductivity 10.2-534.0 µS/cm, dissolved oxygen 7.4-12.5 mg/L, total alkalinity 25.0-190.2 mg/L, total hardness 0.0-320.0 mg/L, total phosphorus 0.004-0.177 mg/L, soluble reactive phosphorous (PO<sub>4</sub>-P) 0.0-0.177 mg/L, ammonium (NH<sub>4</sub>-N) 0.0-0.007 mg/L and nitrite+nitrate (NO<sub>2</sub>-N+NO<sub>3</sub>-N) 0.003-0.087 mg/L. Thirty-two species of phytoplankton belonging to six orders was recorded. Bacillariophyceae dominates the phytoplankton list with 19 species followed by seven species of Chlorophyceae, and Dinophyceae and Chrysophyceae was represented by only one species. Thirty-seven species of zooplankton belonging to four groups were identified. Rotifera was the major group of zooplankton comprised of 17 species and copepoda was represented by least number (four) of zooplankton. Forty species of fish belonging to 3 orders and 9 families were recorded from the Trishuli-Narayani River system. The order Cypriniformes constituted the highest number of fish species (70%) followed by Siluriformes (20%) and Perciformes (10%). Among the fish identified, according to IUCN species red list four species were vulnerable and six species were rare.

## **Nursing Performance of Gardi (*Labeo dero*) Fry in Captive Environment**

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Gardi (*Labeo dero*) is one of the important indigenous fish species contributing livelihoods of people in mid-hill region of Nepal. Low recovery during nursing from hatchling to fry stage constrains its farming on a commercial scale. Therefore, this study was conducted to find out the possibilities of raising recovery rate of gardi hatchlings fed with supplementary feed versus natural food developed in pond by fertilization. Gardi hatchlings were stocked at a density of 100 larvae/m<sup>2</sup> in six experimental hapas (2m x 2m x 2m size) fixed in same pond. Ponds were fortnightly fertilized with 12.8 kg N/ha and 9.2 kg P/ha by urea and di-ammonium phosphate, respectively to develop natural food. Micro feed was provided 3 times a day as supplementary feed. The results revealed that fry fed with supplementary feed demonstrated significantly ( $p<0.05$ ) higher recovery (92.03%) and net weight gain (0.78 g) compared to recovery (69.33%) and growth (0.47 g) of fish raised on natural food in 70 days nursing. Water temperature ranged from 27.4-29.0 °C during experimental period while other water quality parameter was within normal range. This successful nursing technology would help the availability of increasing the number of fry in the future for its commercialization.

**Observation on the Performance of Wild Jalkapur  
(*Pseudeutropius murius batarensis*) Fry in Ponds at Trishuli**

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Jalkapur (*Pseudeutropius murius batarensis*) is distributed in snow-fed River of mountain regions of Nepal, northern India and Bangladesh to a lowest altitude of 570 m. It is indigenous valuable migratory fish species popular for its taste, food value and sporty nature. Its natural populations has been reported to be declined from various natural habitats due to anthropogenic activities and habitat destruction, and the species falls under threat category. In view of the conservational value and the aquaculture potential of jalkapur, domestication efforts have been initiated at Fisheries Research Centre, Trishuli. Jalkapur fry with an average weight of 1.0 g were collected from Trishuli River and reared in 8 m<sup>2</sup> earthen ponds, which continuously receives water from Trishuli River. Fry was fed with trout crumble feed, earthworm and white groves, and boiled flesh of tilapia was also provided as an alternate feed. Preliminary observation revealed that the optimum temperature for the growth and survival of jalkapur ranged from 18.0°C to 23.0°C and the lowest temperature for survival is 14.0°C. Fry survived and grew well at 6.5 to 8.6 mg/L of dissolved oxygen and 6.5 to 7.5 pH of rearing water. Refusal to feed and fish mortality was observed at temperature below 12.0°C during November to January. Fish became highly vulnerable to fungal infection at low water temperature (<12.0°C) and over handling of fish during winter months synergized the mortality. Mean body weight of fish reached to 80.0 g with a mean growth rate of 0.24 g/day for a rearing period of 11 month. Environmental manipulation (temperature control) and feed development for the rearing of jalkapur in captive conditions will be the focus area for research.

**Pellet Fish Feed Production and Management for Intensive  
Aquaculture Development in Nepal**

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Being an agricultural-based country, Nepal has a number of agricultural by-products that can be used as animal feed to reduce the feed cost but formulation of quality feed is the difficult task due to the unavailability of quality feed ingredients and large variation in nutritional value of major feed stuffs available in different agro-ecological region of the country. More than 45% of the total global aquaculture production is dependent upon the supply of external feed inputs, which occupied more than 70% of total production cost. Demand for quality Pellet fish feed has increased in recent years with the commercialization of trout farming as well as large-scale carp and catfish farming.

Pellet feed can be prepared by using single, double or more ingredients mixture. Fine grinding of materials is the best binding of pellet and can use external binder for better water stability to utilize for a longer time inside the water. Presently some private feed industries are producing Sinking and floating pellet feed for fish inside the country.

Feed competition among animal husbandry and human is one of the limiting factors and non-plant source of protein such as shrimp meal and fish meal contribute 20-50% to supply protein in aqua feed and subject to import from abroad. 60% substitution of shrimp meal with soybean is possible and reduces feed cost by about 40% without affecting the growth and feed efficiency in trout farming. Cost effective Pellet feed can produce by improving palatability and digestibility of raw ingredients to reduce the food conversion ratio (FCR) then feed cost. High cost usually associated with the inclusion of high level of animal protein source in pellet feed to meet the dietary requirement of different fish species.

For the substantial growth of commercial and intensive fish farming production of floating and sinking pellet fish feed in private sector is indispensable and government should provide some necessary support in terms of technical, quality control, taxation and investment measures. Research on processing techniques and, additives and enzymes for improving feed performances and digestibility are required.

**Preliminary Observations on Breeding and Fry Rearing of Pangas  
(*Pangasius hypophthalmus*) at Eastern Region of Terai**

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River catfish (*Pangasius hypophthalmus*) locally known as pangas is one of the major food fish species with its highest productivity in culture system. In recent years, fish farmers of Nepal have shown interest to grow this species in ponds aiming to increase profitability and satisfy ever increasing market demand for fish. Seeds (fry) of this fish is not readily available and the technology of seed production has not been well adopted and verified in the country. Attempts were made on breeding and fry rearing of pangas at RARS, Tarahara and observations were made on reproductive and nursing characters and performance. Pangas matured at 3<sup>+</sup> year age in pond environment and spawning season observed was early June to September when water temperature ranged between 26°C to 31°C. Gonado-somatic index during spawning period estimated was 17.5±4.1% and fecundity ranged between 117,000 to 153,000 eggs/kg spawner. Ovulin (LHRH-A) at dose 0.5 ml/kg spawner was found effective to induce spawning after 8-14 h of latency period. Mean fertility rate and hatching rate from five breeding episodes estimated was 90.1±5.9% and 73.2±11.6%, respectively. Post-hatching survival of larvae was poor (<5% within 48 h) due to high cannibalism. Day-old larvae stocked at low density (0.6 million/ha) in rotifer enriched nursery pond and fed with a custard egg and soya powder at early days and later fed with carp fry diet resulted in 18.3% survival of fry with growth rate of 0.2g/day in 45 days of rearing. Concentrated studies on nursing management synchronized with live food production in nursery ponds for pangas larvae have been suggested.



## **Prospects and Status of Rainbow Trout (*Oncorhynchus mykiss*) Farming in Rasuwa District**

**Arjun Bahadur Thapa and Prem Timalisina**

Fisheries Research Station, Dhunche, Rasuwa

Email: arjunbdrthapa@yahoo.com

Nepal basically a mountainous country (83% of its area covered by hill and mountain) and possess tremendous free flowing unexploited coldwater resources, a huge opportunity for the production of high value coldwater fishes. Coldwater fisheries had been less prioritized in past due to poor infrastructure, representation, suitable technical packages on fish culture program in mid-hills and higher mountains. Fisheries in high altitude mountain could be commercialized with comparative advantages, as the fisheries products from Himalaya could be easily branded for marketing by producing huge amount. More than a decade of continuous and untiring efforts by Nepal Agricultural Research Council (NARC) with JICA's support complete technology package of rainbow trout (*Oncorhynchus mykiss*) farming has been generated. Nuwakot and Rasuwa districts and by now is already well established by farmers of 24 districts. So Rasuwa is one of the leading and potential Himalayan district for tourism as well as water resources and wider ranges of biodiversity due to its altitudes 314-7,134 MSL. There are many rivers like; Trisuli, Bhotekoshi, Falaku, Langtang, Chilime, Mailung, Narsing, Ghatte Khola and its tributaries with many spring waters and falls. There are many lakes (Kaunda) in this district. Supporting by "Himali Project" with high subsidized investment agriculture farming is emerging rapidly. Rainbow trout farming is one of them. There are 13 grower farmers and two hatchery farmers have already been established and being increased in this district. There is a felt need of promotion of well proved high-production technology of rainbow to increase the supply of animal protein in the daily diet ultimately improving the health and the livelihood status of people; generate income employment for the rural poor, as well as promoting more ecologically balanced use of land and water resources. Farmers are visualizing Rasuwa Gadi point for exporting the product to China by branded with "Product from Himalaya," which has already been initiated.

## **Quality of Fresh Fish Preserved in Different Containers for Transportation**

**Neeta Pradhan<sup>1</sup>, Madhav Shrestha<sup>2</sup>, Achyut Mishra<sup>3</sup>, Suresh K. Wagle<sup>1</sup>  
and Prashansa Shrestha<sup>3</sup>**

<sup>1</sup>Fisheries Research Division, Godawari

<sup>2</sup>Agriculture and Forestry University, Rampur

Food Research Division, Khumaltar

<sup>3</sup>Agriculture Engineering Division, Khumaltar

Email: neetapradhan2015@yahoo.com

Three different types of container, high density plastic box (PB), Styrofoam box laminated with wooden plate with valve for water discharge (FWB) and plain Styrofoam box (SB) was selected for storing the fresh fish. Twenty-four hour starved *Cyprinus carpio* (mean weight 500-700 g) was stored at 10.0 kg/box in each test container with 1:1 ice fish ratio. Temperature (°C) was recorded at every two hour interval. Total plate count (cfu/g), Total volatile base nitrogen (TVN), peroxide value (Meq/kg) of the stored fish was made for 96 hour of storage at eight hour interval. FWB showed high insulation ability in maintaining chilling temperature ( $-0.16 \pm 0.5^{\circ}\text{C}$ ) than the insulation ability of PB ( $-0.09 \pm 0.7^{\circ}\text{C}$ ) and SB ( $1.7 \pm 4.4^{\circ}\text{C}$ ) containers. Ice melting was rapid in PB while slow melting was observed in FWB container. The highest value of Total plate count (TPC) ( $19000000 \text{ cfu/g}$ ) was observed in PB at the end of the experiment. Highest value of

peroxide level was 10.72 meq O<sub>2</sub>/kg in PB container at 96 hour of storage. The results indicated that the container FWB could be promoted in future for storage and transportation of fresh fish as it demonstrated the ability to maintain chilling temperature, slower down the growth of microbes and raise of peroxide value.

### **Small Scale Aquaculture Technology to Enhance Fish Production in Nepal: Action Research Outcomes**

**M.K. Shrestha, R.N. Mishra, S.K. Wagle, S. Rai, N. Bhattarai and L. Karki**

Department of Aquaculture, Agriculture and Forestry University,

Rampur, Chitwan

E-mail: madhavshrestha1954@gmail.com

An action research was carried out in Nawalparasi and Rupandehi districts as a supplementary component of Agriculture Nutrition Extension Project (ANEP) funded by WorldFish Bangladesh. The project has been supporting the project mission to develop carp-SIS culture models to small-scale farmers for family nutrition considering the necessity to demonstrate and evaluate carp-SIS culture system in farmers' field with their participation. The experiment was conducted in 2x2 factorial Randomized Completely Block Design (RCBD). There were four treatments and each had five replicates. Treatments include T1 (Carp + SIS in seasonal pond), T2 (Carp + SIS in perennial pond), T3 (Carp in Seasonal pond) and T4 (Carp in perennial pond). Pond dikes were used for seasonal vegetables production and nutrient rich orange flesh sweet potato. Results of this study revealed that SIS did not affect the growth and production of fishes. Moreover, the overall production was higher with SIS due to their niche utilization and feed utilization. There was no significant effect of ponds type because both perennial and seasonal ponds were new and only fish stocked first time so the perennial ponds were not more fertile than seasonal ponds. Results of this action research indicated that per capita fish consumption could be increased from 2.6 kg/person/year to 6.7 kg/person/year resulting in increased per capita protein supply by 157% (i.e., from 0.85 g/person/day to 2.2 g/person/day). On the other hand, pond dike vegetable cultivation technology contributed 34.6 g/person/day to the total per capita vegetable consumption. At the mean time, small scale aquaculture technology became able to generate on an average additional household income of NRs 6,066 ranging from the minimum of NRs 3,000 to a maximum of NRs 14,000.

### **The Efficacy of Clove Oil As An Anesthetic for Use on Fingerling of Common Carp, *Cyprinus carpio***

**Anita Gautam, Suresh K. Wagle, Prakash Kunwar**

Fisheries Research Division, Godawari, Lalitpur

Email: ganita\_2014@yahoo.com

Anaesthesia is essential to minimize stress and physical damage during handling of fish in captivity. To evaluate the effects of different concentrations and exposure time of clove (*Eugenia caryophyllata*) oil on the anesthesia and recovery stages of common carp (*Cyprinus carpio*) fingerling weighing 4.4±0.7 g were studied via immersion method. Induction time in common carp fingerling exposed to nine concentrations of clove oil (100 mg/L to 500 mg/L at 50 mg intervals) was determined. Clove oil appears to be highly effective as an anaesthetic with no side effects to both fish as well as humans. An induction time of less than or equal to five minutes, and

a complete recovery in ten minutes was used a basis to record the anaesthesia stages for different doses. The onsets of individual phases of anaesthesia and recovery stages were also studied. Concentration of 250 mg/L (induction  $277 \pm 80$  seconds and recovery time  $315 \pm 66$  seconds) at temperature between 18.2 °C to 19.3°C was determined as the lowest concentration that induces anaesthesia in common carp in less than five minutes. Induction and recovery times were dose-dependent. An inversely proportional relationship was observed between concentrations of anaesthetic and induction time. The recommended maximum clove oil concentration for induction time (stage IV) during the short time anesthesia is equal to 250 mg/L (212.5 mg/L eugenol) for common carp fingerling with 6-8 min time for stage III of recovery. Findings of this study will be helpful to develop standardized techniques for transportation and breeding of this most cultured species.

## **PRESENTATION SLIDES**

*In the order they appear in the agenda starting on page 5*

**KEYNOTE PAPER**

**TECHNICAL SESSION I**

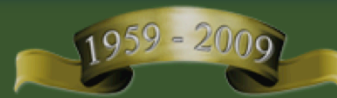
**TECHNICAL SESSION II**

**TECHNICAL SESSION III**

**TECHNICAL SESSION IV** [Slides for “Efficacy of an eco-friendly anaesthetics clove oil during simulated transportation of rohu (*Labeo rohita*)” not available]



**AIT**  
Asian Institute of Technology



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PARTNERING ASIA'S FUTURE



# Emerging Opportunities and Trends in Aquaculture/Fisheries Globally including Nepal

**Ram C. Bhujel, PhD**

**Director, Aqua-Centre**  
FABS, SERD, Asian Institute of Technology (AIT), Thailand

**Director,**  
World Aquaculture Society (WAS) – Asia pacific

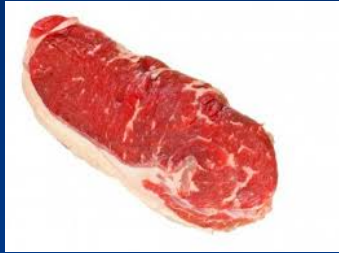
Email: [Bhujel@ait.asia](mailto:Bhujel@ait.asia) or [Director@aarm-asialink.info](mailto:Director@aarm-asialink.info)

# Outline

- **Current trends of fish consumption and production**
- **10 ways of increasing fish supply**
- **Success stories / examples**
- **Conclusions and recommendations**

# Background

**Red meat** ==> **white meat** ==> **seafood**



More people are attracted towards seafood mainly because:

1. Seafood is healthier (low/no fat)
2. More people are becoming health conscious
3. More people have increased income
4. Fish is cheaper in many countries/areas

## Canadian Per Capita Consumption of Beef

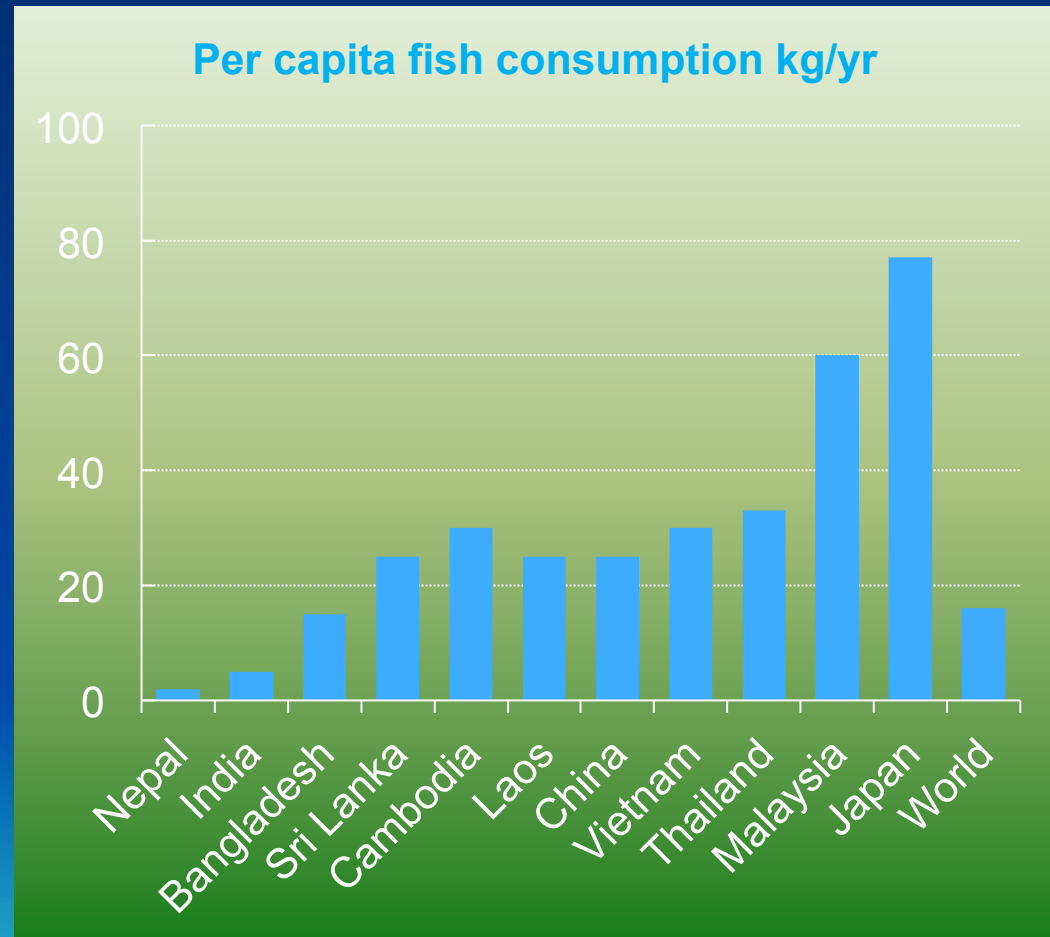


Source: Statistics Canada / Post \*estimate \*\*forecast



# Fish consumption (kg/person/yr)

- ✓ World = 20 kg
- ✓ Nepal 2 kg
- ✓ India 8 kg
- ✓ Bangladesh 18 kg
- ✓ Cambodia 35
- ✓ Laos 35 kg
- ✓ China 30 kg
- ✓ Vietnam 35 kg
- ✓ Thailand 35 kg
- ✓ Malaysia 60 kg
- ✓ Japan – 80 kg
- ✓ Maldives – 190 kg



# Nepal:

Source	Tons	Per cent
Buffalo	175,132	43.5%
Fish	64,000	14.3%
Goat	55,578	13.8%
Eggs	49,685	12.3%
Chicken	42,810	10.6%
Pig	18,709	4.6%
Others	2,938	0.7%
<b>Total</b>	<b>402,372</b>	<b>100%</b>

## Why buffalo?

- Cheap
- Momo

## Why not fish?

- Afraid of bone
- Don't know
- Not available

Animal protein	Price (NRs/kg)	Remarks
Goat	700-800	Fat+ (most preferred)
Pork	300-350	Fat++
Chicken	250-300	Bird flue
Buff	200-300	Red meat
Fish	200-350	1/3 <sup>rd</sup> of goat
Prawn	1,100-1,200	Imported from Thailand or Bangladesh?

# Whole sale Fish Market in Kalimati

- More than 25 shops
- Fish sales per shop per day:
  - ✓ Low season (Swasthani brata) = 20 kg
  - ✓ Peak season (festivals, wedding) = 200 kg



Average productivity of rice = 3.2 ton/ha  
Average productivity of fish = 4 ton/ha

Tilapia and Pangasius = 40-50 ton/ha  
Pangasius in Vietnam = 400 ton/ha

	Area (ha)	Fish production (ton)	Remarks
Total irrigated land	1,331,521		
1%	13,315	53,261	Convert to pond
2%	26,630	106,522	Convert to pond
5%	66,576	266,304	Convert to pond
20%	266,304	99,864	Fish in rice field
20%	266,304	1,065,217	Convert to pond

*Assuming, 4 ton fish / ha is easily achievable..*



# Rice field fisheries

1. Catch wild fish in ricefields – tradition in Cambodia
2. Culture of fish in rice fields - Common in China





# Corners of rice fields



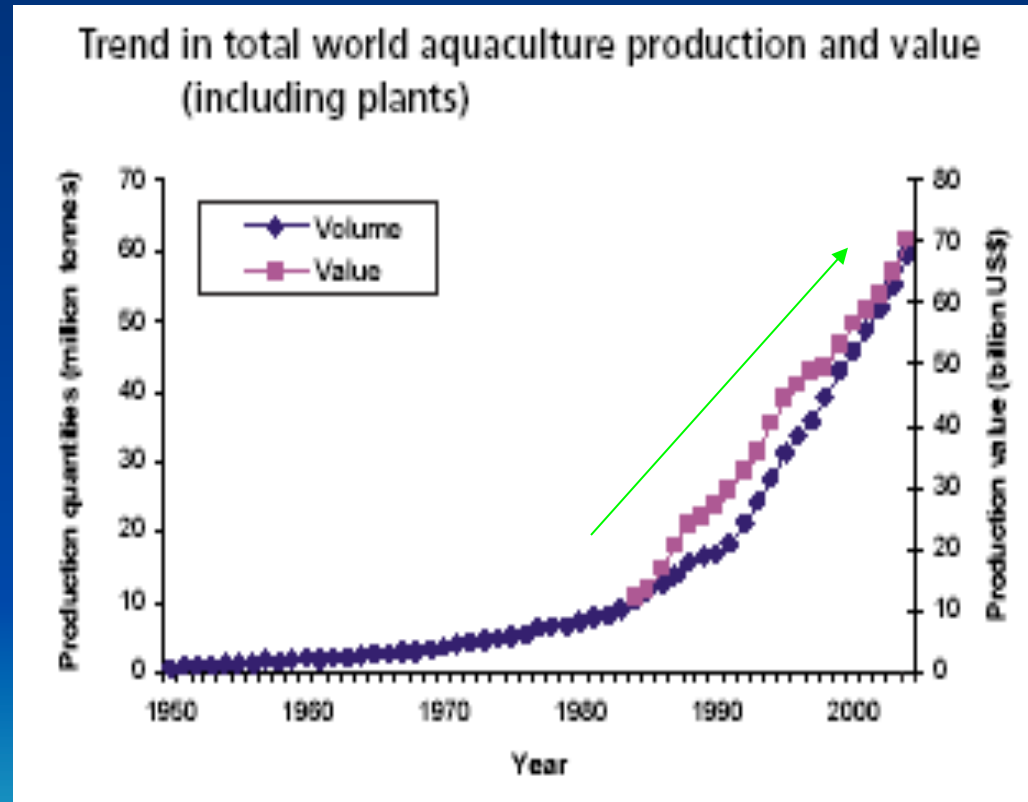
# Aquaculture in the world (recent trends)

Fastest growing food  
production sector

~ 70.5 million mt



< 0.5 million mt in  
1950s:

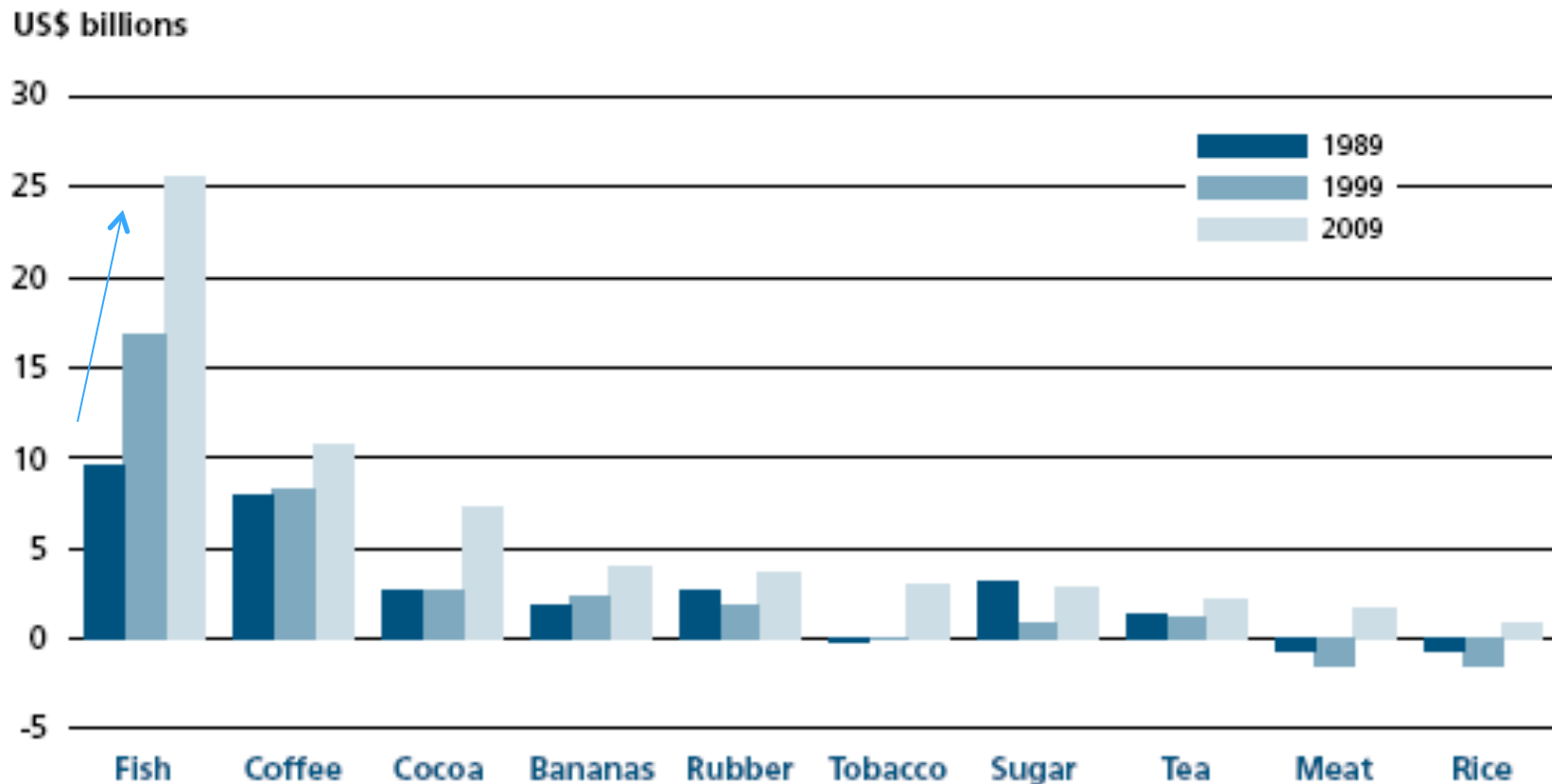


Source: State of World Aquaculture 2010 (FAO)

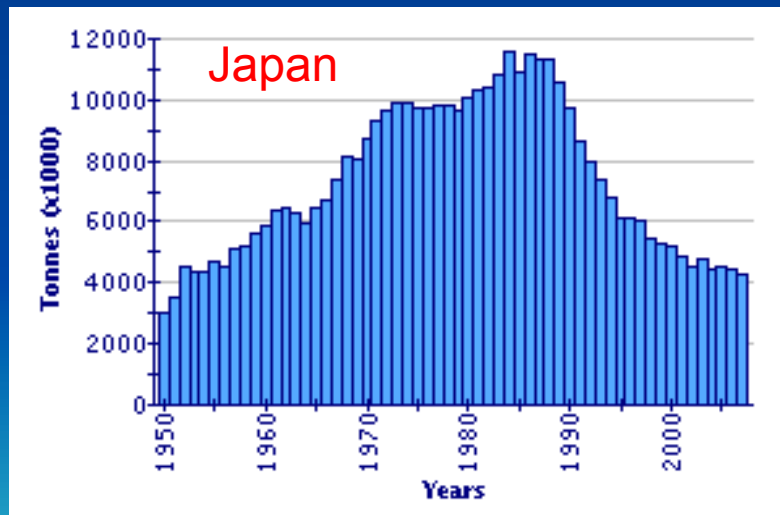


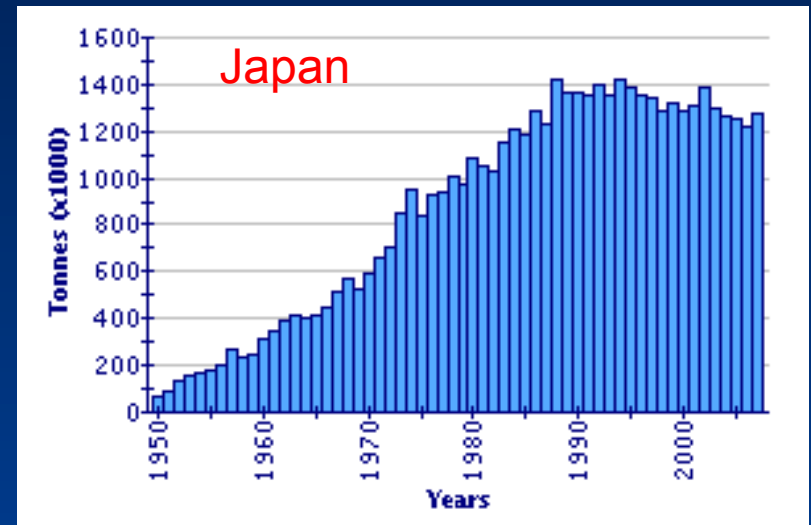
Fish is the #1 export agricultural items of developing countries by value and it is increasing by decade

Net exports of selected agricultural commodities by developing countries

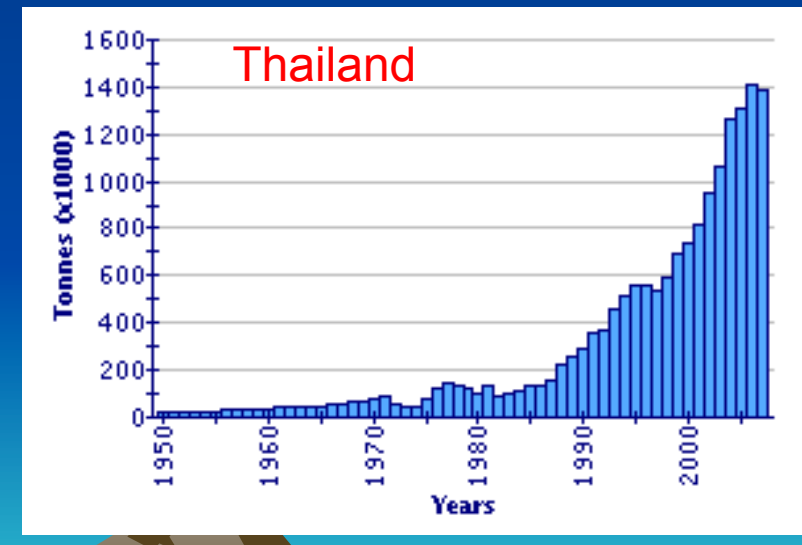
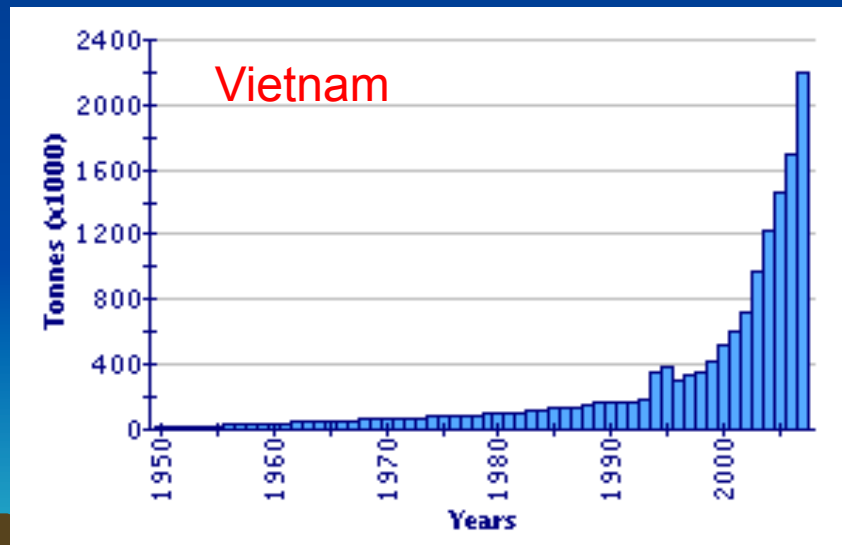
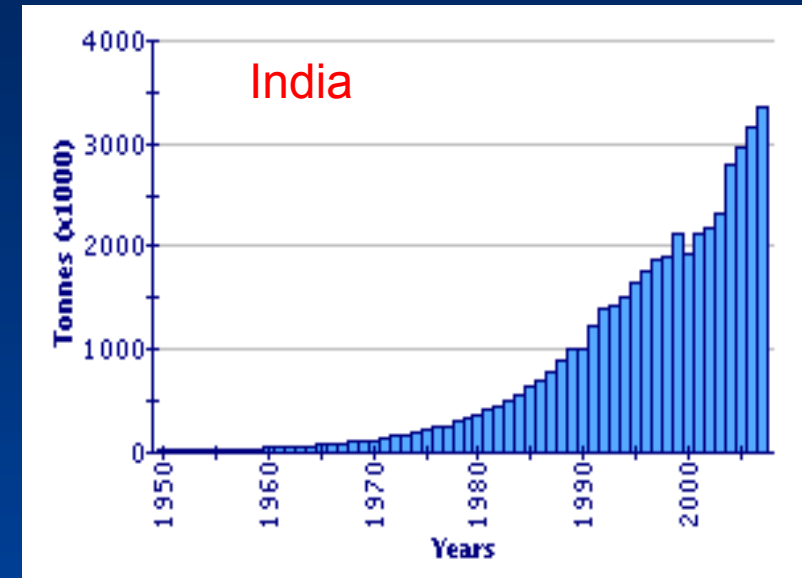
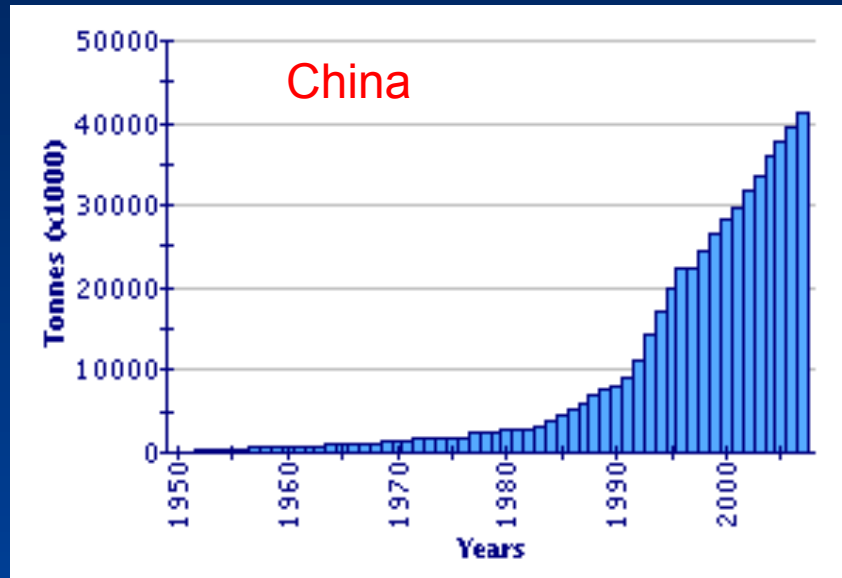


# Fish from wild (Capture is declining rapidly in developed countries)





# Aquaculture production in various countries



**Table 4 – World top-20 aquaculture producers of food fish\* in 2010 and 2011**

Top producers in 2010		Quantity (tonnes)	Top producers in 2011		Quantity (tonnes)
1	China	36 734 215	1	China	38 621 269
2	India	3 785 779	2	India	4 573 465
3	Viet Nam	2 671 800	3	Viet Nam	2 845 600
4	Indonesia	2 304 828	4	Indonesia	2 718 421
5	Bangladesh	1 308 515	5	Bangladesh	1 523 759
6	Thailand	1 286 122	6	Norway	1 138 797
7	Norway	1 008 010	7	Thailand	1 008 049
8	Egypt	919 585	8	Egypt	986 820
9	Myanmar	850 697	9	Chile	954 845
10	Philippines	744 695	10	Myanmar	816 820
11	Japan	718 284	11	Philippines	767 287
12	Chile	701 062	12	Brazil	629 309
13	USA	496 699	13	Japan	556 761
14	Brazil	479 399	14	Korea, RO	507 052
15	Korea, RO	475 561	15	USA	396 841
16	Malaysia	373 151	16	Taiwan, POC	314 363
17	Taiwan, POC	310 338	17	Ecuador	308 900
18	Ecuador	271 919	18	Malaysia	287 076
19	Spain	252 351	19	Spain	271 961
20	France	224 400	20	Iran	247 262
<b>Total of top-20 producers</b>		<b>55 917 410</b>	<b>Total of top-20 producers</b>		<b>59 474 657</b>
Others		3 104 775	Others		3 225 644
<b>World total</b>		<b>59 022 185</b>	<b>World total</b>		<b>62 700 300</b>

\*Food fish = fishes, crustaceans, molluscs, amphibians, reptiles (excluding crocodiles) and other aquatic animals (such as sea cucumber, sea urchin, etc.) for human consumption.

Source: State of World Aquaculture 2012 (FAO)

# Exporters

1. China: US\$19.6 billion
2. Norway: \$10.4 billion
3. Vietnam: \$7.0 billion
4. Thailand: \$7.0 billion
5. India: 7:0 Billion

# Importers

1. USA : \$19.0 billion
2. Japan : \$15.3 billion
3. China : \$8.0 billion

# For Nepal: major species

Warm water	Cold water
Carp	Rainbow trout
Tilapia	Indigenous species
Pangasius	- Sahar
Catfish	- Asala
Snakehead	- Gardi
Prawn	



# Carp culture in India: Composite culture

Some ponds can be very large e.g. 20 ha





# Rohu in Myanmar

1. Extensive system in large ponds
2. Chicken houses over the large ponds
3. Low production cost
4. Export to Bangladesh, India, Nepal



# Indian Major Carps: Problems

- Y – bones in the muscles are the problem for consumers
- No export market

1. India ?
2. Bangladesh?
3. Pakistan ?
4. China?
5. Myanmar
6. Thailand?
7. Vietnam?

They all have tried alternatives





# Tilapia – Aquatic Chicken

- Restaurants,
- Street vendors,
- mall & super stores in SE Asia
- Local market
- Export





# Pakistan

	Carp	Tilapia
Stocking	1,200 /acre	15,000 / acre
Production	1,000 kg/acre	7,000 kg/acre
Grow-out period	12-15 months	6-7 months
Potential revenue	\$3,000/acre	\$14,000/acre



# Pakistan:

## Tilapia is a BIG WAVE!

- Medical doctor
- Retired army general
- Hotel owner- Lahore & Phuket
- Carp farmers







ITS 2014



ITS 2014  
**INDIA TILAPIA SUMMIT 2014**  
December 18, 2014 - Vijayawada

ITS 2014





**Research:**  
Rajiv Gandhi Centre  
for Aquaculture



**Private hatchery**  
Aresent Bio-Tech



January 15



# Tilapia Culture systems

Small (50 m<sup>2</sup>)



Large ponds (10 ha)





# Tilapia in China, the largest producer (40%)

- Monoculture in Hainan (from Peter Edwards)
- Large ponds, traditionally - pig shed on the dike
- Now feed commercial pellets if farmers want to export





# Cage culture

Vietnam: River cages (Navico - Nam Viet Corporation)





# Cambodia, Thailand and Vietnam

- Floating village – e.g. Mekong river in Thailand
- Canal (Klong 13 near AIT)







Indonesia

A screenshot of the Regal Springs Tilapia website banner. The banner features the company logo at the top, which includes a crown and the text "REGAL SPRINGS". Below the logo, the text "REGAL SPRINGS TILAPIA" is displayed in a large, bold font, followed by the tagline "SETTING THE STANDARD FOR RESPONSIBLE AQUACULTURE". The banner also includes a collage of six small images: a tilapia fish, a person working on a cage, a boat, a person in a hat, and a box of tilapia. At the bottom of the banner, the text "...the first one compliant to the Tilapia Aquaculture Dialogue (TAD) standards..." is visible.

REGAL SPRINGS TILAPIA  
SETTING THE STANDARD FOR RESPONSIBLE AQUACULTURE

...the first one compliant to the Tilapia  
Aquaculture Dialogue (TAD) standards...

© REGAL SPRINGS



# Tilapia Cages

Lake Harvest, Kariba Lake, Zimbabwe, Africa

1. Cage size = 19 m diameter, Production = 35 ton
  2. Cage size = 24 m diameter, Production = 65 ton
- # Total production = 12,000 ton/year



# Main issue of Cage culture

## 1. Environmental / pollution problem (?)

e.g. 100 cages to produce 100 tons of fish

Amount of nitrogen expected to be in the environment

$$\begin{aligned} &= 100 \text{ ton} \times 2.0 \text{ FCR} \times 30\% \text{ undigested} + \text{leftover} \times 30\% \text{ CP} \times 16\% \text{ Nitrogen} \\ &= 2,880 \text{ kg N per 32 weeks of grow-out period} \\ &= 90 \text{ kg per week} \end{aligned}$$

If a Lake is 100 ha in size, which means 1 km long and 1 km wide, the total volume of water

$$\begin{aligned} &= 100 \text{ ha} \times 10,000 \text{ m}^2 \times 1000 \text{ liter} \\ &= 1,000,000,000 \text{ litres of water volume} \end{aligned}$$

$$\begin{aligned} \text{Increased nitrogen due to cage culture} &= 90 \times 1,000 \times 1,000 / (1,000,000,000 \text{ L}) \\ &= 0.09 \text{ ppm per week} \end{aligned}$$



# Recently - Cages in ponds

- 10-15 cages in a pond – rotation
- Feed the fish in cages and less feed outside
- Tilapia in cages and Pangasius, carps outside
- Harvest a cage a week





# Mexican model

1. No worry about soil type, movable / flexible
2. Water re-circulatory system





# Integrated farming





# Mono-sex tilapia hatcheries - Thailand:

## Manit Farm

- Phetchaburi Province



## Phum Thai

- Prachinburi province



Sales = 10 million fry/month  
= US\$100,000 / month



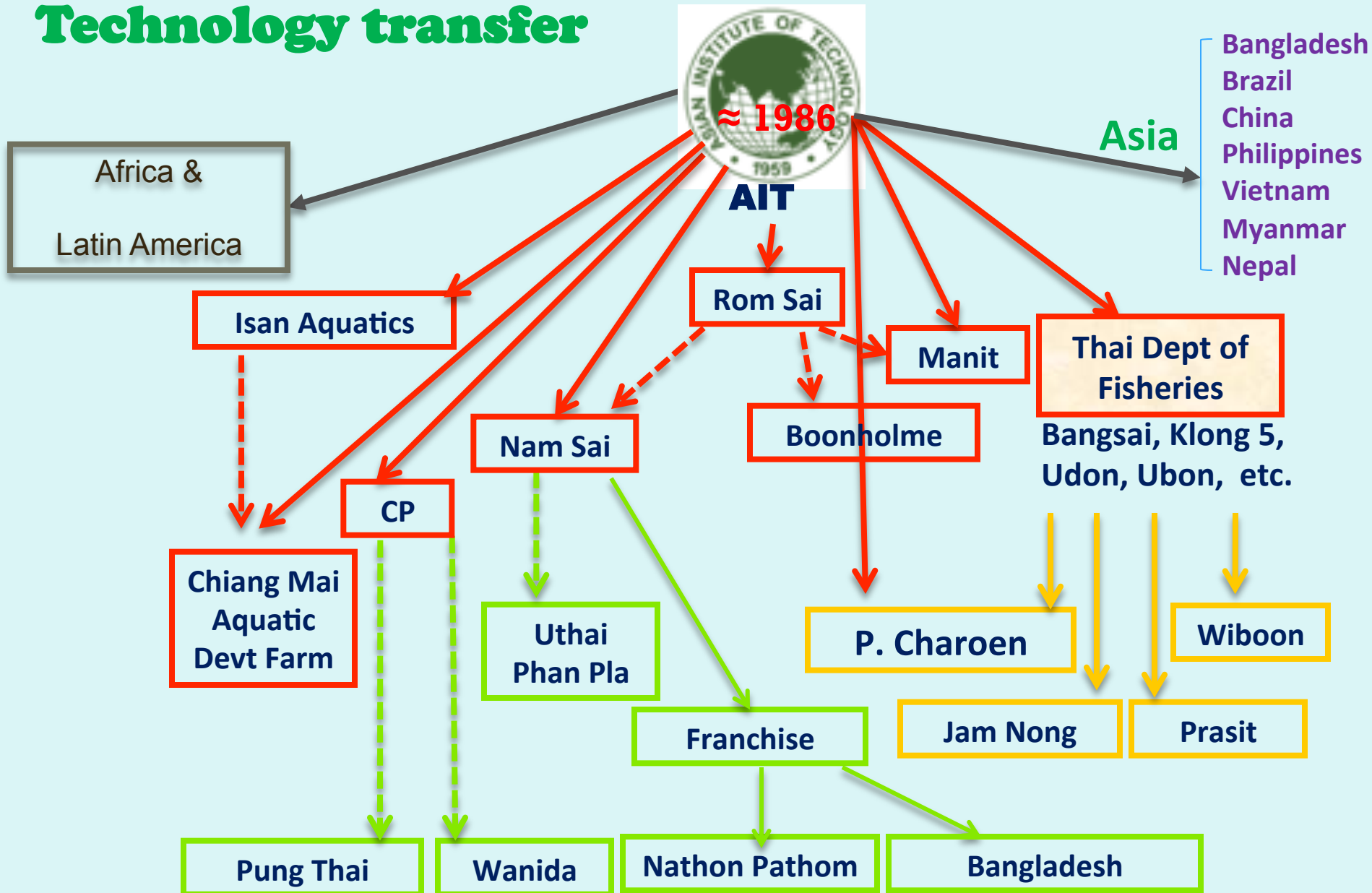
# Biggest & sophisticated



- P. Charoen Farm
- Chachongsao Province
- Estd. 30 yrs, SRT production started 8 yrs ago
- Automatic systems including train leagues for fish transport
- Investment over 500 million Baht (\$15 million)
- Sales = 30 million fry per month
- Revenue: ~ US\$10,000 /day



# Technology transfer





Eager to learn





# Bangladesh



এশিয়ান ইনস্টিটিউট অব টেকনোলজি (AIT)  
এর কারিগরী সহযোগীতায় অত্যাধুনিক  
হ্যাচারী কোয়ালিটি একোয়াব্রীডস লিমিটেড

কোয়ালিটি একোয়াব্রীডস লিমিটেড  
Quality Aquabreeds Limited





# Cage culture in Rivers:

Cage size: 6 m X 3 m x 1.5 m

Stocking size: 20 g

Density: 37-40 fish / m<sup>3</sup>

Harvest = >400 g

Feeding = floating pellets



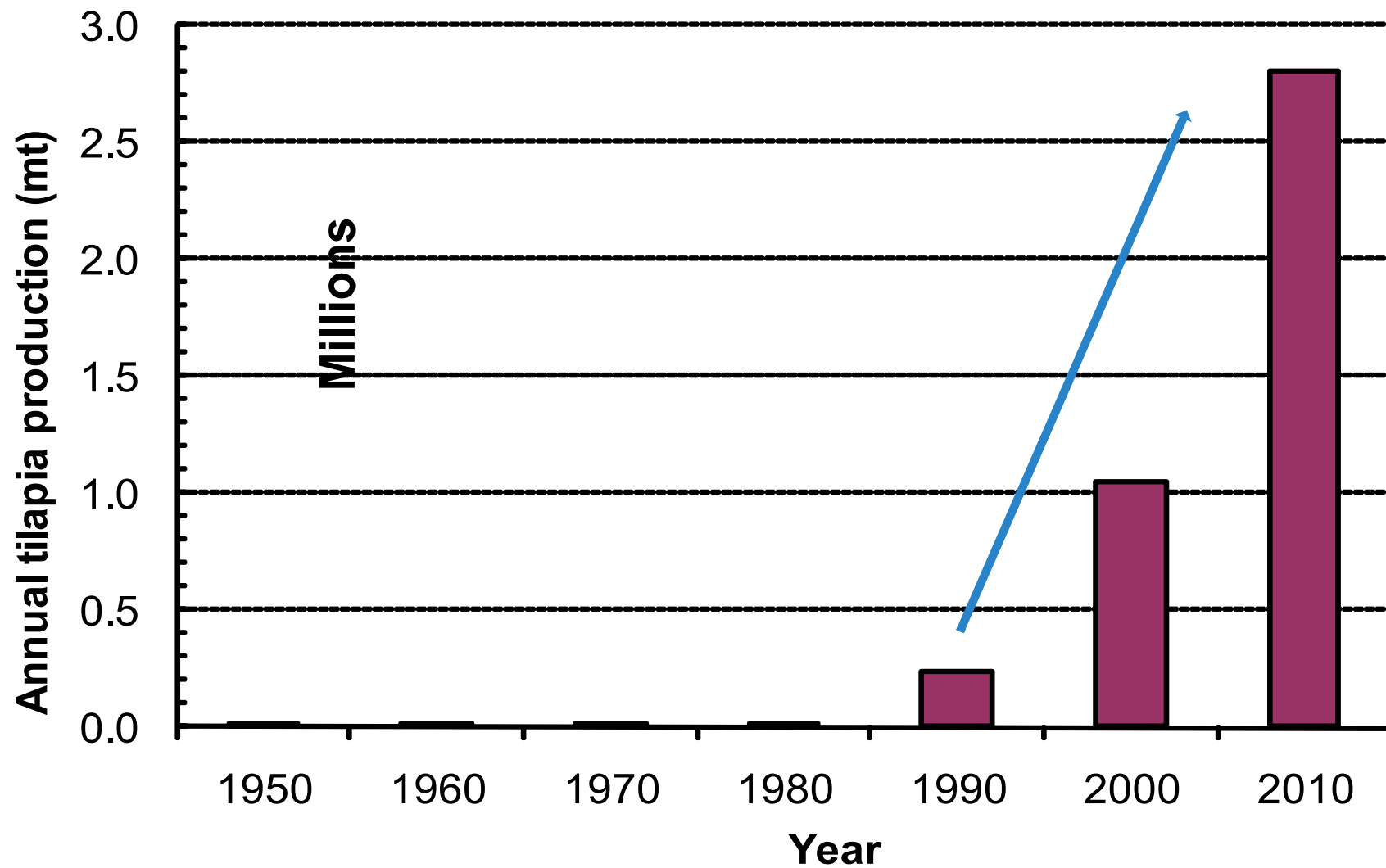
Cages at Rahamatkhali ghat, Meghna  
river Laxmipur

# Emerging trends:

1. **Airlines:** Food in the airlines
2. **Restaurants:** McDonalds', Burger King etc
3. **Schools:** Lunch for school children
4. **Military barracks:** canteens
5. **Hospitals:** medical doctors suggesting to eat more fish and food for sick people in Hospitals

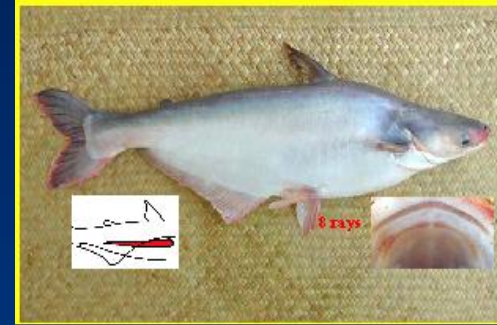


# Global production trend of tilapia



# Pangasius Catfish: Vietnam

- **Yield:** 400 tons/ha / yr
- **Pond:** 0.5 ha & 4 m deep
- **Stocking:** 80 fingerling /m<sup>2</sup>
- **Feed** – rice bran, soybean meal or oilcakes or floating pellets
- **Net profit:** ~10,000 US\$/m from 15 ponds
- **Total value:** 2 billion US\$/yr
- **Employment:**
  - 40,000 farmers (mostly men)
  - 200,000 women work in processing factories





About 1,000 people work in a single Pangasius processing factory





# Bangladesh:

(Mymensingh area)

1. Most farmers in a village converted rice field into *Pangasias* ponds
2. Stocking 40/m<sup>2</sup>
3. Prod = 40-50 ton/ha
4. No export yet



# Pangasius Breeding

- Hormone injection
- 5-7 kg brood
- Produces nearly >0.5 million eggs





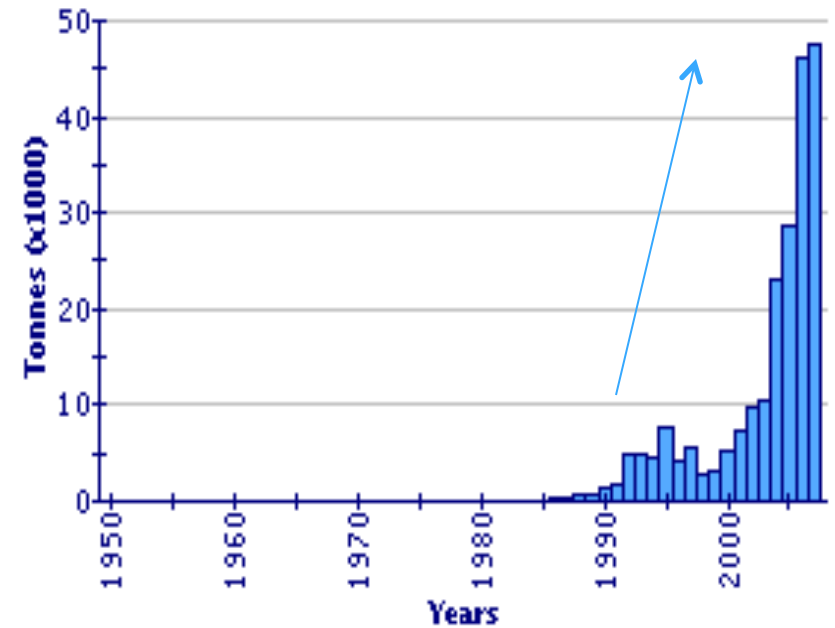
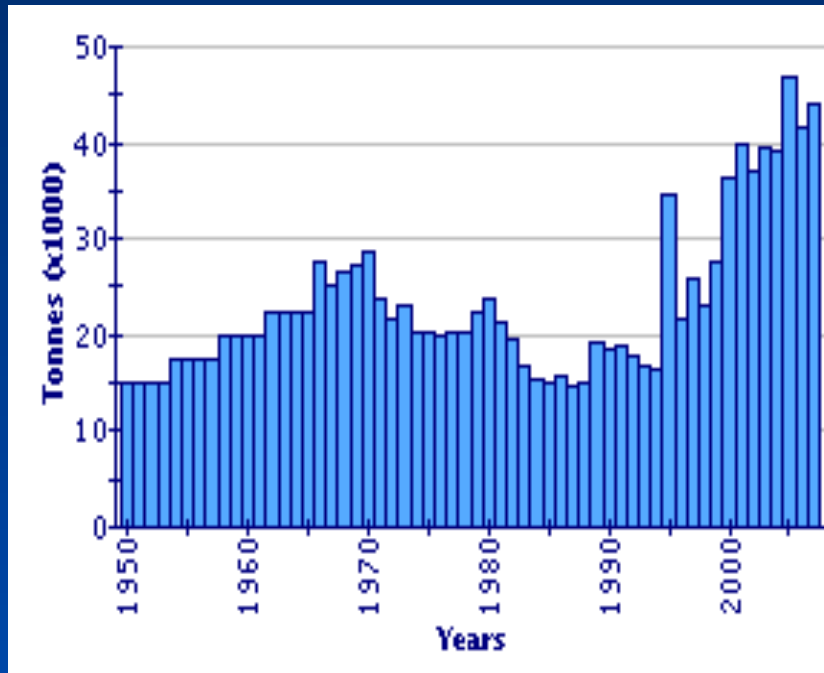
## Pangasius egg incubation in Thailand



# African Catfish *Clarias gariepinus*

Capture

Culture





# Hybrid catfish in Thailand

Male African Catfish (*Clarias  
gariepinus*)

X

Female Asian (*Clarias  
macrocephalus*)



January 15



# Egg stripping:

Up to 20 kg eggs / day



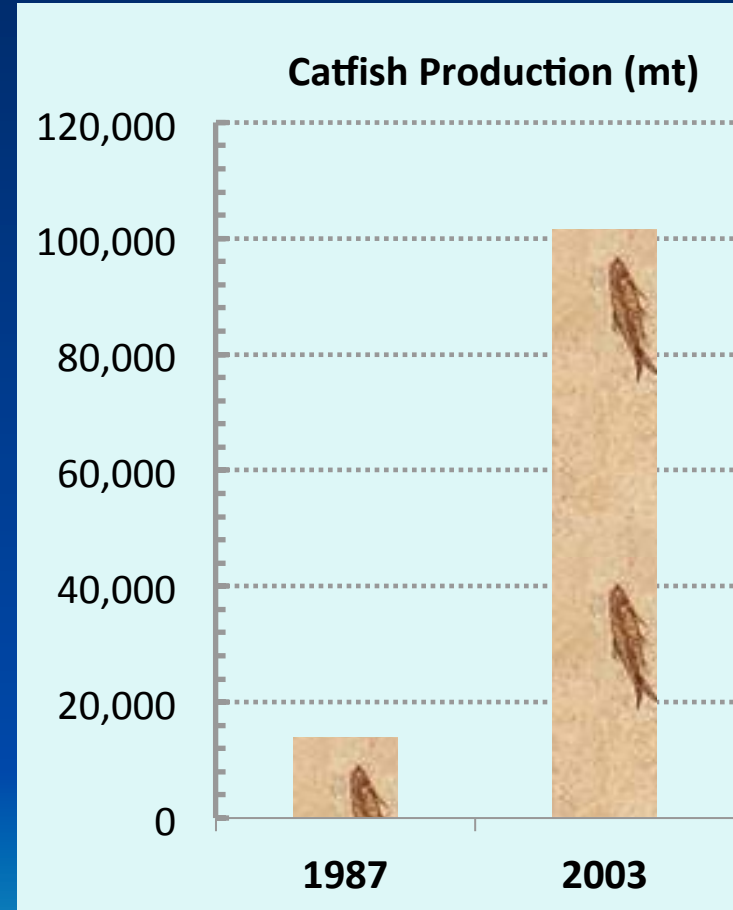
# Catfish grow-out

1. Crushed / minced chicken bones
2. Floating pellets



# Walking Catfish Production in Thailand

1. Production increased by 7 times from 1987 to 2003.
2. Second only to tilapias among all fish species
3. Staff at DOF fisheries stations initially produced fry to distribute to farmers and acted as trainers for hatchery operators. One of these fisheries stations in Pathum Thani





# Snakehead (*Channa* spp.)

- Popular in Thailand
- Breeding - success
- But wild collection – cheaper
- Hundreds of villagers / farmers collect fry and sell to the farm



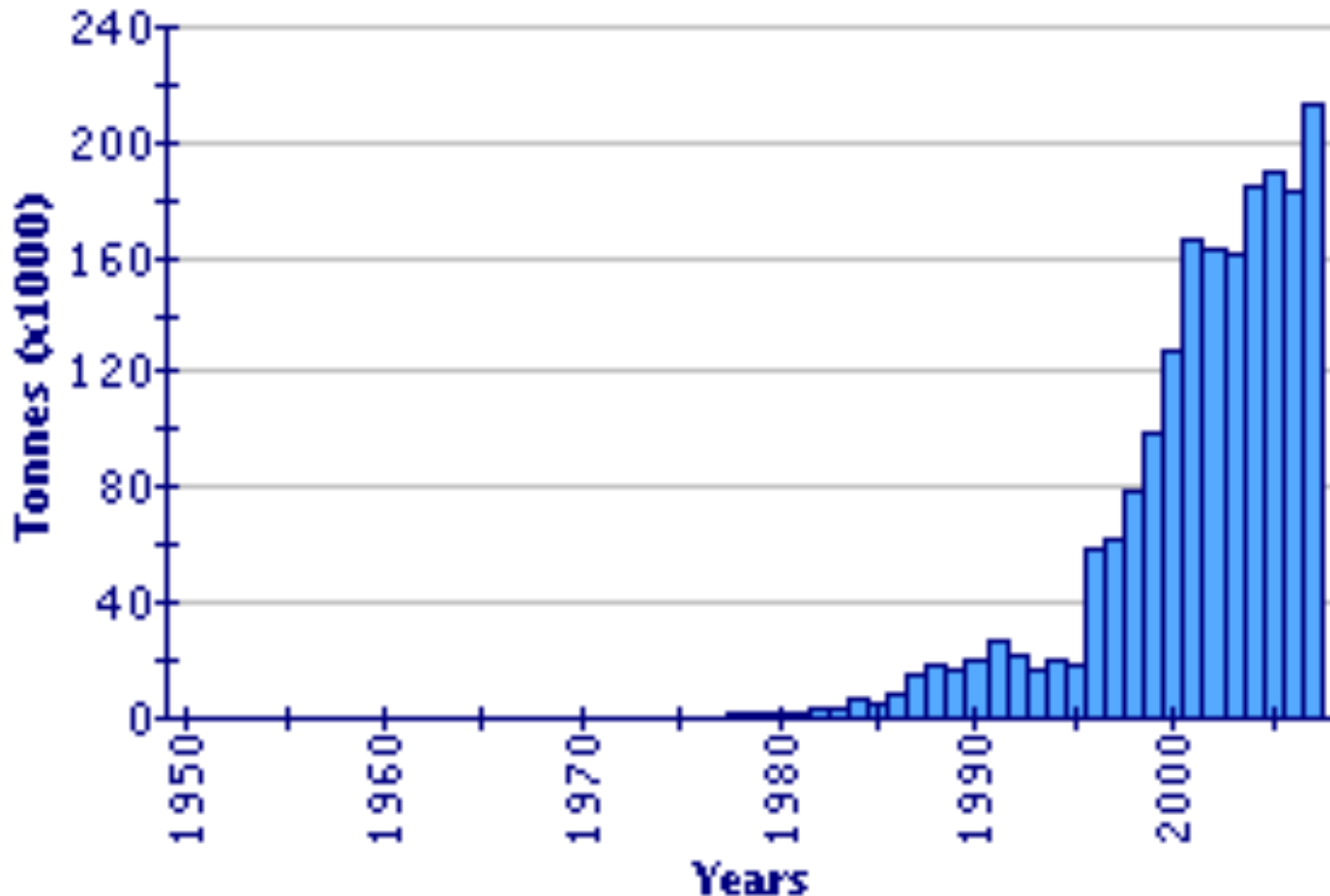
# Snakehead

- Feed: 30 ton / day (FCR 1:1)
  - ✓ Trash fish 80% (12 Bt/kg)
  - ✓ Rice bran 20% (9 Bt / kg)
  - ✓ Feeding 2 times a day
- Harvest size = 700 – 800 g
- Buyers come to buy
- Price = Bt110/kg  
= US\$3.8 / kg
- Total sales: 4 tons /day
- Daily income = US\$11,400



# Freshwater prawn

## *Macrobrachium rosenbergii*





# Freshwater Prawn (*Macrobrachium rosenbergii*)

- **Nepal:** No cultured, only imported
  - Breeding success at IAAS, NARC
  - High seed demand from farmers
  - High price in restaurants/market
- **Great opportunity**
  - Hatchery business
  - Grow-out business
  - Market



# Freshwater Prawn

(*Macrobrachium rosenbergii*)

- **Thailand** – 200 m<sup>2</sup> rice plot
  - Rice 10kg = 120 Baht (US\$4)
  - Prawn  $200 \times 0.9 \times 0.05 \times 150$   
= ~1,300 Bt = **US\$40**
- **Bangladesh:**
  - 4 times the return on investment
  - mostly cultured in small rice farms (Gher systems)
  - Hundreds of thousands poor benefit





# Freshwater Prawn Farm Management Practices

## Feed and feeding

- All farmers use commercial pelleted feeds
  - 40% crude protein,
  - 15% water,
  - 5% fat,
  - 3% fiber, and
  - 1% phosphorus)
- Use feeding trays
- FCR = 2:1



15/09/2008



# Processing and storage

1. Simple sun drying
2. Smoking + drying
3. Pickle
4. Paste
5. Cold storage





# Recommendations: 10 ways i.e. FIS-CAS-P2-W2

- ① **F**eed: train farmers to produce home-made feed
- ② **I**ntensify more increase production
- ③ **S**eed: produce more and high quality
- ④ **C**ulture systems – integrated with vegetables,
- ⑤ **A**dditional areas: corners of rice plots, swamps, reservoirs, community lakes
- ⑥ **S**pecies diversification: promote tilapia and Pangasius
- ⑦ **P**rocessing – smoking, drying, canning, crackers, pickle, fish powder, paste,
- ⑧ **P**romotion & marketing – tech. packages, cook book
- ⑨ **W**ater management, fertilization
- ⑩ **W**ild stock enhancement

# The followings play important roles:

1. Manuals
2. School curriculum
3. Cook book
4. TV
5. Radio
6. Internet / social media
7. News paper articles
8. Conferences
9. Trade shows /exhibitions
10. Slogan for awareness campaign e.g.  
“A fish a day, keeps doctors away”



# Potential areas

Terai, Inner Terai and mid-hills







## Women in Aquaculture

- 2000 – 2008
- Nearly 300 families
- Cooperatives
- Chitwan & Nawalparasi
- AIT, IAAS, DoFD, NARC





# AwF – Project

- 2008-2011
- Nearly 200 families
- Mid-hills e.g.  
Lamjung & Gorkha





**For more info:**

**Facebook:** Nepal Aquaculture Promotion (NAP) Group

**Email:** [bhujel@ait.ac.th](mailto:bhujel@ait.ac.th)

**Thank you**



# EMERGING TRENDS AND CHALLENGES IN AQUACULTURE AND FISHERIES IN NEPAL



*Rama Nanda Mishra*  
*Program Director*

*Directorate of Fisheries Development*

*NEFISH Convention, Kathmandu, 30-31 January, 2015*

# Background

---

- ✘ Malnutrition rates in Nepal are among the highest in the world.
- ✘ Nearly 50% children under 5 years of age are severely or moderately stunted and 24% of all women are undernourished.
- ✘ Among Nepalese, protein malnutrition is rampant as meat products are expensive to include in regular diets. However, in general fish is considered poor's meat
- ✘ Fish contributes nearly 18% of total animal protein supply in Nepal.

# Back ground

---

- ✖ Aquaculture has a growth rate of 8.41
- ✖ Average Aquaculture growth increased from 6.95 after Launching of Fish Mission Program.
- ✖ Production from capture Fisheries has remained constant since last 5 years.
- ✖ Demand growth is much higher than production growth resulting in increasing trend of fish import.



# Current Status

<b>Total Fish Production</b>	<b>64900 mt.</b>
------------------------------	------------------

<b>Capture Fisheries</b>	<b>21500 mt.</b>
--------------------------	------------------

<b>Culture Fisheries</b>	<b>43400 mt.</b>
--------------------------	------------------

<b>Employment</b>	<b>551,000</b>
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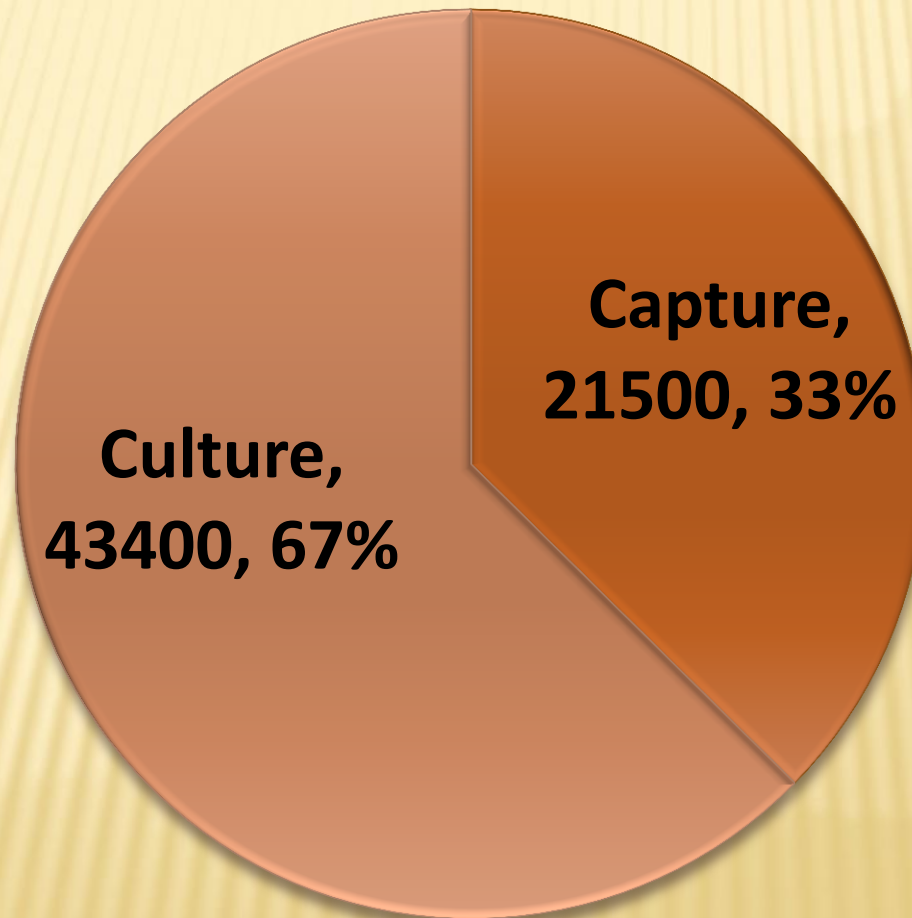
<b>Per capita availability</b>	<b>2.27 kg.</b>
--------------------------------	-----------------

<b>AGDP contribution</b>	<b>aprox.</b>	<b>3 %</b>
--------------------------	---------------	------------

<b>NGDP contribution</b>	<b>aprox.</b>	<b>1 %</b>
--------------------------	---------------	------------

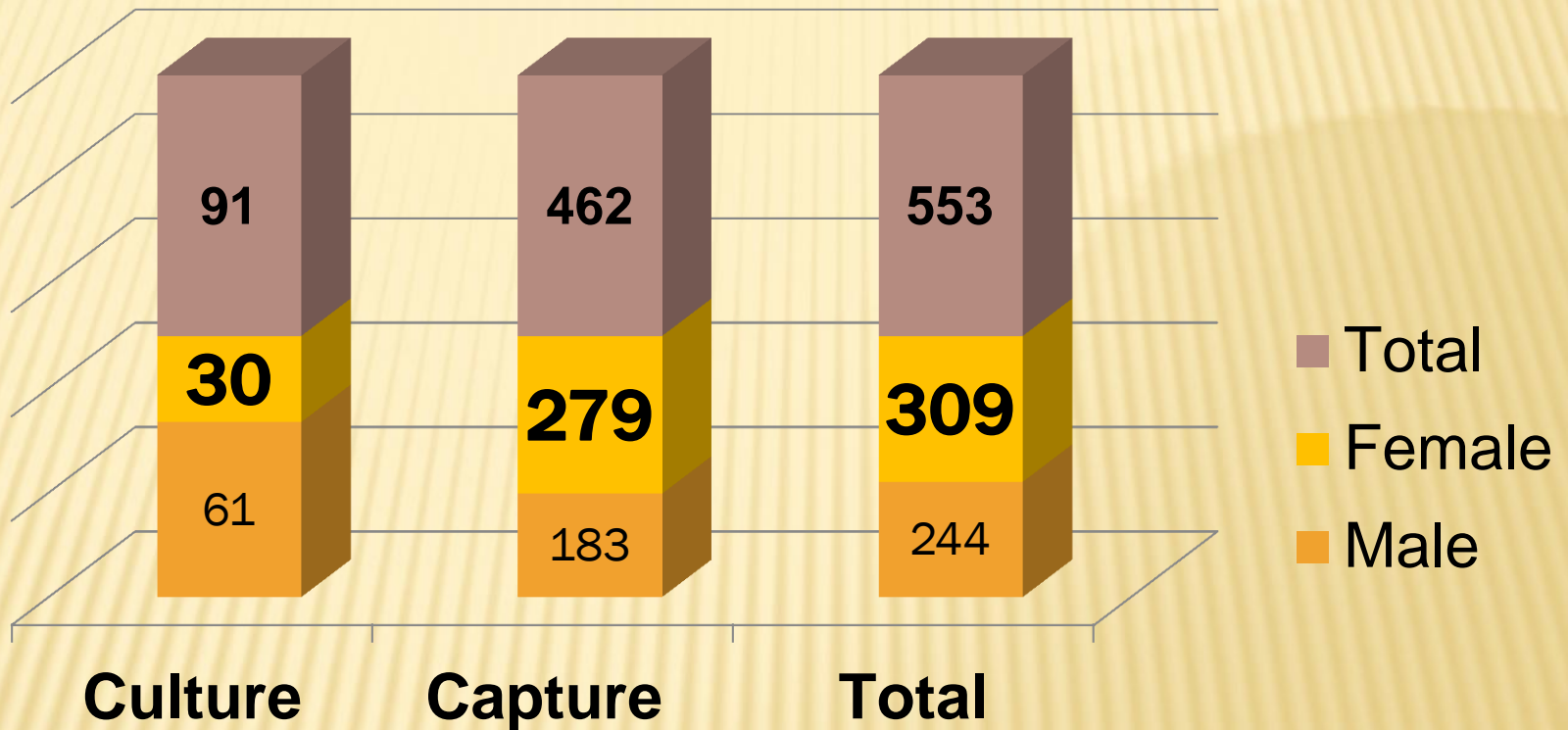
# **NATIONAL FISH PRODUCTION (2013/14)**

**( METRIC TONNES )**



**Per capita 2.3 kg**

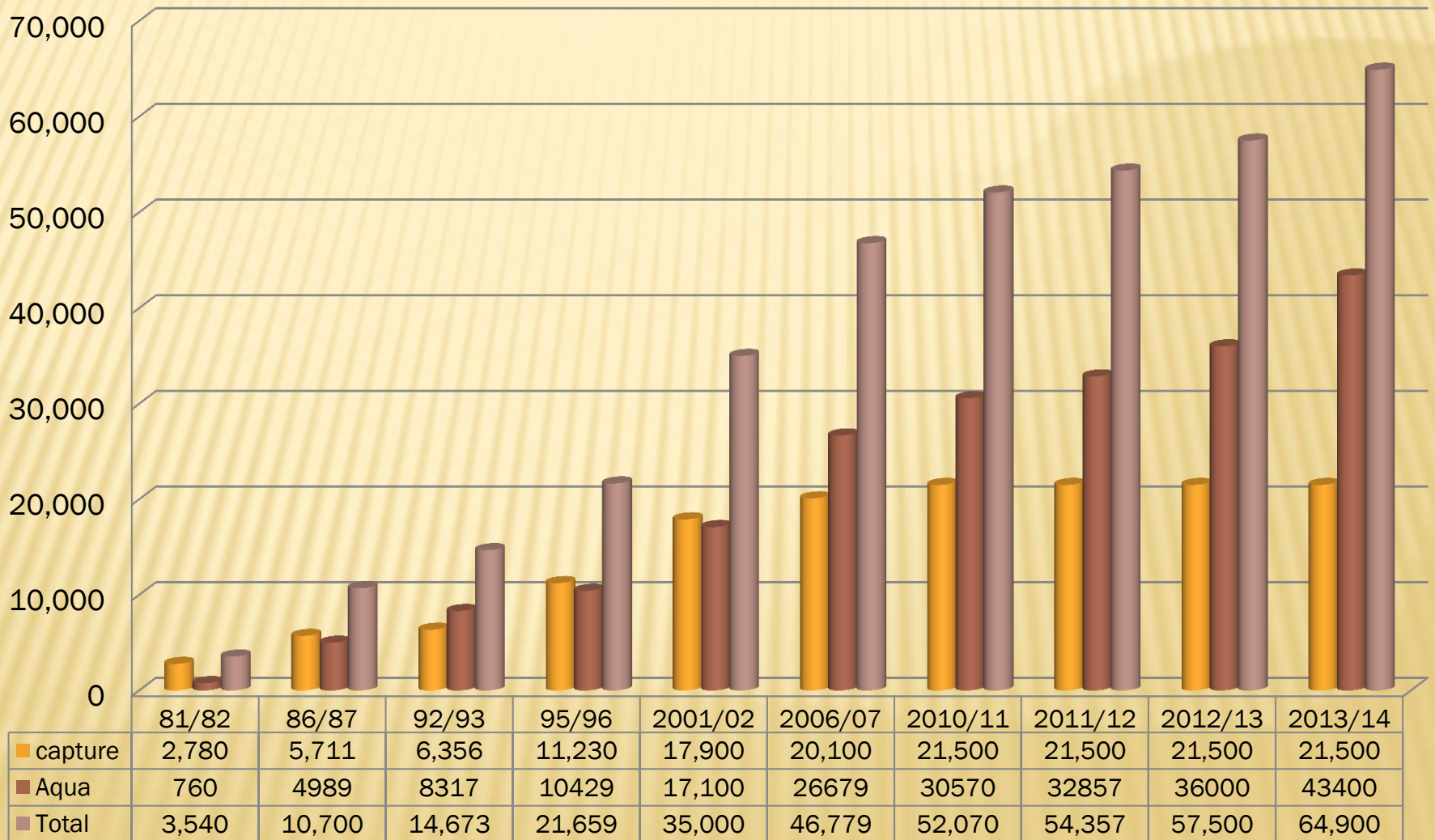
# PEOPLES INVOLVEMENT



- 24 ethnic groups livelihood is dependent on fisheries
- Around 3% of the population is benefited(820,000)
- 56% female participation (culture-33%, Capture-60%)

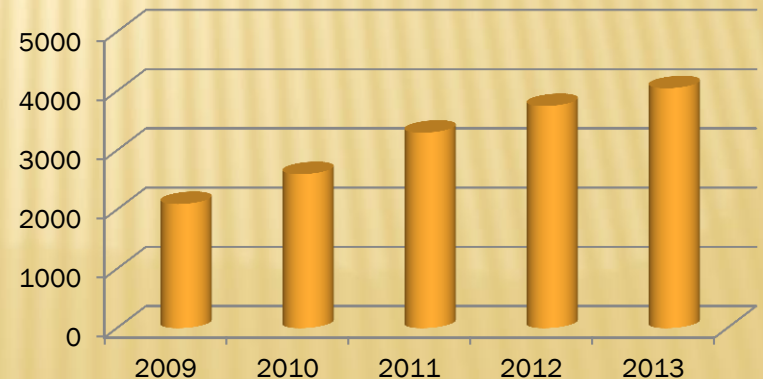


# FISH PRODUCTION TREND



# Trend of fish production

System	2009	2010	2011	2012	2013
Pond Fish culture	23780	24837	26941	29999	31221
Other area (Swamps and Ditches, ghols)	2096	2600	3300	3750	4050
Paddycum fish culture	135	45	45	45	45
Cage fish culture	480	480	360	360	360
Enclosure fish culture	140	140	140	140	140
Trout Fish Culture in Raceway	80	100	140	180	180
Fish Production in Public Sector	19	28	24	26	24
Fish Production from Capture Fisheries	21500	21500	21500	21500	21500
<b>Total</b>	<b>48230</b>	<b>49730</b>	<b>52450</b>	<b>56000</b>	<b>57520</b>

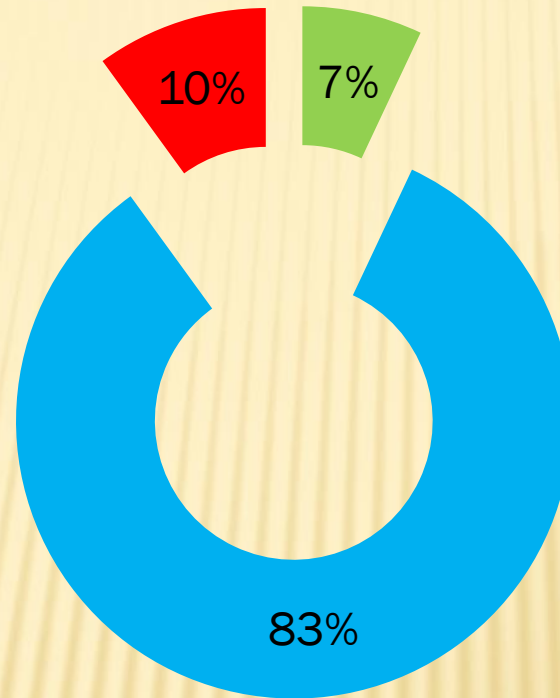


# Development Trend

YEAR	81/82	12/13	31/32
Fish production	3350	57520	3,64,000
Pond productivity	.8	3.96	8.15
Capture culture ratio	3.7 : 1	1:1.7	1 :15.9
Per capita	0.33	2.27	10.0

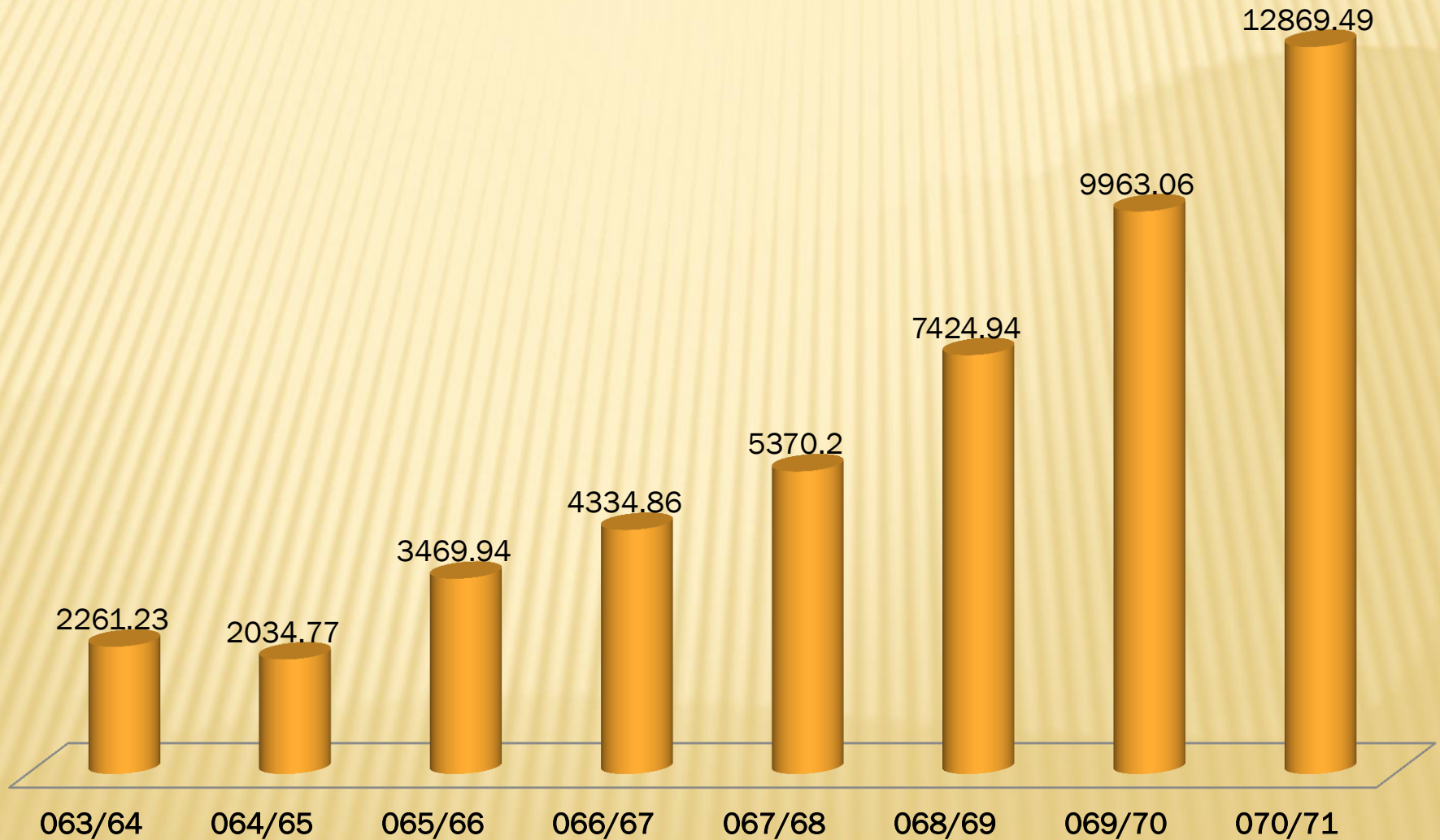


# Intensity of farming



■ Extensive    ■ Semi-intensive    ■ Intensive

# Trend of Fresh Fish Import



# Export/ Import Trend

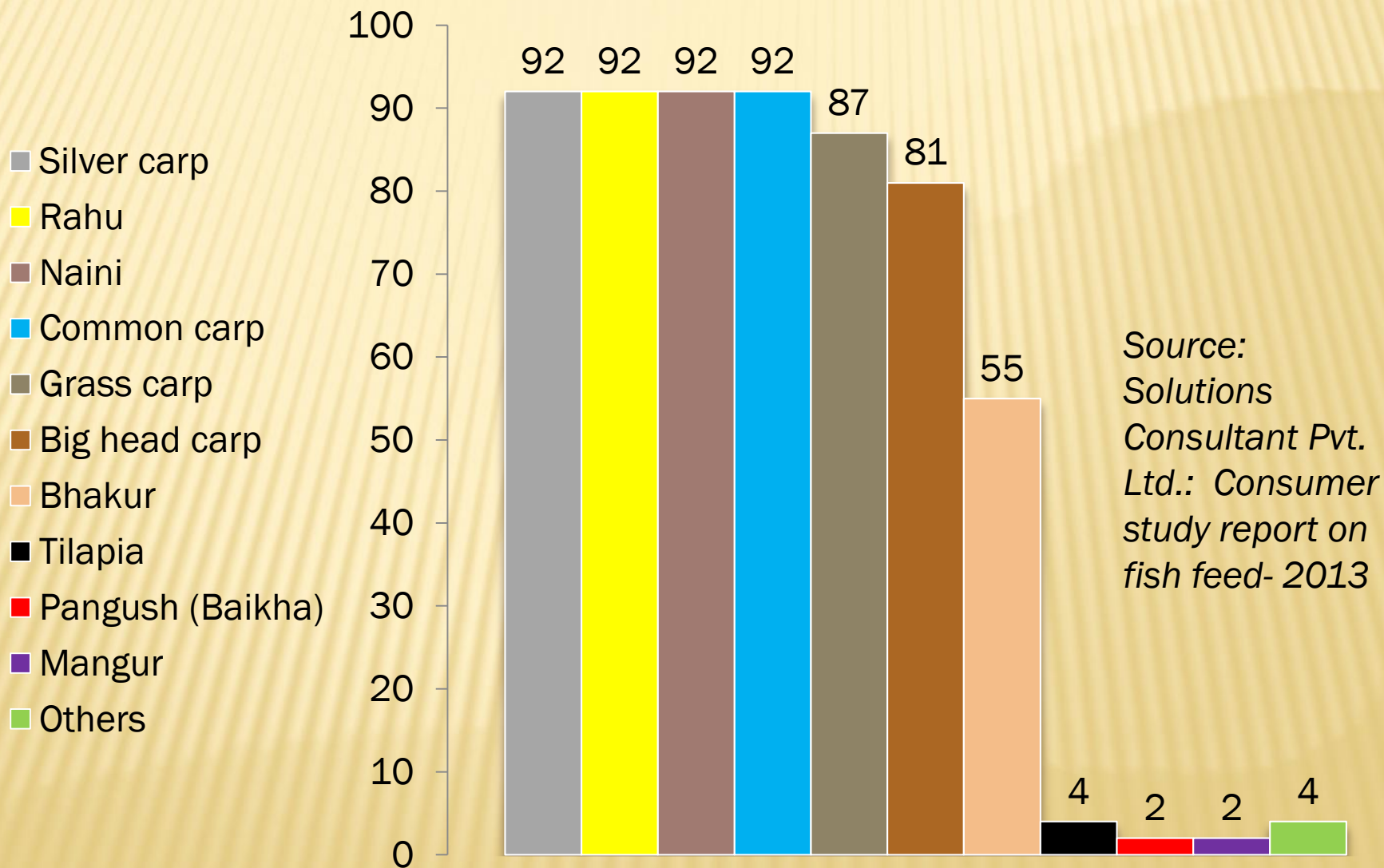
SN	Year	Import						Export		
		Fresh fish (mt)	Boneless fresh Fish (mt)	Fish seed (Number)	Dried fish (mt)	Fish Meal (mt)	Aquarium fish (kg)	Fresh fish (mt)	Fish seed (Number)	
1	061/62	2547.38	-	949235	74,75	166.43	1950	1.56	233475	
2	062/63	2058,11	-	1884200	246.07	1602.95	3666	6.42	113000	
3	063/64	2261.23	-	849270	2510.83	30.02	549764	2.86	-	
4	064/65	2034.77	-	172590	277.12	351.2	2611884	4.15	22300	
5	065/66	3469.94	-	14212	313.68	1097.75	-	134.65	25100	
6	066/67	4334.86	253.2	7493	294.89	432.2	-	850.0	-	
7	067/68	5370.2	18.0	3287834	334.11	481.0	11158	0.36	-	
8	068/69	7424.94	381.82	8975129	580.81	272.33	28972	0.095	-	
9	069/70	9963.06	270.8	14564100	514.64	214.12	104548	0.2	-	
10	070/71	12869.49	203.3	11083000	1.1	19419.61	217248 (NO.)	-	-	



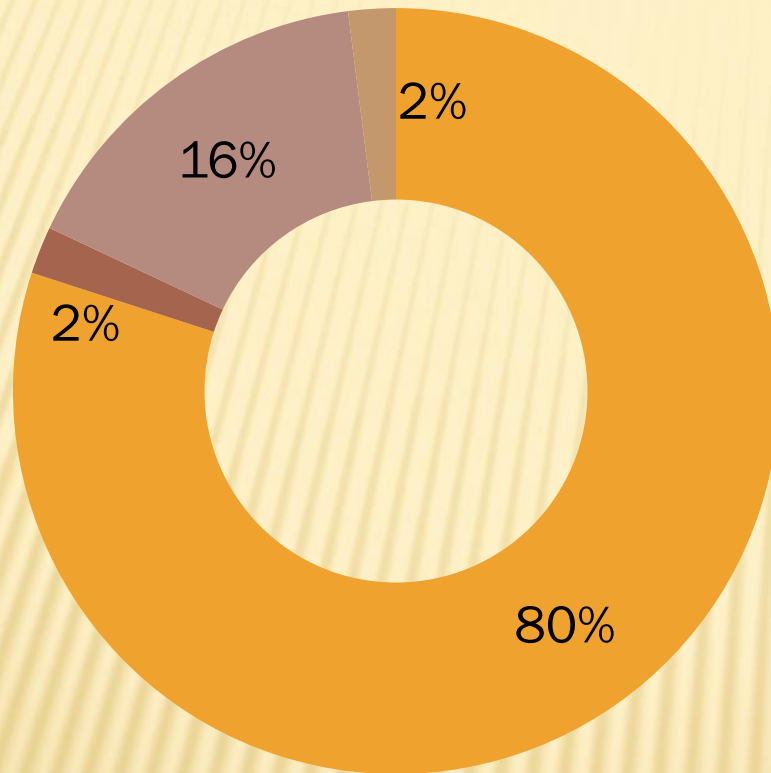
Years involved in fish farming	Percent
Less than 5	29.6
5 to 9 Years	24.4
10 to14 Years	17.7
15 to19 Years	8.7
20 to 24 Years	7.2
25 Years and More	12.3

*Source: Solutions Consultant Pvt. Ltd.: Consumer study report on fish feed- 2013*

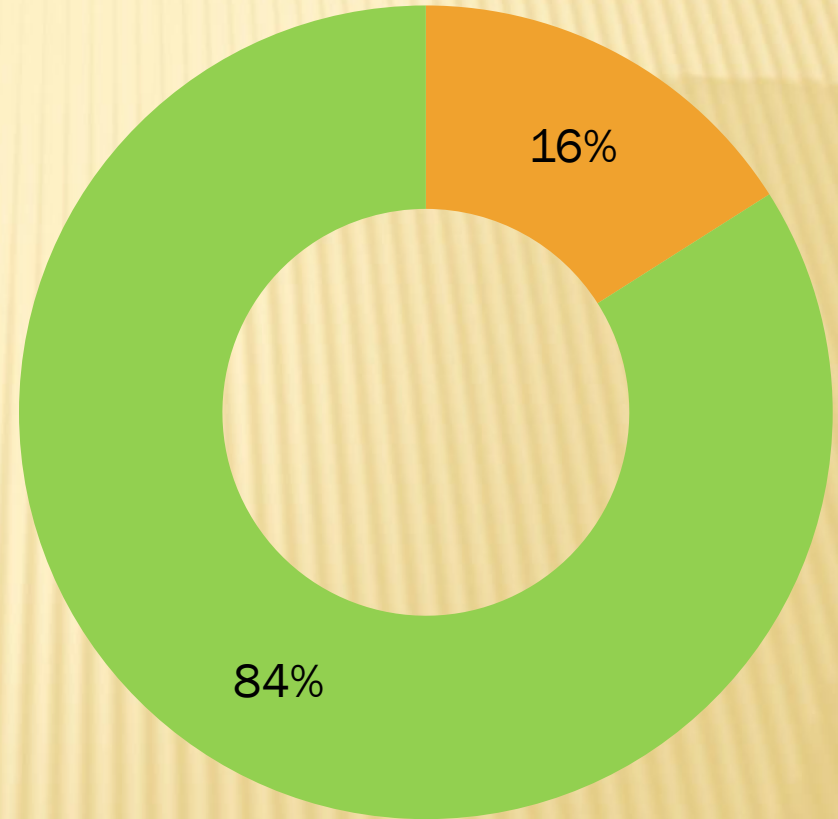
# PRRCENTAGE OF FARMERS FARMING VARIOUS FISH SPECIES



# Feed and Feeding



- Traditional Feed
- Combination of traditional and commercial feed
- Self-made pellet
- Commercial Feed- Pellet



- Yes
- No



# FEED EFFICIENCY OF FARMED ANIMALS

Food Systems	FCRs (kg dry feed/kg wet Weight gain +/- SD)	% Edible	Production Efficiencies (kg dry feed/kg of edible wet mass)
Tilapia	1.5 (0.2)	60	2.5
Catfish	1.5 (0.2)	60	2.5
Freshwater Prawns	2.0 (0.2)	45	4.4
Milk	3.0 (0.0)	100	3.0
Eggs	2.8 (0.2)	90	3.1
Broiler Chickens	2.0 (0.2)	59	3.1
Swine	2.5 (0.5)	45	5.6
Rabbits	3.0 (0.5)	47	6.4
Beef	5.9 (0.5)	49	10.2
Lamb	4.0 (0.5)	23	17.4

Source: Dr. Barry A. Costa-Pierce, Global Conference on Aquaculture 2010

# Initiation Of Mechanization Through Demonstrations

S N	Year	Airators	Pelleting Mechine	Remarks
1	67/68	2	2	
2	68/69	15	17	
3	69/70	26	-	
4	70/71	10	8	
5	71/72	47	36	Some more may be added





# water logged areas are converted to ponds







# Aquaculture has reached Himalayan region- Trout Farming





# Aquaculture is expanding to mid hills





# Pond Aquaculture is expanding rapidly





# Species diversification- Tilapia , Pungassius and Clarius farming



# POND PRODUCTIVITY

	Kg./Ha.
Extensive	1,823
Semi intensive	5,669
Intensive	11,852
ALL	6,069



	Extensive	Semi intensive	Intensive
Morang	2%	84%	14%
Saptari	58%	42%	
Sunsari	5%	95%	
Dhanusha		94%	6%
Mahottari	7%	88%	5%
Chitwan		87%	13%
Bara		75%	25%
Parsa		75%	25%
Rupandehi		89%	11%
Nawalparasi		94%	7%
Bardiya	5%	90%	5%
<b>Productivity (Mt./Ha.)</b>	<b>0.87</b>	<b>3.32</b>	<b>7.05</b>



# LIVE FISH SALES AND MARKETING HAS INCREASED



# EXCHANGE PROGRAMS AND IT HAS HELPED TO BRING NEW TECHNOGY





# CHALLENGES TO AQUACULTURE

---

- ✗ Seed Quality
- ✗ Species diversity
- ✗ FCR
- ✗ Waste disposal
- ✗ Quality production
- ✗ Biosecurity and food safety
- ✗ Balanced supply
- ✗ Urban Aquaculture



# MAJOR THREATS TO FISHERIES

- ✗ Hydropower and irrigation dams
- ✗ Habitat degradation
- ✗ Exploitation
- ✗ Introduced species
- ✗ Pollution







**The development of transport links and other construction activities can have major impacts on freshwater systems, as shown by the sedimentation caused by road construction.**



# WIDER CONSERVATION EFFORTS





# RECENT EFFORT

---

- ✘ Fish mission program up scaled
- ✘ Youth targeted special program
- ✘ ODOP
- ✘ Fish policy draft prepared and submitted to MOAD.
- ✘ Mega Project document for overall development of Fisheries and Aquaculture has been prepared and submitted to Government.
- ✘ Fish insurance policy formulated and in operation.
- ✘ Mechanization subsidies specific to aquaculture is recognised.

# Recommendations

- Formalization of fisheries and Aquaculture Policy
- Formulation of Aquaculture Act
- Formalization of Fish seed Act
- Enforcement of Aquatic Life protection Act
- Introduction of Co-management in Aquatic Resource management
- Resource allocation based on potentialities
- Institutional restructuring for more accountability and prosperity
- Formulation and implementation of quality standard for fish and fish products



***Thank  
You  
For the  
Patience***





# Trading-off fish biodiversity, hydropower & food security : challenges & opportunities

मत्स्य विविधता, जलबिधत र खाद्य सुरक्षाको  
समायोजन : चुनौति र अवसर




**Tek Gurung, Suresh Wagle,  
Arun Baidya, Agni Nepal**

*Trade-off : to accept a disadvantage so that one can have a benefit*

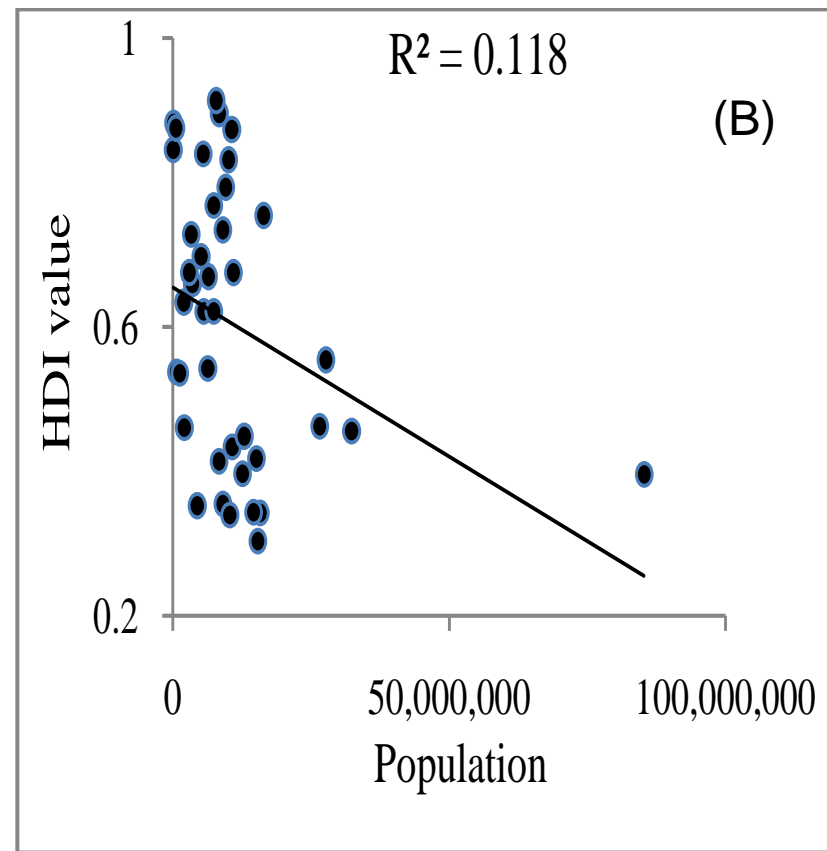
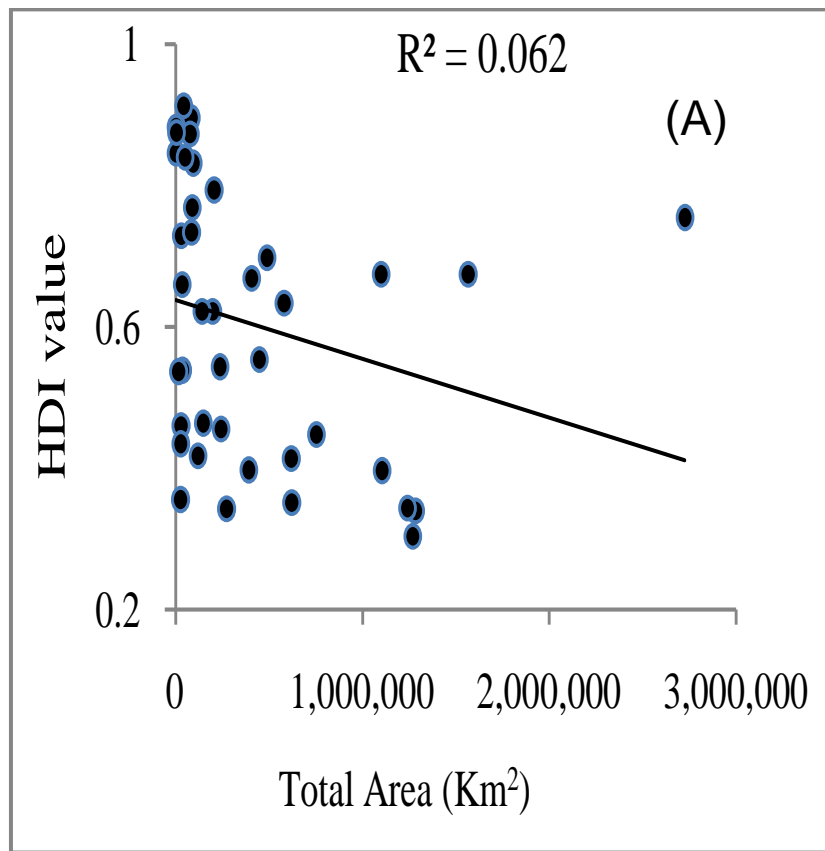
खाद्य सुरक्षा : मूल मानवाधिकार, खाधान्न उपलब्धता, पहुँच र सदुपयोग

**उद्देश्य**

- मत्स्य विविधता, जलबिधुत र खाद्य सुरक्षा बीच अन्तरसम्बन्ध र trade-off बारे प्रकाश, छलफल र निष्कर्ष

- 
- भुपरिवेष्ठित vs. समृद्धि (Smith 1776, Faye *et al.* 2004)
  - भुपरिवेष्ठित देश नै अति कम बिकसित (UNDP 2012)
  - समुद्र सम्म कठिन पहुँच, दुर्गम विश्व बजार, महँगो ढुवानी (Kharel & Belbase 2010)
  - गरीब पर्वतीय मूलुक हरुले बिदेशी मुद्रा खर्चेर खाधान्न, पेट्रोलियम, उर्जा जस्ता आधारभूत आवश्यकता आपूर्तिगर्नु पर्ने बाध्यता

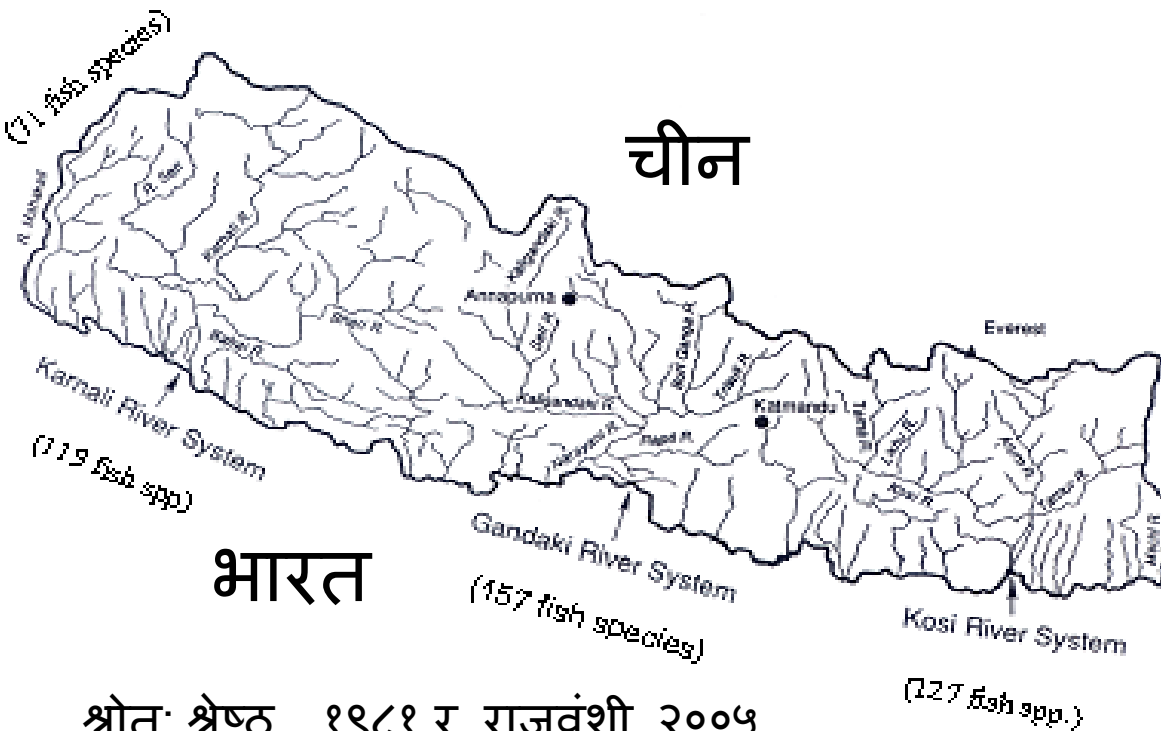




भुपरिवेष्टित मुलुकका HDI र देशको कुल क्षेत्रमा (A) र जनसंख्या (B) मा अन्तरसम्बन्ध

# नेपालमा नदी प्रणाली : मत्स्य विविधता, जलबिद्युत र खाद्य सुरक्षाको सन्जिवनी (LIFELINE)

तीन महत्वपूर्ण नदी प्रणाली : कोशी, गण्डकी र कर्णाली

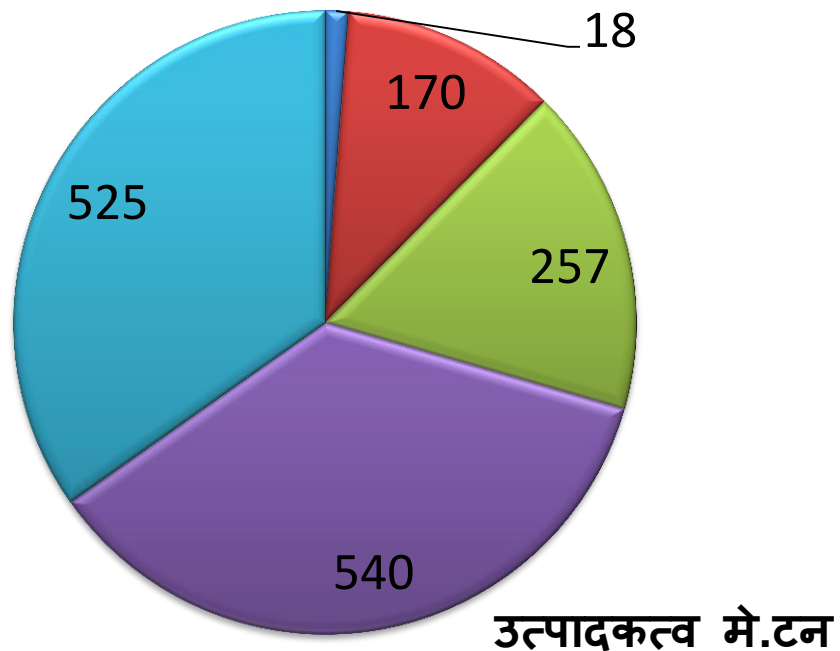
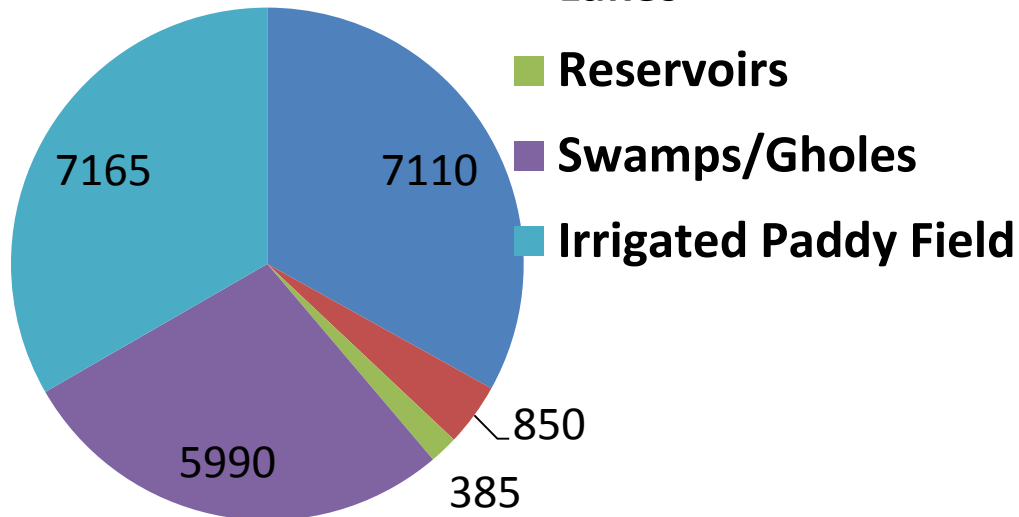


श्रोत: श्रेष्ठ १९८१ र राजवंशी २००५

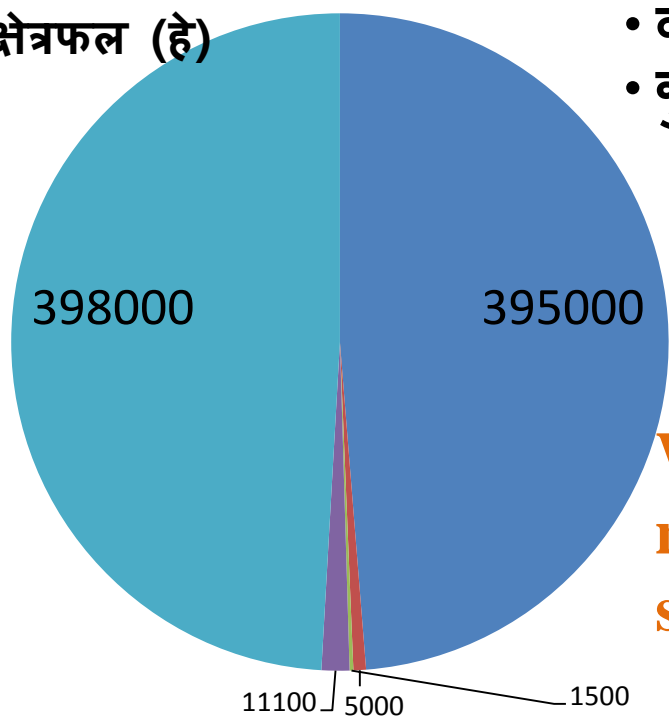
१४ जनजाति (१०.८ प्रतिशत) जनसंख्या आश्रित



उत्पादन मे.टन



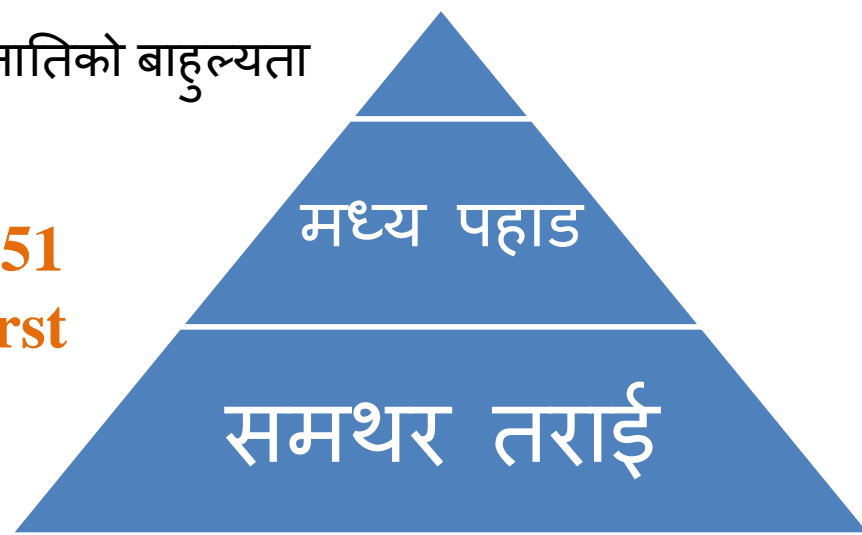
क्षेत्रफल (हे)



- वार्षिक समातिने माछा उत्पादन (२०१२) जम्मा २१,५०० मेटन
- कुल माछा उत्पादन को ४३ प्रतिशत

मत्स्य प्रजातिको बाहुल्यता

**Worth US\$ 51 million at first sale**

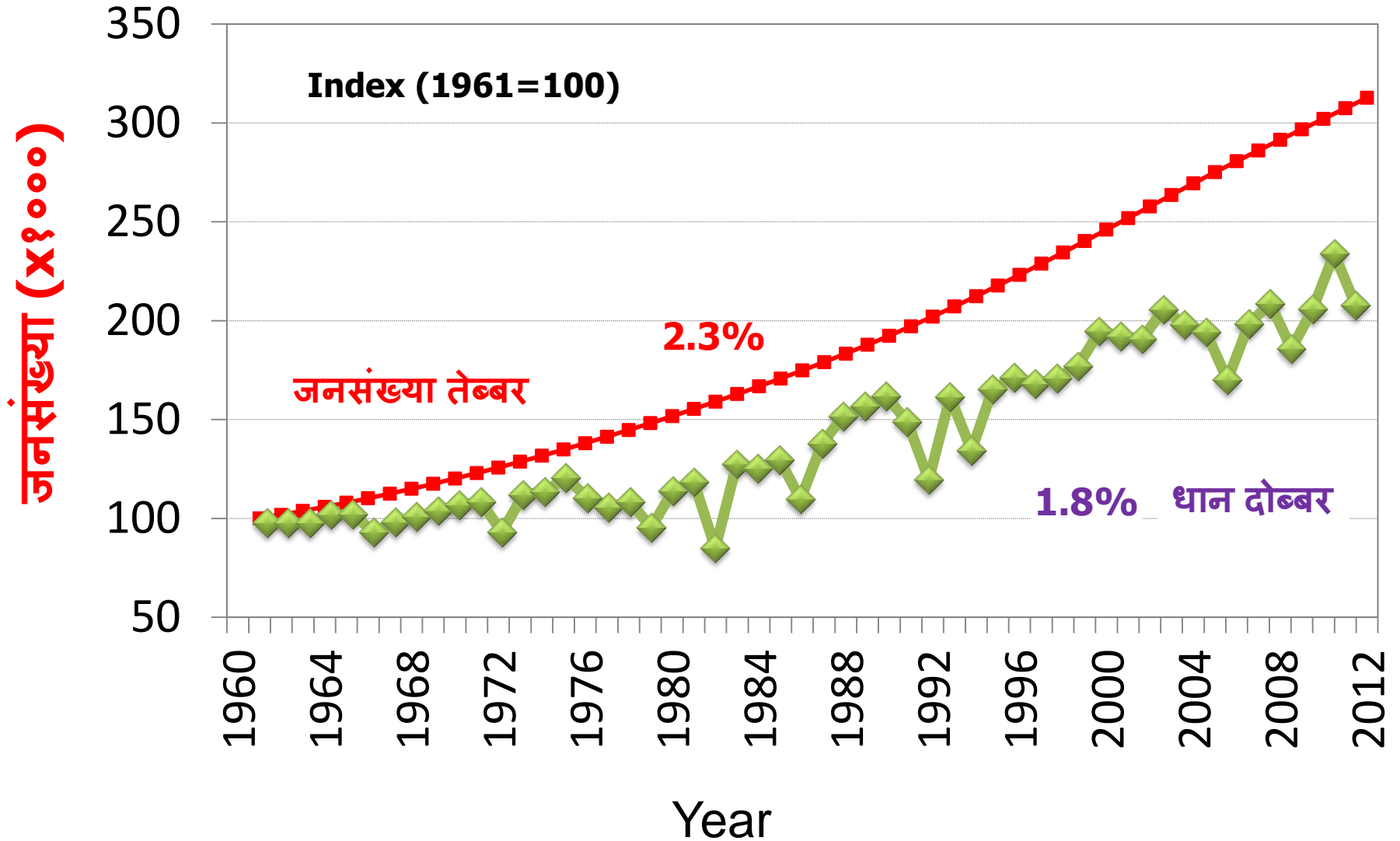




# खाद्य, जल र उर्जा सुरक्षा

- नेपाल विश्वकै एक खाद्य सुरक्षामा कमजोर देश हो,
- भारत बाट चामलको आयात रु ५ अर्ब
- भारत बाट तरकारीको आयात रु २.८४ अर्ब
- फलफूल आयात रु ६९५ मिलियन गत वर्ष को ४५० मिलियन
- माछा आयात रु ३ अर्ब, मासु आयात रु १५ अर्ब
- कुल सिंचित क्षेत्र २७.७४ प्रतिशत (२००८, World Bank)
- ७५ घण्टा लोडसेडिङ प्रति हप्ता
- रु ३२ अर्ब बिजुली, जेनेरेटर, इन्वर्टर आयात

# जनसंख्या र धान उत्पादन

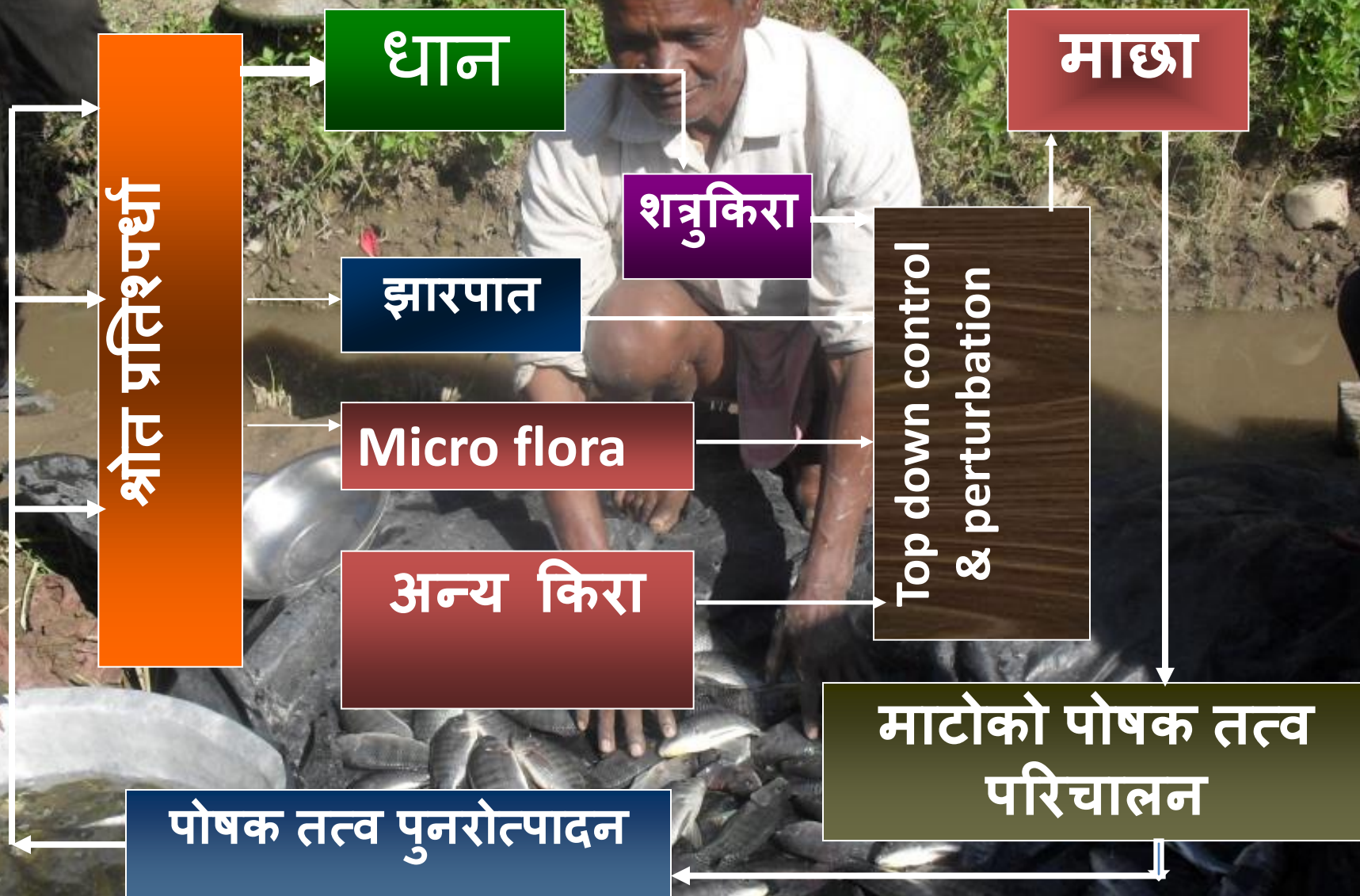


# धानखेतमा माछा पालन बाट खाद्य तथा पोषण सुरक्षा ?



Photo source: Shrivastava









**WARNING  
PESTICIDES**



**FIRE WILL CAUSE  
TOXIC FUMES**

COMPLEX To register call 800-362-8173. Register #2087



# रैथाने माछामा ह्रास

- वातावरणीय ह्रास, प्रदूषण र वासस्थान लोप
- वन अतिक्रमण, बालुवाकरण
- प्राकृतिक बहाव परिवर्तन
- गरिबी
- अत्यधिक मत्स्य दोहन
- जागरुकतामा कमि
- कानून परिचालनमा न्युनता
- जलवायु परिवर्तन
- विषादी



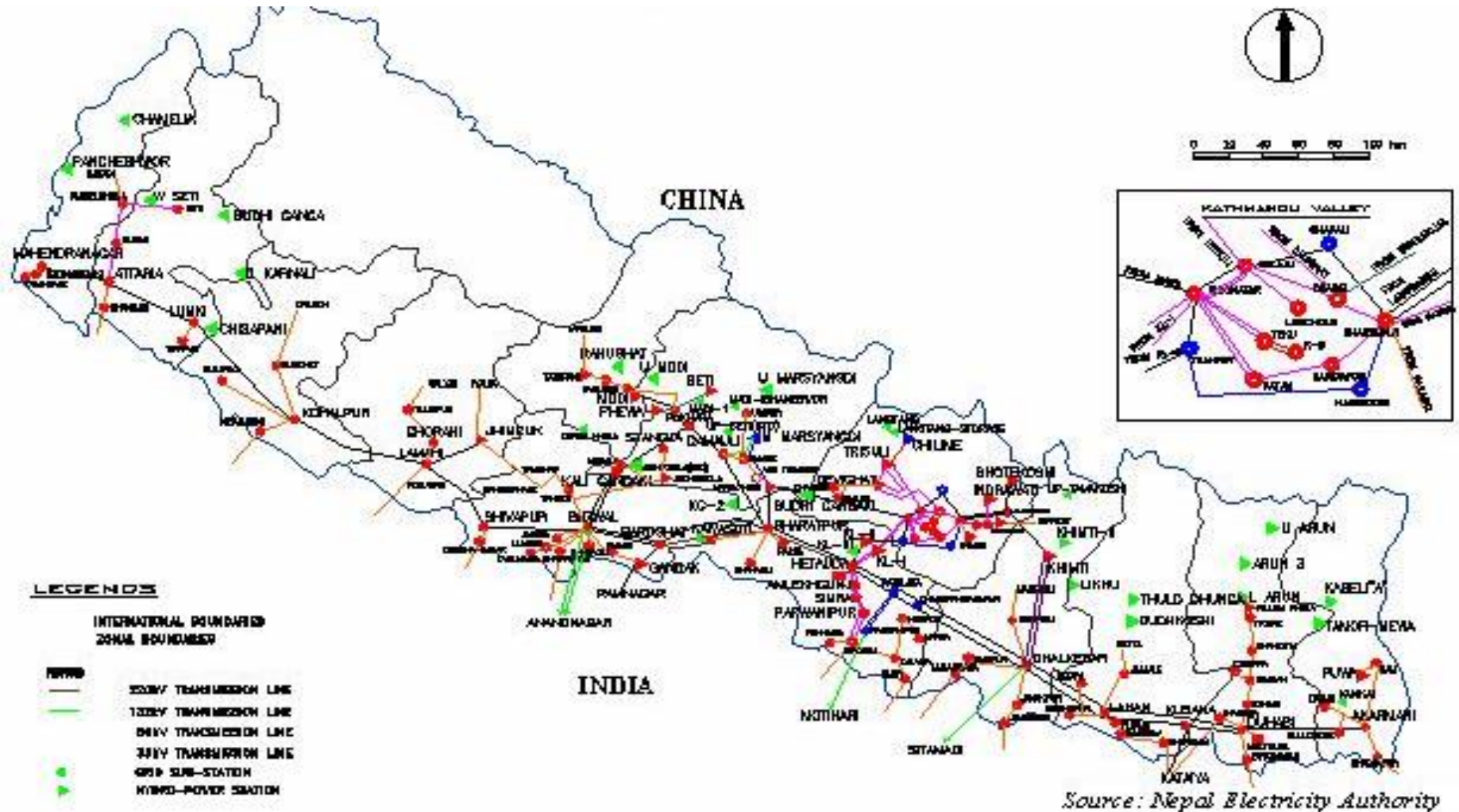
प्राकृतिक प्रजनन स्थानको अतिक्रमण



Photo source: Shrivastava



# प्रमुख जलबिधुत आयोजना हरू



## तामाकोशी जलबिधुत आयोजना

# काली गण्डकी नदीमा अवस्थित जलबिधुत केन्द्रमा निर्मित मत्स्य प्रजनन केन्द्र: के trade-off वा समन्वयका अभ्यास हो ?



मत्स्य प्रजनन केन्द्र- काली गण्डकी





जलचर संरक्षण ऐन २०१७ संशोधन सहित २०५६

कुनै पनि नदीमा बिधुत वा सिचाईका लागि बाँध लगाइएमा मत्स्य हँयाचरि वा मत्स्य भर्याङ निर्माण गरिनु पर्ने

जलचर संरक्षण ऐन किन ?

• हयाचरी, भर्याङ, मत्स्यनिकास (Fish pass), catching and hauling जस्ता प्रावधानले बाँध व्यवस्थापनका अंग रहेकाले जैविक विविधता र दिगो बिकास प्रति सम्मान प्रदर्शन गर्दछ,



*Esomus danricus*



*Sisor rhabdophorus*



# ढतसुत नलकलस (Fish Pass)

ढलँधढल ढतसुत नलकलश अतुतनुत  
ढलथललुलल ढलनुदुढल नलरुढलण ढलकलल  
तलतलरल ढलट उकुललन असढुढलव हुनल



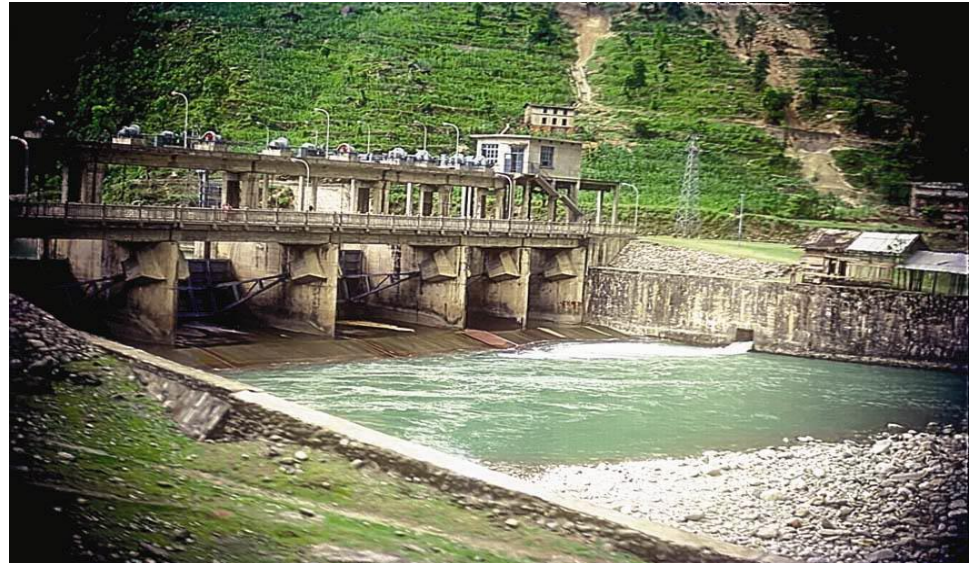
# मत्स्य भर्याङ (Fish Ladder)

- नजिकका सामाजिक  
आर्थिक परिवेशका  
कारण असफल



Andhi Khola Fish Ladder, Nepal

(Photo: Shrestha TK)





# काली गण्डकीमा संकलित रैथाने माछा र तिनका प्रजनन



**Sahar, *Tor putitora* & *Tor tor***



**Buchhe Asala, *Schizothorax plagiostomus***



**Katle, *Neolissocheilus hexagonalepis***



**Rewa, *Changunius changunio***

**(Photo: Baidya)**





**Egg stripping**

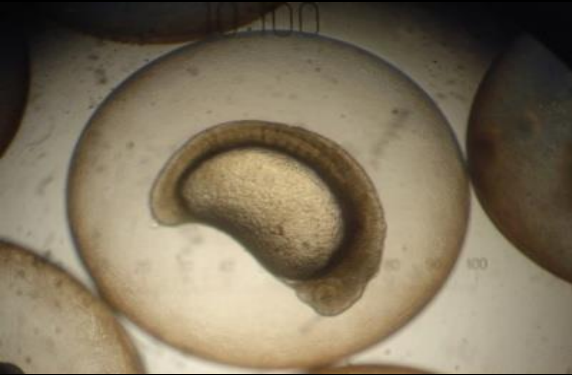
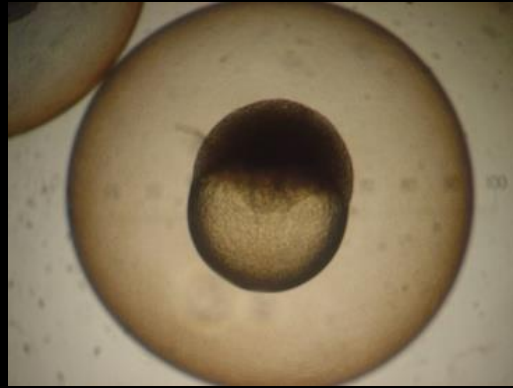


**Milt addition**



**Fertilized eggs**

# माछामा भ्रुण बिकास क्रम



(Photo: Baidya)

# काली गण्डकीमा स्टक गरिएका रैथाने भुरा संख्या

(in thousands)

Fish sp	Year											Total
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
<i>Tor putitora</i>	20	40	80	123	160	110	260	92	26	0	52	<b>963</b>
<i>N. hexagonalepis</i>	30	60	45	64	55	0	0	0	25	0	57	<b>336</b>
<i>S. plagiostomus</i>	16	37	18	22	15	20	50	0	0	0	75	<b>253</b>
<i>Labeo dero</i>	40	300	470	156	510	630	390	392	30	404	208	<b>3,530</b>
<i>Labeo rohita</i>	0	0	50	47	0	0	0	0	0	0	0	<b>97</b>
<i>Labeo pangusia</i>	0	0	0	0	15	0	110	371	0	84	341	<b>921</b>
<i>Garra annandelai</i>	0	0	0	0	5	0	0	0	0	0	0	<b>5</b>
<i>Garra gotyla</i>	0	0	0	0	5	0	0	0	0	0	0	<b>5</b>
<i>Labeo angra</i>	0	0	0	0	0	0	0	0	0	0	69	<b>69</b>
Others	0	0	0	40	0	0	0	0	0	0	0	<b>40</b>
<b>Total</b>	<b>106</b>	<b>437</b>	<b>663</b>	<b>452</b>	<b>765</b>	<b>760</b>	<b>810</b>	<b>855</b>	<b>81</b>	<b>488</b>	<b>802</b>	<b>6,219</b>

(Source: Baidya)



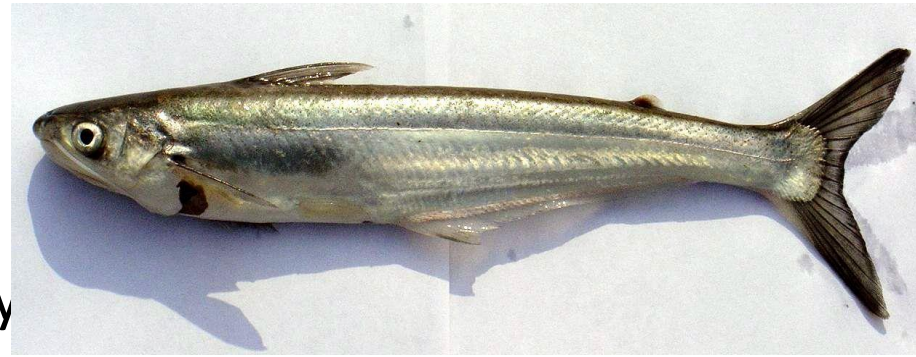
# स्थानीय प्रतिनिधिहरूको समुपस्थितीमा माछा भुरा स्थापन भैला



Photo source: Baidya, Nepal



- Cost of KGHP system = 354.8 m US\$
- Cost of fish hatchery = 2.8 m US\$
- Income (KGHP) = 51 to 64 m US\$/y
- Budget of Hatchery = 0.0042 m US\$/y
- Annual Return from fisheries = ?



Jalkapur, *Pseudeotropius murius*

- काली गण्डकी जलबिधुत आयोजनाको कुल लागत ३५४.८ मि डलर
- हयाचरी को लागत २.८ मि डलर
- जलबिधुत आयोजना को आय ५१-६४ मि डलर /वर्ष
- हयाचरी संचालन खर्च = ०.००४२ मि डलर /वर्ष
- हयाचरीको आम्दानी ?



Rajbam, *Anguilla bengalensis*

# हैसियत बिग्रेका ताल पुनर्स्थापना प्रविधि

- ताल क्षेत्र अतिक्रमण
- पानीमा घुलित अक्सिजनमा कमि
- सामुहिक मरण
- जैविक विविधतामा कमि

प्रभाव:  
उत्पादन ह्रास, बेरोजगारी, खाद्य असुरक्षा



1999-00



2005-06



2010-11



# पहाडक लागि मत्स्य पालन प्रविधि



*New challenge and research opportunities*

## जलाशयमा मत्स्य पालन : सफलताको कथा





*New challenge and research opportunities*



महत्त्व शृंखला : मत्स्य पर्यटन बाट गरिबी निवारणक साथै मत्स्य संरक्षण हुन् सक्ने

Photo by S Sunuwar



# बजारमा अत्यधिक मांग



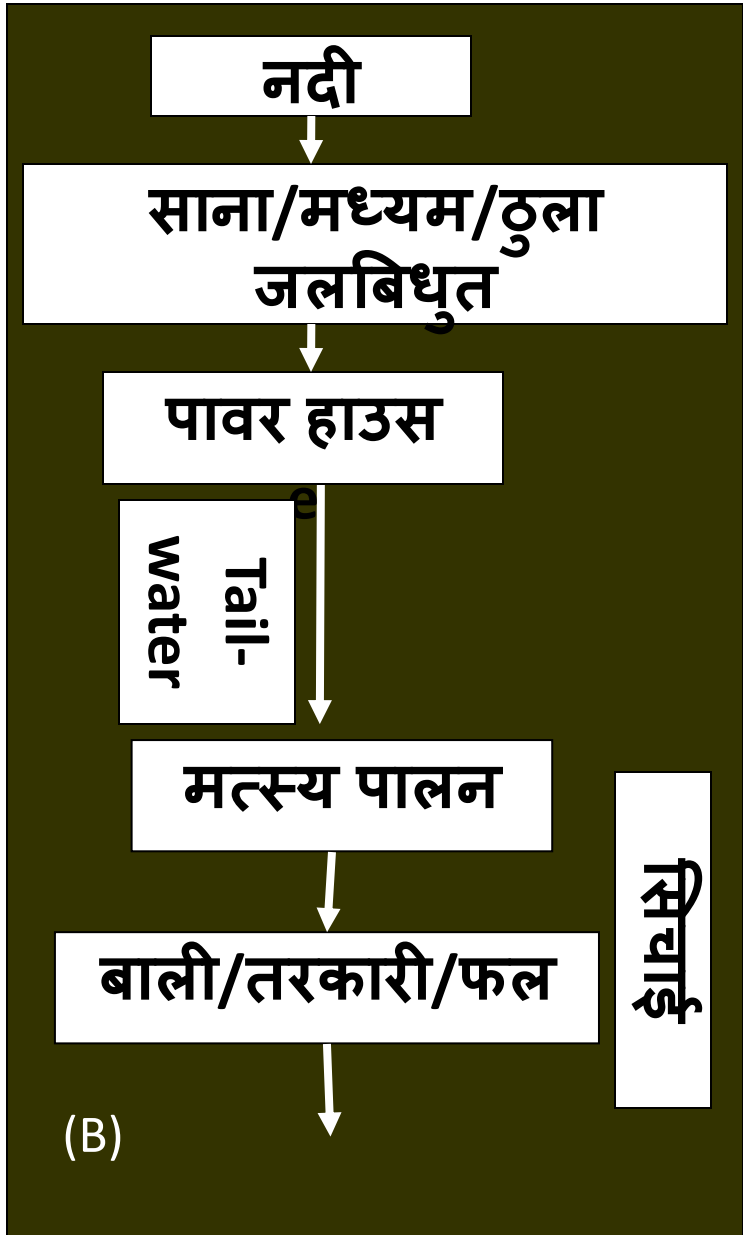
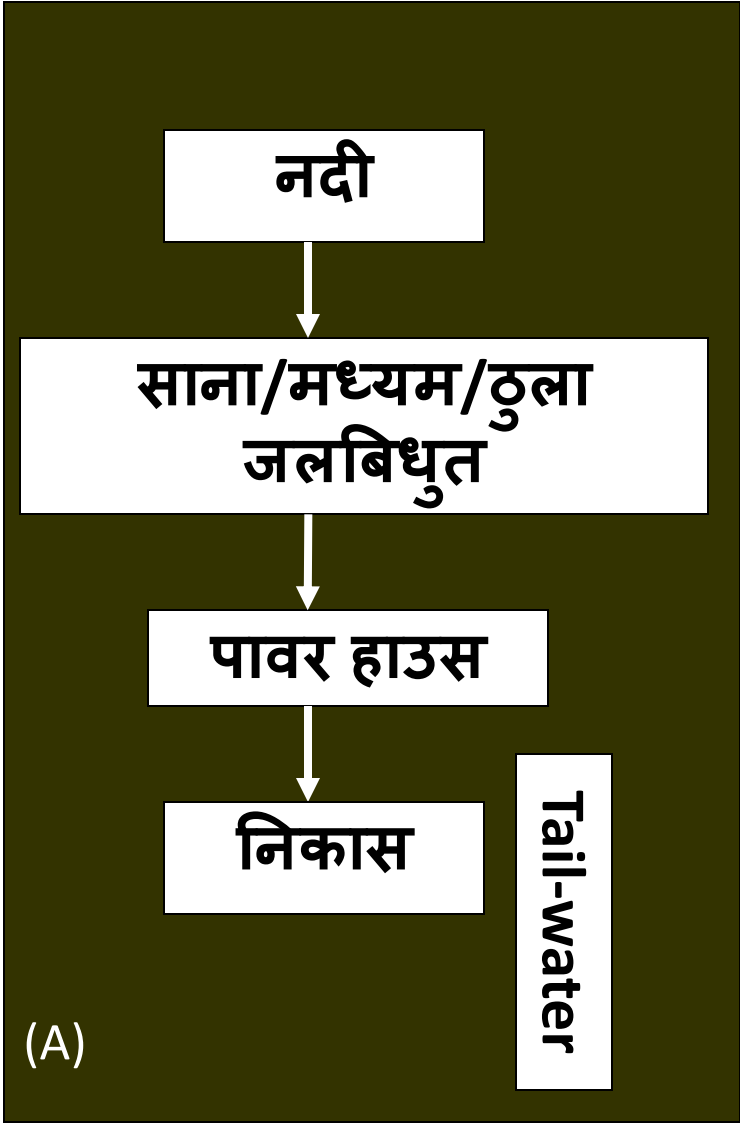
## नया चुनौती हरू :

- उपभोक्ता समुह को गठन सँगसँगै संरक्षण एवम सम्बर्द्धनमा पहल
- संरक्षण एवम सम्बर्द्धनमा महिला र जनजाति को सहभागिता
- माछा स्थापन वृद्धि नियमन (Stock enhancement regulation)
- बाँध सँगै रैथाने माछा ह्याचरी स्थापना प्रविधि प्याकेजको अनुसरण
- जलीय जैविक सम्पदा लगायत मत्स्य पालनमा अनुसन्धान र बिकास

# अनुसन्धानका अवसरहरू

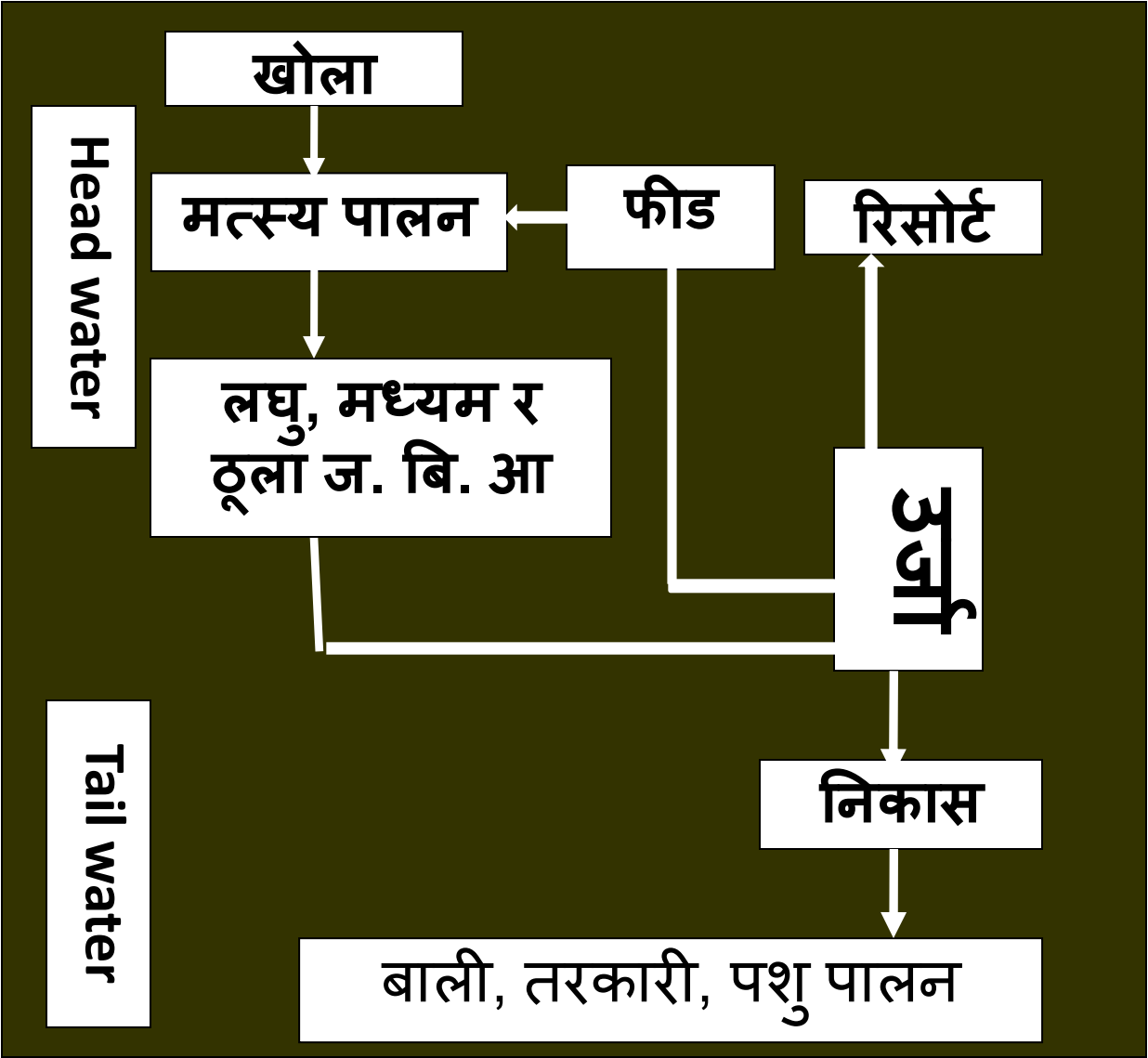
- मत्स्य परिस्थितिकी विज्ञान
- Adaptive environmental management
- Ecological, societal “Trade-offs analysis”
- Integrated Water Resource Management
- Climate change
- Tourism Recreational Fisheries
- मत्स्य पालन





पारम्परिक (A) र आधुनिक मत्स्य, जलबिधुत, र कृषिका अन्तरसमायोजन परिदृष्य (B)

जलबिधुत, खाद्य, र माछा उत्पादनका अन्तरसंजाल



## अन्तमा,

- मत्स्य पालन, बाली, बागवानी, पशुपालन, र जलबिधुत हाम्रो जस्तो भौगोलिक अवस्थाका देश मा एकिकृत तवरले खाद्य, उर्जा र जल सुरक्षाका लागि संचालन गर्नु एक अकाट्य उपाय हो,
- मानवीय क्रियाकलाप तथा उर्जा, पानी र खाद्य सुरक्षाका लागि गरिने बाट मत्स्य विविधतामा ह्रास हुनेगरेकोले समायोजन (Trade-off) स्वरूप संरक्षण लगायत मत्स्य उत्पादन अभिवृद्धि कार्यक्रम प्राथमिकताका आधारमा संचालन हुनु पर्द छ ,



ધન્યવાદ









## **First NEFIS Convention and Annual General Assembly**

January 30-31, 2015,  
Kathmandu, Nepal



## **Small Scale Fishery in Uplands of Nepal**

**MDI Experiences from the Uplands of  
Makawanpur, Udaypur, Dailekh &  
Jumla Districts of Nepal**

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By

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# The Hills & Mountains

- The hills and mountains collectively called uplands constitute two third of the total land area of Nepal.
- The hills and mountains are major sources of water in Nepal.
- The water resources appear in a diverse form and support a diverse fish fauna.
- It is reported that 94% of the total fishery ponds are built in Terai region of Nepal. This indicates that, uplands are often neglected areas from aquaculture development perspectives.
- Though, fish is said to be the cheapest source of protein, it rarely reaches the tables of uplands people.





# MDI Experiences

Udaypur (2009-2012)

Nutrition Focused programme WFP/ DANIDA

S.N	Type of Ponds	Nos. of Ponds	Size of the Ponds (Range)	Species
1.	Earthen Ponds	87	68 – 464 m <sup>2</sup>	CARP Species
2.	Cemented Ponds (Aquaponic Types)	75	3-6 m <sup>3</sup>	Mostly African Catfish, Magur ( <i>Clarius garipeineus</i> )
	<b>Total</b>	<b>162</b>		



# Dailekh (2011-2013)

## Nutrition Focused \_WFP

S.N	Type of Ponds	Nos. of Ponds	Size of the Ponds (Range)	Species
1.	Earthen Ponds	88	20-120 m <sup>2</sup>	CARP Species ( common, Rohu,Grass,Nain )
2.	Cemented Ponds (Aquaponic Types)	97	4-6 m <sup>3</sup>	Catfish, Magur (Clarius gariepinus)
	<b>Total</b>	<b>162</b>		
3.	<b>Supplied Died Mortality rate</b>		<b>64714 fries 21950 34%</b>	
4.	<b>Total Production Consumed Sales</b>	<b>7370 kg 6210 kg (84%) 1160 kg (16%)</b>	<b>Rs. 175,200</b>	





Fry size Fingerlings  
brought from  
Mahadevpuri Nepalganj



Nursery pond at Noumule,  
Dailekh.



Fingerling stocking at  
farmers pond.



Distribution from Noumule  
Nursery pond.

# Fish pond of Dailekh

**Earthen ponds**



**Cemented ponds**





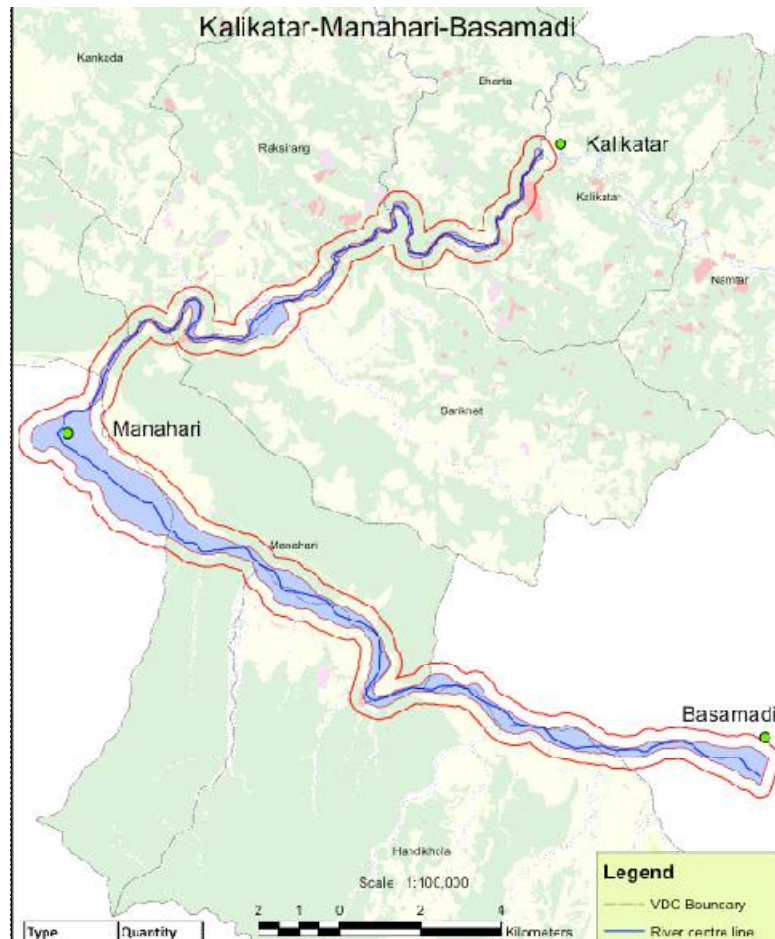
# Makawanpur (2012-2014)

Conservation & Livelihood (CARP-SIS Polyculture) – UNDP GEF  
Small Grants Programme (US \$ 28,000)

S.N	Type of Ponds	Nos. of Ponds	Size of the Ponds (Range)	Species
1.	Earthen Ponds	123	42-2400 m <sup>2</sup> (average 437 m <sup>2</sup> )	Common, Bighead, Silver, Grass & Local species
	<b>Total</b>	<b>123</b>		
2.	Total Production Total Sales  Consumed	4279 kg 3626 kg (61 farmers) 653 kg	Rs. 1,055,010	(As of December 2014)
3.	Productivity	Approx. 3.75 MT/ha	Source: Assignment Report, AFU	



# East Rapti River Basin



## SIS SPECIES

1. Pothi( *Puntius chola*)
2. Pothi/Sidhara (*Puntius chonchonius*)
3. Sahar(*Tor putitora*)
4. Chepuwa (*Aspidoparia morar*)
5. Chiplefaketa/Bagh (*Raiamas bola*)
6. Khasre (*Barilius bendelisis*)
7. Pothi (*Puntius sophore*)
8. Gardi (*Labeo dero*)
9. Sahar (*Tor tor*)
10. Faketa(*Barilius barna*)
11. Bhoti/Hile (*Channa orientalis*)
12. Kapre (*Glyptothorax pectinopterus*)
13. Budhuna (*Garra annandallie*)
14. Kauwa/Thunge (*Xenentodon cancila*)
15. Galara,Patharchatti (*Chagunius chagunio*)
16. Gadela (*Nemacheilus corica*)
17. Tengra (*Mystus bleekeri*)
18. Bam (*Macrognathus pancalus*)
19. Singhi/Chilni/Aagomachha (*Amblyceps mangois*)
20. Bam/Gainchi (*Macrognathus aral*)
21. Thend (*Labeo angra*)
22. Goira/Pategadela (*Acanthocobitis botia*)
23. Naun/Lata (*Lepidocephalus guntea*)
24. Goira (*Somileptes gongota*)

25. Baghi (*Botia geto*)
26. Baghi (*Botia lohachata*)
27. Ratokapre (*Pseudecheneis sulcatus*)
28. Patekapre (*Pseudolaguvia ribeiroi*)
29. Tengar/Kanti (*Aorichthys aor*)
30. Pothi (*Puntius ticto*)
31. Mara/Dhawai (*Amblypharyngodon mola*)
32. Dedhawa (*Esomus danricus*)
33. Nakuro Budhuna (*Garra gotyla*)
34. Chucho Bam (*Mastacembelus armatus*)
35. Jhing (*River Prawn*)
36. Katile (*Neolissochilus hexagonolepis*)
37. Jalkapoor (*Ompok bimaculatus*)

## CARP SPECIES

1. Rahu (*Labeo rohita*)
2. Naini (*Cirrhina mrigala*)
3. Common carp/scale carp (*Cyprinus carpio var communis*)
4. Bighead carp( *Aristichthys nobilis*)
5. Common carp/mirror carp (*Cyprinus carpio var specularis*)
6. Grass carp (*Ctenopharyngodon idella*)
7. Silver carp (*Hypophthalmichthys molitrix*)

Source: D.K Jha 2012, AFU,  
Rampur, Nepal





# Harvesting in Handikhola



# Tilapia culture – on the way





# Use of Excavator – A very cost effective way in digging ponds





Expansion of Fish Farm of Ram H. Bista  
from 1 kattha in the beginning to 8  
kattha in the second year and 12 kattha  
now – Handikhola VDC



Construction works under financial  
support of development banks (ADB/N  
& Supreme Bank), Hetaunda

## Jumla – Common Carp & Asla

- A research work in collaboration with DADO in Jumla
- Location
  - Tatopani & Garjyangkot
- Altitude – 2514 meters
- Date stocked : 7, jetha 2071
  - Tatopani (50 fries)
  - Garjyangkot (300 fries)
- A joint research work carried out by Mr. Rahul Ranjan, Mahendra Bhandari & Khop N. Shrestha





# Tatopani and Garjyankot Jumla

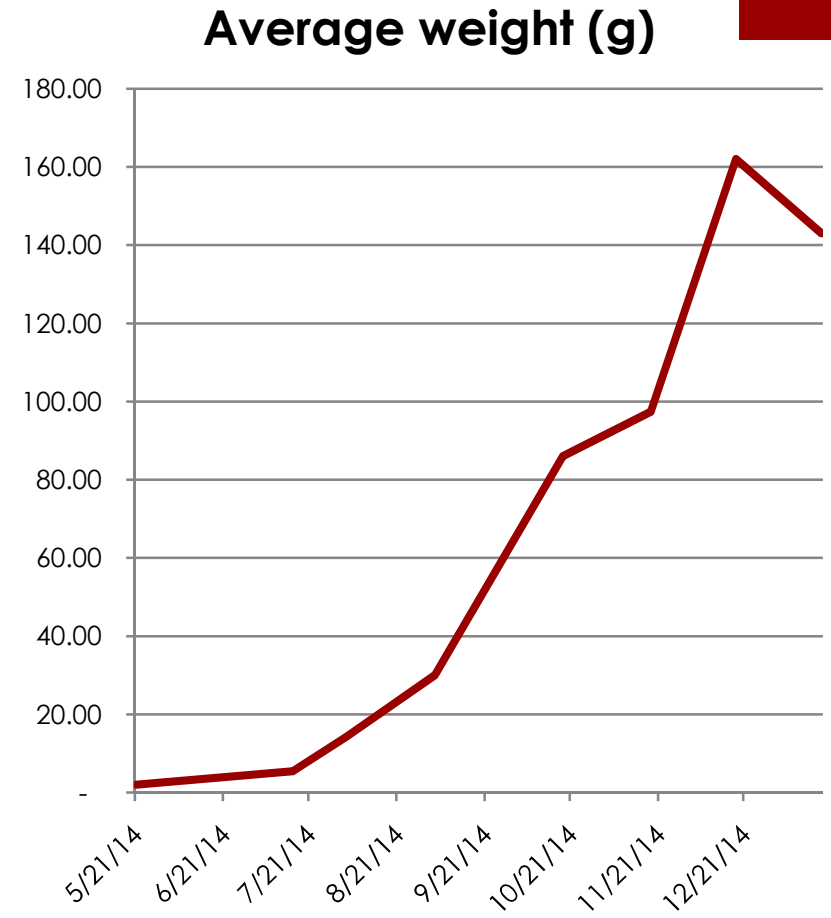






Date Measured	Average weight (g)	Temp (°C)
5/21/14	2.00	22
7/15/14	5.42	22
8/3/14	14.25	23
9/3/14	30.00	24
10/18/14	86.00	14
11/18/14	97.38	14
12/18/14	162.00	11
1/17/15	143.00	10

Date	Largest	Medium	Smallest
11/18/14	300		65
12/18/14	297	130	43
1/17/15	291	132	45



**Local Asala (20 Months)**



**Common Carp (6 Months)**





# Predation



Locally built 'Phadke' used for trapping kingfisher birds



Kingfisher bird

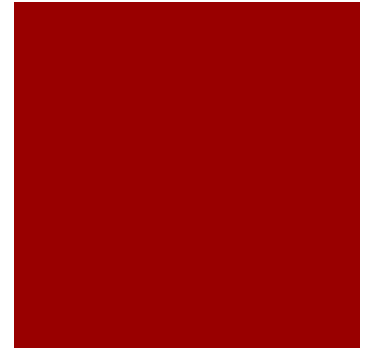


# Conclusion & Recommendation

- Small-scale fishery can make up an important contribution to nutrition, food security, sustainable livelihoods and poverty alleviation of the upland dwellers.
- So, it needs to be given higher priority and promote fishery in the upland areas of Nepal.







**Thank You**



# **VALUE CHAIN SCENARIO OF MAJOR CARPS IN CHITWAN DISTRICT , NEPAL**

Rim Bdr Thapa  
M.Sc. Aquaculture  
FDO, DADO, Sunsari

# 1. INTRODUCTION

# 1.1 Background

- Value chain is a sequence of target oriented combinations of production factors that create a marketable product or service from its conception to the final consumption (Herr, 2007).
- It links all the steps of production, value addition and marketing.
- Recently Nepal has shown marked increase in aquaculture production near about 57,520 Mt produced (AICC, 2012/13) which is 1,520 Mt more than fiscal year 2011/12.



# Background .....

- Carp poly-culture has been developed as a popular system.
- Aquaculture in Nepal has been shown to benefit rural communities by providing an important supply of protein and additional income generation, and by empowering women who care for fish ponds (Bhujel et al, 2008).

## 1.2 Rational of study

- Recently Nepal has shown marked increase in aquaculture production near about 57,520 Mt produced (AICC, 2012/13) which is 1,520 Mt more than fiscal year 2011/12.
- With huge unmet and growing domestic demand for fish and related products, Commercialization of this sector has potential for growth and for import substitution (Bhattari *et.al*, 2013).

## 1.2 Rational of study

- Diminishing resources, the energy crisis and the resultant high cost of fishing have led to an increased realization of the potential for and versatility of aquaculture as a viable and cost effective alternative to capture fisheries (Ayyappan & Jena, 2001; Ayyappan, 2004).
- Long marketing channels are one of the reasons for increased marketing cost and bring efficiency in marketing.



## 1.2 Rational of study

- Depicting the nature of the technology in India, the percentage of gross return accruing to capital ranged from 35.71% for weed-based fish culture to 73.70% for high input carp poly-culture. Within the category of 'capital', variable inputs earned a much higher share of gross returns (20.56 – 65.33%) than did fixed inputs (7.08–17.23%) (Kathia, *et.al*, 2005).
- The share of labor varied between 6.67% for low input carp polyculture to 22.22% in the case of weed-based fish culture and 25.00% in the case of paddy-cum-fish culture (Kathia, *et.al*, 2005).

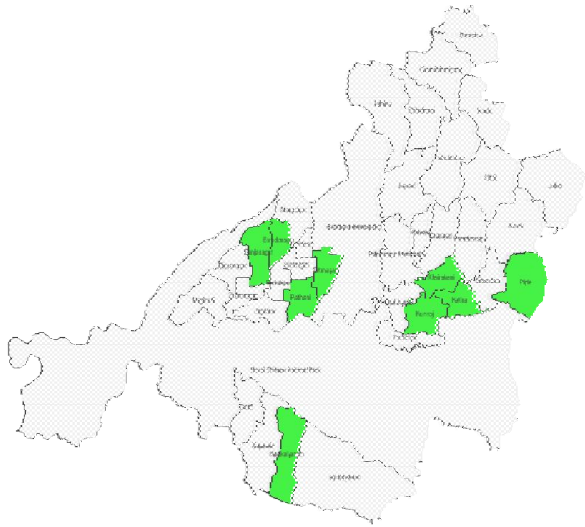
# 1.3 Objectives

To explore the value chain scenario of major fish in Chitwan, district.

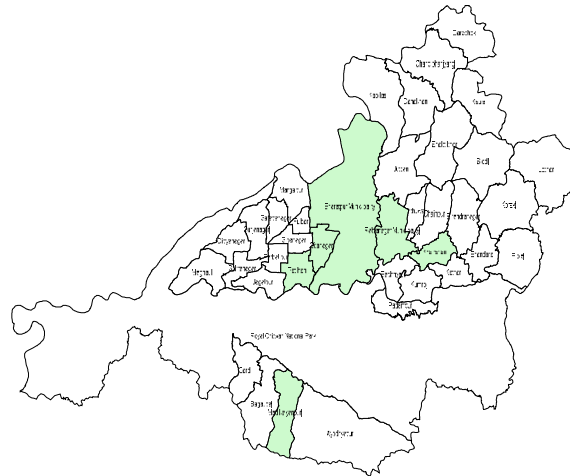
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# RESEARCH METHODOLOGY

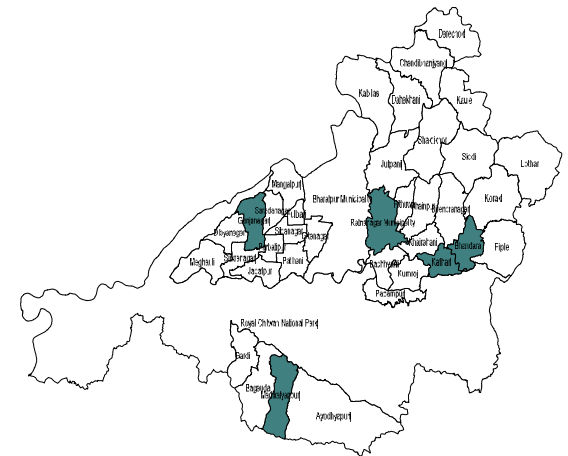
## Research Location



Study area of fish  
farmer



Study area of fish  
traders



Study area of fish  
seed producers



# Sampling

Purposive random sampling was done based on the sampling frame prepared by DADO, Chitwan.

- Altogether 121 fish farmers, 35 fish seller and 8 fish seed producers was taken as sample size.
- Co-ordination schema was developed to find out the relationship between the stakeholders of the value chain.

# Data collection

- Field survey through structured and semi structured questionnaire, focus group discussion, direct observation and key informant interview were employed concerned stakeholders of value chain for primary information.
- Secondary information was collected from the various published materials.

## **Data analysis**

- Collected data was analyzed by using Statistical Package SPSS and Microsoft Excel software packages.
- Value chain map was prepared.



## Indexing

- Farmers perception on the importance given to the different production and marketing constraints were analyzed by using 3 point scale of constraint comprising very high importance, medium, and the least importance by using 3, 2, and 1, respectively.

and calculation was done using formula;

- $I_{imp} = \sum (S_i F_i / N)$
- Where,
- $I_{imp}$  = Index of importance
- $\sum$  = Summation
- $S_i$  = Scale value
- $F_i$  = Frequency of importance given by the respondents
- $N$  = Total numbers of respondents

## **4. RESULT AND DISCUSSION**

# **Sociodemographic information**



Table 1: Ethnicity of the respondent in the study area

Ethnicity	Sampled households	
	Frequency	Percent
Chaudhary	112	68.29
Brahmin /chhetri	45	27.43
Mallha	7	4.28
Total	164	100

*Source: Field survey, 2013*

Table 2: Major occupation of the respondent in the study area

Major occupation	Agriculture	Services	Business	Total
Frequency	100	37	27	164

*Source: Field survey, 2013*

Table 3: Education level of the households Member

Education level	Frequency	Percent
Illiterate	35	21.34
Literate	47	28.65
Primary	45	27.43
Secondary	30	18.30
Higher Education	7	4.28
Total	164	100.00

*Source: Field survey, 2013*



# **Economic characteristics**

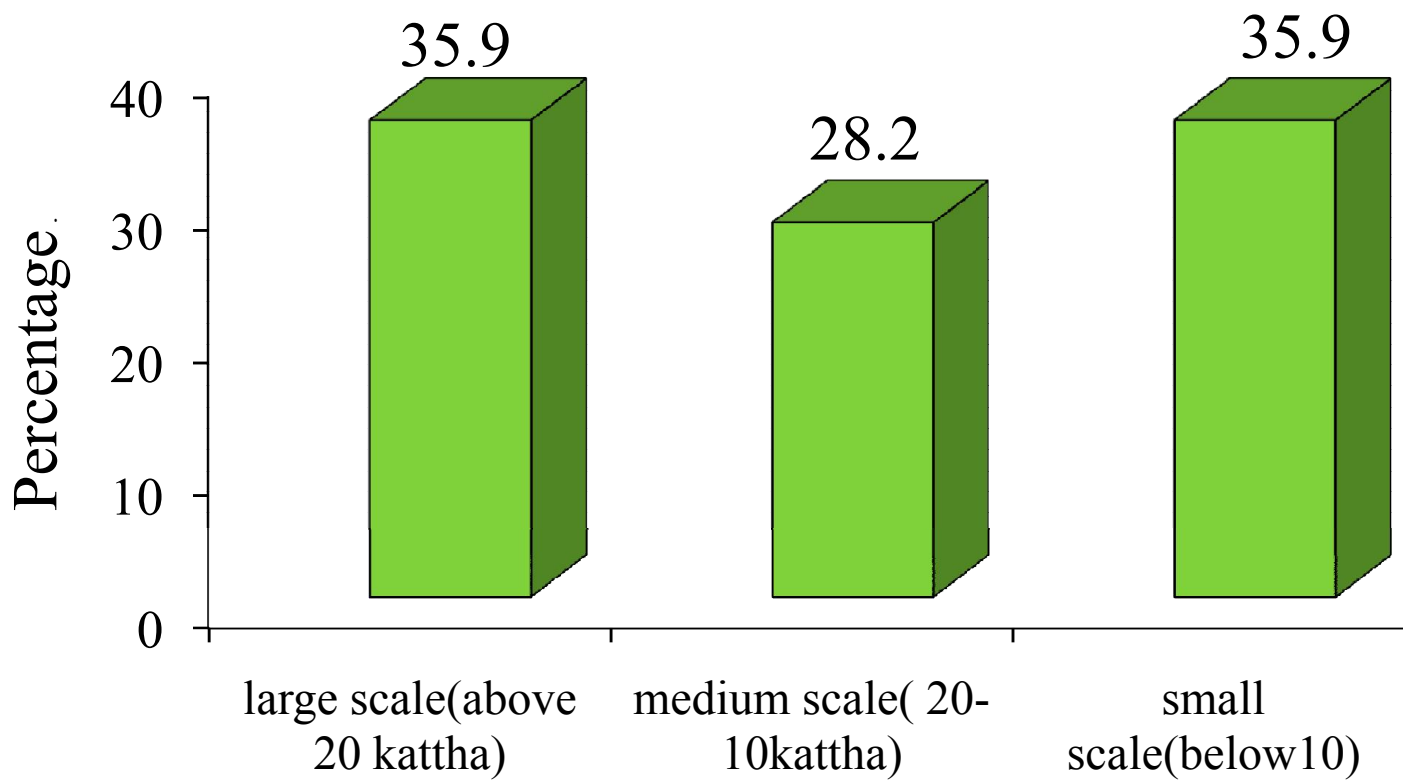


Figure: Status of the pond size

*Source: Field survey, 2013*

□ Own pond      ■ lease pond

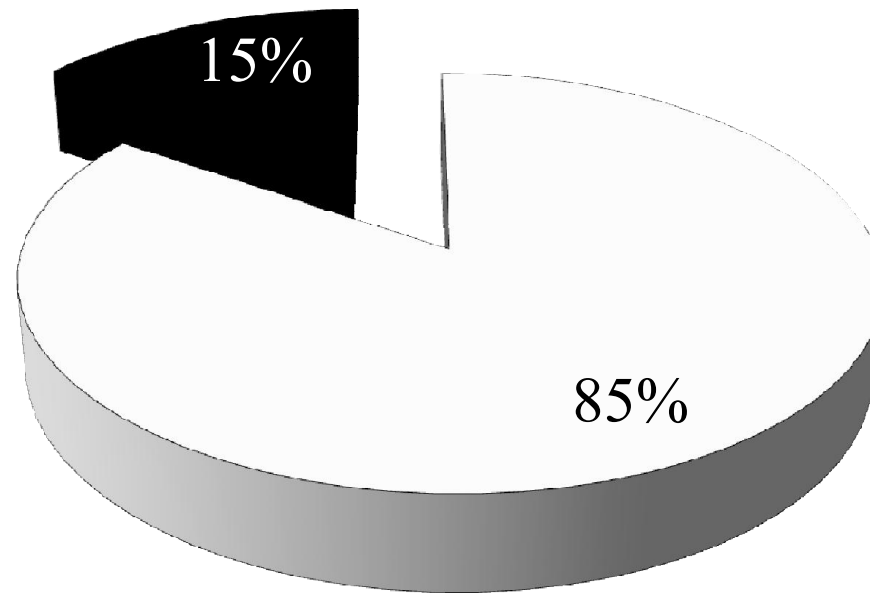


Figure 2 : Status of ownership of pond

*Source: Field survey, 2013*



Table 4 : Culture period for the table fish production

Carp fish	Mean $\pm$ SEM	Maximum	Minimum
Culture period ( month)	9.9744 $\pm$ 0.27364	12	7

*Source: Field survey, 2013*

□ winter season      ■ summer season

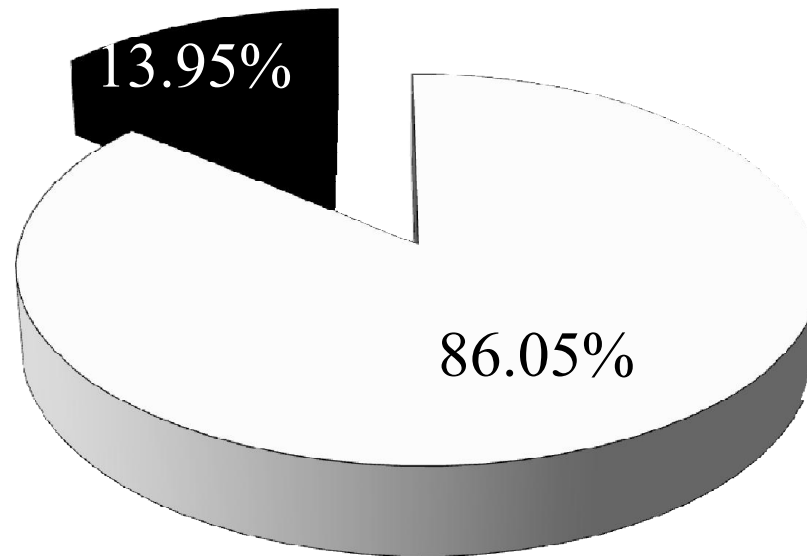


Figure 3 : Fish harvesting pattern

*Source: Field survey, 2013*

□ Retailer    ■ Fish farmer as seller    ■ Intermediaries

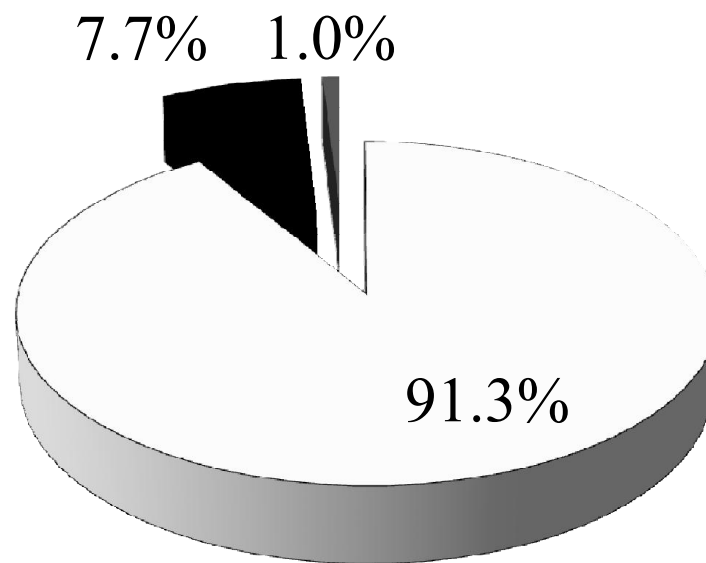


Figure 4 : Status of fish traders

*Source: Field survey, 2013*



■ Government hatchery □ Private hatchery ■ Private nursery

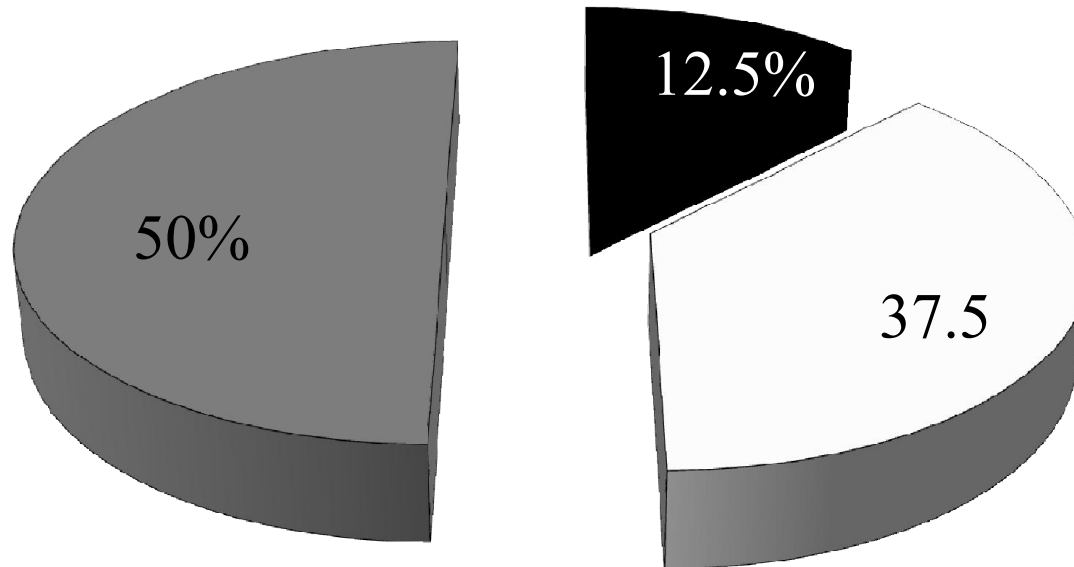


Figure 5 : Status of seed producer

*Source: Field survey, 2013*

Table 5 : Average production, cost and returns per hectare in Chitwan district

Average Production (Mt/hectare)	Cost (Rs/hectare)	Returns (Rs/hectare)	B/C ratio
4.66	3,11,422	7,38,936	2.41
Total	3,11,422	7,38,936	2.41

*Source: Field survey, 2013*

Table 6 : Average revenue and average gross margin of fish production per hectare

Fish	Average revenue	Average gross margin
Per hectare	7,38,936	4,27,514
Per kg	158.57	91.74

*Source: Field survey, 2013*



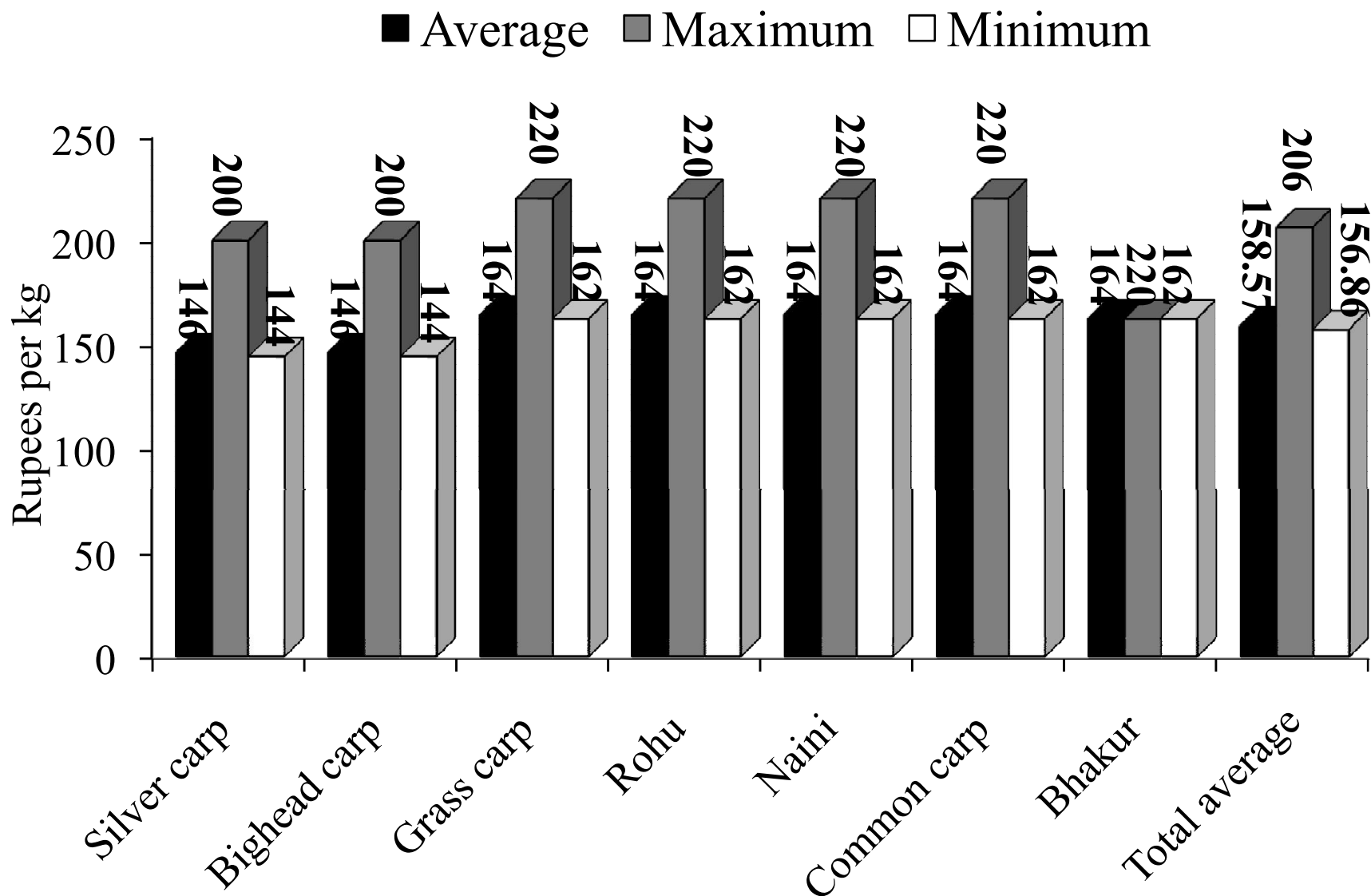


Figure 7 : Farm gate price of fish Rs/Kg

*Source: Field survey, 2013*

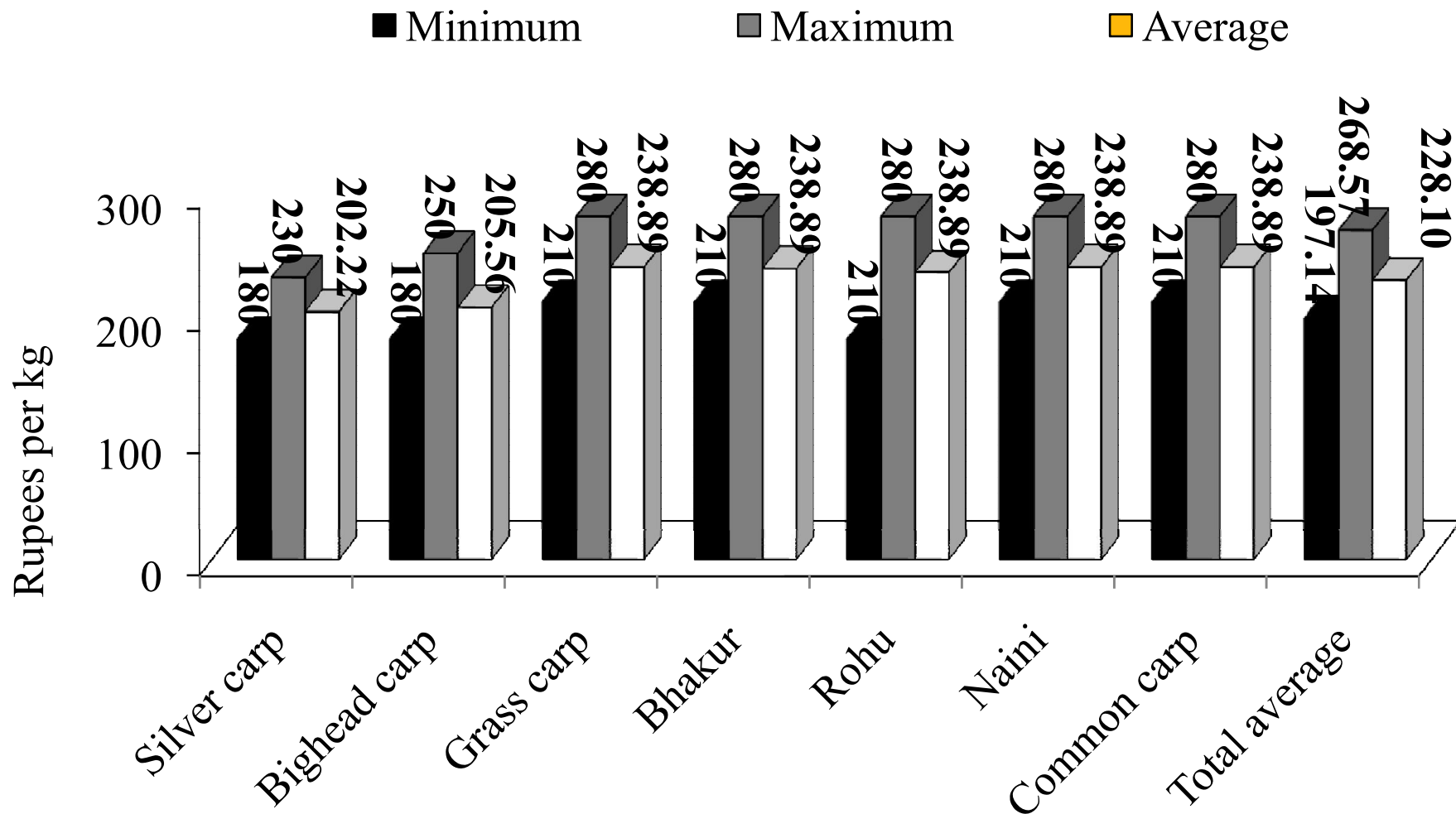


Figure 8 : Retail price of fish Rs/ kg

*Source: Field survey, 2013*

Table 8 : Intensity of preference of fish species by consumer

Preference	Index	Rank
Rohu	0.94	I
Common carp	0.82	II
Naini	0.72	III
Grass carp	0.38	IV
Bighead carp	0.36	V
Silver carp	0.24	VI

*Source: Field survey, 2013*



Table 9 : Demand of fish based on weight of fish (kg)

Fish species	Range of the fish weight (kg)
Silver carp	1.0-1.5
Bighead carp	1.0-1.5
Grass carp	1.5-2.0
Rohu	0.5-1.0
Naini	0.5-1.0
Common carp	1.0-1.5
Bhakur	1.0-1.5

*Source: Field survey, 2013*

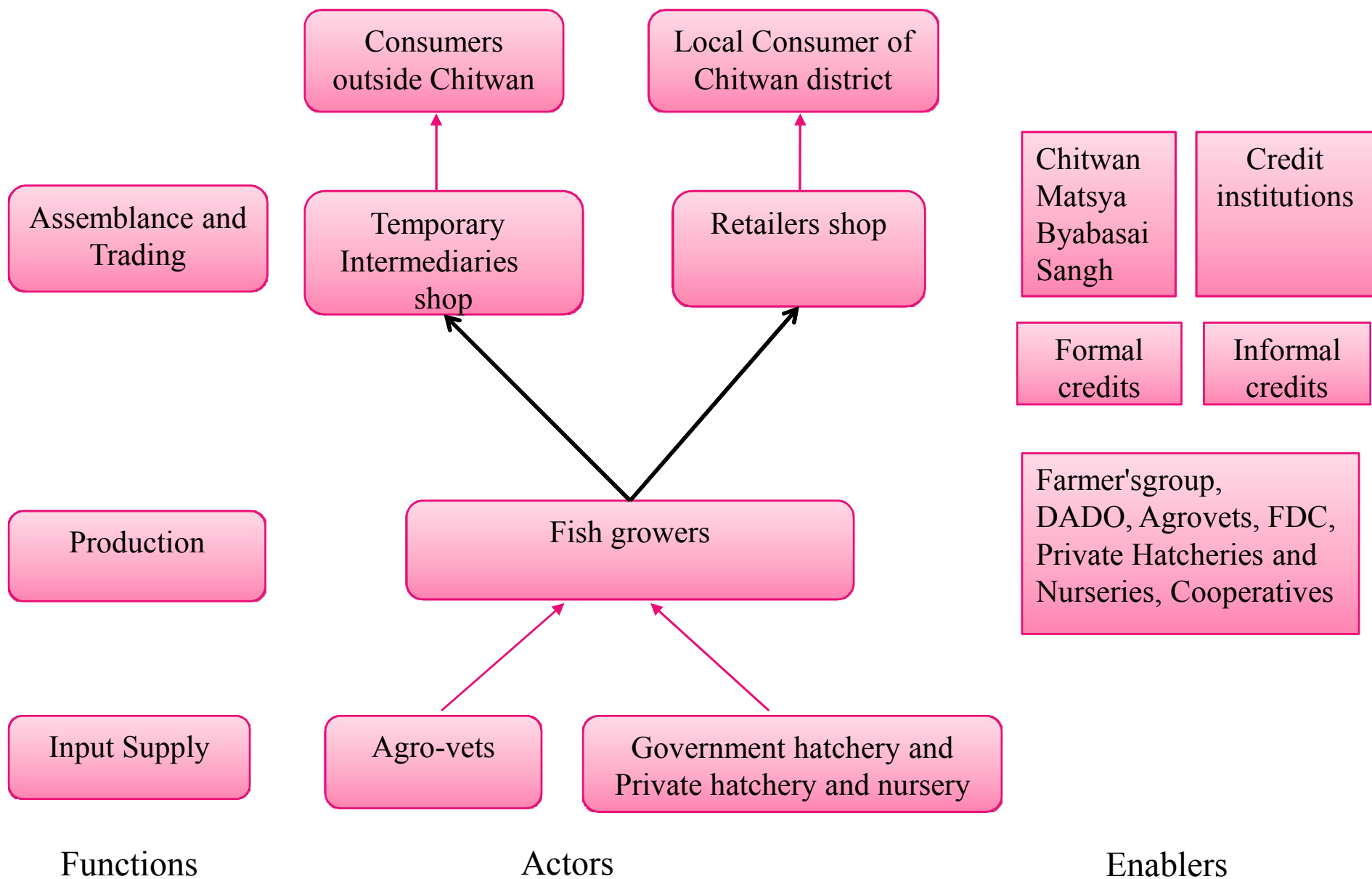


Figure 9: Value chain map of fish in Chitwan district *Source: Field survey, 2013*

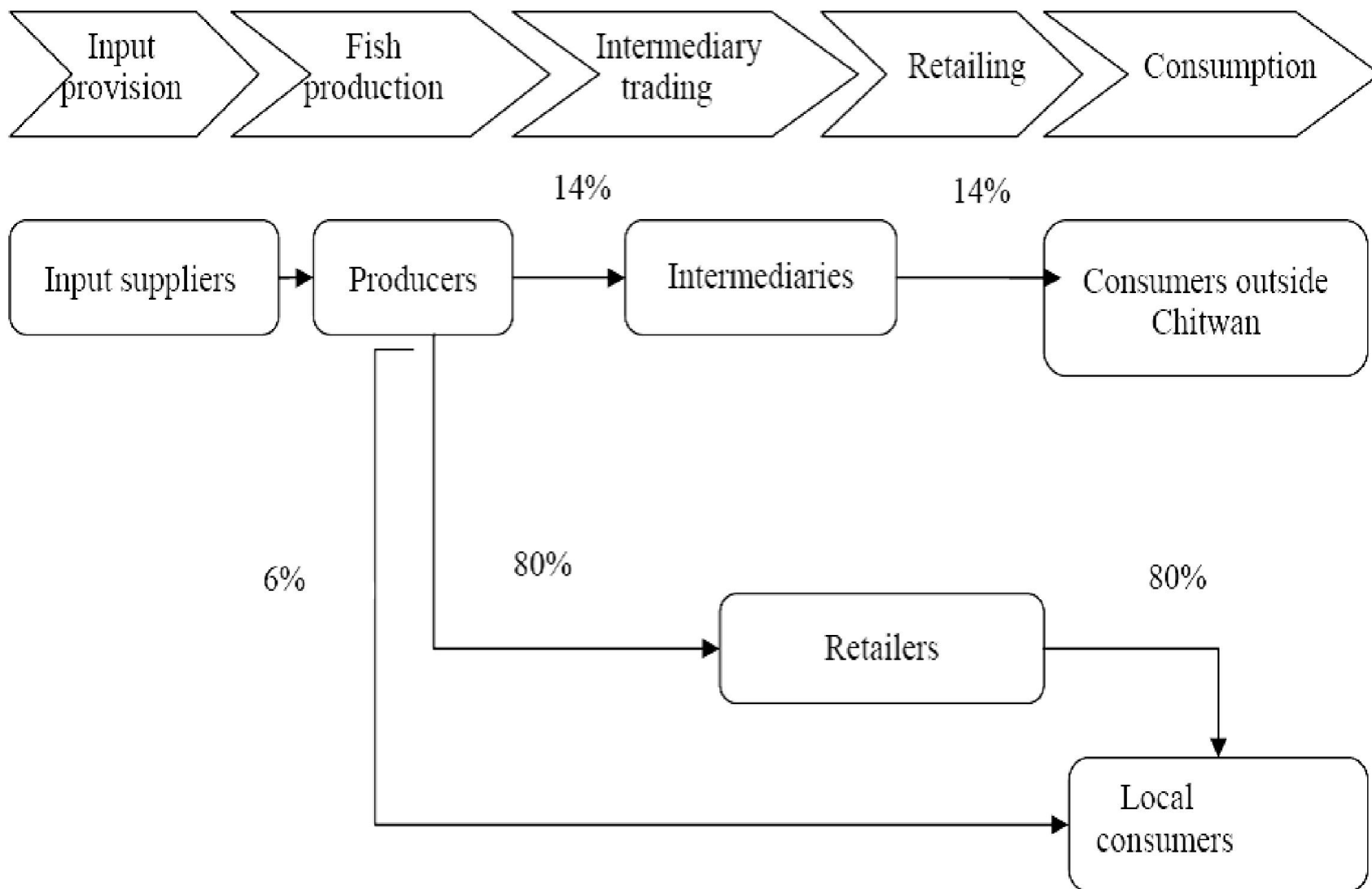


Figure 10 : Volume mapping of fish supply

*Source: Field survey, 2013*



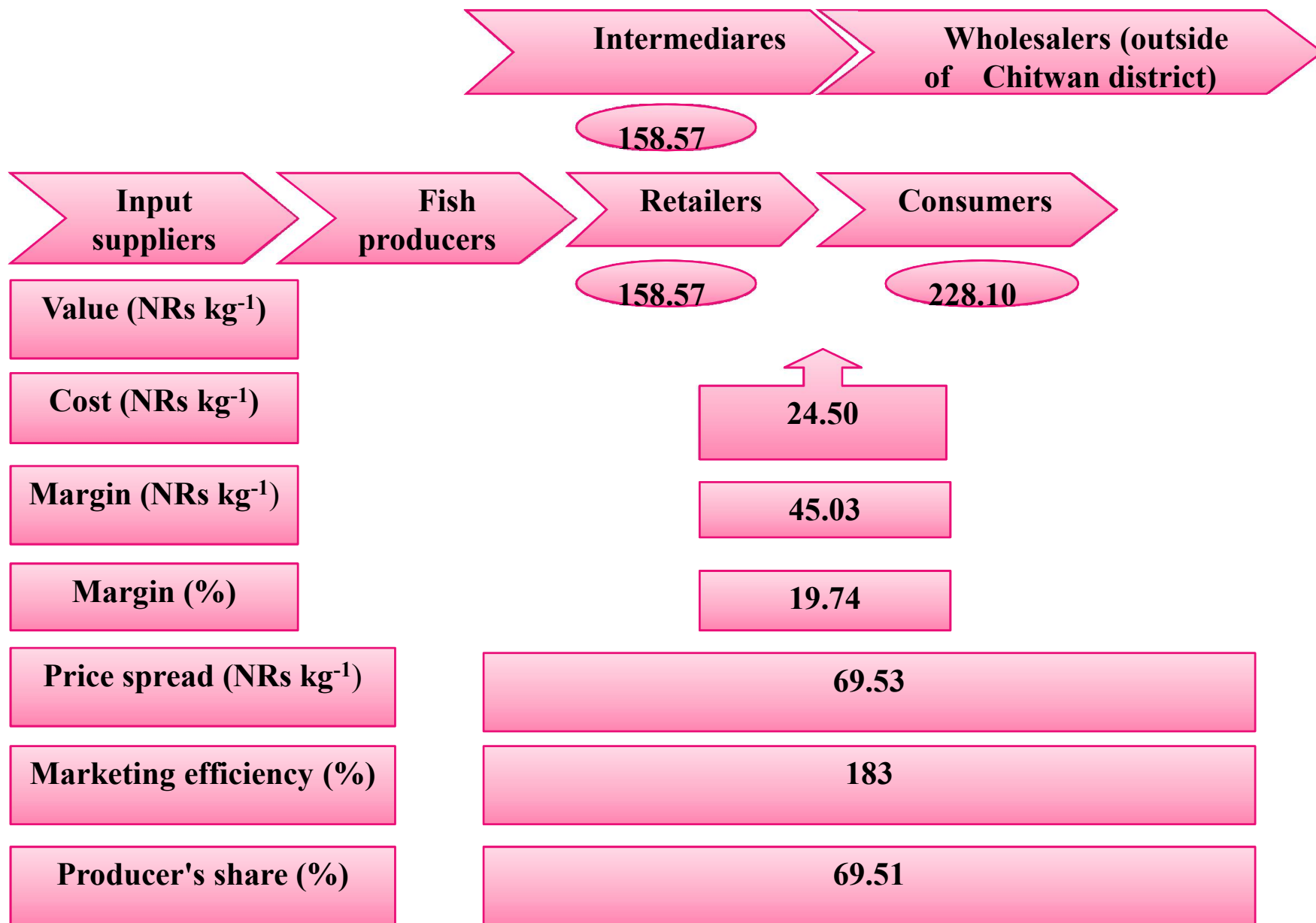


Figure 11 :Marketing cost, margin, price spread, marketing efficiency and producer's share in the core process of fish value chain

*Source: Field survey, 2013*

# 5. Summary

- Input suppliers, fish producers, intermediaries, retailers and consumers were the main actors in the Carp value chain of Chitwan district.
- The production of the fish per hectare of production pond was 4.66 Mt. The average cost of production and average returns per hectare were NRs 3,11,422 and NRs 7,38,936.
- The benefit cost ratio analysis showed that the fish farming was profitable enterprise with the B/C ratio 2.41.

➤ The average gross margin from the fish production was NRs. 4,76,598 per hectare and NRs. 91.74 per kg of fish.

➤ Rohu (Index value 0.94) is the most preferred fish followed by Common carp (Index value 0.82).



➤ The local consumers consumed 80.00 % of the total fish production. Only 14% of the remaining product exported to other district namely Kaski (Pokhara), Dhading (Malekhu) and Kathmandu.

➤ The price spread, marketing efficiency and producer's share was NRs 69.53 per kg, 183% and 69.51% respectively.

## 6. Conclusion

- Gross margin and high B/C ratio received by the Carp growers showed that the carp business is profitable in the production point.
- The retailers were the main intermediary actors in the carp value chain of Chitwan district. They were the main actors for inter-selling of carp within the district.
- Most of the fish is consumed within the district. Marketing efficiency of the fish business is above 100%, so its marketing is feasible in Chitwan district.





**Research Glimpse**



प्रो. दिपक अधिकारी

फोन: ९८१६२६४२८५  
९८४५३५९९३०

# अधिकारी माछा पसल



जडी-ट  
पिपल चौक

हामी कहाँ माडीको ताजा माछा होलसेल तथा खुद्रा पाउनुका साथै होम डेलिभरीको पनि सुविधा विवाह, पार्टी, भोजमा माछा चाहिएमा हामीलाई सेवा दिने मौका



द.सं.: ७४९/०६४/०६५

श्री गोपालनगर माछा उत्पादक तथा वितरक सहकारी संस्था लि.

कल्याणपुर-८, माडी, चितवन  
स्थापना: २०६४




THANK  
YOU  
VERY MUCH

# Substrate Based Carp and Small Indigenous Fish Polyculture to Enhance Fish Production and Family Nutrition



Sunila Rai<sup>1</sup> and Anu Toivonen<sup>2</sup>

<sup>1</sup>Associate Professor/Assistant Dean (Academic)  
Agriculture and Forestry University  
Chitwan, Nepal



# **Twinning Support to Women Fish Farmers' Organizations in Nepal**

**(March 1, 2012 – August 31, 2013)**



## **Twinning Partners**

1. Rural Integrated Development Society
2. Finnish Fish Farmers' Association

## **Supporting Technical Partners**

1. Institute of Agriculture and Animal Science
2. District Agriculture Development Office

## Project site

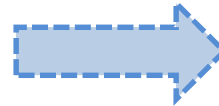




# Carp polyculture



**Household Income**



**Household  
consumption**

**Protein**



**Household nutrition**

# Carp – SIS polyculture



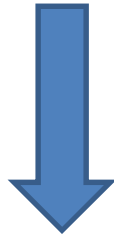
Protein

Micro-nutrients

Household consumption

Household Income

Household nutrition



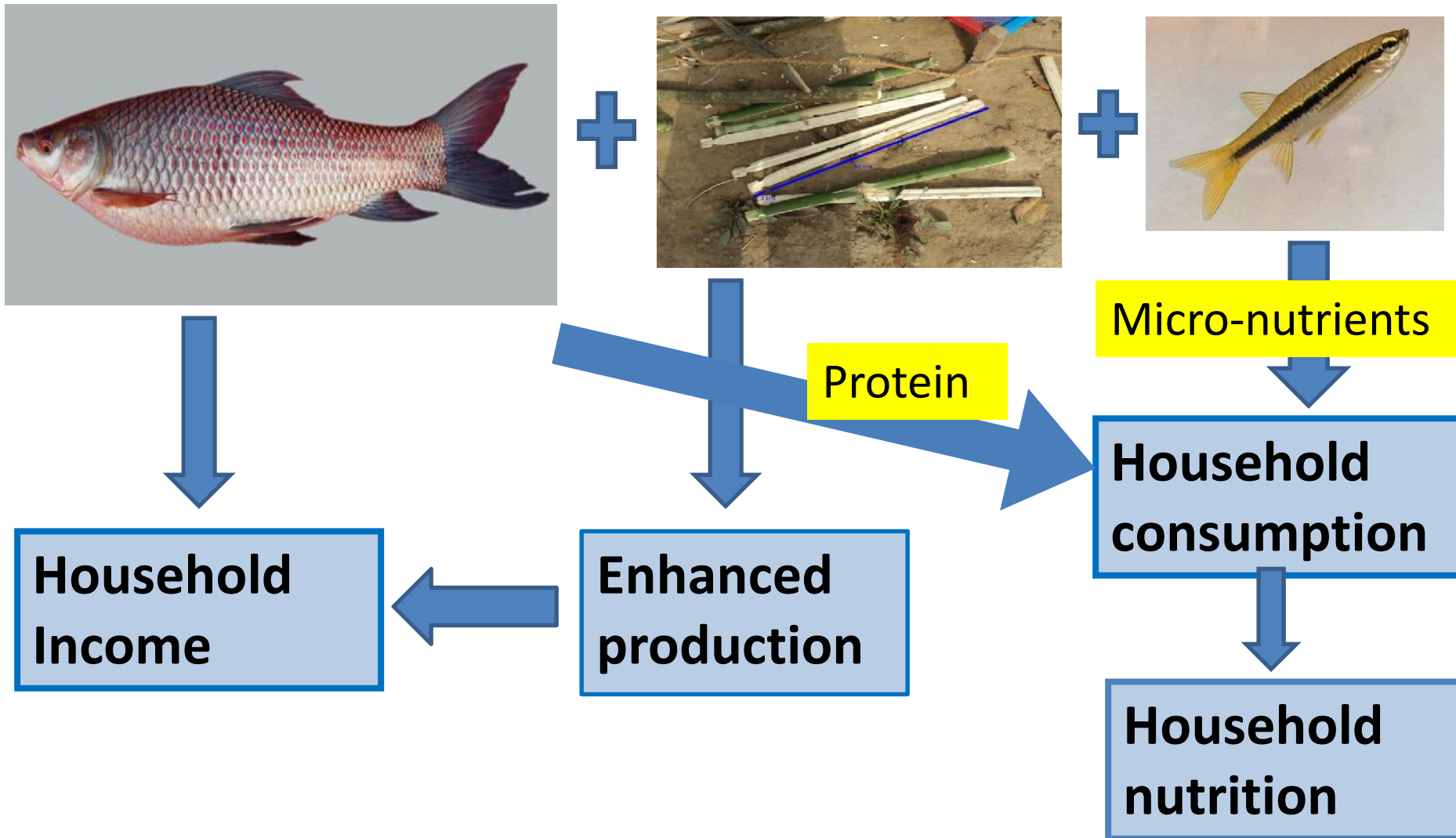
## Vitamin A, Iron and Zinc content in four common Small Indigenous Fish Species (SIS) of Terai, Nepal

SIS	Vitamin A (RAE/100g raw, clean parts)	Iron (mg/100g raw, clean parts)	Zinc (mg/100g raw, clean parts)
Dedhuwa ( <i>Esomus danricus</i> )	107.5	6.2	4.5
Faketa ( <i>Barilius sp.</i> )	84.5	1.0	3.6
Mara ( <i>Amblypharyngodon mola</i> )	685.5	2.4	4.3
Pothi ( <i>Puntius sophore</i> )	56.0	3.1	4.2
<b>Carp</b>			
Mrigal ( <i>Cirrhinus cirrhosus</i> )*	< 30	2.5	-
Silver carp ( <i>Hypophthalmichthys molitrix</i> )*	< 30	4.4	-

\*Roos et al. 2007



# Carp-SIS polyculture in substrate ponds



# Activities

Pond construction  
(approx. 100 m<sup>2</sup>) –  
50 new ponds



Pond preparation





# Substrate - Stripe bamboo installation





# Stocking

## Carp

1. Rohu (*Labeo rohita*)
2. Mrigal (*Cirrhinus mrigala*)
3. Bighead Carp (*Aristichthys nobilis*)
4. Silver carp (*Hypophthalmichthys molitrix*)
5. Grass carp (*Ctenopharyngodon idella*)
6. Common carp (*Cyprinus carpio*)

## SIS

1. Dedhuwa (*Esomus danricus*)
2. Pothi (*Puntius sophore*)



## Stocking density (No./ha)

Species	Carp (N=18)	Carp+SIS (n=26)	Carp+SIS+Substrate (n=6)
Silver carp	3,500	3,500	3,500
Bighead carp	1,000	1,000	1,000
Rohu	2,500	2,500	2,500
Mrigal	1,000	1,000	1,000
Common	1,000	1,000	1,000
Grass carp	1,000	1,000	1,000
SIS	-	50,000	50,000
<b>Total</b>	<b>10,000</b>	<b>60,000</b>	<b>60,000</b>

# Management

- Feed: dough of rice bran and mustard oil cake (1:1 ratio).
- Feeding rate: 3% of biomass of Carp.
- Biweekly fertilization: Urea and DAP @ 470 g/100 m<sup>2</sup> and 350 g/100 m<sup>2</sup>.





- Partial harvesting of SIS



- Increased household consumption





# Final harvesting





# Extra production





# Farm produce for household consumption

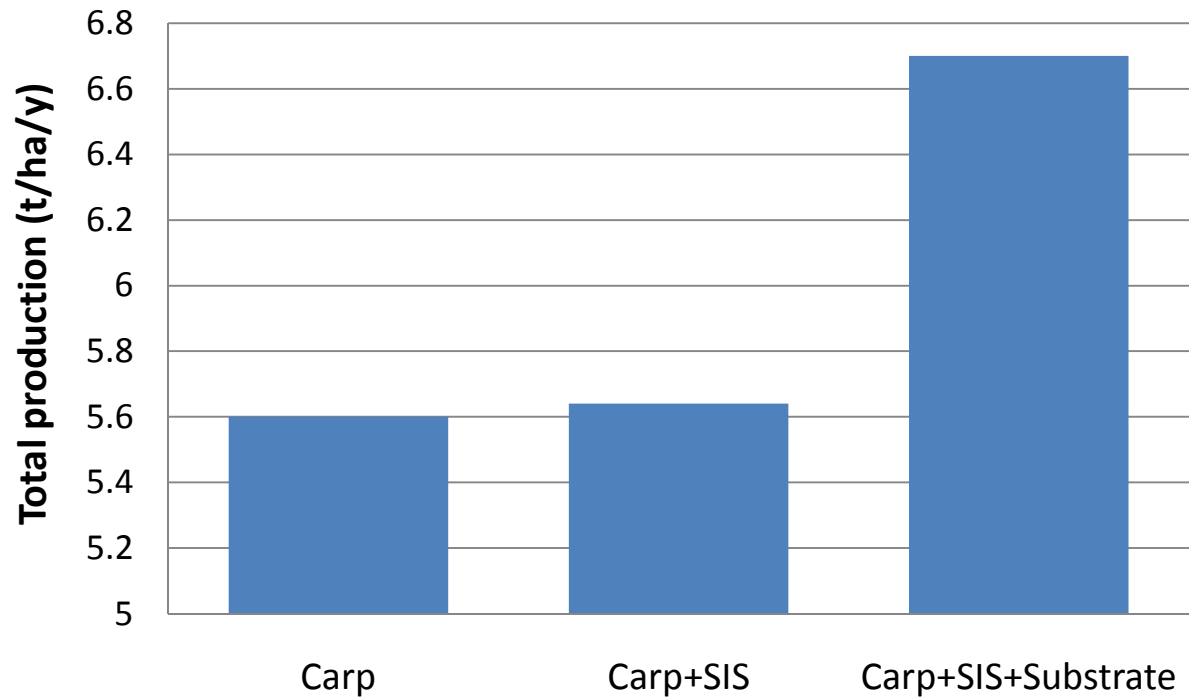


# Production

- Average total fish production was 5.8 t/ha/y.

- Carp and SIS contributed 93.5% and 6.5% to the total production, respectively.

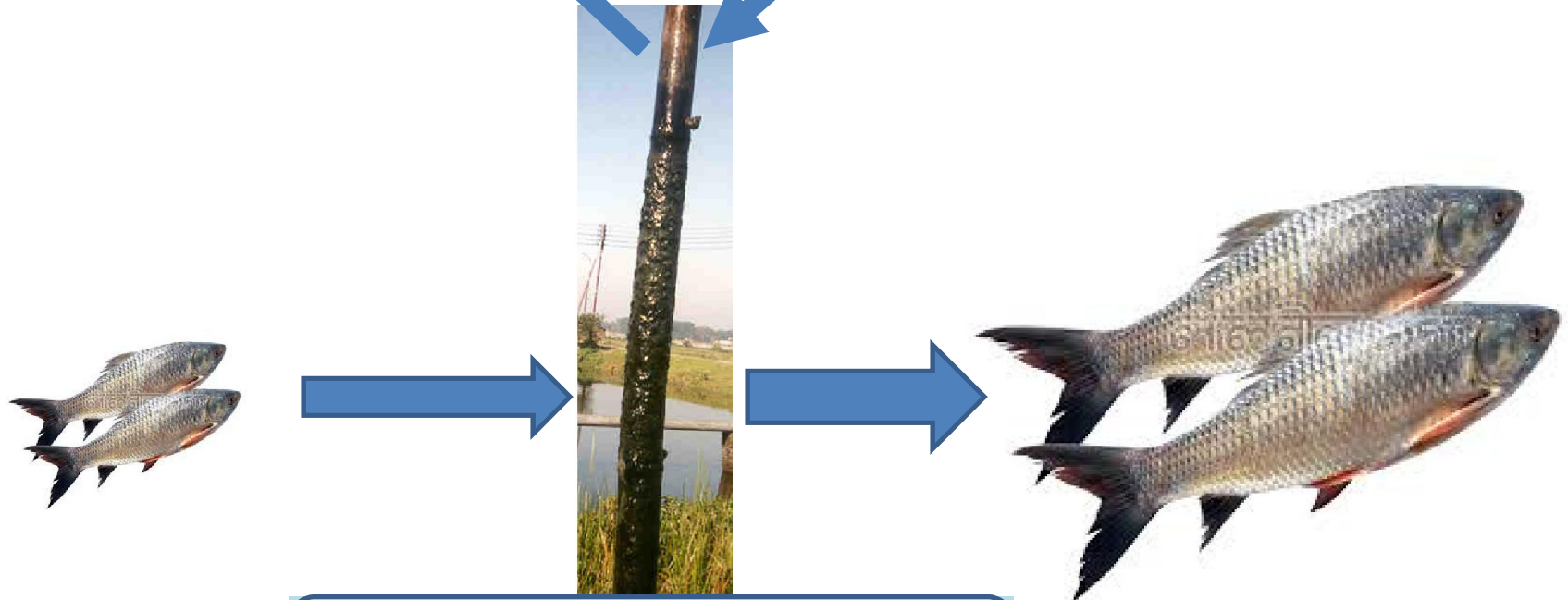
**Total fish production (t/ha/y) in different polyculture systems**



# Substrate based carp-SIS polyculture

Removes nutrients  
from water

Adds oxygen in  
water



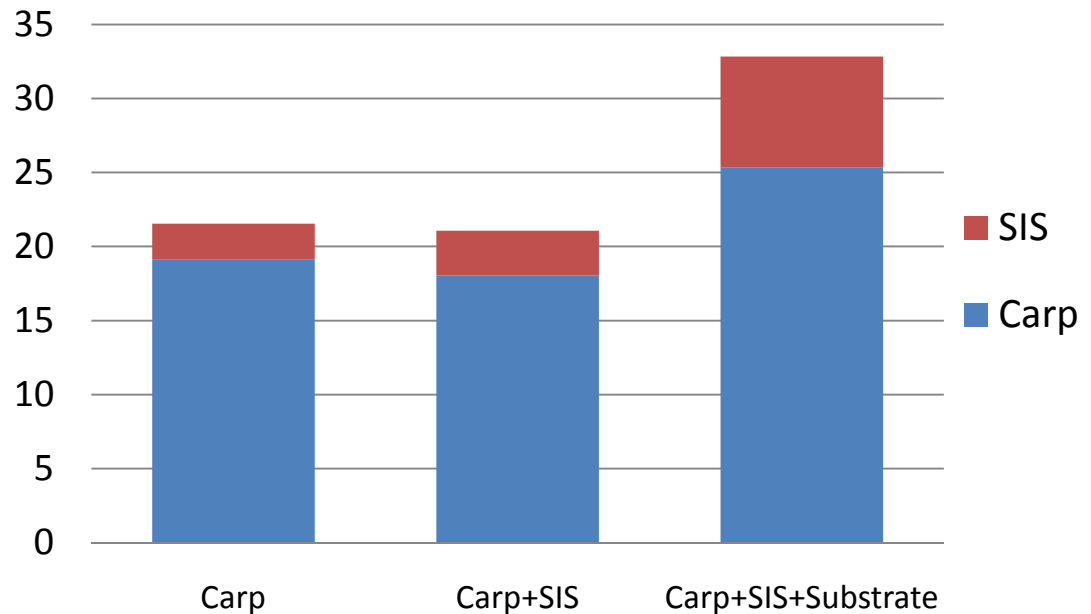
Periphyton: Quality food  
(23-26% protein)



# Consumption

- Consumed 44.5% of the total production on average
- Fish consumption rate was 4.7 kg/caput/y - double of national average

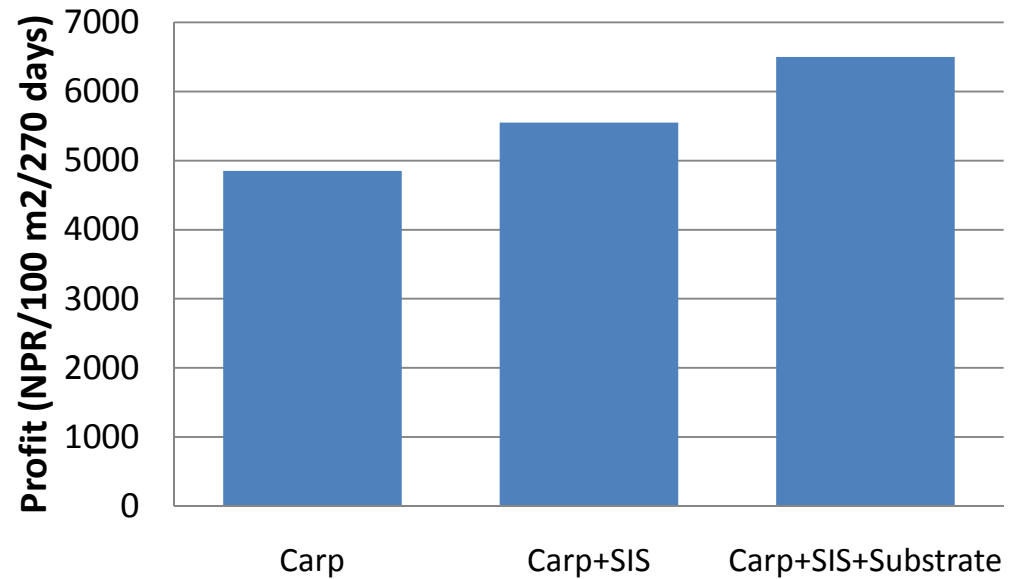
Household fish consumption in different polyculture systems (Kg/household/270 days)



# Income

- 96% farmers sold surplus carp
- Farmers sold 55.5% of the total production.
- Income spent on household expenditures.

**Profit earned from different polyculture systems (NPR/100 m<sup>2</sup>/270 days)**



# Marketing

- Marketing: not a problem because small production.
- Farmers sold carp on the pond site.
- Customers come to farmers' house to buy fish.





# Value Chain

```
graph LR; A[Input suppliers] --> B[Farmer]; B --> C[Consumer];
```

Input  
suppliers

Farmer

Consumer

# Seed production

- Substrate : Common carp spawning
- Seed sustainability
- Income through fingerling sale



# Bottlenecks

- Harvesting inconvenience
- Solution: improvisation in substrate form and installation (On station trial by Sabita Jha)





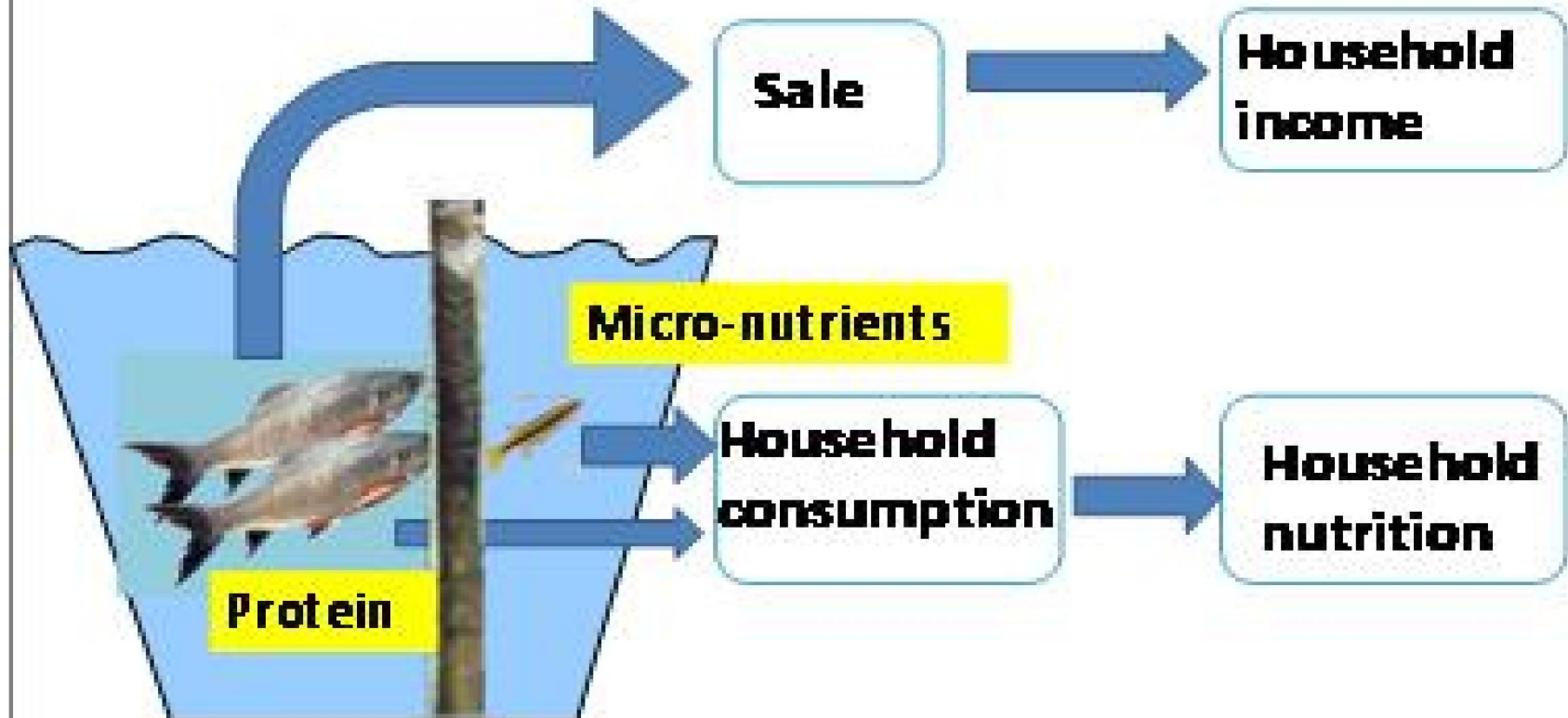
# Verification trials

- On Station trial : Sabita Jha  
(AquaFish Innovation Lab)
- On Farm trial: Rajan Pd. Poudel  
(Finnish Government)



# Conclusion

## Carp – SIS polyculture in substrate pond







Thank you

Ministry for Foreign Affairs of Finland

FFD

Agricod



# **ENVIRONMENTALLY FRIENDLY CAGE CULTURE: A SUCCESSFUL MODEL OF SMALL-SCALE AQUACULTURE FOR LIVELIHOOD OF DEPENDANT COMMUNITIES IN NEPAL**



Jay Dev Bista, Surendra Prasad, Agni Prasad Nepal, Ram Kumar Shrestha, Md Akbal Husen Ram Prasad Dhakal, Santosh Sing and Madhav Kumar Shrestha

# Water Resources

The water resources (area in ha.) of the country can be divided into four categories:

Natural water bodies : 401,500

- Rivers: 395,000
- Lakes: 5,000
- Reservoirs: 1,500

Village ponds: 7,300

Marginal swamps: 12,500

Irrigated paddy fields: 7,18,696

**Total: 11,38,031 ha.**

# Water Resources





# Lakes





# Reservoirs



# National production from different fisheries and Aquaculture practices

S.N.	Aquaculture/fisheries practices	Area (ha)	Production (mt.)
1	Ponds fish culture	6735	31649
2	Gholes and swaps	1670	2096
3	Rice-fish culture	300	135
4	Cage fish culture	80,000 m <sup>3</sup>	480
5	Enclosure culture	100	140
6	Capture fisheries	Open water	21,500
	<b>Total</b>		<b>56000</b>

Source: DoFD 2012



# Cage fish culture

- Cage fish culture adopted in Nepal during 1975-1980.
- Cage fish culture contributes to the improvement of livelihood, ensuring food security, generating income at subsistence level and creating additional jobs.
- However, cage culture of planktivore carps retains its importance in socio-economically disadvantaged areas.
- Currently, this technique has spread across the country with varying degree of adaptation to local conditions.
- This is the most viable and low cost small scale fresh water aquaculture technology for wetland dependents in Nepal.

# Management of Cage Fish Culture

**Marketing**

**Harvesting**

**Grading**

**Growth  
monitoring**

**Cage cleaning  
and  
Maintenance**

**Stocking of fish**  
**Species**  
**Density**  
**Ratio**  
**size**

**Site selection**  
**Landing of cage**



# Management practices of cage fish culture in lakes and reservoir

- **Cage material:** Nylon or polyethylene knot-less floating type
- **Cage size:** 50 m<sup>3</sup> (5m x 5m x 2m) in general
- **Cage frame:** Bamboo structure act as frame and float





- **Stocking Density:** depends on the productivity of lakes and reservoir (6-10 fish/m<sup>3</sup>)
- **Feeding:** No feeding for planktivorous fish but Aquatic macrophytes for herbivorous (Grass carp)
- **Growing period:** Depends on the productivity of lakes and reservoir (18 to months from rearing to harvesting)
- **Harvesting:** Partial/Complete



# Major fish species for cage fish culture ...

- **Silver carp and Bighead carp**

- Feed on naturally available plankton
- Suitable for extensive type cage fish culture
- Dominant in cage fish culture



- **Grass carp**

- Suitable in area with aquatic macrophytes



# Research findings

## Productivity of cage during 1980

	During 1980s*		
	Phewa	Begnas	Rupa
Major species	BC + SC	BC + SC	SC + BC
Density/m <sup>3</sup>	6	10	10
Initial weight	15-20	15-20	15-20
Growth rate g/day	1.5	4	7
Productivity kg/m <sup>3</sup>	3.4	4.7	5

**\* Swar and Pradhan (1992)**



# Research findings

## Productivity of cage during 2000

	During 2000s**		
	Phewa	Begnas	Rupa
Major species	BC + SC	BC + SC	SC + BC
Density/m <sup>3</sup>	10-12	10-12	10-12
Initial weight	20-25	20-25	20-25
Growth rate g/day	1.7	1.0	0.7
Productivity kg/m <sup>3</sup>	5.0	3.0	2.0

**\* Gurung (2001), Wagle (2000)**

## Fish growth and Productivity (Phewa Lake)

	<b>During 2012***</b>	
<b>S.N</b>	<b>Major species</b>	<b>SC + BC (3:7)</b>
<b>1</b>	<b>Density/m<sup>3</sup></b>	<b>10 Fish.m<sup>-3</sup></b>
<b>2</b>	<b>Initial weight</b>	<b>10-15</b>
<b>3</b>	<b>Growth rate g/day</b>	<b>0.38- 0.65</b>
<b>4</b>	<b>Productivity kg/m<sup>3</sup></b>	<b>1.55 kg.m<sup>-3</sup>.yr<sup>-1</sup></b>

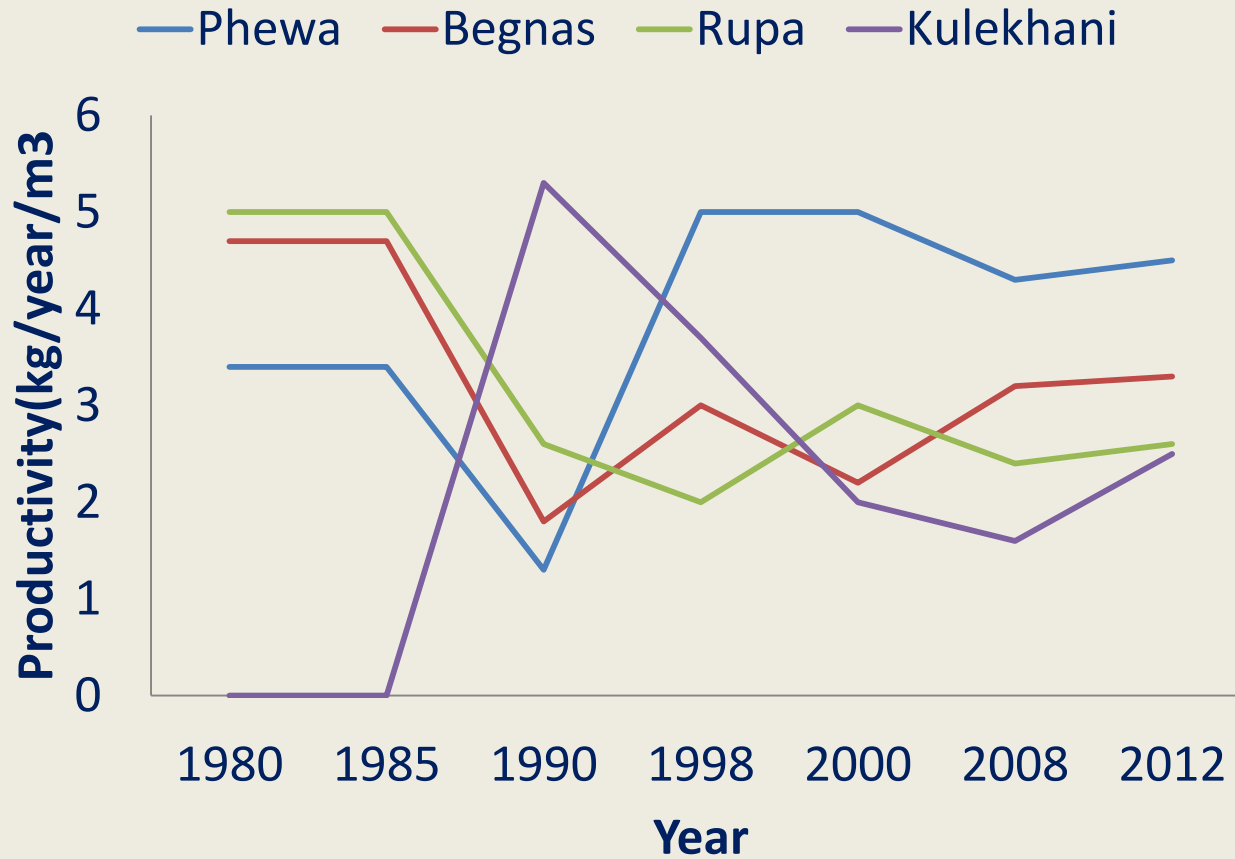
\*\*\*Husen et al.,2012

# Productivity of cage with Grass carp culture

Cage volume	50m <sup>3</sup>
Culture period	480 days (16 months)
Gross production	416.83 kg
Net production	394.38 kg
Mean growth	3.11 g/day
Mean yield	8.4 kg / m <sup>3</sup>



# Productivity trend



# Production and productivity

**Table 1.** Present status of private sector cage fish culture in Lakes of Pokhara valley and Kulekhani Reservoir,

<b>Location</b>	<b>No. of farmer</b>	<b>No. of cage</b>	<b>Volume (m<sup>3</sup>)</b>	<b>Estimated production (mt)</b>
<b>Phewa</b>	<b>90</b>	<b>630</b>	<b>24000</b>	<b>103</b>
<b>Begnas</b>	<b>37</b>	<b>120</b>	<b>6000</b>	<b>19</b>
<b>Rupa</b>	<b>53</b>	<b>117</b>	<b>5850</b>	<b>14</b>
<b>Kulekhani</b>	<b>239</b>	<b>1630</b>	<b>81500</b>	<b>114</b>
<b>Total</b>	<b>419</b>	<b>2467</b>	<b>117350</b>	<b>250</b>

# Environmenta and cage fish culture



## Lake water sampling and analysis

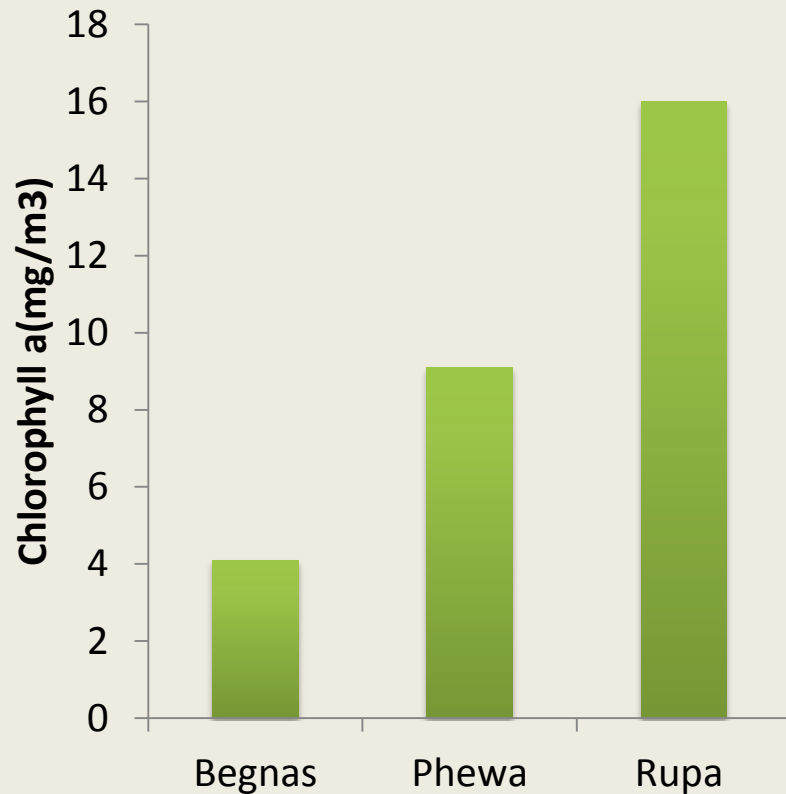


## Physico-chemical variables of Pokhara valley lakes

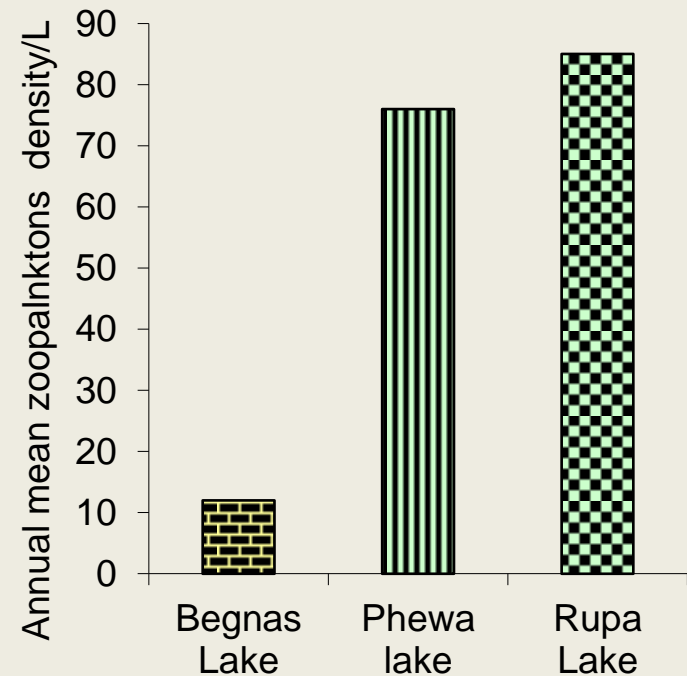
Physico-chemical variables (Mean±SD)	Begnas	Phewa	Rupa
Water temperature(°C)	22.3±4.5	22.7±3.9	22.2±4.8
Dissolved oxygen (mg/L)	5.8±3.0	4.9± 2.9	8.1±2.2
pH	6.7	7.0	6.9
Ammonium (NH <sub>4</sub> <sup>+</sup> ) nitrogen (mg/ L)	0.019±0.036	0.004±0.009	0.010±0.016
Nitrate(NO <sub>3</sub> <sup>-</sup> ) + Nitrite(NO <sub>2</sub> <sup>-</sup> ) nitrogen (mg/ L)	0.031±0.066	0.022±0.039	0.035±0.082
Soluble reactive phosphorus Po <sub>4</sub> <sup>-</sup> P(mg/ L)	0.002±0.002	0.003±0.011	0.002±0.002
Total phosphorus (mg/ L)	0.006±0.005	0.006±0.012	0.011±0.012
Chlorophyll <sub>a</sub> (mg/m <sup>3</sup> )	<b>4.1±3.8</b>	<b>9.1±9.2</b>	<b>16.0±12.1</b>
Transparency (m)	2.1±0.6	2.3±0.7	0.7±0.3

# Present status of plankton in lakes of Pokhara valley

## Chlorophyll a concentration

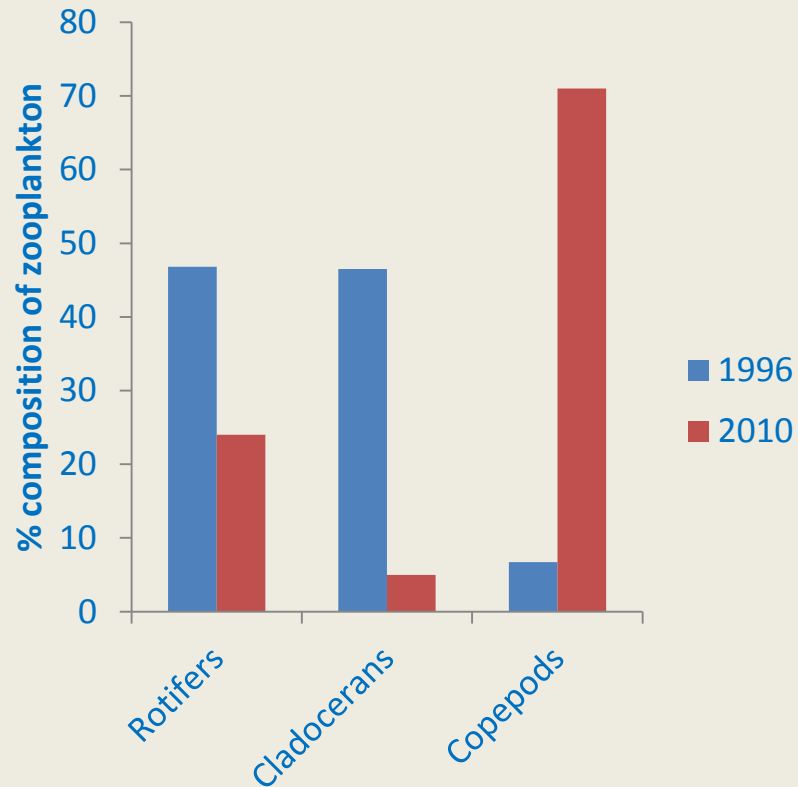


## Zooplankton density

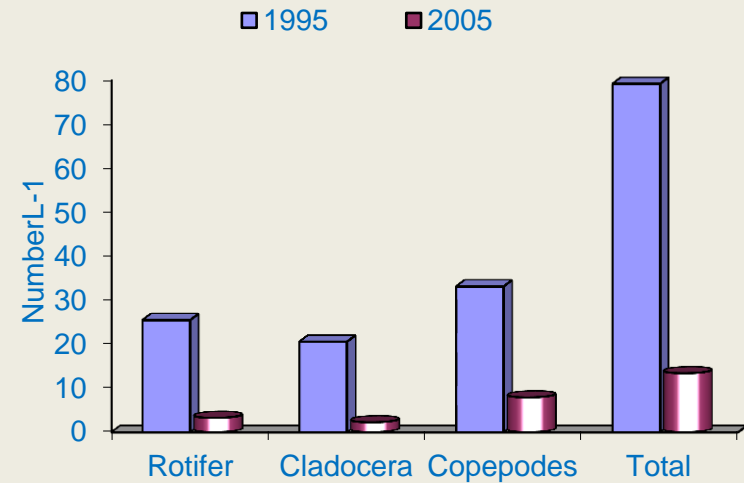


# Changes in Zooplankton composition

## Phewa lake



## Begnas lake

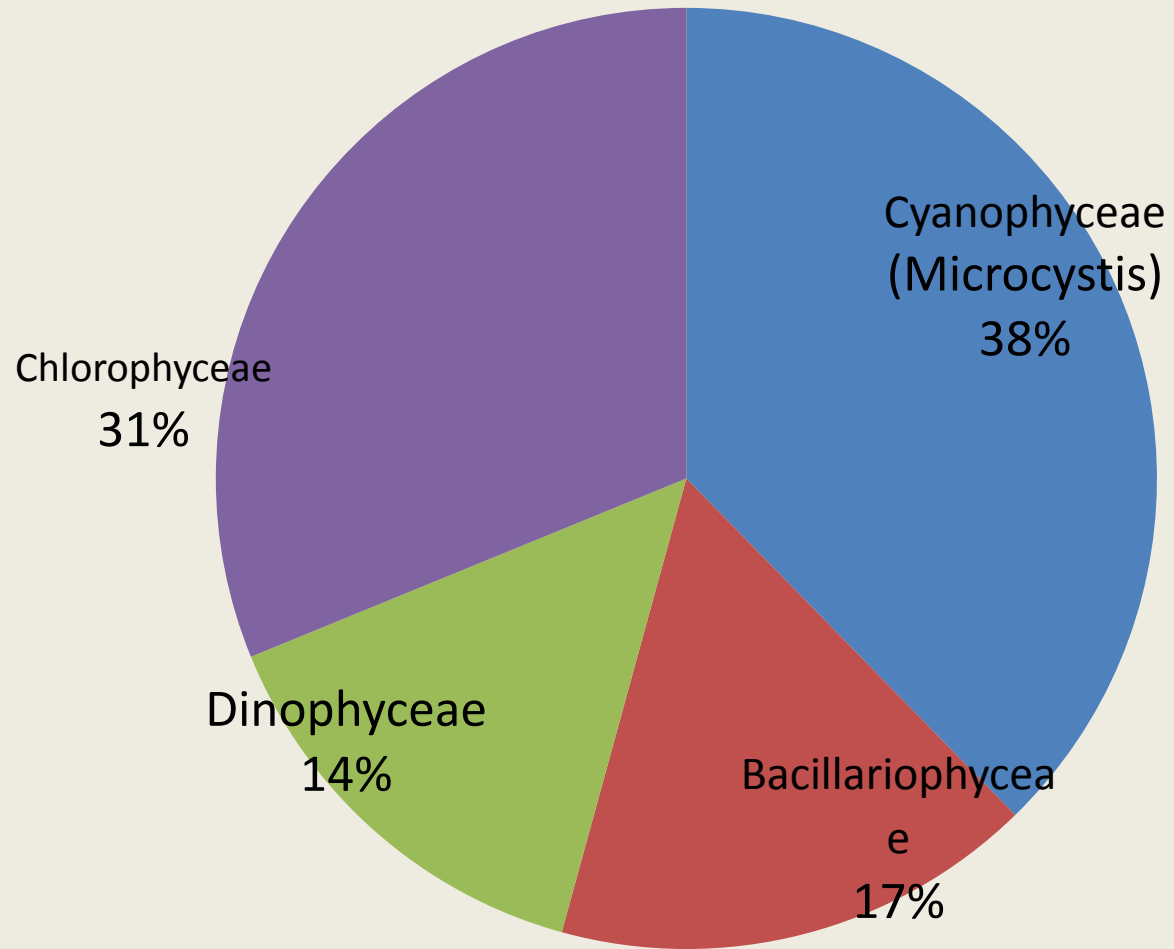


Source: Husen et al., 2009

Source: Husen et al., 2012 and Mulmi and Rai, 1998 .



# Phytoplankton phyla composition(Phewa Lake)



# Nutrient and organic matter removal by fish



## Estimated removal of nitrogen and phosphorous from cage and pen culture (2012).

Updated from Pradhan and Panth, 1995.

Particulars	Fish yield (Mt.)	Phosphorous removed <sup>1</sup> (kg/year)	Nitrogen removed <sup>2</sup> (kg/year)
Lake catch	126	428.4	3225.6
Enclosure	9	30.6	230.4
Cage culture	250	850.0	6400
<b>Total<sup>3</sup></b>	<b>385</b>	<b>1309</b>	<b>9856</b>

<sup>1</sup> Assuming P content of fish=0.34% of harvested fish

<sup>2</sup> Assuming N content of fish=2.56% of harvested fish

<sup>3</sup> Assumeing P and N addition with fry/fingerlings is not significant

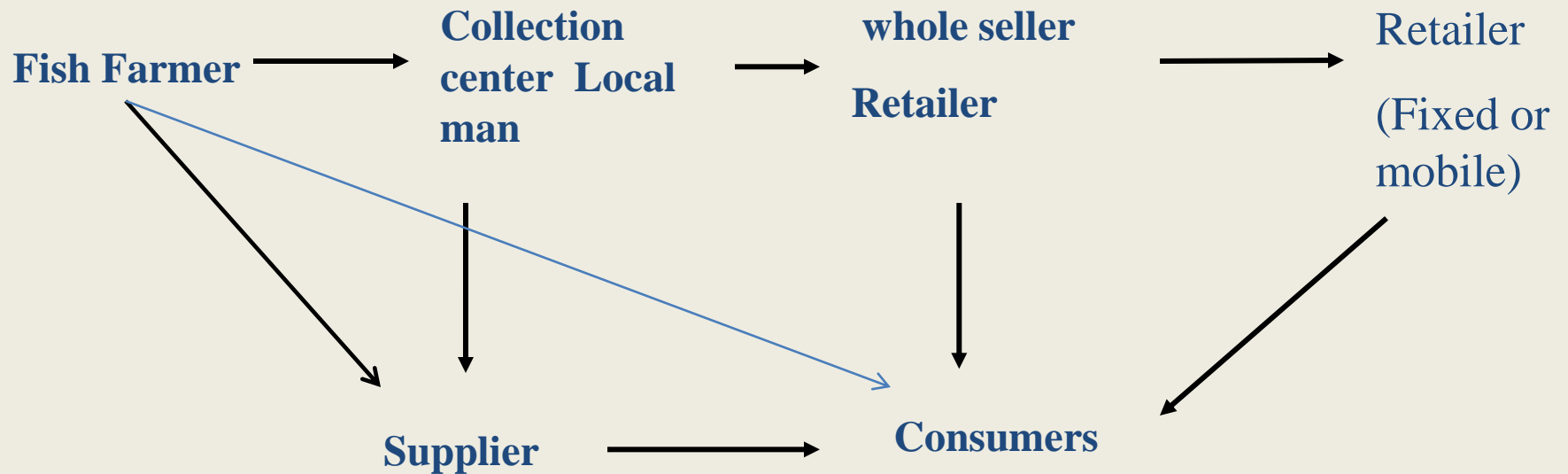




**Fish harvesting**



# Existing fish marketing channel



# Socio demographic profile

Indicator	Phewa			Begnas		
	1980	2005	2012	1980	2005	2012
<b>Total HH no</b>	<b>47</b>	<b>59</b>	<b>90</b>	<b>31</b>	<b>39</b>	<b>42</b>
<b>Family size no</b>	<b>4.3</b>	<b>5.1</b>	<b>6.0</b>	<b>5.6</b>	<b>6.0</b>	<b>6.0</b>
<b>Literate %</b>	<b>17.2</b>	<b>46</b>	<b>51.1</b>	<b>21.2</b>	<b>41.6</b>	<b>47.6</b>
<b>High School %</b>	<b>2.1</b>	<b>3.3</b>	<b>6.7</b>	<b>2.6</b>	<b>11.1</b>	<b>7.1</b>
<b>University %</b>	<b>0</b>	<b>2</b>	<b>3.3</b>	<b>0.0</b>	<b>1.9</b>	<b>11.9</b>
<b>Housing land%</b>	<b>62.7</b>	<b>81.3</b>	<b>98</b>	<b>0.0</b>	<b>44.4</b>	<b>81</b>
<b>Concrete and tin roof house%</b>	<b>73.0</b>	<b>100</b>	<b>100</b>	<b>5.0</b>	<b>95.0</b>	<b>100.0</b>
<b>Access to portable water%</b>	<b>8.0</b>	<b>100</b>	<b>100</b>	<b>0.0</b>	<b>93.2</b>	<b>100.0</b>
<b>Access to health service%</b>	<b>10.2</b>	<b>97.6</b>	<b>100</b>	<b>6.8</b>	<b>93.2</b>	<b>100</b>
<b>Use of toilet%</b>	<b>0.0</b>	<b>21.8</b>	<b>99</b>	<b>0.0</b>	<b>10.1</b>	<b>97.6</b>
<b>Use of cooking gas%</b>	<b>3.4</b>	<b>94.6</b>	<b>97.8</b>	<b>0</b>	<b>53.8</b>	<b>59.5</b>
<b>Radio/television/mobile%</b>	<b>5.8</b>	<b>83.2</b>	<b>100</b>	<b>5.6</b>	<b>76.3</b>	<b>100</b>
<b>Motorbike%</b>	<b>0.0</b>	<b>10.2</b>	<b>6.7</b>	<b>0</b>	<b>7.7</b>	<b>7.1</b>

: Swar et al 1980; Wagle et al 2005; Husen et al 2012



# Production assets, income and expenditure of Jalari community

Asset/Household	Phewa		Begnas	
	2005	2012	2005	2012
Boat, No/HH	0.96	1.0	0.92	1.0
Gill net, No/HH	18	20	17	15
Nursery cages No/HH	2.5	1.1	1.6	0.36
Production cage No HH	5.3	5.6	2.7	0.48
Annual income (NRs)/HH	126,848.0	200,000.0	99,522.0	156,000.0
A. Cage fish culture	27.3	25.0	18.8	3.8
A. Capture fishery	54.1	75.0	60.9	96.2
Employment and agri. Labor	6.4	5.6	9.6	4.8
Shop/hotel and farming	6.2	0.0	5.5	7.1
Tourism services	2.7	0.0	3.6	0
Annual expenditure (NRS)/HH	80,786.0	120,000.0	76,891.0	96,000.0
Proportion of ann. expend. %				
Food items	50.6	53.2	49.1	60.0
Clothing	8.2	5.1	10.7	10.7
Education	20.5	25.0	7.4	11.0
Health care	6.7	7.0	8.1	10.0
Entertainment, transportation	8.0	9.7	9.2	6.3

# **Conclusion and Recommendation**

- **Cage fish culture became promising intervention to improve the livelihood of resource deprived and displaced communities.**
- **Cage fish farming could be one of the best options for livelihood enhancement to local displaced communities by hydropower and irrigation projects.**
- **New approaches of cage fish culture should be promoted for improving production and profitability to farmers.**
- **Feeding based culture technology can be applied to enhance the productivity of Cage fish farming in upcoming large Hydro dam Reservoirs.**

# Supporting agencies to cage fish culture

- **FAO/UNDP**
- **JICA**
- **IDRC**
- **DFID**



# Acknowledgement

**We are grateful to FAO/UND and JICA for providing Grant aid and technical co-operation in cage fish culture development in Nepal.**





***Thanks for your Attention***



# **POLYCULTURE OF MIXED-SEX NILE TILAPIA WITH PANGAS AND SAHAR**



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# INTRODUCTION

- Nile tilapia (*Oreochromis niloticus*) is an important aquaculture species.
- However, mixed-sex culture of Nile tilapia has several problems due to uncontrolled reproduction.
- Polyculture of mixed-sex Nile tilapia with predatory fish species helps to control the Nile tilapia recruits.
- Sahar (*Tor putitora*) and Pangas (*Pangasius hypothalamus*) might be a good options for controlling Nile tilapia recruits.
- In this experiment, we tried to create a polyculture system of Sahar and/or Pangas with mixed-sex Nile tilapia fitted to local conditions of Nepal.



Nile tilapia



Sahar



Pangas



## Materials and Methods

**Location:** Center for Aquaculture Research and Production (CARP), Kathar, Chitwan

**Duration:** 150 days

**Experimental unit:** 9 earthen pond of 200 m<sup>2</sup>

**Species:** Mixed-sex Nile tilapia, Pangas and Sahar

**Treatments:** 3

**Replications:** 3

**Experimental design:** CRD



## Treatments:

**T<sub>1</sub>:** Nile tilapia monoculture @ 1 fish/m<sup>2</sup>

**T<sub>2</sub>:** Nile tilapia @ 1 fish/m<sup>2</sup> + Pangas @ 0.5 fish/m<sup>2</sup>

**T<sub>3</sub>:** Nile tilapia @ 1 fish/m<sup>2</sup> + Sahar @ 0.5 fish/m<sup>2</sup>

- **Stock weight (g):** Nile tilapia: 23-28 g  
Pangas: 31-52 g  
Sahar: 12-20 g
- **Water depth:** 1 m
- **Feed/Feeding rate:** 24% CP pellet (NIMBUS)  
@ 2% body weight, once a day
- **Fertilization:** None
- **Water quality measurement:** Biweekly
- **Growth check:** Biweekly



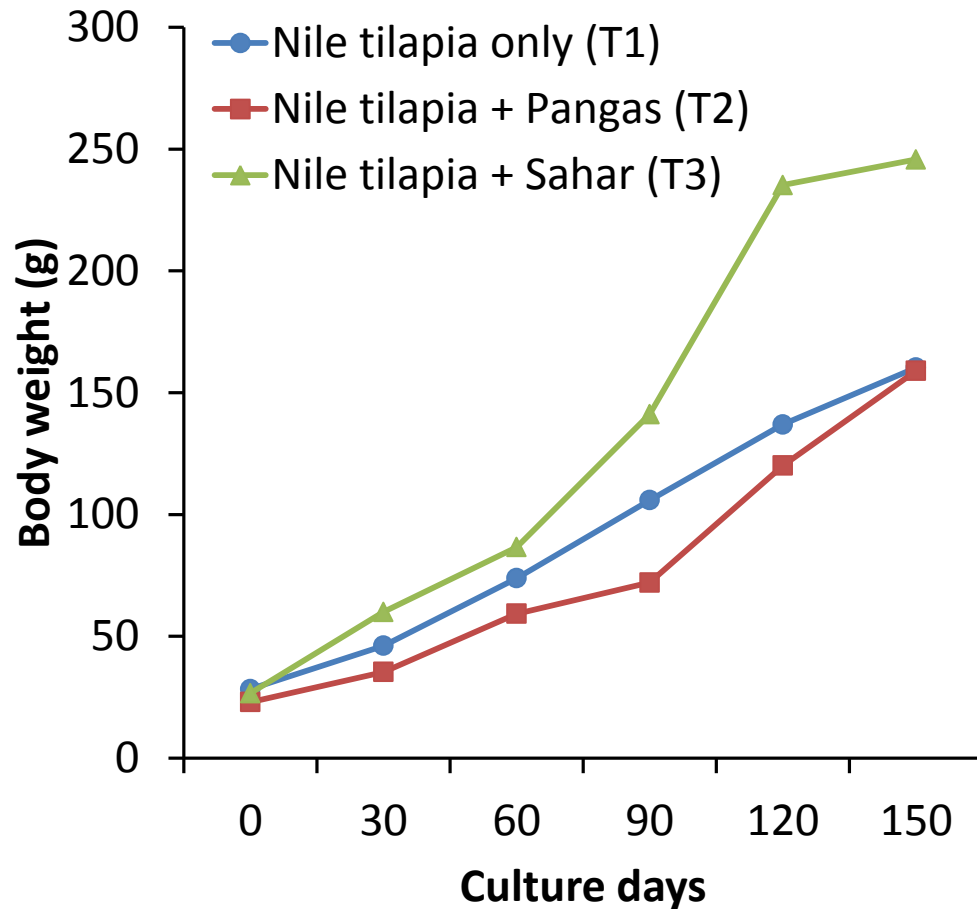
## Results and Discussion

**Table 1. Performance of Nile tilapia in different treatments during 150 days.  
Data based on 200 m<sup>2</sup> pond size.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Stock number	200 ± .0.0 <sup>a</sup>	200 ± 0.0 <sup>a</sup>	200 ± 0.0 <sup>a</sup>
Av. weight (g)	28.3 ± 1.3 <sup>a</sup>	23.0 ± 5.1 <sup>a</sup>	26.6 ± 1.3 <sup>a</sup>
Harvest number	196.0 ± 4.0 <sup>b</sup>	199.0 ± 1.0 <sup>b</sup>	95.0 ± 15.9 <sup>a</sup>
Av. harvest weight (g)	160.3 ± 4.6 <sup>a</sup>	159.9 ± 16.2 <sup>a</sup>	245.7 ± 8.8 <sup>b</sup>
Gross fish yield (kg/ha/cycle)	1571.7 ± 65.8 <sup>a</sup>	1581.7 ± 163.2 <sup>a</sup>	1156.2 ± 157.7 <sup>a</sup>
Net fish yield (kg/ha/cycle)	1288.5 ± 53.2 <sup>a</sup>	1351.7 ± 112.3 <sup>a</sup>	890.3 ± 169.2 <sup>a</sup>
Survival (%)	98.0 ± 2.0 <sup>b</sup>	99.5 ± 0.5 <sup>b</sup>	47.5 ± 7.9 <sup>a</sup>

- There were no significance differences on production of Nile tilapia among treatments.
- The survival of Nile tilapia in T<sub>3</sub> was low due to low dissolved problem.

**Figure 1. Growth trend of Nile tilapia in different treatments.**



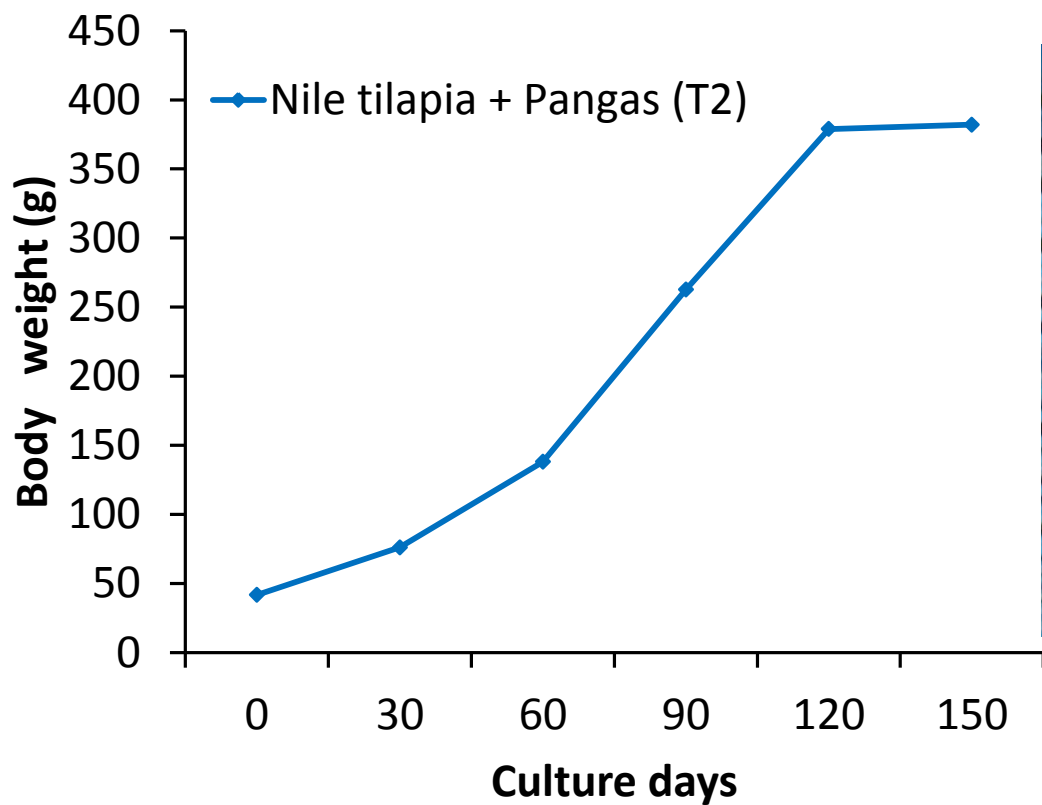
- The harvest size of Nile tilapia was significantly higher in  $T_3$  than  $T_1$  and  $T_2$ .



**Table 2. Performance of Pangas in different treatments during 150 days.  
Data based on 200 m<sup>2</sup> pond size.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Stock number	-	100 ± 0.0	-
Av. weight (g)	-	41.6 ± 6.1	-
Harvest number	-	97.0 ± 1.0	-
Av. harvest weight (g)	-	382.0 ± 40.1	-
Gross fish yield (kg/ha/cycle)	-	1858.3 ± 225.9	-
Net fish yield (kg/ha/cycle)	-	1650.0 ± 200.3	-
Survival (%)	-	97.0 ± 1.7	-

**Figure 2. Growth trend of Pangas during experiment.**

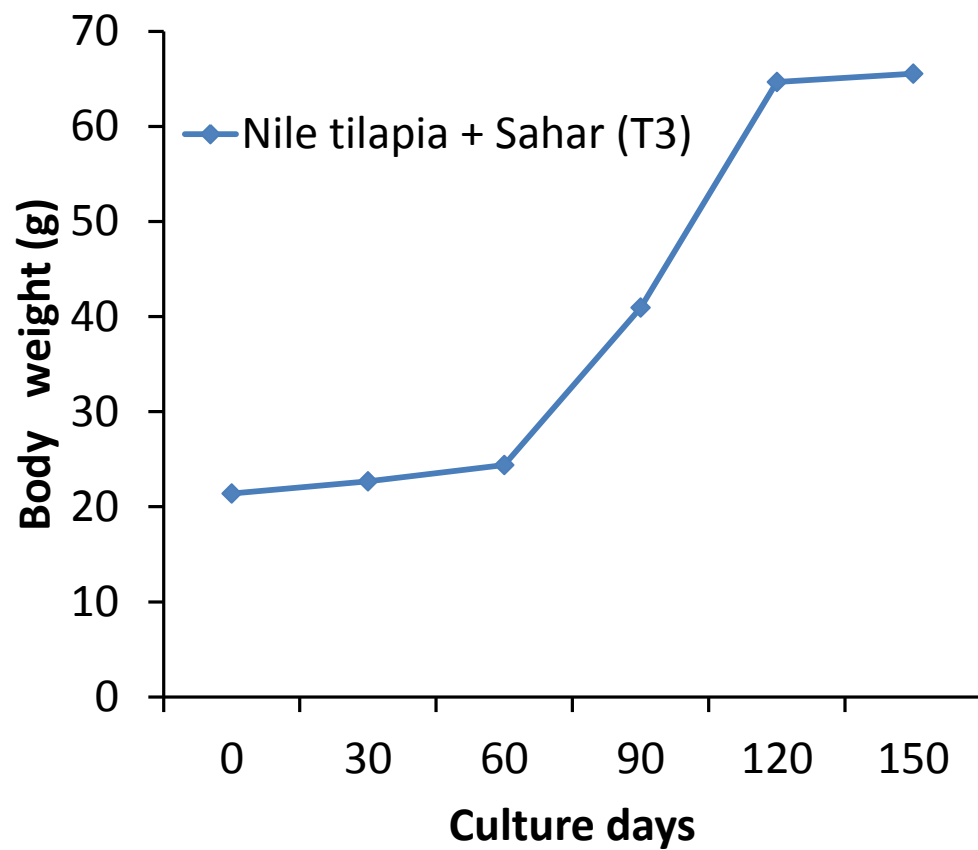


**Table 3. Performance of Sahar in different treatments during 150 days.  
Data based on 200 m<sup>2</sup> pond size.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Stock number	-	-	100 ± 0.0
Av. weight (g)	-	-	21.4 ± 4.9
Harvest number	-	-	28.7 ± 11.3
Av. harvest weight (g)	-	-	65.5 ± 14.0
Gross fish yield (kg/ha/cycle)	-	-	108.5 ± 52
Net fish yield (kg/ha/cycle)	-	-	45.9 ± 45.9
Survival (%)	-	-	28.7 ± 11.3

- **The survival of Sahar was very low due to low dissolved problem.**

**Figure 3. Growth trend of Sahar during experiment.**





**Table 4. Combined performance of Nile tilapia, Pangas and Sahar in different treatments during 150 days. Data based on 200 m<sup>2</sup> pond size.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Total stock weight (kg)	5.7 ± 0.3	8.8 ± 1.5	7.5 ± 0.7
Total harvest weight (kg)	31.4 ± 1.3 <sup>a</sup>	68.8 ± 7.7 <sup>b</sup>	25.3 ± 4.2 <sup>a</sup>
Gross fish yield (kg/ha/cycle)	1571.7 ± 65.8 <sup>a</sup>	3440.0 ± 383.2 <sup>b</sup>	1264.6 ± 209.6 <sup>a</sup>
Net fish yield (kg/ha/cycle)	1288.5 ± 53.2 <sup>a</sup>	3001.7 ± 308.8 <sup>b</sup>	891.8 ± 239.4 <sup>a</sup>
Gross fish yield (ton/ha/10 months)	3.1 ± 0.1 <sup>a</sup>	7.0 ± 0.8 <sup>b</sup>	2.5 ± 0.4 <sup>a</sup>
AFCR	2.7 ± 0.1 <sup>a</sup>	2.1 ± 0.0 <sup>b</sup>	6.5 ± 1.8
Cost per kg fish production (NRs)	160.3 ± 5.7	130.1 ± 2.9	-

- Gross and net fish yield were significantly higher in T<sub>2</sub> than T<sub>1</sub> and T<sub>3</sub>.
- AFCR was significantly lower in T<sub>2</sub>.

**Table 5. Nile tilapia recruits. Data based on 200 m<sup>2</sup> pond size.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Total number	2580.0 ± 310.5 <sup>c</sup>	1090.3 ± 258.7 <sup>b</sup>	23.7 ± 9.0 <sup>a</sup>
Total weight (kg)	24.5 ± 1.9 <sup>c</sup>	14.9 ± 4.0 <sup>b</sup>	0.5 ± 0.4 <sup>a</sup>
Gross yield (kg/ha/cycle)	1225 ± 95.0 <sup>c</sup>	743.8 ± 199.0 <sup>b</sup>	26.7 ± 22.2 <sup>a</sup>

- The number and gross weight of tilapia recruits were significantly highest in T<sub>1</sub>, intermediate in T<sub>2</sub> and lowest T<sub>3</sub>.



**Table 6. Water quality.**

Parameters	Treatments		
	Nile tilapia only (T <sub>1</sub> )	Nile tilapia + Pangas (T <sub>2</sub> )	Nile tilapia + Sahar (T <sub>3</sub> )
Water temperature (°C)	29.3 ± 0.0 <sup>a</sup> (22.2-32.0)	29.5 ± 0.1 <sup>a</sup> (23.4-31.8)	29.9 ± 0.1 <sup>a</sup> (23.4-31.7)
Dissolved oxygen (mg/L)	5.7 ± 0.4 <sup>b</sup> (3.7-10.8)	5.3 ± 0.4 <sup>b</sup> (2.7-11.3)	1.5 ± 0.0 <sup>a</sup> (1.0 ± 2.2)
pH	7.0 (6.2-9.2)	7.3 (6.7-8.8)	7.4 (7.0-7.8)
Secchi disk depth (cm)	34.7 ± 0.2 <sup>a</sup> (21.4-52.3)	31.8 ± 2.2 <sup>a</sup> (22.4-45.3)	33.8 ± 2.5 <sup>a</sup> (21.5-46.0)

• Dissolved oxygen was significantly lower in T<sub>2</sub> than T<sub>1</sub> and T<sub>3</sub>, which caused high mortality of fishes.

## Summary and Conclusions

- Gross and net fish yield is significantly higher in Nile tilapia and Pangas polyculture system compared to Nile tilapia monoculture.
- Cost per kg fish production is significantly lower in Nile tilapia and Pangas polyculture system compared to Nile tilapia monoculture.
- The number and gross weight of tilapia recruits are significantly highest in Nile tilapia monoculture than polyculture with Pangas and Sahar.
- Polyculture of Nile tilapia with Sahar (1:0.5 ratio) might be risky as it caused lower dissolved oxygen. Probably the stocking density of Sahar should be reduced.
- Further experiments are recommended to fine-tune the stocking ratios of Nile tilapia, Pangas and Sahar.



## Acknowledgements

This research was supported by the Fisheries Research Center (FRC), Pokhara and NIMBUS feed.

**Thank You**

# Live Food Organisms : Application in Aquaculture



**Presenter**  
**Prabesh Singh Kunwar and Narayan Giri**  
**Directorate of Fisheries Development**  
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# 1. Background Information

## 1.1. General Background



fav



& encouraged pellet feed

➤ Establishment of feed industries

Live food

culture and application





## 1.2. Fish Seed Production in Nepal

- Seed
- Dist
- The
- Nurse
- Surv
- 60%)



nd 222

gerlings:

**Seed supply is a challenging issue: time, space, effort**

## 2. Larvae culture

- The larvae culture **techniques are normally different** from conventional nursery and grow-out procedures
- **Need special care:** usually very small, extremely fragile
- **Physiological development:** incomplete

**Sensitivity in first-feeding, has become one of  
the major bottlenecks**

### 3. Fish Larvae: Characteristic features

#### 3.1. Mouth size

Mouth size is generally **correlated with body size**, which is influenced by **egg diameter** and the period of endogenous feeding

Species	Egg diameter(mm)	Length of larvae (mm)
Atlantic salmon ( <i>Salmo salar</i> )	5.0 - 6.0	15.0 - 25.0
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	4.0	12.0 - 20.0
Common carp ( <i>Cyprinus carpio</i> )	0.9 - 1.6	4.8 - 6.2

The mouth size of first-feeding larvae usually restricts the size of the food particles which can be ingested

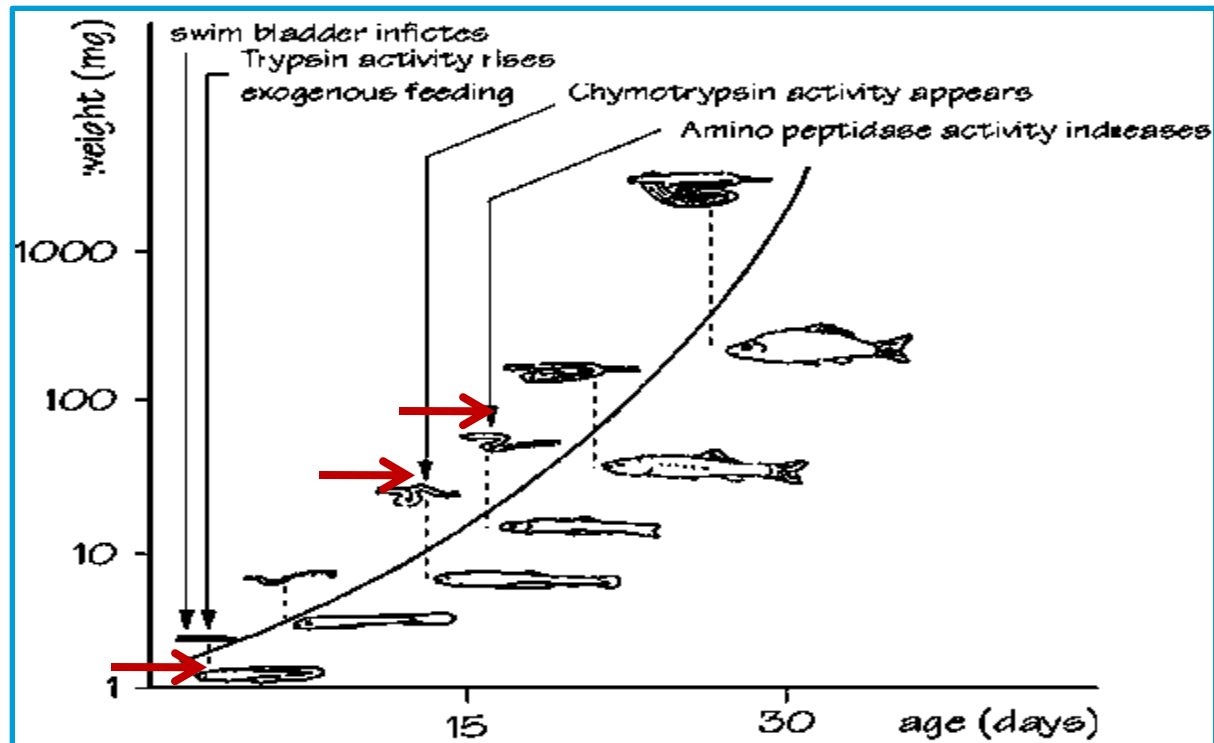
## 3.2. Digestive System

- Depends on **yolk sac**: not ready for external feeding
- During the early development of the digestive tract there is no needed **set of enzymes** to digest formulated feed





- **Common Carp**: after filling of swimming bladder and exogenous feeding intensifies:- the trypsin activity rises. Later, within about 15 days chymotrypsin activity appears then the amino peptidase activity increases



**The developmental status of the digestive system dictates the possibility or not of the larvae to digest the food ingested**

### 3.3. Sense Organs

- The degree of development of the functional sense organs is crucial.
- The eyes of fish **larvae usually only contain cones** in the retina resulting in [poor visibility](#), whereas the eyes of **juvenile fish also contain rods** with more visual pigments in the retina.

## Food Selection Sriteri:

- **small enough** to fit into their mouth size
- **easily digestible** (ie. contain **free amino acids** instead of **complex protein molecules**)
- contains enzyme systems which allow **autolysis**
- supplies all the **essential nutrients** required by the larva
- **easily detected** by fish larvae to be ingested

## 4. Why Live Food?

live food organisms **meet all the necessary criteria** for these small larvae

- Available in various sizes

- They contain proteins, fats, carbohydrates, minerals, vitamins, amino acids and

- Live foods are

- Their active swimming behavior attracts larvae

- Also equally c



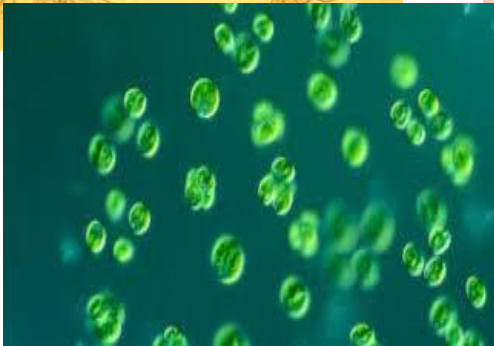
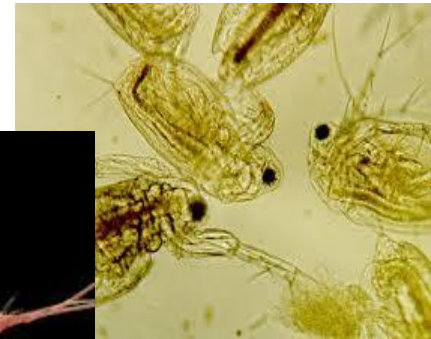
**Artificial larval feeds are no match to live food organisms  
in terms of acceptance, nutritional and other factors**



## 5. Important Live Food organisms

- The most valuable resource for aquaculture
- Includes both phytoplankton and zooplankton

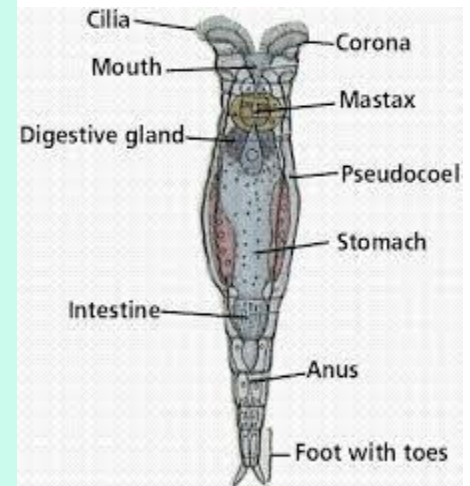
# living capsule of nutrition



## 5.1. Rotifer

- Small **ciliated protozoan**
- Rotifers are popularly called as **wheel animalcules**
- Planktonic nature and ability to be cultured in large quantities
- 2500 species of rotifers have been described and many have been cultured, ***Brachionus plicatilis*** is commonly used in fish hatcheries around the world.
- A popular choice as a food item for fish larvae.
- Depending on the mouth size of the fish (**50 to 200 micron** ) rotifers are used.

**Nutritional Value:** Rotifers are composed of about **52 to 59% protein, up to 13% fat and 3.1% n-3 HUFA**



## 5.2. Artemia

- Small aquatic **crustaceans**
- Commonly known as **brine shrimp**
- **most popular** live food organism used in aquaculture
- The **biggest advantage** of using Artemia: produce live food on demand from **dry and storable powder**
- **Metabolically active:** free swimming larvae (**nauplii**) of about **0.4 mm** length.
- Artemia has high nutritive value.
- **All the life stages** of Artemia, i.e. cysts (decapsulated), nauplii, juveniles, sub-adults are used as feed.



**Magic Powder**



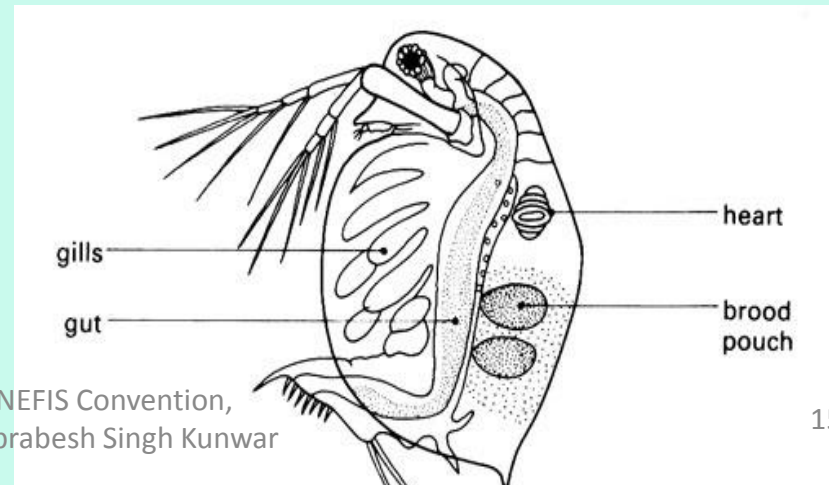


## 5.3. Cladocerans

- Generally called '**water fleas**'
- Belongs to class – Crustacea, phylum – Arthropoda
- Cladocerans : **Daphnia** and **Moina** are important as live food.

### 5.3.1. Daphnia

- Found all over the world: **freshwater ponds, tanks and lakes**
- contains: proteases, peptidases, amylase, lipase and even cellulase which **serve as exoenzymes**
- size (**1–5 millimeters**) : serves as live food for advanced stages of fishes.

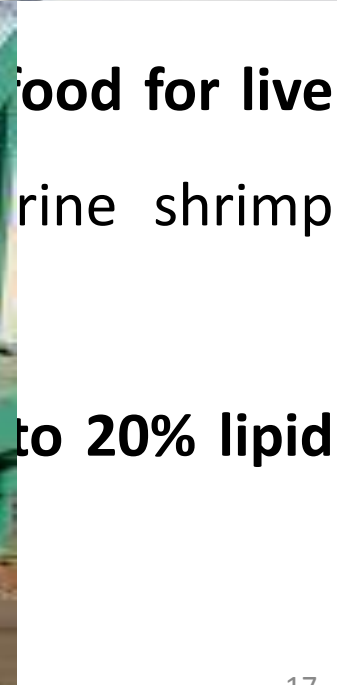


### 5.3.2. Moina

- Primarily inhabitants of temporary **ponds or ditches**.
- Size: **0.5 to 2 mm**
- The protein content of Moina usually averages **50% of the dry weight**.
- Adults normally have a higher fat content (20-27%) than juveniles (4-6%.)
- Moina has also been extensively utilized as live food in many hatcheries
- **Ornamental fish culture : most common** live food organism



- Food for live  
marine shrimp  
to 20% lipid



# Nutritional Value

Pigments/Carotenoids	B-carotene, astaxanthin, lutein, zeaxanthin, canthaxanthin, chlorophyll, phycocyanin, phycoerythrin, fucoxanthin
Polyunsaturated fatty acids (PUFAs)	DHA(C22:6), EPA(C20:5), ARA(C20:4), GAL(C18:3)
Vitamins	A, B1, B6, B12, C, E, biotin, riboflavin, nicotinic acid, pantothenate, folic acid
Antioxidants	Catalases, polyphenols, superoxide dismutase, tocopherols
Other	Antimicrobial, antifungal, antiviral agents, toxins, <b>aminoacids</b> , <b>proteins</b> , sterols, MAAs for light protection.

*Source: Priyadarshani and Rath, 2012*



## 5.5. Tubifex

- Class - Oligochaeta under the phylum - Annelida.
- Not for larval and post-larval stages
- It is one of the best candidates owing its

sh

to

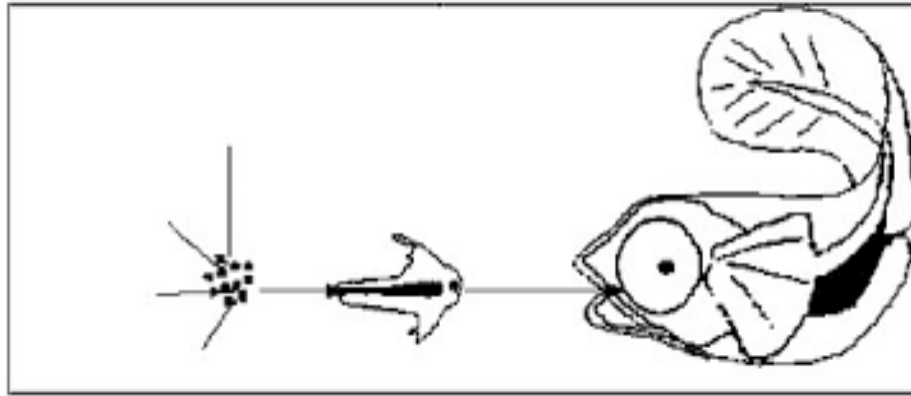
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Oliver Lucanus

## 6. Live Food Enrichment

- Bio-encapsulation
- Meet the Species specific requirement



**Boost the importance and potential  
of live food organisms**



## 7. Natural Food of Some Cultivable Species in Nepal

### 7.1. Common Carp

- It takes 15–40 days to completely develop mouth and digestive tract in common carp (Lavens and Sorgeloos, 1996).
- During this phase they **feed on zooplankton**

### 7.2. Silver Carp

- During the larval stage (<15 mm TL) silver carp **feed on zooplankton** and the digestive tract is less than the body length.
- At 21–23 mm TL the digestive track increases to 6–7 times of body length, where after the fish start to **feed mainly on phytoplankton** (Liu and He, 1992).

### 7.3. Grass Carp

- The Larvae first feed on **protozoa and small zooplankton including rotifers and then switch to larger zooplankton including cladocerans** (Dabrowski and Poczyczynski, 1988) and copepods.
- After 15-20 days, when the early juveniles are approximately 26 mm TL, they start to ingest duckweed and soon there after feed almost exclusively on macrophytes (Ni and Wang, 1999).

### 7.4. Rohu

- Rohu fry feed mainly on **zooplankton**.
- Juveniles and adults show a strong positive selection for phytoplankton, vegetable debris and aquatic plants and a negative selection for all zooplanktonic organisms (Chondar, 1999).

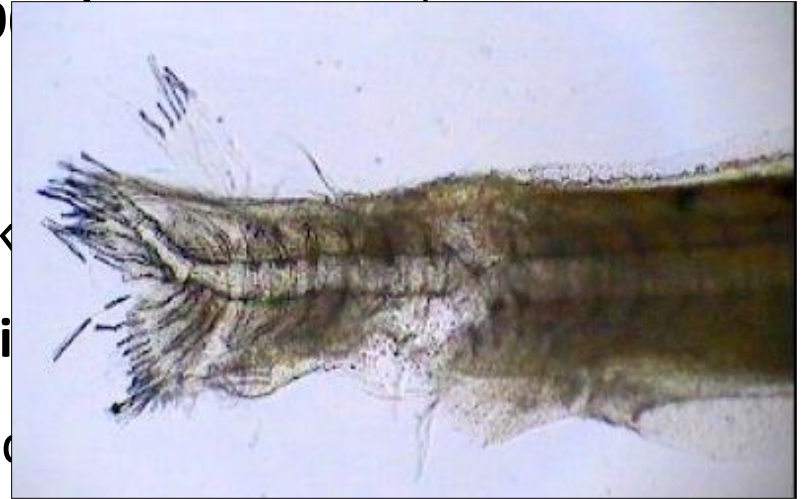


## 7.5. Pangassius

- After hatching, striped catfish consume **zooplanktons**
  - 3–4 days old are **highly cannibalistic** if not fed to satiation
  - At day 20, juveniles can efficiently use formulated feeds
- (Le *et al.*, 2000).

## 8. Application and Result

- **Cannibalism: population loss (15 to 90%)** (Hecht and Appelbaum, 1988).
- The study conducted by Altaffand Janak **live food (rotifers) can prevent cannibalism** of Koi Carp and enhance their growth and survival.
- Kouba et al., 2011 also **reported 90% survival** in crayfish fed with freshly decapsulated *Artemia* cysts.
- Sorgeloos et al. (1998, 2001) have shown **benefits of using Artemia both in fish and crustaceans.**



live food: at proper time play a major role in achieving **maximum growth and survival of the young ones of finfish and shellfish** ( Das et al., 2012).

- In **Striped catfish** the **highest survival rate** and fastest growth has been achieved using ***Artemia* and *Tubifex*** (Le et al., 1998).
- Mehmood *et al.* (1998) reported that the **live food to first feeding Rohu larvae enhances growth, health and survival and hence significantly reduces rearing costs.**

## Growth performance of Koi carp larvae fed with different feeds during 21 days rearing period (Mean $\pm$ SE)

	A	B	C	Mixed diet	Pellet feed
Survival rate (%)	<b>80<math>\pm</math>5.00</b>	70 $\pm$ 7.63	75 $\pm$ 5.00	71.6 $\pm$ 6.66	<b>50<math>\pm</math>10.40</b>
Cannibalism (%)	<b>19.67<math>\pm</math>5.33</b>	29.67 $\pm$ 7.63	24.33 $\pm$ 4.70	27.33 $\pm$ 6.35	<b>48.66<math>\pm</math>10.8</b>
Specific growth rate (SGR) (%)	<b>1.33<math>\pm</math>1.14</b>	0.72 $\pm$ 0.59	1.09 $\pm$ 0.91	0.10 $\pm$ 0.05	<b>0.03<math>\pm</math>0.02</b>

Source: Altaff & Janakiraman, 2013



## Growth and survival of *Labeo rohita* larvae fed different feed

Parameters	Artificial Diet 45% protein	Brachionus	Wild zooplankton	Enriched zooplankton	Artemia	Chironomus	Oligochaetes
SGR (%day <sup>-1</sup> )	8.87 ± 0.23	10.38 ± 0.10	11.05 ± 0.16	12.05 ± 0.11	11.74 ± 0.11	9.13 ± 0.08	9.84 ± 0.18
Survival (%)	74.66 ± 2.30	81.33 ± 2.30	87.33 ± 2.30	92.0 ± 2.0	89.33 ± 3.05	76.66 ± 3.85	74.0 ± 3.46

Source: Bakhtiyar et al., 2011

- Despite the effort that has been made in the development of **formulated starter feeds for larval fish**, **live food still remains a better option** in terms of growth and survival compared to formulated diets (Verreth et al., 1987; Mitra et al., 2007).

**The success of larval rearing depends on  
the availability of suitable live food  
organisms that determines the fate of  
Commercial aquaculture**

**Thanks for your time  
and patience !!!**







# Successful Semi-artificial Breeding of Pond Reared **Tor Mahseer, *Tor tor*** and Observation on its Initial Growth

Arun P. Baidya and Santa K. Shrestha

Kali Gandaki Fish Hatchery

Beltari, Syangja, Nepal

SEP 13 2010



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1.2. Status of indigenous fishes in Nepal

1.3. Breeding success of Mahseer

1.4. Mahseer of the World

1.5. Introduction of Tor Mahseer

1.6. Objective

## 2. Material and Methods

## 3. Results

## 4. Conclusion

## 5. Acknowledgement

# 1. Introduction

## 1.1. Importance of Tor Mahseer

- **High value food and game fish.**
- **Long living species** (Desai 1982).
- **Hardy Fish:** on the basis of temperature tolerance, it is **eurythermal** (cold-water & warm-water fish)(Desai 2003)
- **Omnivorous feeding habit:** **Fry** feeds on **filamentous algae, insects and diatoms**, which does not compete with carps (planktivorous); **juveniles** are **insectivorous** and **adults** feed on **aquatic macrophytes, filamentous algae, molluscs and insects** (Desai 2003).

# 1. Introduction

## 1.1. Importance of Tor Mahseer

### Conservation status:

- **Only one Endangered species in Nepal** (Shrestha 1995)
- In danger of extinction (ED) Report IUCN Nepal (Shrestha 1999)
- Vulnerable and threatened in Bangladesh (Ameen et al. 2000)
- Threatened fish of the world (Islam 2005)
- Endangered species in Nepal (Shrestha 2008)
- **Only one Endangered species in Nepal** (Shrestha 2012)
- IUCN Red List Status: Near Threatened (NT) (IUCN2014)

# 1. Introduction

## 1.2. Status of Indigenous Fishes of Nepal

- The updated list of indigenous fish of Nepal has been listed a number of **230 species** including **16 endemic species** (Ranjbanshi 2012).
- Including some recently discovered endemic species of insufficiently known status, at present total **16 Indicator Indigenous Species (IIS)** (**Insufficiently known 7, Rare 3, Vulnerable 5 and Endangered 1**) are recommended for their legal protection (Shrestha 2012)
- Out of **157 fish species** reported from the Kali Gandaki River System, **57 species** were collected from the Kali Gandaki River (Shrestha and Chaudhary 2004).



# Mahseer in Nepal

Scientific Name	English Name (Mahseer)	Local Name (Sahar)	Diagnostic character	Threat status
<i>Tor tor</i>	Tor Deep-bodied	Falame Malunge	Head length <b>shorter</b> than body depth; LI scales: <b>22-27</b>	<b>Endangered</b> (Shrestha 2008; Shrestha 2012)
<i>Tor putitora</i>	Putitor Golden	Pahelo Sunaulo	Head length <b>greater</b> than body depth; LI scales: <b>25-28</b>	<b>Fairly common</b> (Shrestha 2012)
<i>Tor mosal</i>	Mosal Copper		Head length <b>equals</b> body depth; LI scales: <b>23-26</b>	<b>Uncommon</b> (Shrestha 2012)
<i>Tor chelynoides</i>	Dark	Halundae	Head length <b>shorter</b> than body depth; LI scales: <b>32-35</b>	<b>Uncommon</b> (Shrestha 2008)

# Mahseer in Nepal



**Golden Mahseer, *Tor putitora***



**Tor Mahseer, *Tor tor***



**Dark Mahseer, *Tor chelynoides***

# 1. Introduction

## 1.3. Breeding Success of Mahseer

- Breeding of Golden Mahseer using **wild matured brood** in **India** (Kulkarni, 1980; Pathani, 1983)
- Breeding of Golden Mahseer using **wild matured brood at FRC, Trishuli on 30<sup>th</sup> August 1979** (Masuda and Bastola, 1985)
- Induced breeding of Golden Mahseer using pond reared wild brood by **hormone treatment at FRC, Pokhara on 1<sup>st</sup> August 1988** (Shrestha, 1990)
- Semi-artificial breeding of **pond reared Golden Mahseer at FRC, Trishuli on 9<sup>th</sup> April, 1993** (Joshi et al., 2002)



# Mahseer in South East Asia



Thai Mahseer, *Tor tambroides*



Large scaled Mahseer, *Tor douronensis*

Pond and tank reared both Mahseer successfully induced spawned by hormone treatment for the first time in **Sarawak, Malaysia on April 2003** after 10 years of domestication (De Silva et.al, 2004; Ingram et al., 2007).





# 1.4. Mahseer in the World

## 1. Geographic Distribution

- Mahseer are distributed into 3 geographical regions: **South Asia** (Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka) **East Asia** (China), and **South East Asia** (Myanmar, Laos, Thailand, Cambodia, Vietnam, Malaysia and Indonesia)
- Introduced in **Papua New Guinea** from Nepal (Coates, 1991)
- Many of the longest rivers in Asia originate from the high mountains of the Himalayan range and plateaus of Tibet
- **Brahamaputra** River of India (South Asia)
- **Changjiang (Yangtze-Kiang)** River of China (East Asia)
- **Mekong (Lancangjiang)** River of Indo China (South East Asia)
- **Salween (Nujiang) and Irrawaddy (Yiluowadi)** Rivers of Myanmar
- **Red (Yuanjiang)** River of Vietnam

Total reported Mahseer species in the World: **34**

(Source: Ambak et al. 2007: Mahseer The Biology, Culture and Conservation;  
Chee Kiat 2004: Kings of the Rivers)



# Major River System and Distribution of Mahseer in Asian Region

## 1.5. Introduction of Tor Mahseer



5.1 kg in Body Weight (BW) & 77 cm in Total Length (TL)

- *Tor tor* (Hamilton 1822) is a **large freshwater, benthopelagic and potamodromous cyprinid fish** (Riede 2004).
- Reported to reach **200 cm in TL** (Shrestha, 2000) and gain maximum **68 kg in BW** (Talwar & Jhingran 1991)
- Distributed in **Pakistan, India, Bangladesh** (Talwar & Jhingran 1991), **Myanmar** (Menon 1999), **Nepal** (Shrestha, 1994) & **Bhutan** (Rajbanshi & Csavas1982).

## 1.6. Objective

- To develop breeding technology and mass seed production of Tor Mahseer, *Tor tor* for restocking in natural environment and aquaculture practices in captivity.



## 2. Material and Methods

- Wild fingerlings were collected from Kali Gandaki River and reared in a control system for more than 12 years.



- Brood fish of Tor Mahseer and Golden Mahseer were stocked at the rate of about 3 Mt/ha in a 0.03 ha size concrete pond with earthen bottom with regular supply of fresh water.
- Feeding: Pellet feed containing 30% CP ad libitum

## 2. Material & Methods



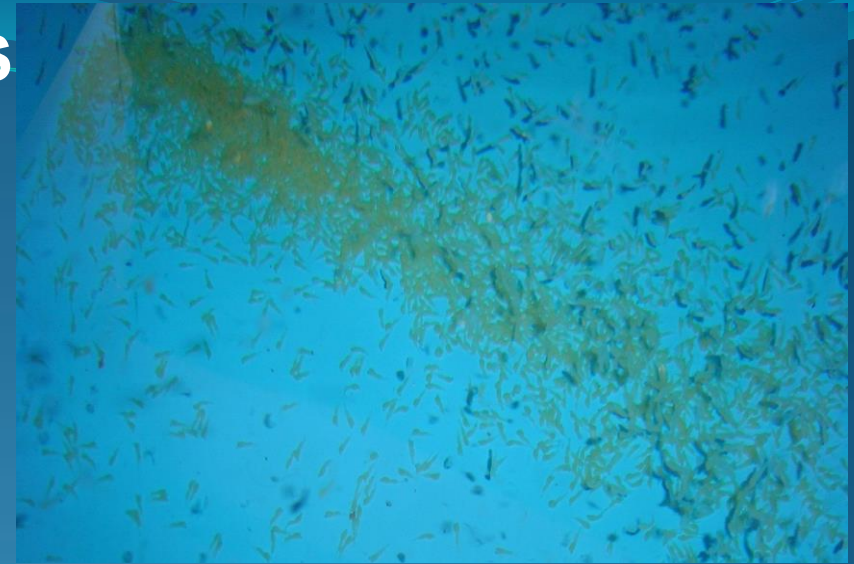
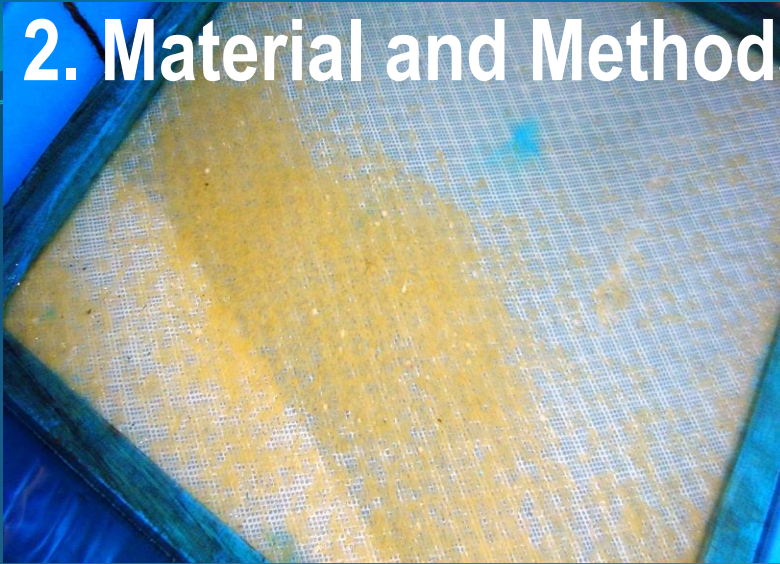
Stripping of eggs, milt and fertilization



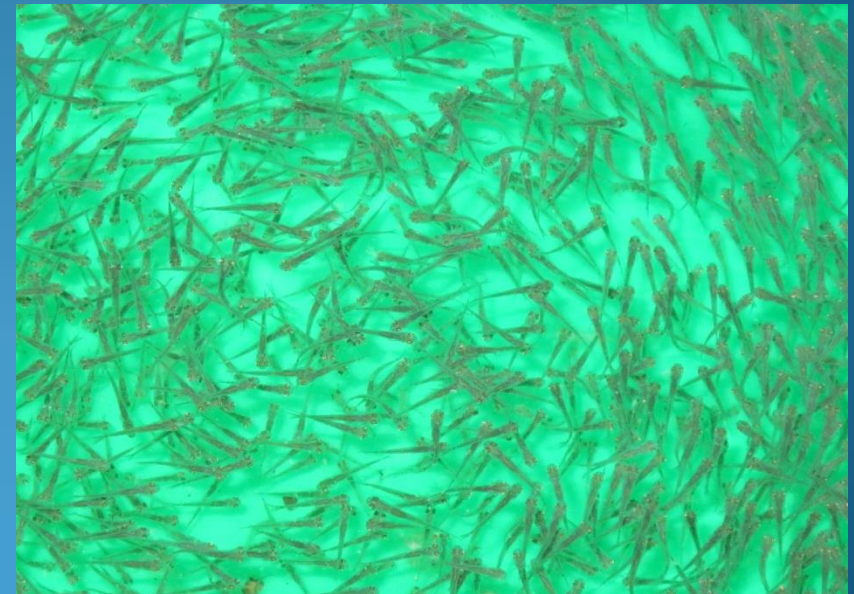
Incubation of fertilized eggs in Atkin



## 2. Material and Methods



Hatching of larvae



Hatchlings of Tor Mahseer (14 dAH)

### 3. Results



Pond reared Tor Mahseer successfully spawned for the first time in Nepal on **29<sup>th</sup> September 2014 (13<sup>th</sup> Aswin 2071)** after domestication for 12 years.

- Breeding season commenced in **July to September** & continues up to **December in Narmada River** (Karamchandani et al. 1967).
- Fish spawn **more than once a year in Narmada River** (Desai 1973)
- Fish breeds **only once a year during July to December with peak in August in Udaipur Lake in Rajasthan** (Chaturvedi 1976).
- Spawn from **March to September**, over gravel and stones in **lakes of Pokhara Valley** (Swar 1979).



### 3. Results

#### Tor Mahseer, *Tor tor*

Body weight of female: 5.1 kg

Total length of female: 77 cm

Water temperature: 22-24°C

Total weight of egg: 250 g

Number of egg/g: 46

Size of egg: **21 mg**

Total egg released: 11,500

Fertilization rate: 95%

Hatching rate: 90%

Total number of hatchlings: 9,500

Total number of juvenile (14 dAH):  
8,880

Size of 14 dAH juvenile: **25 mg**

Size of 45 dAH juvenile: **109 mg**

Size of 75 dAH: **194 mg; 26 mm**

Size of 105 dAH: **221 mg; 28 mm**

#### Golden Mahseer, *Tor putitora*

Body weight of female: 1.5 kg

Total length of female: 56 cm

Water temperature: 22-24°C

Total weight of egg: 100 g

Number of egg/g: 78

Size of egg: **12 mg**

Total egg released: 7,800

Fertilization rate: 90%

Hatching rate: 85%

Total number of hatchlings: 6,000

Total number of juvenile (14 dAH):  
5,500

Size of 14 dAH juvenile: **17 mg**

Size of 45 dAH juvenile: **68 mg**

Size of 75 dAH: **136 mg, 24mm**

Size of 105 dAH: **172 mg; 26 mm**

### 3. Results

Size of tank: 37.5 sq. m., Water depth: 0.8 m

Stocking:

*Tor tor* (8000 nos., 213/sq. m.) *Tor putitora* (5500 nos., 147/sq. m)

*Tor tor* (880 nos., 21/sq. m., 278 mg)



*Tor tor* (75 dAH, 194 mg, 26 mm)



*Tor putitora* (75 dAH, 136 mg, 24 mm)



**Pond No. R-4**



*Tor putitora* (172 mg, 26 mm)



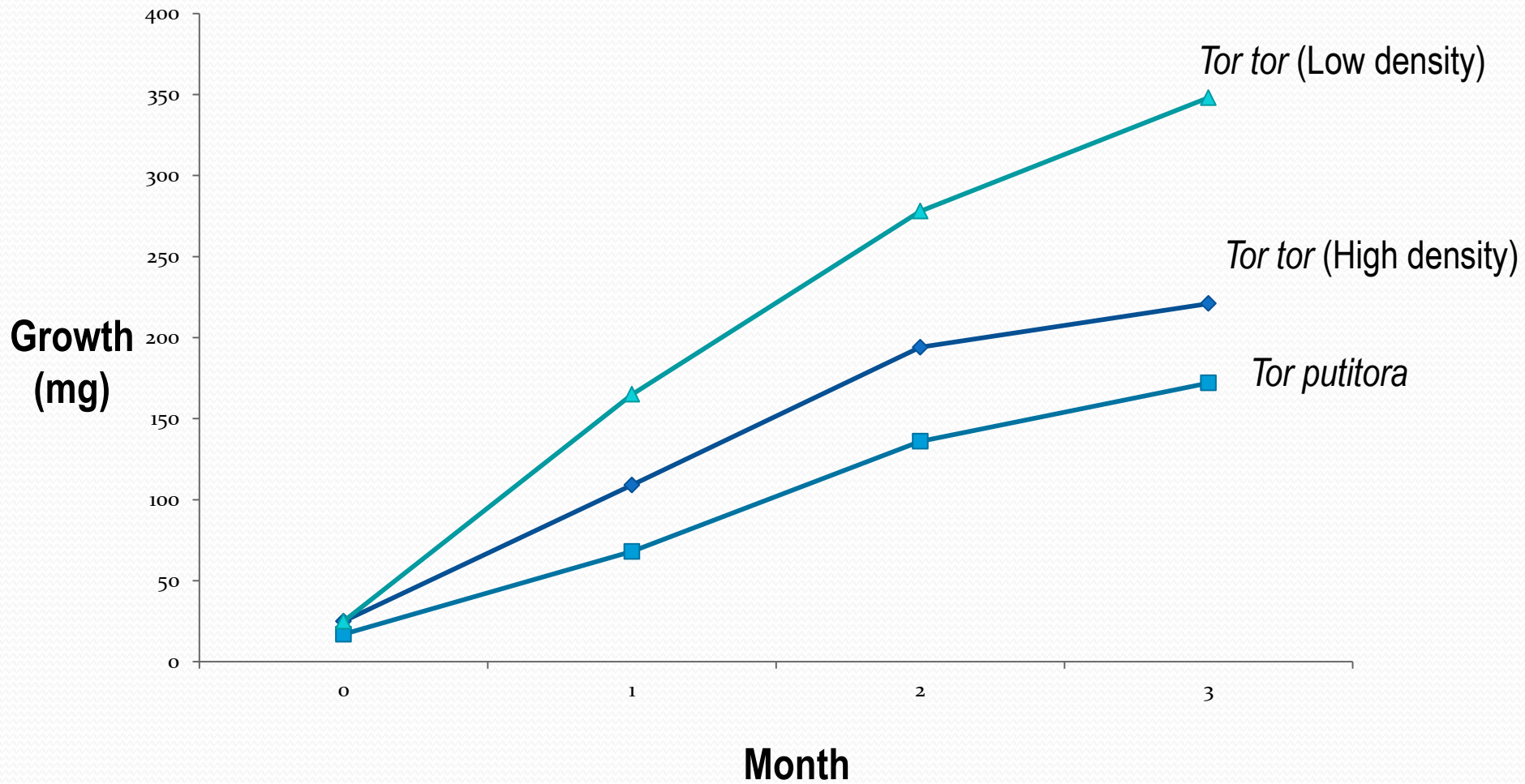
*Tor tor* (348 mg, 30 mm)

**Pond No. R-5**



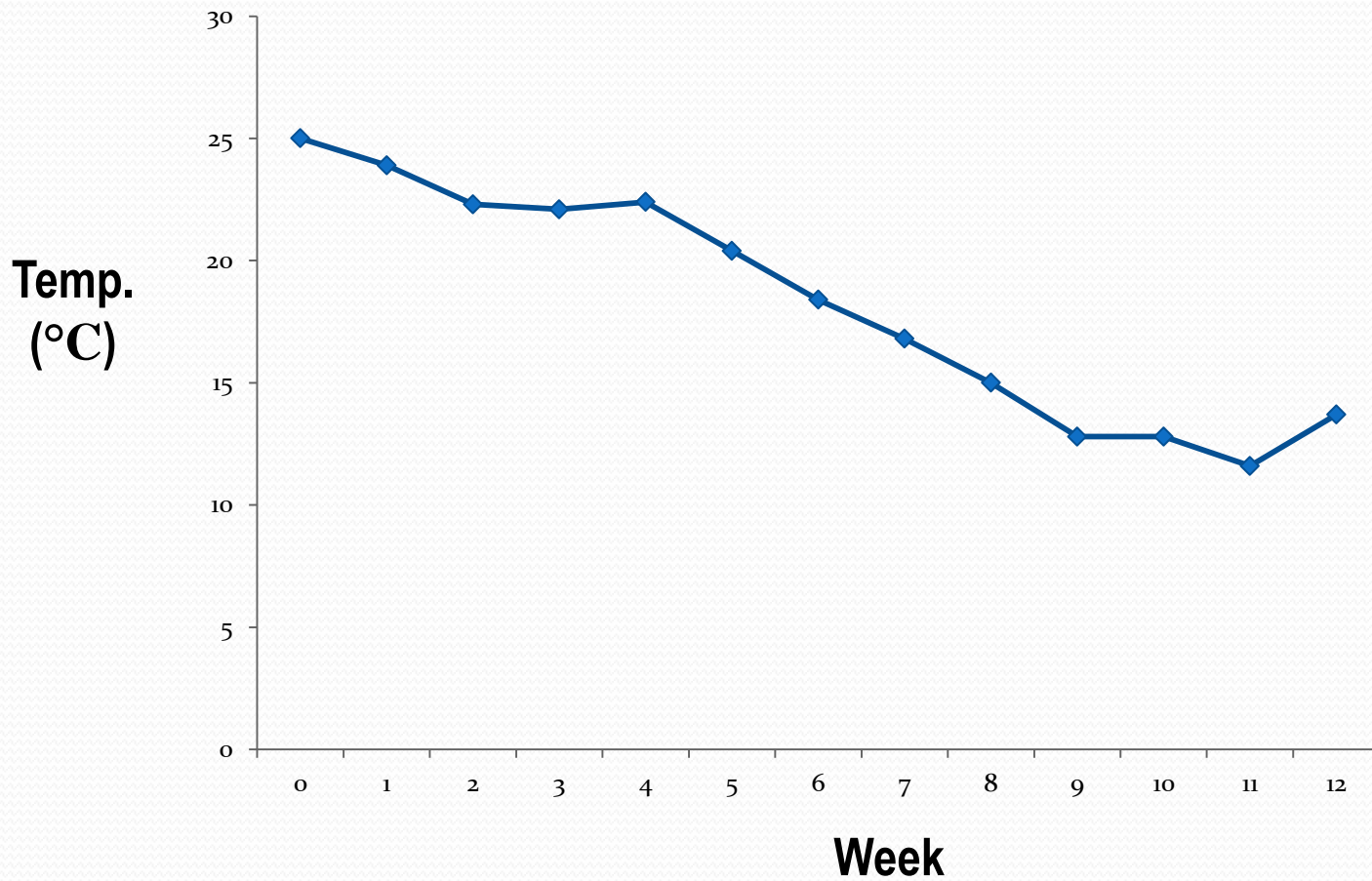
*Tor tor* (221 mg, 28 mm)

**105 dAH Juveniles of Mahseer**



**Growth of *Tor tor* and *Tor putitora***





**Water temperature of *Tor tor* reared nursery pond**

## 4. Conclusion

- This preliminary study indicates that Tor Mahseer will **grow faster** than Golden Mahseer and **attain sexual maturity earlier**.

Female Tor Mahseer attained first sexual maturity at

273-290 mm TL in Narmada River (Karamchandani et al 1967)

340-380 mm TL in Narmada River (Desai 1973)

320-390 mm TL in Udaipur Lake (Chaturvedi 1976)

280-350 mm TL in Bhim Tal (Pathani and Das 1983)

- The success of breeding promises that there are possibilities of **mass seed production** of Tor Mahseer.
- This fish could be a **potential candidate** for the development of an **open water fishery as well as aquaculture**, and to **restore this endangered species in open waters**.



## 5. Acknowledgement

- Nepal Electricity Authority (NEA)
- Nepal Agricultural Research Council (NARC)



**Relation between Endangered Fish  
and  
Displaced Poor Fisher Community**



# Save the Mahseer



# Thank You



# STATUS OF CARP SEED SURVIVAL AND HEALTH MANAGEMENT IN NEPAL

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# Aquaculture in Nepal



- Further development in 1960's
- Significant progress 1980/81 - ADB loan investment
- Semi-intensive carp polyculture
- 7 Carp species: Rohu, Mrigal & Catla, SC, BC & GC)+ CC sp.)
- New species: Tilapia, Pangasius, Trout

# Problem Statement

- 1 Fish seed quality – management problem
- 2 Low survival (20-30%) and slow growth at early stages of carps have been major obstacles in meeting the demand of fry
- 3 Bacterial infection in fish larvae causes of mass mortality, still a bottleneck

# Objectives

## Overall objective

- To study the existing practices of carp seed health management in Nepal
- To identify the cause of **low survival** of different stages of carp seed hatchlings, fry and advanced fry in private fish hatcheries in Nepal.



# Literature review

- Agriculture is the major contributor to the Nepalese economy (34%GDP)
- Aquaculture and fisheries is one of the important parts of agriculture sector contributing about 1% and 3% of the total GDP and agricultural GDP respectively (DoFD-2014)
- Aquaculture has great potential for future expansion, 2-4 times more profitable than other high value agricultural activities (Sharma and Leung, 1998)

# Literature review

- Fish Hatcheries are economically profitable business, therefore, about 80% seed is produced by private sector
- Three stages of fish seed i.e. hatchlings; fry and fingerlings are distributed. Private sector supply 5.7 million fry in 2001/02 to 93 million fry in 2013 within a decade (DoFD, 2014).
- Bacterial, fungal and parasitic diseases are problems
- The economic loss from EUS in some districts was estimated to be around US\$30,000 (NACA/FAO, 2009)

# Research Methods: 2 major parts

- 1) A hatchery survey
- 2) On-station trial at AFU / IAAS

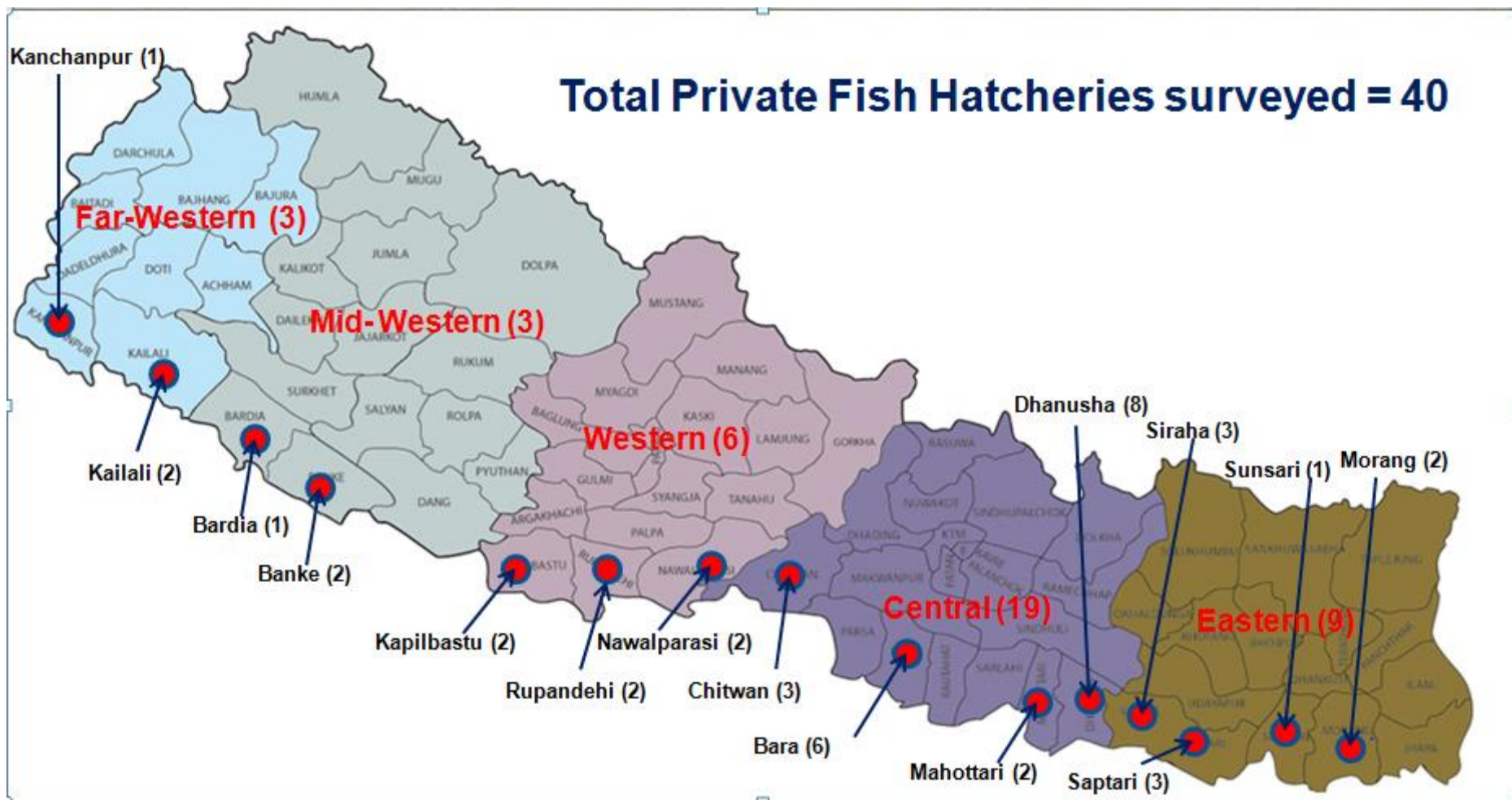


# Methods: 1: Survey

- Survey period: March 2009 to December 2013.
- Total private fish hatcheries surveyed – 40
- A detailed survey of private fish hatcheries from different developmental regions representing 15 districts .was conducted:
  - Eastern-9;
  - Central-19,
  - Western-6,
  - Midwestern-3 and
  - Farwesten-3



# Survey: District and Number of Hatcheries



# Methods: Survey

## Data collection:

- 1 Questionnaire preparation
- 2 Primary data
- 3 Secondary data
- 4 Survey Data analysis



# **Results & Discussion**

## **Part 1: Survey**

# Fish seed Survival-Central

	Hatchling survival	Fry survival	Fingerling survival
1	20	55	60
2	10	35	60
3	20	50	70
4	25	65	80
5	15	50	60
6	20	55	70
7	16	50	65
8	15	50	60
9	25	55	65
10	30	55	70
11	20	50	60
12	25	55	65
13	30	55	60
14	25	55	65
15	35	65	80
16	20	40	60
17	35	50	60
18	20	55	60
19	15	50	60
Mean	22.15789	52.36842	64.73684
SD	6.882047	6.945906	6.556101
SE	1.57885	1.5935	1.504073

10 to 15 21.05%

16 to 20 36.84%

21 to 25 21.05%

26 to 30 10.53%

31 to 35 10.53%

100.00%



# Fish seed Survival-Eastern

Hatchery	Hatchling survival	Fry survival	Fingerling survival
1	30	55	60
2	35	50	60
3	25	55	70
4	30	50	65
5	30	55	70
6	18	50	70
7	30	55	60
8	35	50	60
9	20	45	50
Mean	28.1	51.7	62.78
St Deviation	5.99	3.53	6.67
SE	1.99	1.18	2.22

# Fish seed Survival-Western

Hatch.	Hatchling survival	Fry survival	Fingerling survival
1	21	45	60
2	25	50	60
3	25	60	70
4	30	55	60
5	35	50	60
6	25	55	65
	26.83	52.5	62.5
	4.92	5.24	4.18
	2.0	2.14	1.71

Hatch.	Hatchling survival	Fry survival	Fingerling survival
1	20	40	50
2	25	50	60
3	25	60	70
	23.33	50	60
	2.89	10	10

Hatcher	Hatchling survival	Fry survival	Fingerling survival
1	25	55	60
2	30	50	60
3	25	55	60
	26.67	53.33	60
	2.89	2.89	0

Name of the diseases	No. of Hatchery	%
Bacterial+Fungal (Saprolegniosis)+ Lice(Argulosis)+ Asphyxiation+Dropsy	28	70
Scoliosis	2	5
Trichodinosis	7	17.5
Black spot	1	2.5
White spot (Ichthyophthiriosis)	2	5

# Conclusions

- 1) Carps are the major species which occupied over 95% of total production in Nepal.
- 2) Carp culture is largely dependent on the seeds produced from private fish hatcheries
- 3) Due to inbreeding and poor management of brood stock quality of seed is deteriorating affected not only survival and growth of the juveniles but also production.
- 4) Mass mortality of hatchlings in rearing unit occurred due to poor management and fish parasite.



# Conclusions

- 6) It was found that substandard quality of seed due to unhealthy competition among the hatcheries. For them quantity is important rather than the quality.
- 7) Data recording system was very poor as most of the hatcheries operators are not well trained
- 8) There are no brood replenishment program followed in the hatcheries.
- 9) Simple hapa rearing showed an improved survival, emphasis should be given to manage nursing in hapas in pond systems.
- 10) Multi-strain probiotics can enhance survival and growth of hatchlings and fry, but not larger fry

# Recommendations

- 1) Carp brood stock improvement program should be initiated through DoFD and improved stocks should be distributed to hatcheries
- 2) Hapa rearing of juveniles improves survival.
- 3) Monitoring and evaluation practices should be installed so that hatchery operators follow the Standard procedures.
- 4) Formulation of fish seed act to regulate the quality of seed.

# Recommendations

5. Parasitic diseases can be controlled by applying proper biosecurity measures.
6. To improve overall seed production program there must be collaborative approach among different organizations of seed producers and all stakeholders.
7. In addition to management, some of the multistrain probiotics may be incorporated for better survival and growth of hatchlings and early fry stages
8. Practical hands-on training should be given to hatchery owners, operators, or managers for better management



# Dietary supplementation of probiotics improves survival and growth of Rohu (*Labeo rohita* Ham.) hatchlings and fry in outdoor tanks



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## ABSTRACT

Low survival (20–30%) and slow growth at early stages of Rohu, *Labeo rohita* have been major obstacles in meeting the demand of fry in Asia. Three experiments were conducted for 30 days each to evaluate the potential benefits of three multi-strain probiotics in three different stages of juvenile Rohu (hatchling—8 days old, fry—38 days old and advanced fry—68 days old) on the survival and growth. In this study, four different types of treatments were used; namely, T1: Control, i.e. feed without any dietary supplements, T2: feed with *Lactobacilli*, *Bifidobacterium*, yeast, Spirulina and phytase, T3: feed with *Lactobacillus*, yeast, seaweed and amylase, and T4: feed with *Lactobacilli*, *Bacillus* and yeast only. Hatchlings fed with T2 feed showed highest survival (74.7%), which is about 25% improvement in comparison to the survival of the Control group (49.9%). Similarly, T3 (60%) and T4 (61.5%) showed at least 10% increment in survival as compared to that of Control (T1). The hatchlings in T2 group had significantly higher ( $p < 0.05$ ) final weight (0.53 g) compared with T1, T3, and T4 which had final weights of 0.30 g, 0.46 g, and 0.39 g respectively. Specific growth rates of T2 and T3 were found significantly higher ( $p < 0.05$ ) in hatchlings. In fry stage, the feed with all the probiotic mixtures showed significantly higher specific growth than the Control. However, these probiotics had no clear effect on the survival at the fry stage and afterwards. In advanced fry stage, there was no significant difference ( $p > 0.05$ ) in final weight and specific growth rate among the treatments. Present study indicated that positive effects of multistrain probiotics on the survival and growth can be seen only at hatchling and fry stages, but not later stages.











These are natives of fish  
ponds other than carps!!!





**Thanks for your  
attention and patience**





# ***An Extruded floating Pellet Feed for Trout and Carp Fish Culture***

***shreenagar***   
*from Ideas to Impacts...*

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# Present Need in Aquaculture

- Increase Fish Productivity per unit area
- Stock large sized 100-150 gram size fingerlings in grow-out fish ponds
- Intensive use of extruded floating pellet feed.
- Grow more feed feeder fish (Major: Common carp, Rohu, Naini) plus (Minor: Silver, bighead, Bhakur, Grass)
- Now Nepalese market needs fresh live fish in market

# What is extruded floating Pellet feed

- Made by extruded machine in high temperature and pressure.
- It is full cooked and hygienic to fish.
- This feed based on balanced formulation.
- This feed floats on Fish pond water surface





# History Extruded floating Pellet Feed

- Its new, the production and marketing started since 2068 BC in Nepal
- Fish farmers are not aware to this feed
- They are dependent on conventional feed rice bran and mustard oil cake
- In extruded floating Pellet feed all nutritional requirement for fish growth is available.

# Why extruded floating Pellet feed for Fish culture

- Use of rice bran, compost and fertilizer causes slow growth of fish and depletion of dissolved oxygen in pond water causes the mortality of fish
- Extruded floating Pellet feed maintains the pond water quality.
- Full utilization of feed by fish
- Fish culture period lower



# Nutritional balance in extruded floating Pellet feed

- High quality fresh raw material use
- Nutritionally required Protein (Amino acid)  
Fish meal, soya flour, mustards oil cake
- Energy (Carbohydrate) Maize, wheat, rice bran
- Micro-nutrient (Vitamin, mineral and oil)

# Types of Extruded Floating Pellet feed for Trout and Carp

- T1 & C1 : Starter for Hatchling, Size 0.3-0.8 mm



- T2& C2 : Fry Nursing, Size 1-2 mm





# Continue...

- T3 & C3 : Fingerlings Nursing, Size 2-3 mm



- T4 & T5 : Grower, Pellet, Size 4-4.5mm



- T5&C5 : Brood stock feed, Size 4.5-5 mm

# Usefulness of Extruded floating Pellet Fish Feed

- Increase the disease resistance
- Decreases the fish mortality
- Maintains the water quality balance
- Improves the meat quality of fish
- Fast growth of fish
- Low FCR Trout 1.2-1.5 Carp 1.5



# Thank you for Listening me !!!

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**Shreenagar**  
*from Ideas to Impacts...*



# **Effect of aeration in pond on oxygen transfer and fish production**

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**1<sup>st</sup> NEFIS Convention**

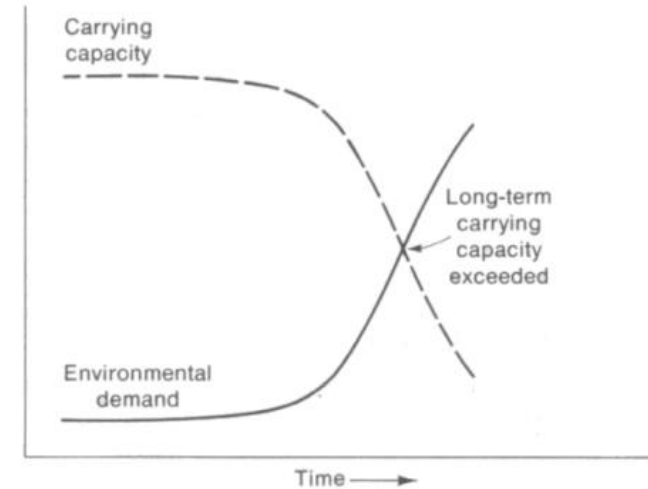


# Introduction

- Demand for fish production as a source of food has increased rapidly.
- Competition for scarce natural resources has recently begun to promote the **development of intensive aquaculture**.
- The goal of intensive, high-density aquaculture is to **maximize carrying capacity**.



- Carrying capacity in aquaculture is defined in terms of **loading density of fish ( $\text{kg}/\text{m}^3$ )** which are limited by hydraulic, chemical, physical, and biological parameters
- Harvest yields are finite and determined by pond carrying capacity.
- Fish farming in high densities can **quickly deteriorate water quality.**
- Limnological characteristics of ponds are highly dynamic.



- The availability of **dissolved oxygen** is the primary factor determining maximum pond biomass.
- Major constraint in the adoption of intensive fish farming is the efficient management of **pond water quality**.
- **Artificial aeration or oxygenation** is employed to increase in dissolved oxygen levels in the aquatic environment and to elevate production rate



- Paddle wheel aerators introduced for enhancing carrying capacity of intensive aquaculture.
- Effectiveness of aerator in local environment has not yet been evaluated.



Aimed to evaluate the effect of paddle wheel aerator on dissolved oxygen dynamics and fish production in intensively stocked polyculture fish pond.



# Materials and Methods

- Location: RARS, Tarahara
- Duration: 9 month/crop, 3 consecutive year
- Ponds: 4 (0.1-0.12 ha)
- Pre-stocking management:
  - Liming: 450 kg/ha
  - Fertilizer: FYM 4 t/ha, DAP 40kg/ha, Urea: 40 kg/ha
  - Water filling: 110-135 cm
- Treatment and stocking % and size (g)

# Treatments, stocking % and size (g)

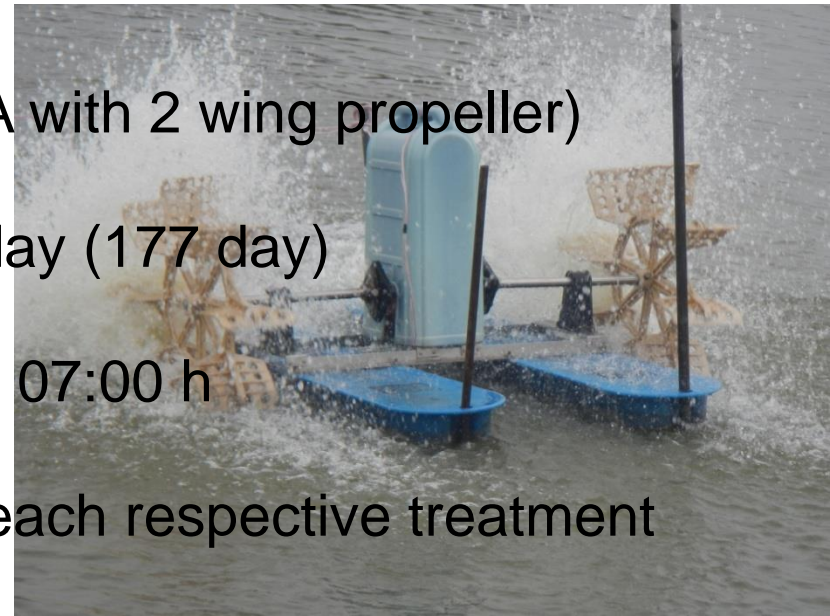
Species	Stocking %	Aeration, 15000/ha T1	Aeration, 20000/ha T2	Unaerated 15000/ha T3	Unaerated 20000/ha T4
Common carp	55.0	28.9	84.0	71.0	39.9
Bighead carp	10.0	<b>170.3</b>	<b>77.5</b>	<b>128.2</b>	<b>266.1</b>
Silver carp	10.0	<b>240.0</b>	<b>144.6</b>	<b>85.0</b>	<b>121.2</b>
Grass carp	25.0	14.6	30.2	14.6	14.3
Mean weight, g		<b>44.1</b>	<b>67.4</b>	<b>61.9</b>	<b>49.7</b>

- **Post stocking management:**

- Feeding : 25% protein, moist ball, 3% TLW, 2 times/day
- Fertilizer: DAP 40kg/ha, Urea 30 kg/ha; 4 times at equal interval of fish growing period.
- Water exchange: as and when necessary for at least 100 cm water depth.

- **Aeration**

- Paddle wheel aerator (0.75 KVA with 2 wing propeller)
- Aeration duration: 2-3 h every day (177 day)
- Aeration time: Morning 04:00 to 07:00 h
- Aerator placement: one unit in each respective treatment

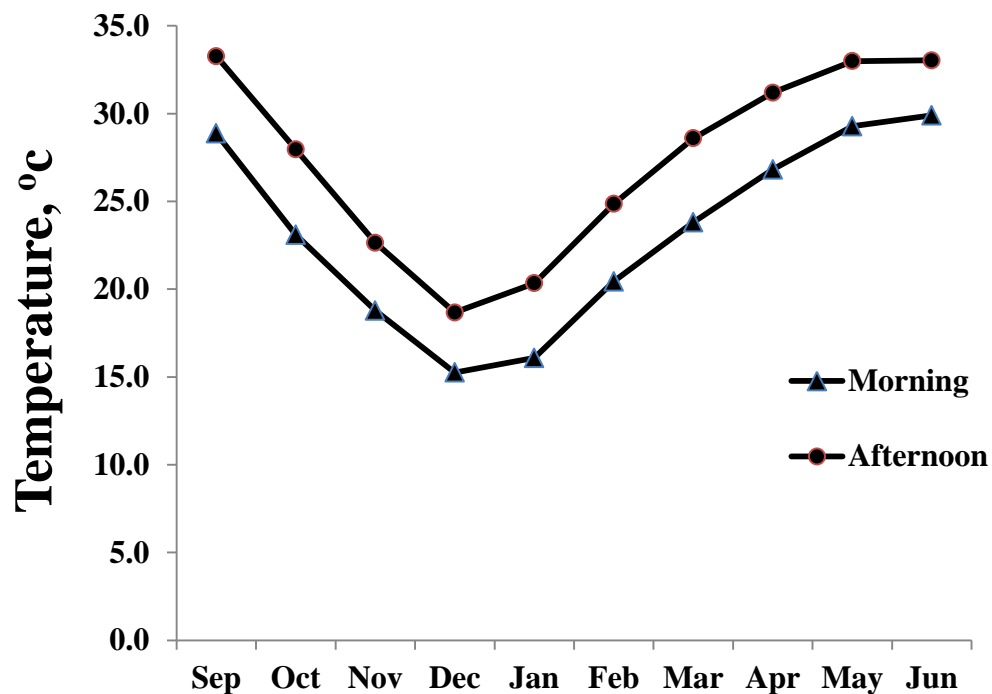


- Monitoring
  - DO measurement (diurnal, seasonal, transfer)
  - Other water quality (physico-chemical & nutrients) before, during and after aeration.
  - Monthly fish growth check up and biomass estimation.
  - Fish health monitoring
- Harvest
  - Fish weighed and counted by species
- Data analysis
  - Fish yield data analyzed with One-Way Anova using STATGraphics ver. 3.3.





# Results

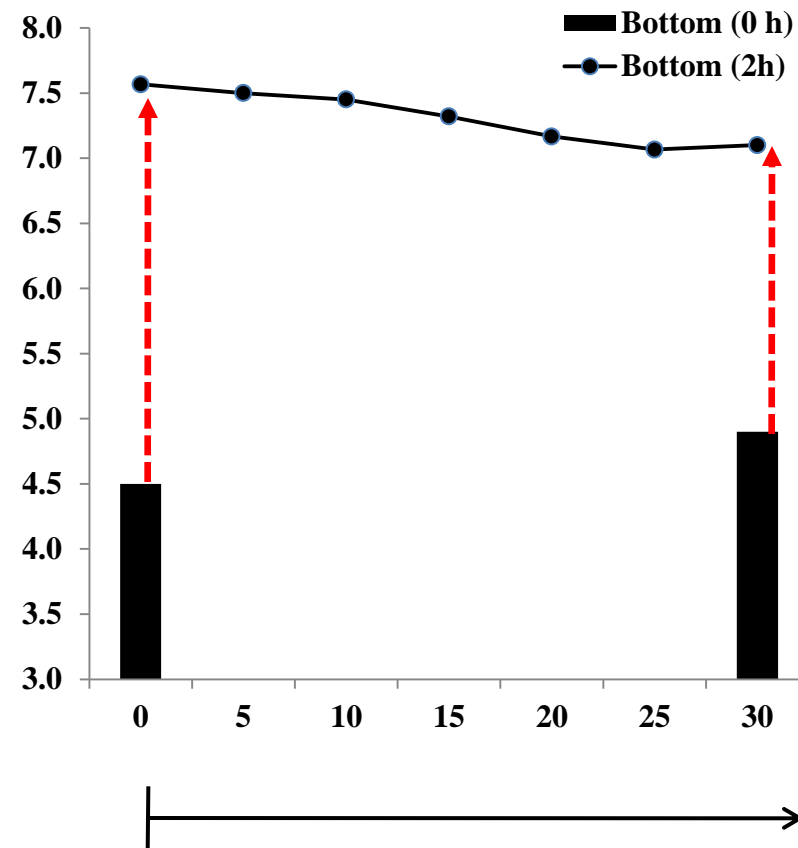
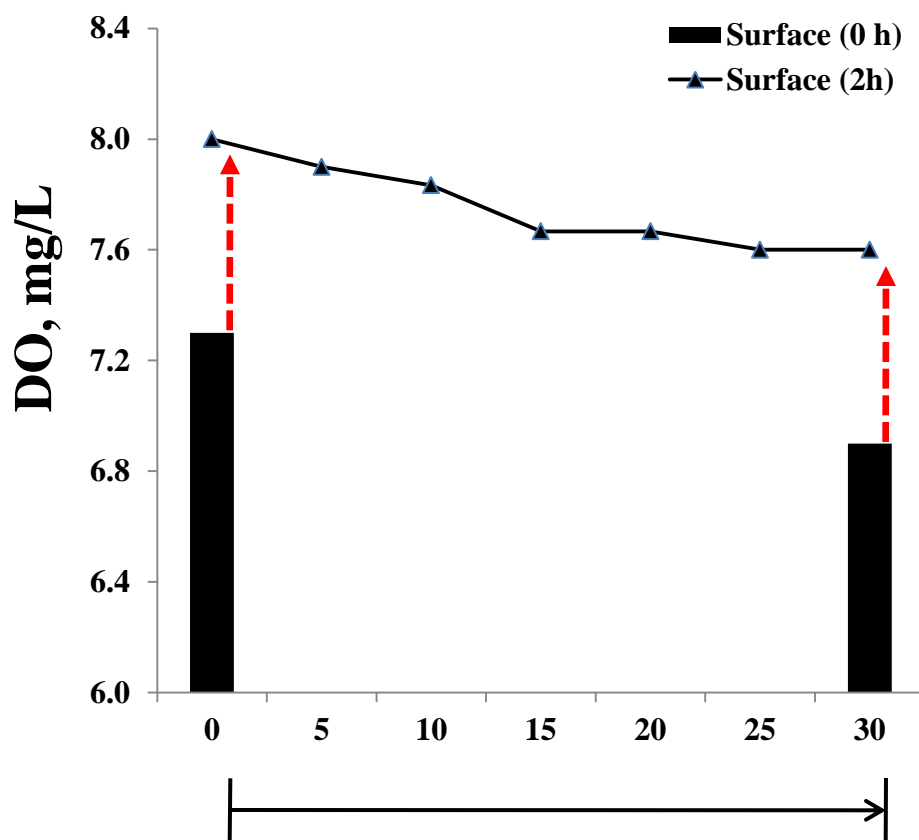


- Water temp. ranged between 15.3-29.9 °C in morning and 18.7-33.3 °C in afternoon.

# Mean variation of limnological characteristics of aerated fish pond

Parameters	BA	DA	AA
Transparency, cm	34.0	42.0	<b>49.0</b>
DO, mg/L	3.4	4.7	<b>4.8</b>
pH	7.6	8.1	7.9
Temp., °C	25.2	22.4	<b>21.7</b>
Conductivity, $\mu\text{s}/\text{sec}$	48.0	48.0	47.0
Alkalinity, mg/L as $\text{CaCO}_3$	56.6	61.1	57.6
Chlorophyll <sub>a</sub> , $\mu\text{g}/\text{L}$	78.6	85.8	84.1
Total phosphorous, $\mu\text{g}/\text{L}$	61.2	40.5	58.1
Phosphate, $\mu\text{g}/\text{L}$	4.9	10.1	<b>13.7</b>
Ammonia, $\mu\text{g}/\text{L}$	33.8	16.2	<b>9.3</b>
Nitrite, $\mu\text{g}/\text{L}$	0.56	<b>1.72</b>	1.33
Nitrate, $\mu\text{g}/\text{L}$	56.2	<b>31.8</b>	39.2

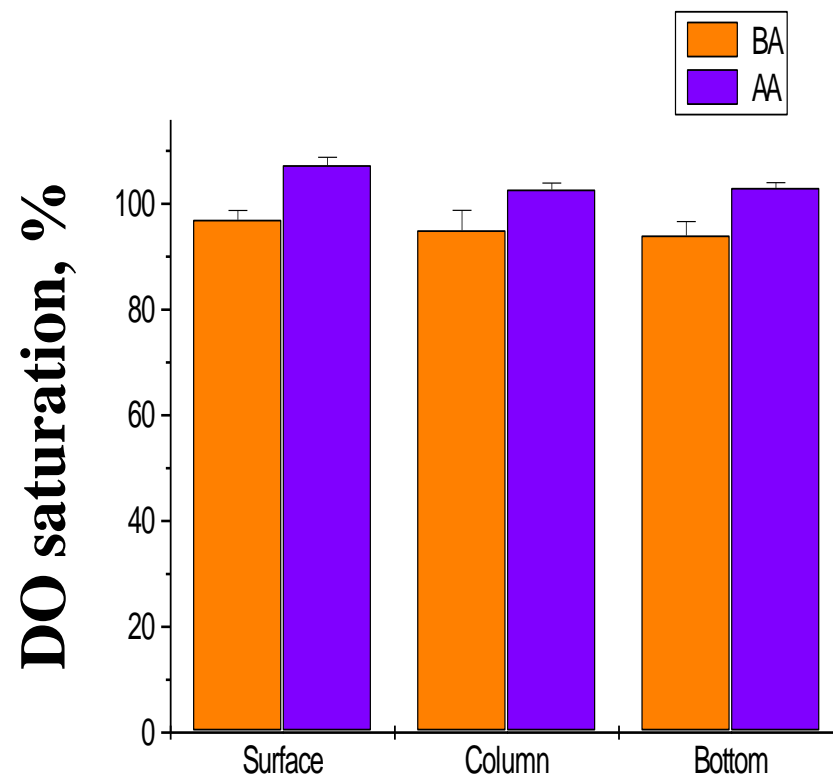
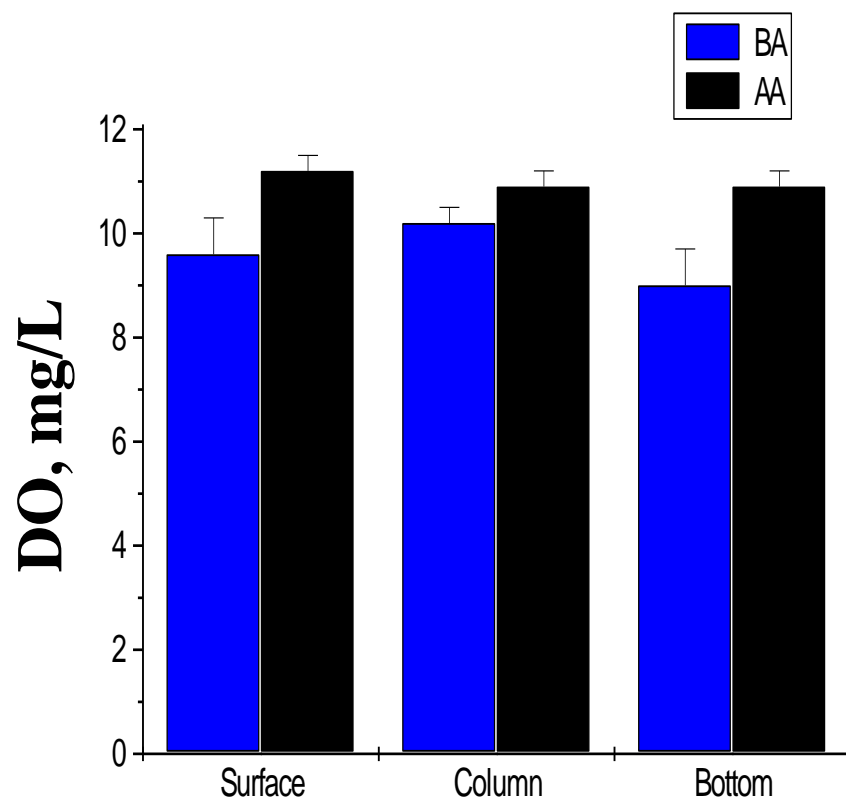
# Dissolved oxygen transfer



Distance from origin of aerator in pond, m

Pond aeration has strong influence on vertical distribution of  $O_2$  than the spacial distribution.

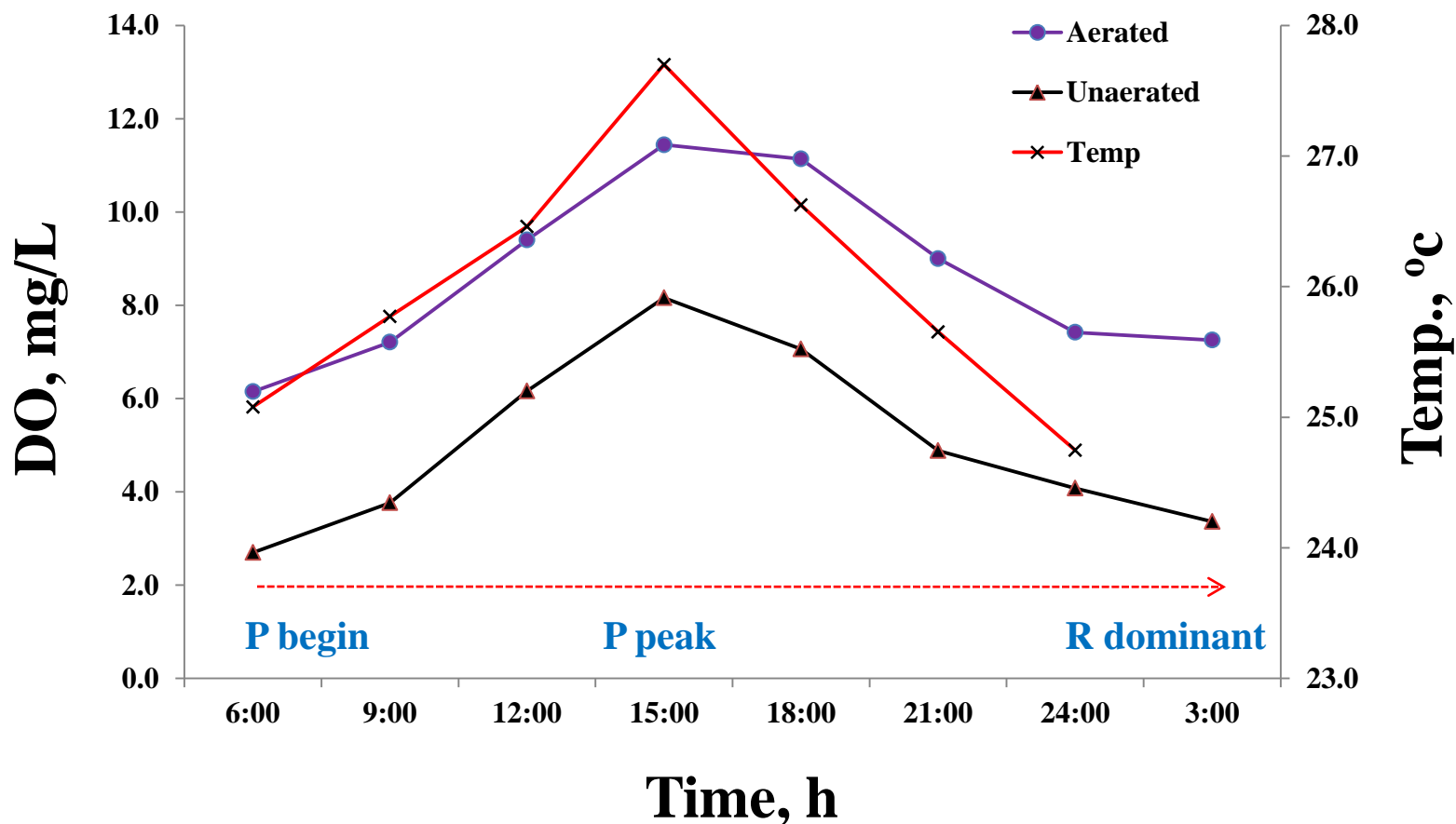
## DO conc. & saturation at different water level in pond



Mean DO concentration increased by 1.1 mg/L and saturation by 12% after 2 h of aeration

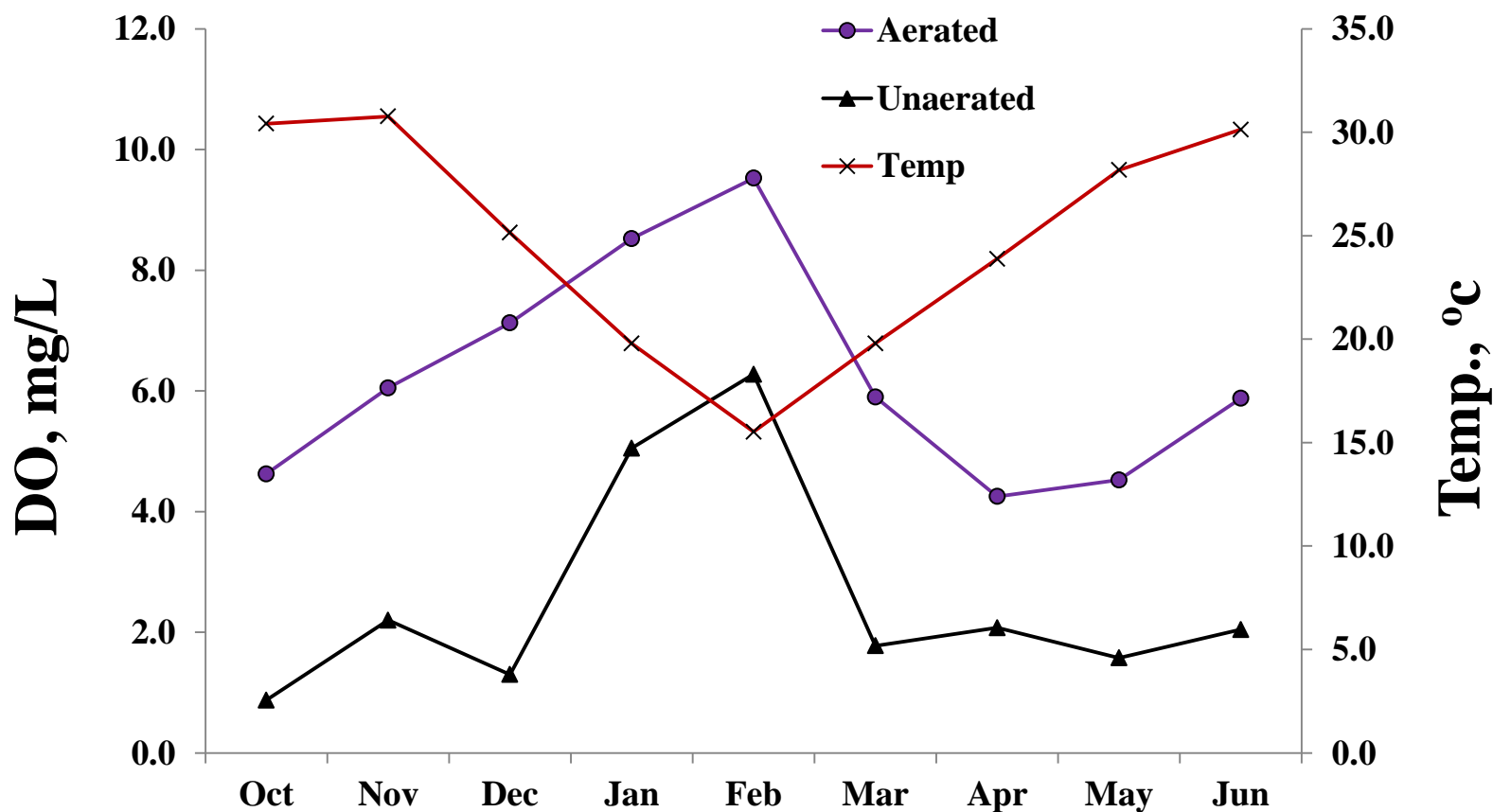


# Diurnal DO cycle in aerated pond



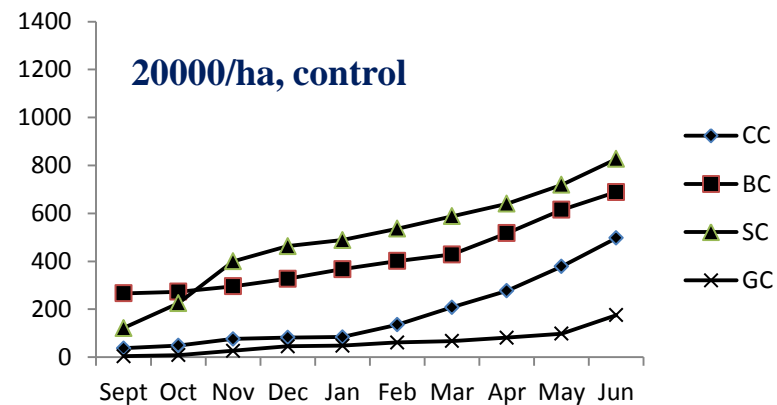
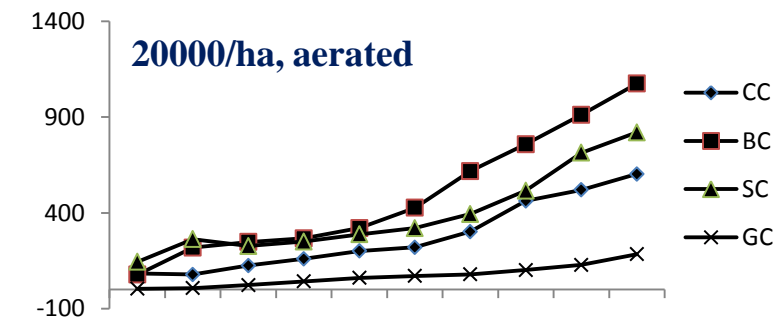
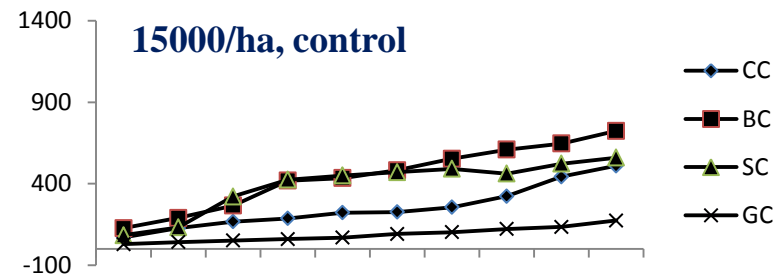
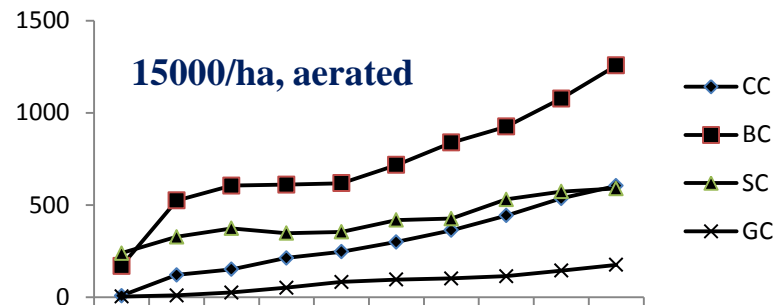
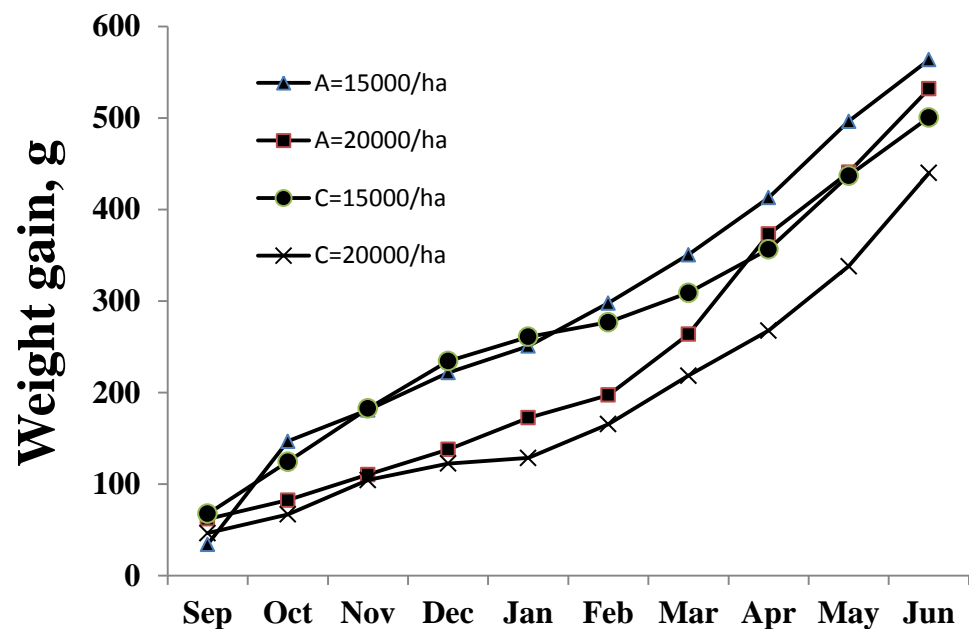
**P- Photosynthesis, R- Respiration**

# Monthly morning DO (mean of water column) in pond





# Fish growth

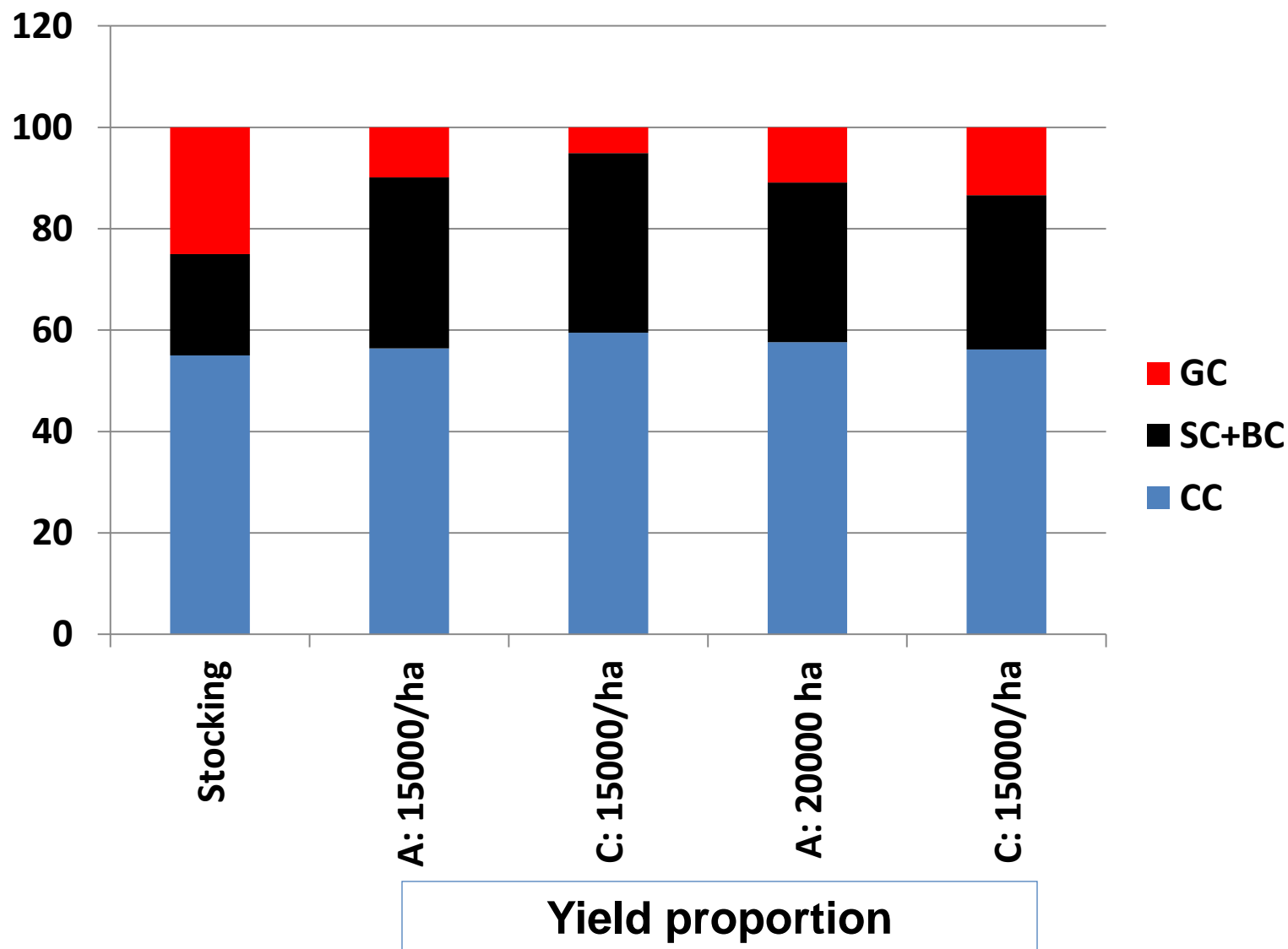


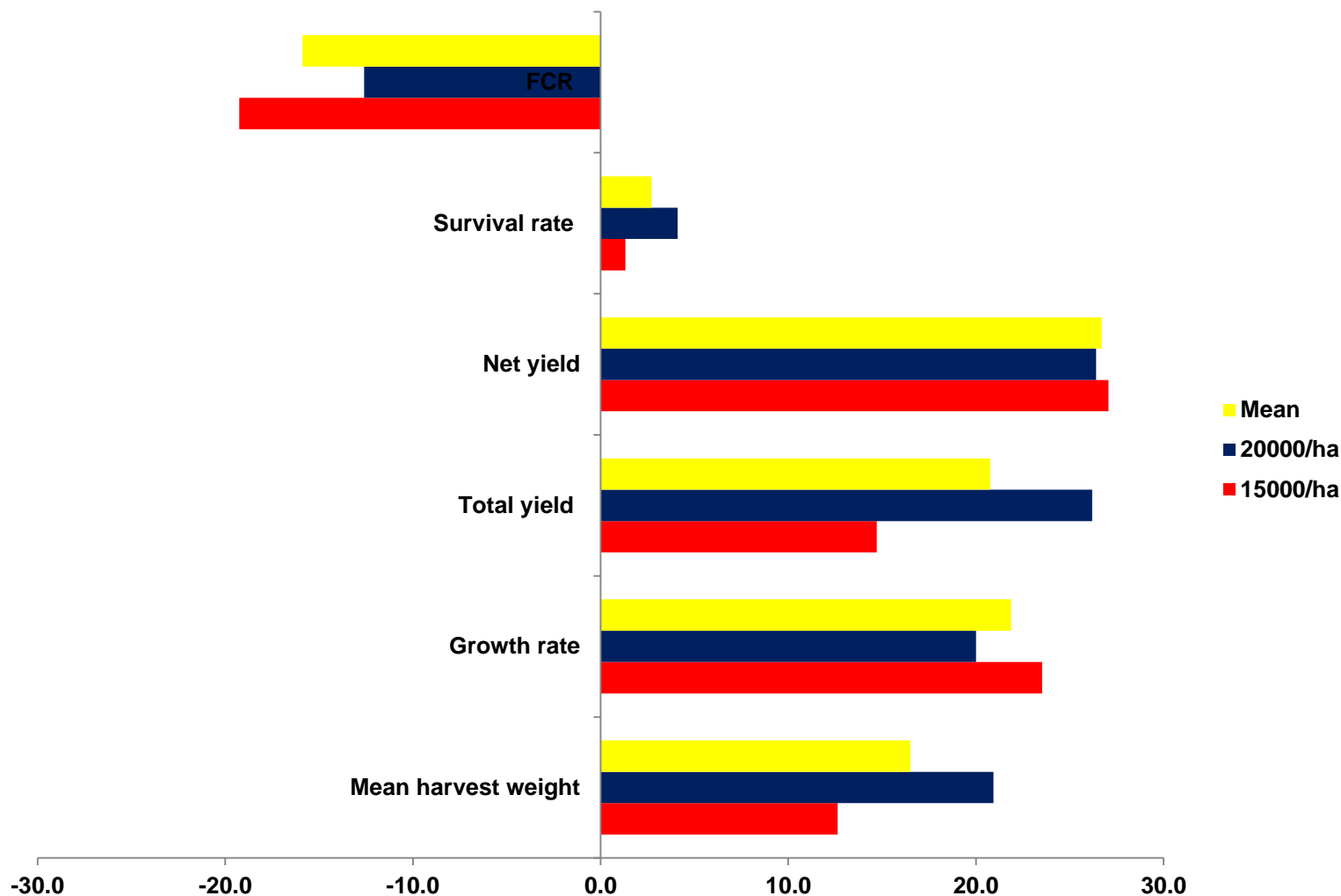
# Fish growth, yield and survival comparison between aerated and control ponds

Parameters	15000/ha		20000/ha	
	Aerated	Control	Aerated	Control
Mean initial size, g	34.1	67.4	61.9	49.7
Gross wt. at stocking, kg/ha	537.1	1055.9	1242.1	994.7
Growing days	254	254	254	254
Mean harvest weight, g	563.6*	500.4	531.7*	439.7
Growth rate, g/day	2.1	1.7	1.8	1.5
Total yield, kg/ha	7482.4*	6522.4	9177.7*	7272.9
Net yield, kg/ha	6945.4*	5466.5	7935.6*	6278.2
Survival %	84.3	83.2	86.1	82.7
FCR	2.14	2.65	2.36	2.70
Yield increase, %	27.1		26.4	



# Species contribution in yield, %

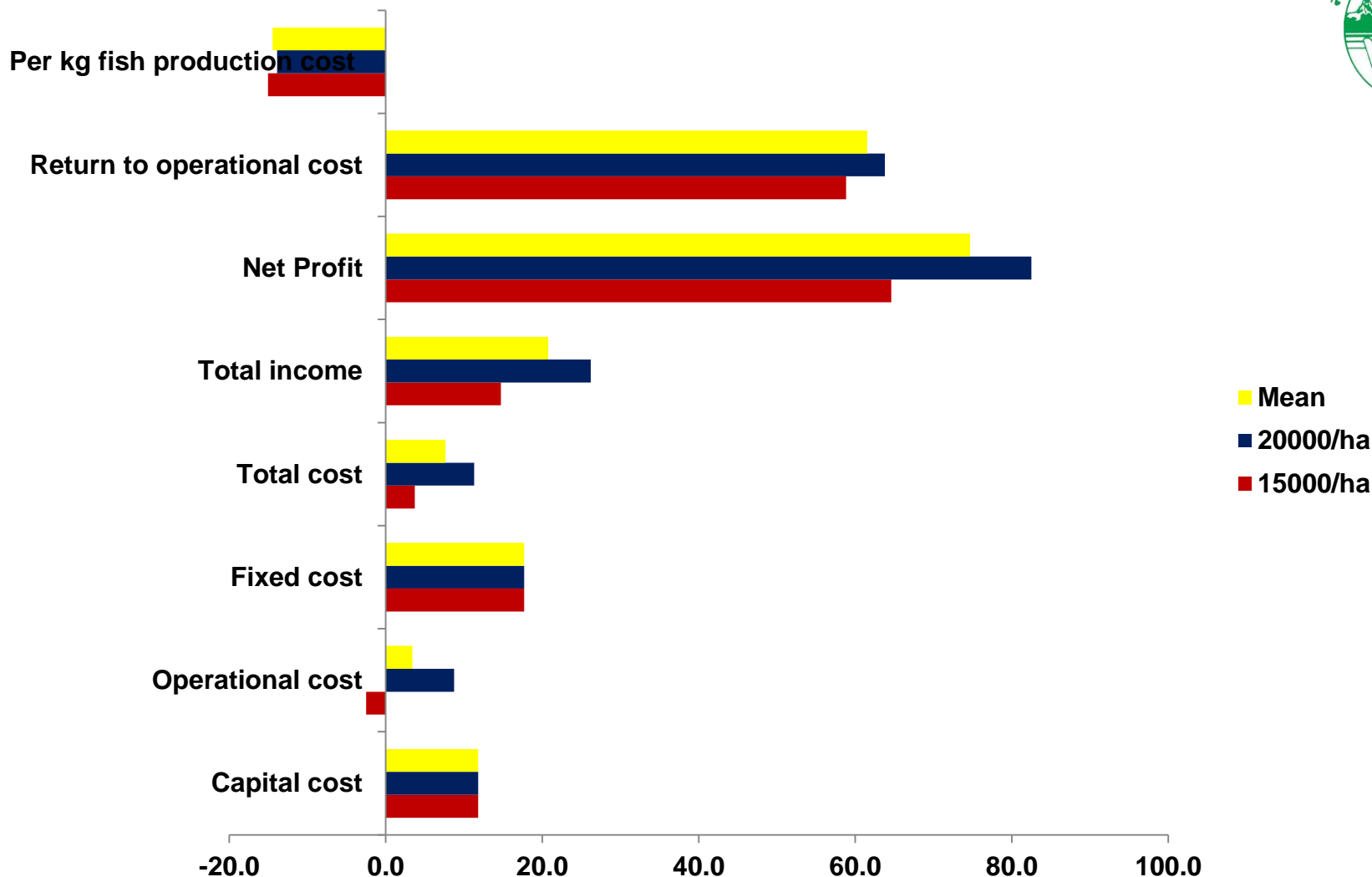




**Effect of the aeration as percent changes in fish production over the unaerated pond**

# Cost benefit of aeration

	Aeration		Control	
Fish density/ha	15000/ha	20000/ha	15000/ha	20000/ha
Capital cost, Rs	1230000	1230000	1100000	1100000
Operational cost, Rs	721397.4	893325.4	739970.5	821684.9
Fixed cost, Rs	386400.0	386400.0	328333.3	328333.3
Total cost, Rs	1107797.4	1279725.4	1068303.8	1150018.2
Fish Yield, kg/ha	7482.4	<b>9177.7</b>	6522.4	7272.9
Fish sale value, Rs	1496489.3	1835546.2	1304471.7	1454575.3
Net Profit	388691.9	<b>555820.9</b>	236167.9	304557.1
Return to capital cost, %	31.6	<b>45.2</b>	21.5	27.7
Return to operational cost, %	35.1	<b>43.4</b>	22.1	26.5
Per kg fish production cost, Rs	<b>96.4</b>	97.3	113.5	113.0



**Effect of the aeration as percent changes in cost benefit over the unaerated pond**



# Conclusion

- Paddle wheel aerator (0.75 KVA) was found effective to increase and distribute DO spatially and temporally in fish pond (0.1-0.2 ha) at level sufficient for fish survival and growth.
- Mechanical agitation of pond water has enhanced average fish growth (15.6%) and net yields (26.7%), and reduced FCR (14.8%) over the unaerated ponds.
- High profit and rate of returns estimated with higher fish density (20000/ha) in aerated pond in this experiment indicating that the need for further studies on the amount of aeration needed for a unit of pond with optimum fish biomass in order to secure maximum profitability.

**Thank You!**

# Spawning response of Sahar (*Tor putitora*) in different seasons under pond reared condition in Pokhara, Nepal



\*Jay Dev Bista<sup>1</sup>, Bharat Shrestha<sup>1</sup>, Ram Kumar Shrestha<sup>1</sup>,  
Surendra Prasad<sup>1</sup>, Agni Prasad Nepal<sup>1</sup>, Arun Prasad Baidya<sup>2</sup>,  
Suresh Kumar Wagle<sup>3</sup> and Tek Bahadur Gurung<sup>4</sup>

# Introduction

- Golden Sahar (*Tor putitora*) so called “mahseer” in India, one of well-known massive fresh water sport fish of mountainous rocky rivers and lakes of most trans-himalayan countries from Myanmar to Afganistan
- Two species of Sahar, *T. putitora* and *T. tor* are reported to inhabit Nepalese torrential waters and lakes of mid hills
- Due to over fishing and physical alterations of their surroundings, it is reported to be declining in their natural habitats.
- At present attempts to culture and conserve *Tor spp.* has been initiated in most of trans-himalayan countries
- In view of the conservation and food value, there has been a concerted effort on artificial propagation in captive condition and evaluation of aquaculture potential of this species.



# Objective

- To determine the breeding behavior, spawning season and proper striping time to assure **success spawning** of Sahar (*Tor putitora*) in captive condition.
- To establish mass scale seed production technology for biodiversity conservation and food security through ex-situ conservation approach.



# Materials and Methods

- Hundred female and 200 male brood fish were reared in 500 m<sup>2</sup> sized 4 earthen ponds.
- Brood fish were fed with 35% protein diets (Table 1). The feeding rate was 2-3% of total body weight.
- Female broods were checked at weekly intervals for maturity after hauling them by drag net at the bank of the ponds.
- The collected broods were partially anaesthetized in 50 mg/L Benzocaine solution and brood were examined by applying gentle hand pressure near the genital opening.
- No hormone injection was applied for spawning

## Contd..

- Females releasing ova on slightest pressure were transported in inside the hatchery where they were fully anaesthetized and stripped gently to receive eggs in clean and dry bowl.
- Milt from healthy males was directly mixed with eggs and mixed for dry fertilization.
- Incubation of eggs was took place in Aitkin's incubators by allowing one layer of eggs to settle on single mesh screen in flow through system, where water flow was maintained 5-6 liters/minute.
- Early hatched larvae possessed a large yolk sac and settled down in the corners of the incubation trays.

**Contd..**

## **Brood management in pond**

<b>Description</b>	<b>Pond 1</b>	<b>Pond 2</b>	<b>Pond 3</b>	<b>Pond 4</b>
Area (m <sup>3</sup> )	500	500	500	500
Stocking No	25 female	25 female	50 female	200 male
Feeding rate (of BW)	2-3%	2-3%	2-3%	2-3%
pH	7.0-9	7.0-9	7.0-9	7.0-9
DO (mg/L)	5.0-9	5.0-9	5.0-9	5.0-9
Temperature <sup>0</sup> C	12.5-32	12.5-32	12.5-32	12.5-32
Depth (cm)	70-90	70-90	70-90	70-90
Transparency (cm)	30-50	30-50	30-50	30-50



## Proximate Composition of pellet feed for sahar brood

S.N	Description	%
1	Crude Protein	35
2	Crude Fat	9
3	Ash	7
4	Fiber	8
5	NFEE*	31
6	Moisture	10

\* Nitrogen free ether extract

Daily feed was supplied to the brood at 2-3% of their body weight.

## Results and Discussion

### Spawning performance of Sahar during 2013

	Feb-Mar 2013	Sept-Nov 2013
Female, No.	100	100
Responded female, No. (%)	60 (60%)	28 (28%)
Normally spawned brood (%)	42 (42%)	6 (6%)
Over matured (%)	18 (18%)	22 (42%)
No response (%)	40 (40%)	72 (72%)
Post spawning mortality (%)	0%	0%

# Results and Discussion

## Spawning performance of Sahar during 2014

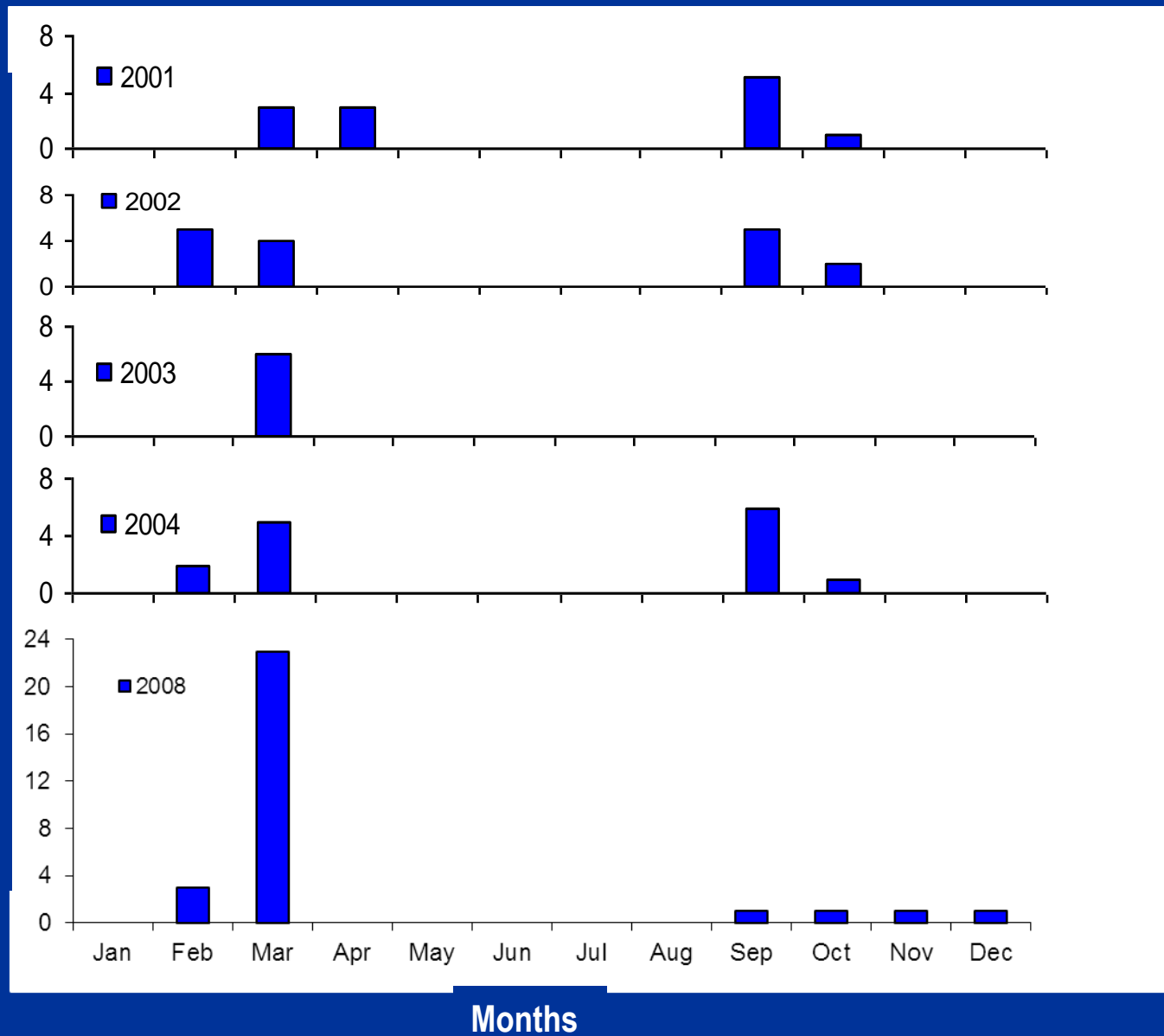
	Feb-Mar 2014	Sept-Nov 2014
Female, No.	100	100
Responded female, No. (%)	72 (72%)	3 (3%)
Normally spawned brood (%)	57 (57%)	0 (0%)
Over matured (%)	15 (15%)	3 (3%)
No response (%)	28 (28%)	97 (97%)
Post spawning mortality (%)	0%	0%

# Mean diameter of ovulated eggs, fertilized eggs and size of newly hatched larvae and yolk-sac absorbed larvae (mm)

<b>Female Body wt. (g)</b>	<b>Diameter of ovulated eggs</b>	<b>Diameter of fertilized eggs</b>	<b>Size of newly hatched larvae</b>	<b>Size of free swimming larvae</b>
2.32	2.27±0.17	2.88±0.12	10.52±0.56	11.81±0.20
3.95	2.58±0.29	2.87±0.13	10.37±0.27	11.46±0.27
3.35	2.41±0.11	2.87±0.13	10.14±0.23	12.00±0.21
2.95	2.28±0.13	2.96±0.08	10.16±0.17	11.98±0.38
3.50	2.53±0.18	2.98±0.08	10.24±0.29	11.77±0.22

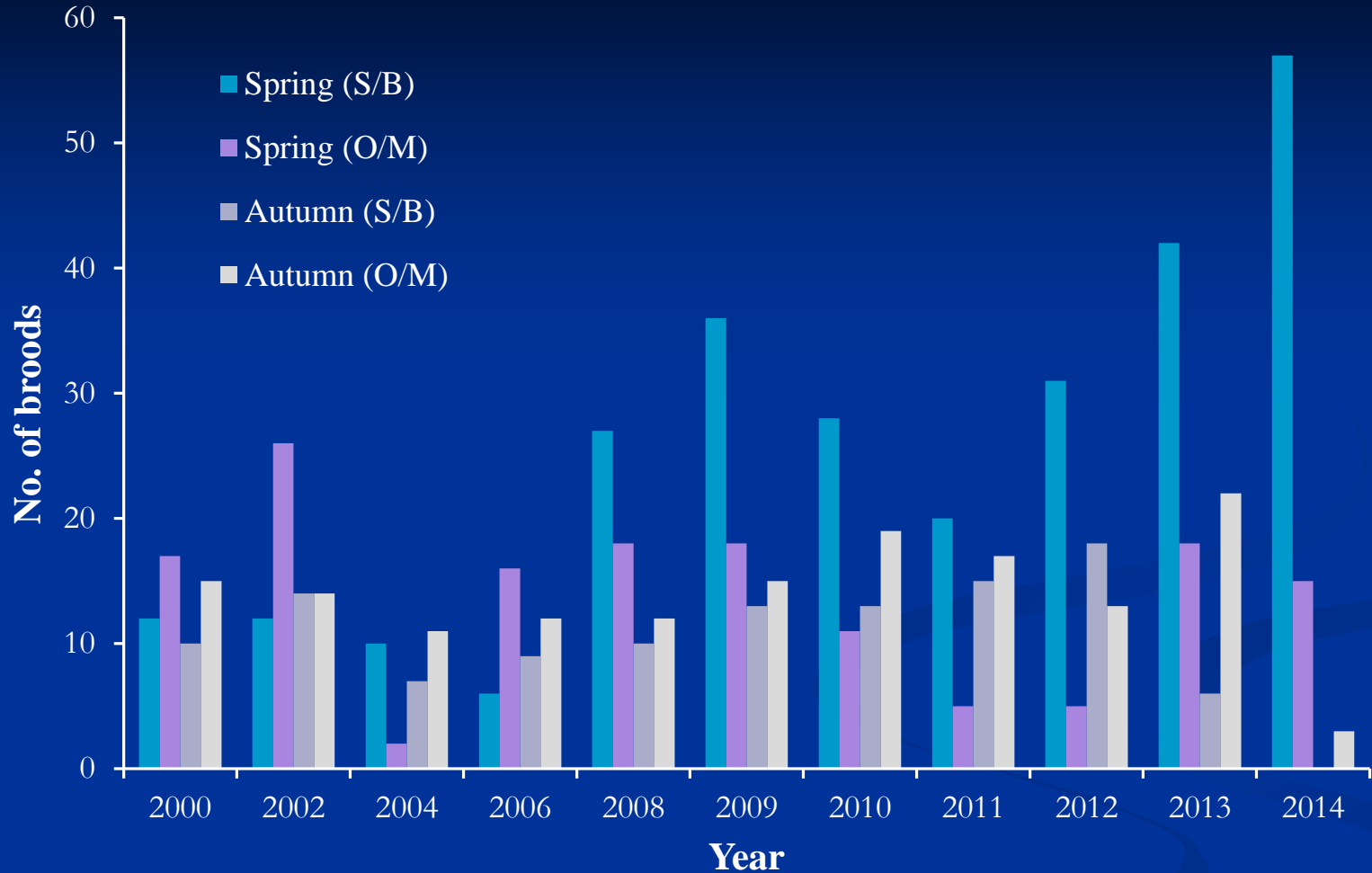


Female Sahar responded to spawning (individual)



Response of Sahar in different months

## Results and Discussion ...



**Spawning behavior of Sahar in spring and autumn season in last few years**

## Results and Discussion ...



# Hatchery Operation



## Sahar (*Tor putitora*) Mass Scale Breeding

Breeding and nursing technology developed

**Fecundity:** ~8000 eggs/kg

**Fecundity:** 90-100 eggs/g

**Hatchability:** 75-95%.

**Fertility:** 80-90 %



# Sahar (*Tor putitora*) in fisheries and aquaculture



Sahar (*Tor putitora*)  
in cage culture



In pond culture



River fisheries

# Conclusion

- Female brood get maturity at the age of 3<sup>+</sup> years (> 700 g) and male at 1 year ( 50-100 g).
- Almost all Pond reared Sahar breed twice in a year in two distinct season (spring and autumn) and most of the females were gained maturity in both season
- The study concluded that most of the Sahar breed during February-March (spring season) than September-October (autumn) under cultured condition.
- The mature broods get over maturity within very short time (1-2 days)
- This study also suggests that higher spawning rate can be achieved by frequent checking of brood fish in every 1-2 days interval for ovulation.
- Sahar *Tor putitora* is now no more endangered/threatened as listed in Red list of IUCN after getting success in mass scale seed production.

# Acknowledgement

- NARC
- NEFIS





# Thanks





# **Cost-benefit analysis of rainbow trout commercial farms: A case study of Kaski District, Western Development Region, Nepal**



Agni Prasad Nepal, Subodh Sharma, Jay Dev Bista,  
Surendra Prasad, Tek Bahadur Gurung, Suresh Kumar Wagle

# Background

## Need of trout farming in Nepal

- Rainbow trout (*Oncorhynchus mykiss*) a cold water fish, suitable to grow commercially by using enormous cold-water resources for aquaculture
- encourage people to produce high quality protein diet and provide an attractive income and employment opportunity
- promotion of fishing tourism in hill streams
- import substitution of high valued fisheries commodities





- Rainbow trout re-introduced in Nepal :
- 50000 eggs of trout received from Japan (Miyazaki Prefecture) in 1988
- 30000 trout eggs were received 2nd time from Japan in 2000 [two strains]



# Development of Technological Package

- Technological packages of trout farming in prevailing ecological condition have been developed by NARC (10 years research at):
  - Fisheries Research Division, Godawari
  - Fisheries Research Centre, Trishuli
- Research thrusts given were:
  - Breeding & seed production
  - Nutrition & feed management
  - Raceway design – utilization of marginal steep land
  - Fish health management
  - Marketing and value chain
  - Participatory uptake of the technology



# Beginning of trout fish farming in private sector

- Trout farming technology was successfully verified in farmer's field in 1998.
- Increasing demand for technology and technical assistance (with production input management).
- Present trout farming, spread over 22 mid-hill and mountainous districts.



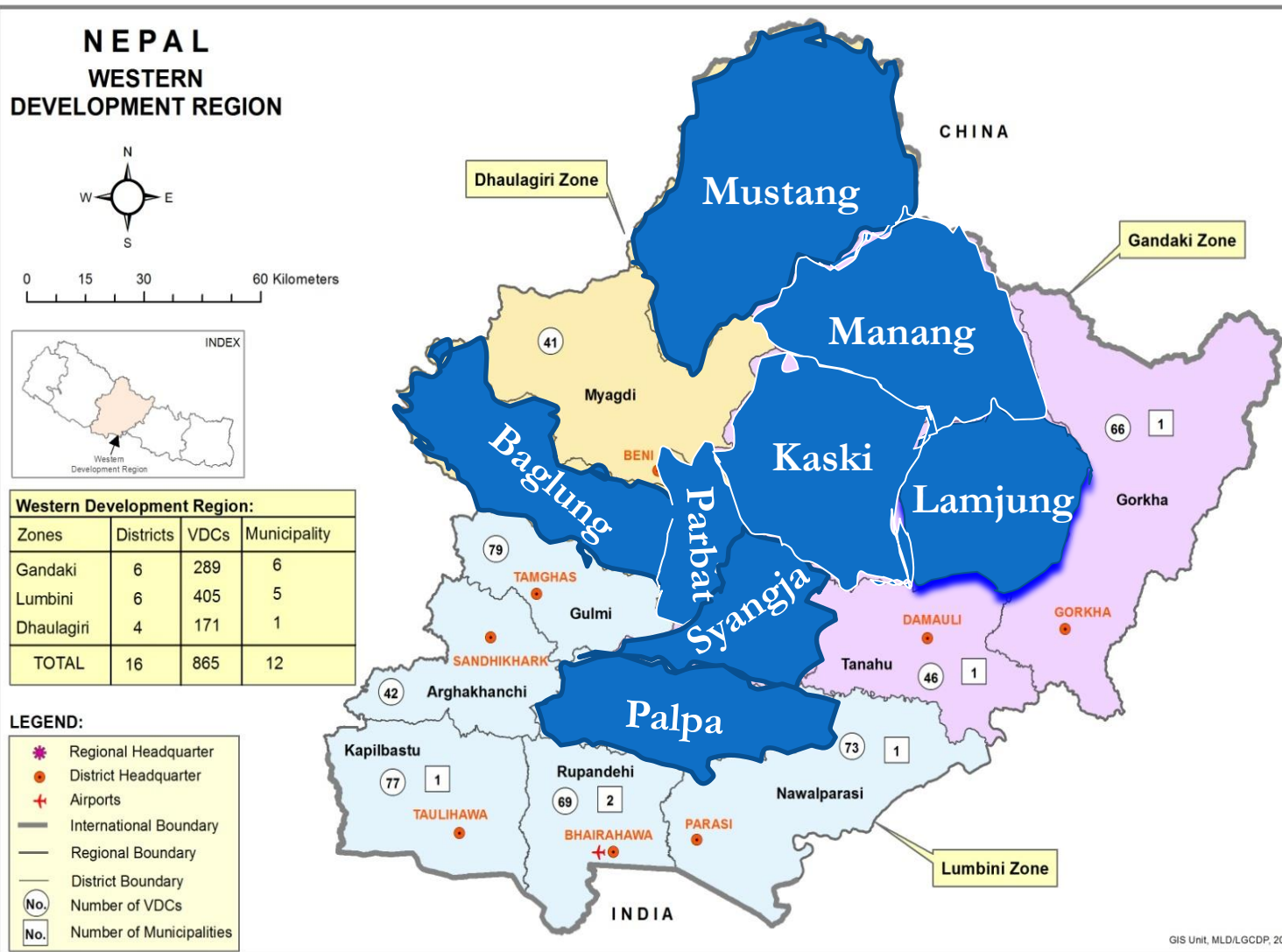
# Expansion of trout fish farming to private sector in WDR

- Trout farming technology was successfully verified and adapted in farmer's field in 2010, in Kaski district.
- Now, increasing number of farmers have shown interest to adopt trout farming in Western Dev Region.
- By the end of year 2014, all together 16 trout farms in 8 districts of WDR,
- Estimated to produce 100 mt trout in 2015 from about 7600 m<sup>2</sup>



# Trout farming districts in WDR

- Mustang
- Manang
- Lamjung
- Kaski
- Baglung
- Parbat
- Syangja
- Palpa





# Objective

- To present a cost-benefit analysis of commercial farms of Kaski District.



# Methodology

- Case study of two commercial farms in Kaski in December 2014
- Gandaki Rainbow Trout Farm having - 1400 m<sup>2</sup> (40 raceways)
- Chhetradip Annapurna Trout Fish Research and Development Pvt. Ltd having 1900 m<sup>2</sup> - (68 raceways)
- Analysis was based on feed efficiency, feed conversion ratio (FCR) and data recorded for annual operational costs expended to produce average marketable size (200 g) fish in each farm.
- Both farms supplied locally prepared 35% Crude Protein containing pellet feed with similar ingredients

# Methodology

- Cost analysis
  - Capital cost
  - Operational cost
    - Variable costs
    - Fixed costs
- Opportunity cost such as land, family labour and interest on Operational cost has not included,
- Interest on bank loan and bank payback installment has been included
- Selling price/kg (NPR) 700 in both farms

# Detail of two commercial farms

## 1. Gandaki Rainbow Trout Farm

- Established: 2067 BS
- Address: Bhurjung Khola, Mulkhet, Sardikhola VDC-3, Kaski
- Farm Owner: Lachhin/Amrit Gurung
- Ownership type: Company Register
- Total Area of the farm: 2 ha. (40 R)
- Water Source: Bhurjung Khola and Spring Water inside Farm
- Water volume: 50-100 L/s
- Water Temp: 13-19 °C
- Permanent/regular staff - 7 (3)



## Detail of two commercial farms

### 2. Chhetradip Annapurna Trout Fish Res. & Dev Pvt. Ltd

- Established: 2069 BS
- Address: Sardikhola, Sardikhola VDC-7, Kaski
- Farm Owner: Indra Gauchhan/  
Krishna Gautam
- Ownership type: Company Register
- Total Area of the farm: 4.4 ha. (88 R)
- Water Source: Sardi Khola (Glacier)
- Water volume: Ample
- Water Temp: 8-21 °C
- Permanent/regular staff - 15 (4)





# Results

- According to the farmers record;
  - to reach marketable size of about 200 g individual body weight from free swimming larvae, it takes 9-10 months in Gandaki Farm, where as 12-13 months in Chhetradip Farm.
  - To produce one kilogram of trou, it costs ;
  - Gandaki Farm - NPR 520.02 and
  - Chhetradip Farm - NPR 504.13 respectively.

## Results .....

### Feed efficiency and FCR

<u>Results</u>	<u>Gandaki Farm</u>	<u>Chhetradip Farm</u>
FE	45.7%	40.0%
FCR	1: 2.2	1: 2.5
Productivity /m <sup>2</sup>	11.43	12.63
Production cost/m <sup>2</sup> (NPR)	5871	6240

The rate of return on operational cost :

35.82 %

40.86 %

## Results .....

- RR on operational cost is significantly higher ( $P > 0.05$ ) at Chhetradip Farm comparing to Gandaki Farm.

## Conclusion on the basis of Results

- The higher Rate of Return in Chhetradip farm might be related to the magnitude of scale of operation.
- The present study suggested that the higher rate of return can be expected from those commercial farms having higher scale of operation.



# Acknowledgement

Gandaki Rainbow Trout Farm

Chhetradip Annapurna Trout R & D Pvt Ltd

NARC



# PROBLEM ASSESSMENT OF RED-BLOOMED FISHPOND IN CHITWAN DISTRICT



**Ram Bhajan Mandal and Narayan Prasad Pandit**  
Institute of Agriculture and Animal Science (IAAS),  
Paklihawa Campus, Rupendehi, Nepal

# Introduction

Red-blooming in fishpond has becoming a common problem in Nepal.

The red-bloom concentrate as a scum at the water surface, which gives unpleasant look, inhibit photosynthesis and cause water quality problems such as depletion of dissolved oxygen, and low fertilizer response of green-algae.

Ponds with high organic load and ponds built in swampy land are more often seen with this problem.

The prevalence of red blooming in fish pond, its causative agent and its effect in fish growth and production in Nepal are not understood.



Farmers generally believe that red blooming has adverse effect on fish such as low fish production, oxygen depletion and fish mortality.



Red-blooming is a challenging issue for management and mitigation for aquaculture and fisheries ?



# Objectives

To find the prevalence of red blooming in fishpond in Chitwan district

To monitor the water quality of red bloomed fish pond.

# Materials and Methods

This research has two major parts:

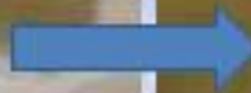
## **(A) Survey of red blooming ponds (seasonally monitoring )**

- Water source and pond management characteristics
- Seasonal variation of red bloom in fishpond
- Effect of red blooming on fish growth and production
- Control measures of red blooming.

## (B) Water quality monitoring (seasonally)

- Total nitrogen
- Total phosphorus
- Total alkalinity
- Chlorophyll-a
- Temperature
- Dissolved oxygen
- pH
- Planktons

## Day time fluctuation of red blooming















# Results

## (A) Major findings of survey

Severe red-blooming fishponds was observed in the Southern part of Chitwan compared to other parts, where water was more stagnant, undrainable and came from under-ground source.

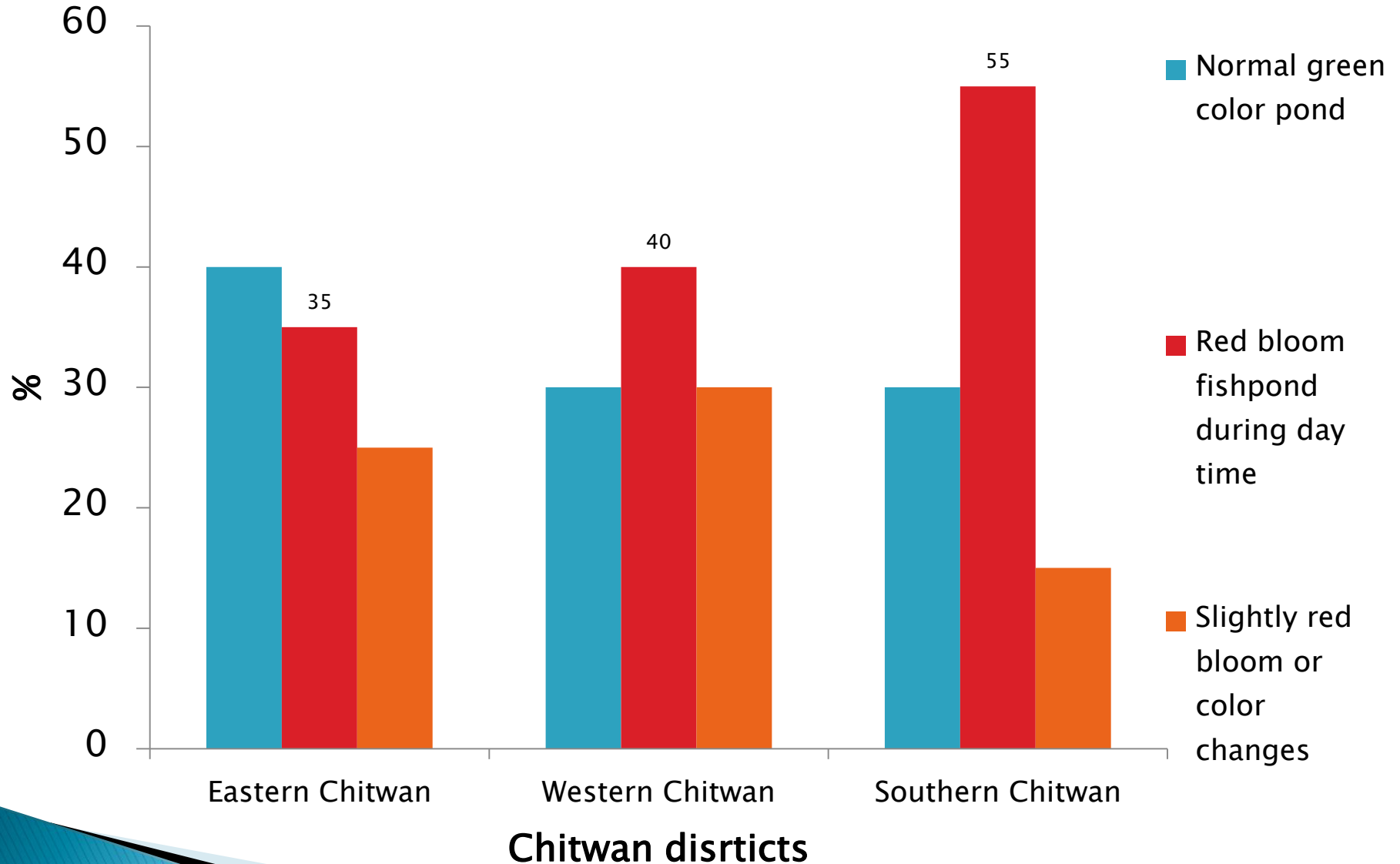
Pond water color changes during day time in eastern part where less affected and constant red color morning to evening in southern part where red bloom 45 % in all season.



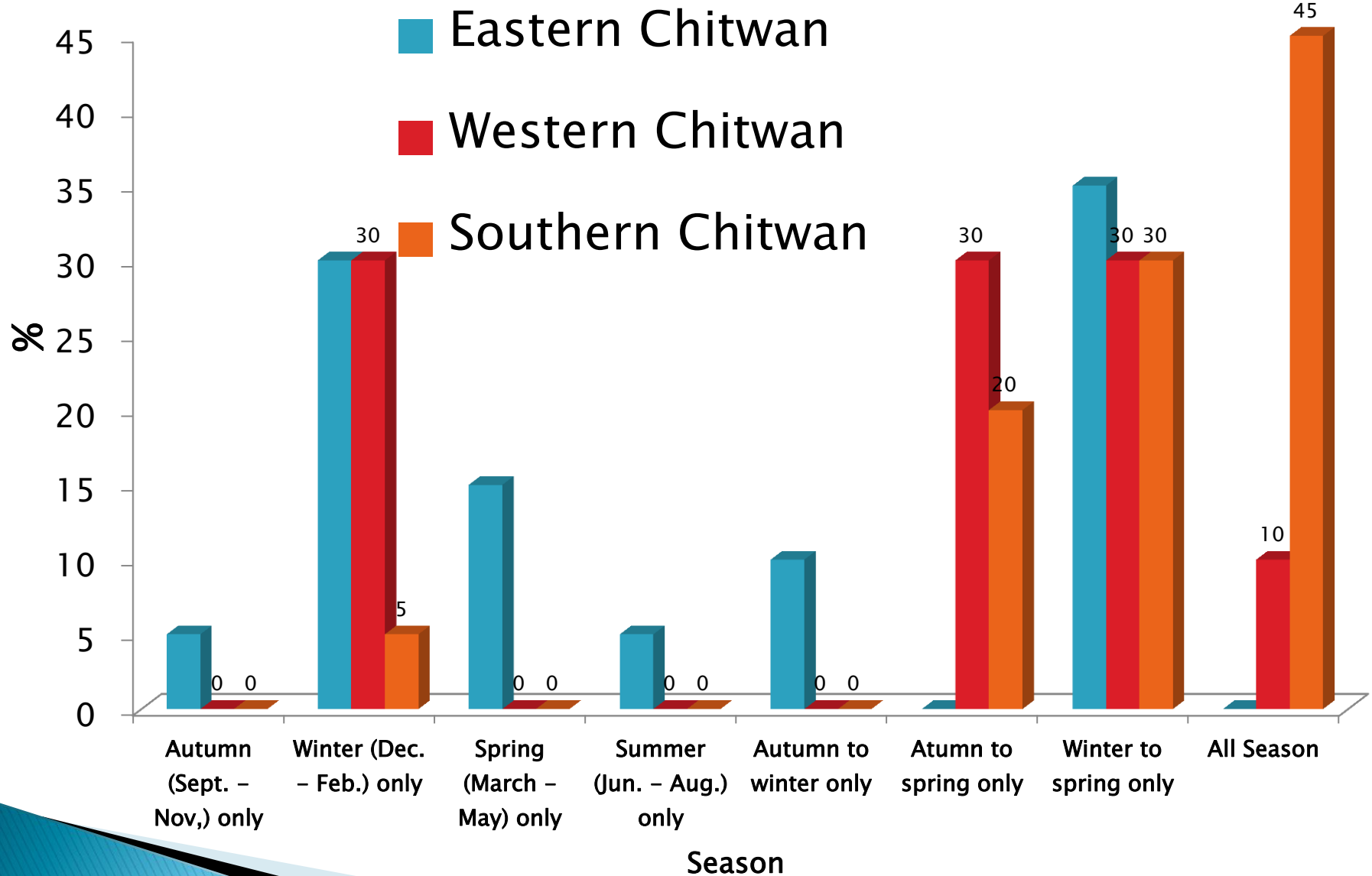
# Field survey red-bloom fishpond of three different regions of Chitwan district

Region	Eastern Chitwan	Western Chitwan	Southern Chitwan
Particular	%	%	%
<b>Water filling ?</b>			
Daily	10	5	0
Monthly	40	20	20
Seasonally	20	30	20
When needed	40	55	60
<b>Water source?</b>			
River	70	15	20
Ground recharge water	5	70	70
Rain and ground pump source	25	15	10
<b>Pond water color?</b>			
Normal green color pond	40	30	30
Slightly red bloom or color changes	25	30	15
Red bloom fishpond during day time	35	40	55
<b>More red blooming fishpond ?</b>			
New pond ( < than three years pond)	10	10	10
Old pond (> than three years pond)	30	20	20
Drainable pond	5	5	0
Un-drainable pond	30	30	30
Organic fertilizing pond	5	5	0
In-organic fertilizing pond	20	30	30
<b>Problem due to red-blooming ?</b>			
DO depletion	30	25	20
Low fish production	20	25	20
High fish production	5	0	0
No change or moderate fish production	45	50	55
<b>Positive effect of red-blooming ?</b>			
Increase fish production	5	0	0
Improve water quality	0	0	0
Food for fishes	30	30	25
Fish mortality	20	30	40
No change	45	40	55
<b>How do you control red-blooming ?</b>			
Inorganic fertilizing	10	0	10
Organic fertilizing pond	10	0	10
Water exchange	30	30	25
Contineous water filling	40	30	25
No idea	10	40	30

# Characteristic features of pond water in Chitwan district



# Characteristic features of Red-bloomed fish pond



## (B) Water quality

Water quality analysis showed that the total phosphorous and total nitrogen contents were significantly higher in red-bloomed fishpond than less red-bloom or normal fishpond.

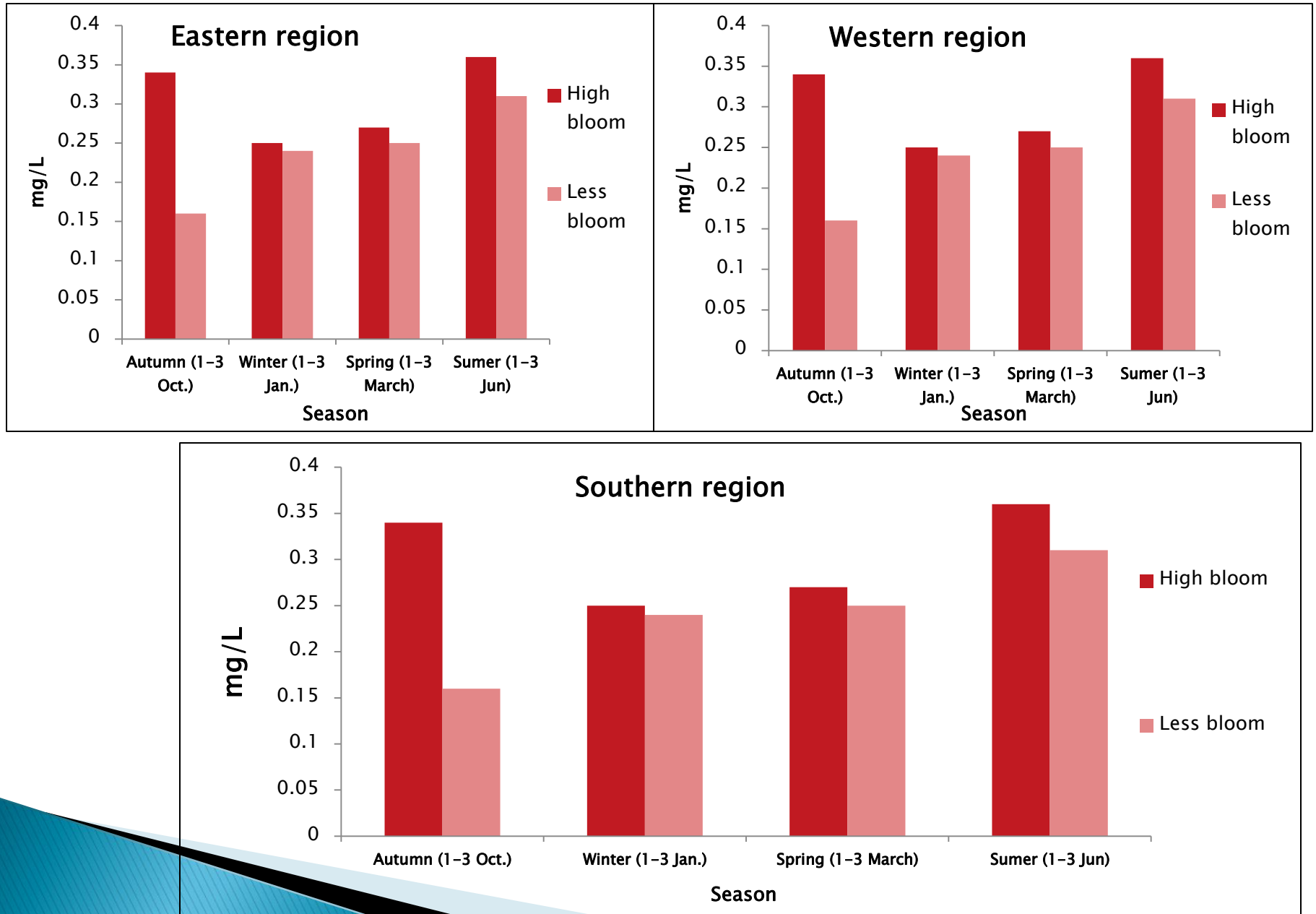
In red-bloomed fishpond, the red algae *Euglena sanguinea* dominated over other phytoplankton species.

The present study showed that the red-blooming in fishpond might be caused by the red algae *Euglena sanguinea*, which is more common in organic-loaded and stagnant water.



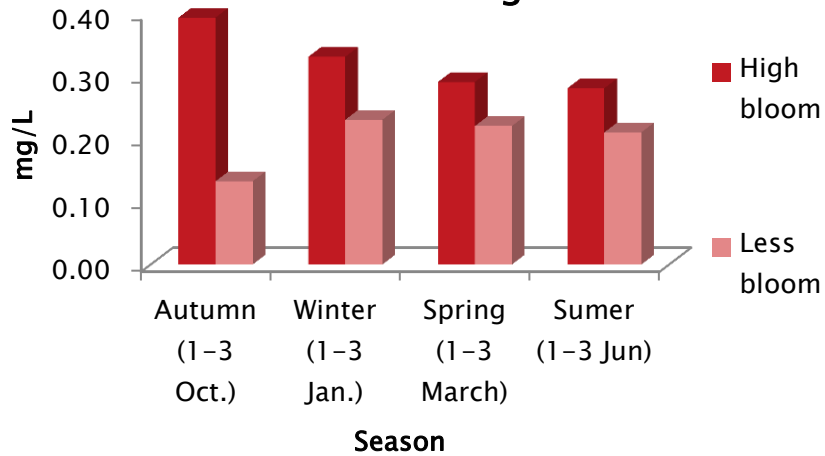
Region/Parameter	Autumn (1-3 Oct.)	Winter (1-3 Jan.)	Spring (1-3 March)	Sumer (1-3 Jun)
<b>Eastern Chitwan</b>				
Total nitrogen (mg/L)	0.28±0.03	0.28±0.02	0.29±0.03	0.31±0.04
Total alkanity (mg/L)	85.65±4.05	88.15±0.65	82.25±5.35	101.20±2.50
Chlorophyll-a (mg/m3)	45.85±3.05	46.35±1.55	46.55±0.05	45.15±0.55
Total phosphorus (mg/L)	0.180±0.00	0.230 ±0.01	0.200±0.01	0.190±0.01
Temprature (0C)	30.35±0.15	20.10±0.20	25.00±0.10	34.40±0.10
DO (mg/L)	5.25±0.15	6.10±0.00	7.35±0.15	7.35±0.05
pH	5.6	6.4	7.7	7.7
<b>Westen Chitwan</b>				
Total nitrogen (mg/L)	0.20±0.08	0.30±0.02	0.31±0.02	0.33±0.02
Total alkanity (mg/L)	84.60±15.3	101.40±22.5	129.85±25.6	126.30±19.4
Chlorophyll-a (mg/m3)	112.25±77.6	106.35±70.6	101.80±63.9	96.45±59.2
Total phosphorus (mg/L)	0.40±0.22	0.38±0.16	0.38±0.15	0.37±0.14
Temprature (0C)	31.10±0.01	21.20±0.00	23.85±0.05	35.40±0.04
DO (mg/L)	7.80±0.60	7.75±0.45	8.20±0.10	7.70±0.60
pH	7.5	7.6	8.3	8.1
<b>Southern Chitwan</b>				
Total nitrogen (mg/L)	0.25±0.09	0.245±0.05	0.26±0.01	0.335±0.03
Total alkanity (mg/L)	112.25±16.2	116.90±18.0	118.00±15.04	121.70±15.0
Chlorophyll-a (mg/m3)	50.75±21.4	48.45±17.3	47.15±11.6	43.55±11.0
Total phosphorus (mg/L)	0.26±0.13	0.28±0.05	0.26±0.04	0.25±0.04
Temprature (0C)	30.70±0.40	21.70±0.10	23.95±0.15	36.10±0.10
DO (mg/L)	5.45±0.05	7.20±0.50	7.25±0.45	7.65±0.15
pH	7.4	7.7	7.8	8.4

# Total Nitrogen mg/L

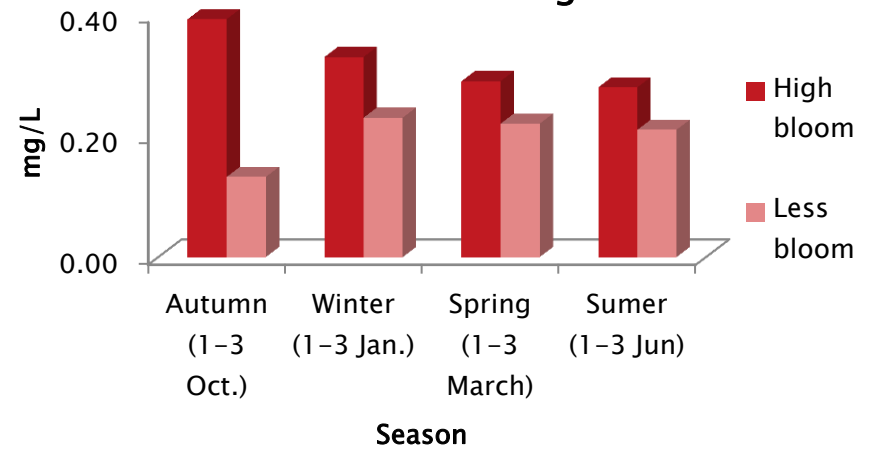


# Total phosphorus mg/L

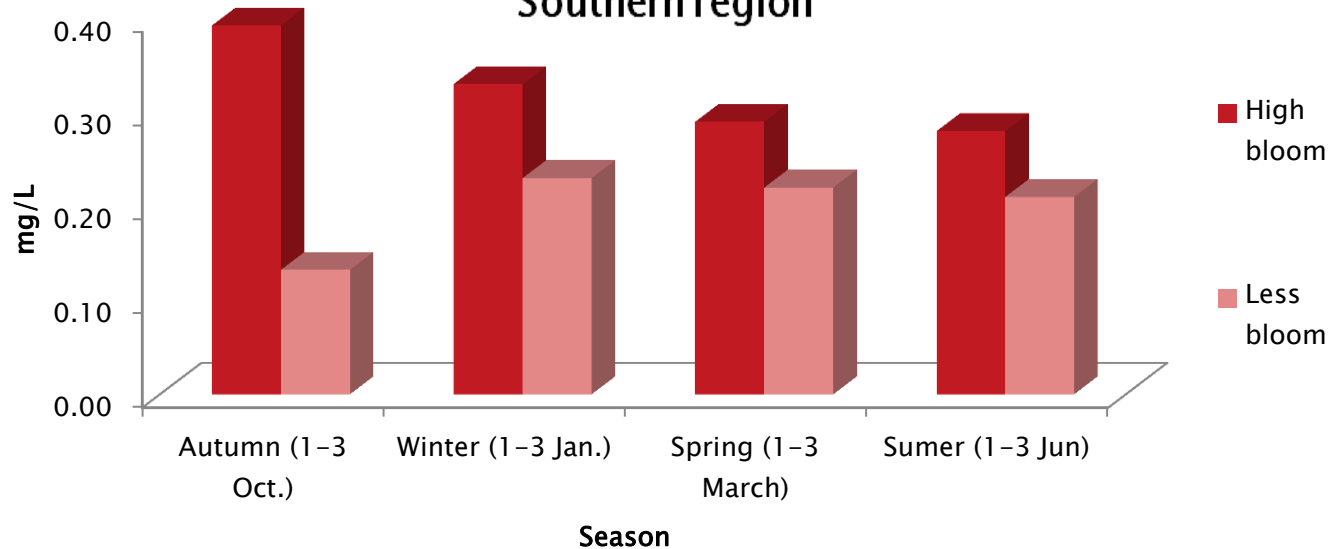
## Eastern region



## Western region



## Southern region



# Seasonal abundance of Phytoplanktons in red-bloom fishpond Chitwan district

Absent (-), 1-10 N/L low (+), 40-50N/L medium (++), over 100 N/L highest (++++)

Region/Parameter	Autumn (1–3 Oct.)	Winter (1–3 Jan.)	Spring (1–3 March)	Sumer (1–3 Jun)
<b>Eastern Chitwan</b>				
Euglena sanguinea	+++	+++	+++	+++
Euglena proxima	+	+	+	+
Glenoidinum quadridens	++	++	++	+
Chorococus schizodernatius		++	+	+
Ankistrodemus facatus	+	+	+	+
Desmodesmids				
Crucigenea tetrapedie	+	+	+	+
<b>Westen Chitwan</b>				
Euglena sanguinea	+++	+++	+++	+++
Euglena proxima	-	-	-	-
Euglena rostrifera	++	++	+	+
Glenoidinum quadridens	++	++	+	+
Desmodesmids	++	++	+	+
Crucigenea tetrapedie	+	+	+	+
Oscillatoria sps.	++	+	+	+
Navicula sps.	++	+	+	+
Actinastrum sps.	++	++	+	+
Spheroecystis schroetri	++	+	+	+
Selenastrum gracile	++	+	+	+
Sencilla estrella	+	+	+	+
Scenedesmus dimorphus	+	++	+	++
Merisopedia glance	++	+	+	+
Chlamydomonus sps.	+	+	+	+
<b>Southern Chitwan</b>				
Euglena sanguinea	+++	+++	+++	+++
Euglena proxima	+	+	++	++
Euglena polymorpha	-	-	-	-
Glenoidinum quadridens	++	++	++	++
Chorococus schizodernatius	+	+	+	++
Ankistrodemus facatus	+	+	+	+
Desmodesmids	+	+	+	+
Crucigenea tetrapedie	+	+	+	+
Spheroecystis schroetri	+	+	+	+
Selenastrum gracile	+	+	+	++
Sencilla estrella	+	+	+	++



## Conclusion

Following conclusions were made from the present study

About 35% ponds of eastern, 40% western and 55% of western region of Chitwan districts have the red blooming problem.

Southern Part of Chitwan has more problem of red blooming.

The *Euglena sanguinea* is the causative agent of red blooming.

The total phosphorous and total nitrogen contents were significantly higher in red-bloomed fishpond than less red bloom or normal fishpond.


Red blooming is more common in organic-loaded and stagnant water.

## Future Research

Further research are needed:

To assess the effect of red blooming in fishpond.

To find the control measure of red blooming in fishpond.

A photograph of a person in a red shirt and grey pants bending over a small pond in a rural setting. In the background, there is a thatched hut and lush greenery. The text "Thank you very much for your attention!!!" is overlaid on the image.

Thank you very much  
for your attention!!!

# **DNA marker based genetic variation of *Labeo rohita* populations from hatcheries and river of Nepal**




Neeta Pradhan, Suresh K. Wagle, Jitendra Maherjan,  
Suraj Sapkota & Ram Rokka



# INTRODUCTION

- Rohu, *Labeo rohita* is a major indigenous aquaculture fish species of Nepal. It is a commercially important fast growing fish, famous for good taste.
- Both private and public fish hatcheries are using captive population of the species for seed production.
- Most of the hatcheries rear their own brood stock and usually do not recruit individuals from riverine source or exchange brood fish among them.
- Therefore each hatchery can be considered as an isolated, self sustaining and genetically closed unit.

- In Nepal carps are bred repeatedly in the hatchery with a limited number of effective parents ( $N_e$ ) to keep the production costs to a minimum.
- As a result genetic erosion may have occurred through inbreeding, genetic drift and the bottleneck effects.
- Retarded growth, poor reproductive performance, morphological deformities and diseases of hatchery seeds have been frequently reported by the farmers.
- The polyculture technologies so far developed are based on species manipulation and application of certain management practices.
- These technologies, no doubt have boosted the fish culture in Nepal several folds.
- However at present it was felt that any more improvement in fish production may not be possible with these technologies.

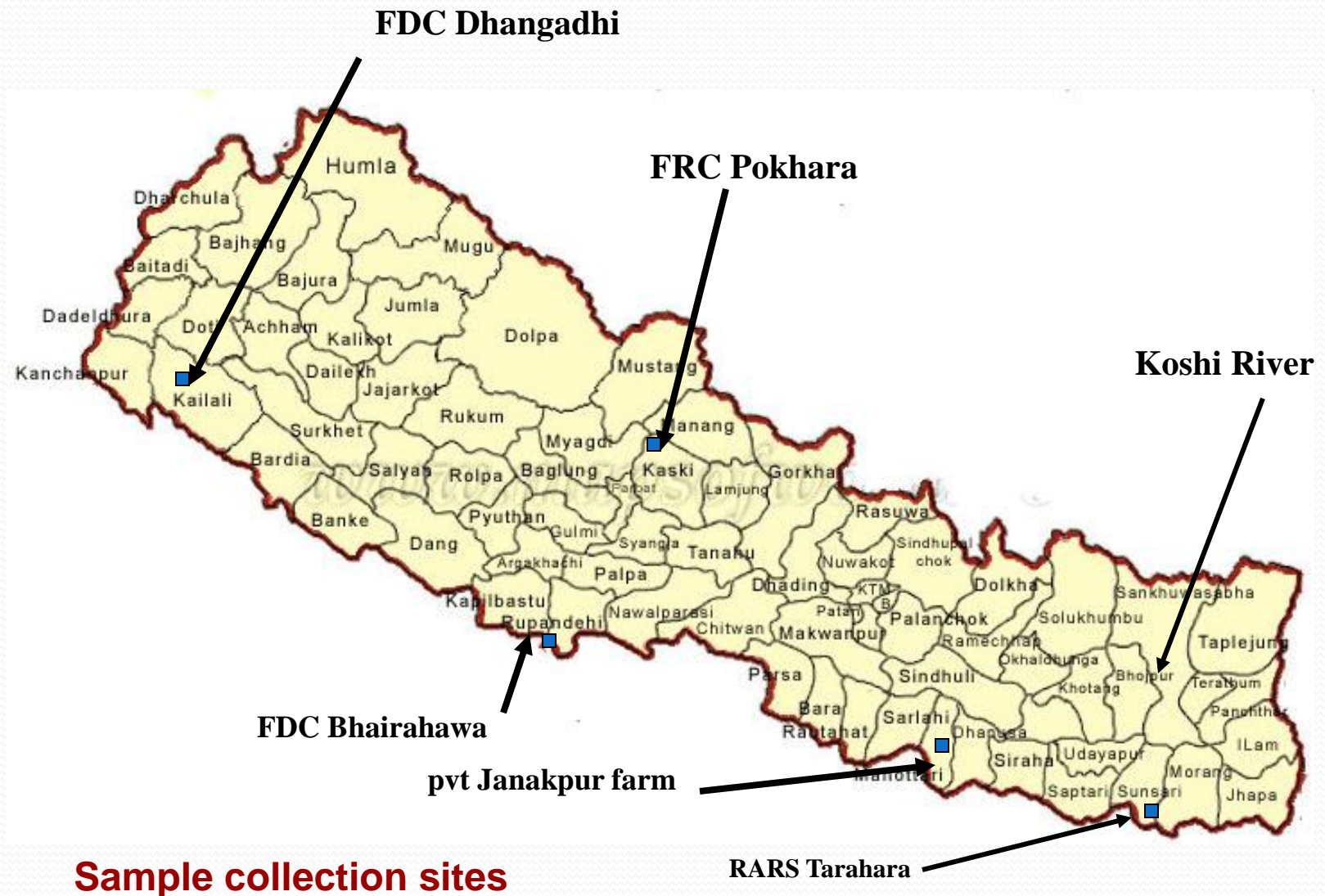
- 
- It need to exploit genetic potentiality of fish.
  - There are a number of options for genetic improvement : selection, intra and interspecies breeding, chromosome manipulation.
  - Selective breeding in aqualture species has been very successful.
  - Bur for selective breeding identification of populations or strains with superior characteristics is one of the most critical steps.
  - Identification of pure stock and Genetic characterization of fish species are essential to establish base population for genetic improvement of fish species.

# OBJECTIVE

This study aims to quantify the magnitude of genetic variability of *Labeo rohita* using molecular marker (microsatellite DNA) to establish foundation population for initiating selective breeding program.

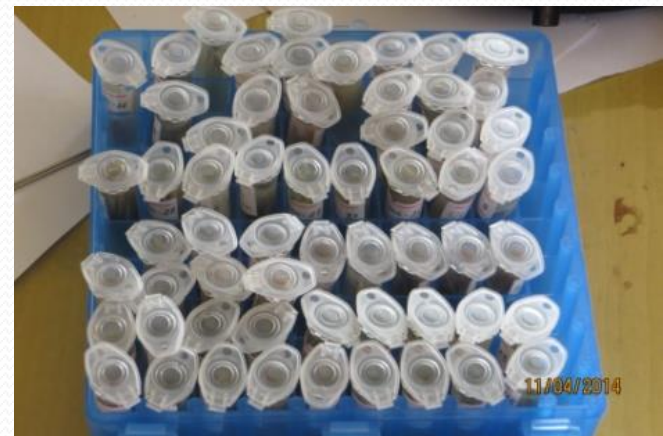


# MATERIALS AND METHODS



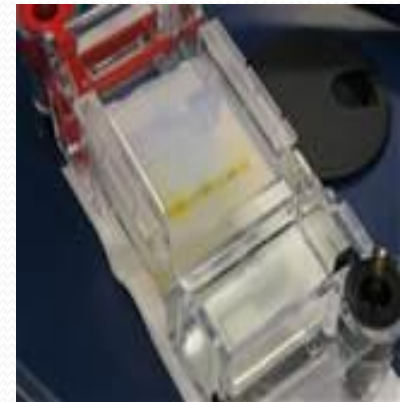
### Sample collection

- Total number of sample : 397
- Samples were preserved in 90% ethanol and transported to laboratory at FRD, Godawari.
- Samples were stored at  $-40^{\circ}\text{C}$  in the laboratory until analysis.
- DNA was extracted following standard procedures (Tagard *et al.*, 1992).



## PCR and agarose electrophoresis

- Twelve polymorphic markers developed from *Labeo rohita*: *Lr1*, *Lr3*, *Lr6*, *Lr10*, *Lr12*, *Lr14a*, *Lr14b*, *Lr20*, *Lr21*, *Lr23*, *Lr24* and *Lr26* were used.
- PCR amplifications were performed using a program with 40 cycles on Thermocycler (MyGene™).
- PCR product from each sample was separated electrophoretically on 2% (w/v) agarose gel containing ethidium bromide in 1x TBE buffer at 250 V for 2 hours.



# Agarose gel electrophoresis



Figure . PCR Product Example of DNA Microsatellite *Lr1* and *Lr21* Locus by 1.5% Agarose Gel Electrophoresis. M: Marker 100 bp; Line B29-K-24: Sample number

Individual genotypes were used for the calculation of allele frequencies, percentage of polymorphic loci, average and effective number of allele per locus, observed and expected heterozygosity (Nei, 1978).



# Data analyses

- Genetic variability was assessed using POPGENE32 software (3.2).
- Differences in heterozygosity between populations were tested using independent sample comparisons (Archie, 1985).
- The program TFPGA was used to calculate F-statistics, deviation from HWE and genetic distance.
- All the results were adjusted for multiple simultaneous comparisons using a sequential Bonferroni correction (Rice, 1989).

# Result

**Table 1.** Allele frequencies of six polymorphic loci in six populations of rohu from river and hatchery of Nepal

Locus	Allele	Pokhara hatchery	Tarahara hatchery	Dhangadhi hatchery	Bhairahawa hatchery	Janakpur hatchery	Koshi River
<i>Lr-1</i>	A	0.4412	-	-	-	0.0286	-
	B	0.5294	0.9750	0.4688	0.2000	0.0286	0.7220
	C	0.0294	0.0250	0.2969	0.6571	0.2857	0.2778
	D	-	-	0.2344	0.1429	0.0286	-
	E	-	-	-	-	-	-
<i>Lr-3</i>	A	-	-	-	0.0526	-	0.3056
	B	0.0286	0.0972	0.0750	0.4476	-	0.0833
	C	0.2571	0.8889	0.6250	0.5000	0.8788	0.4444
	D	0.6857	0.0139	0.3000	-	0.1212	0.1667
	E	0.0286	-	-	-	-	-
<i>Lr-10</i>	A	-	-	0.0476	-	-	-
	B	0.8824	0.9706	0.6190	0.8378	1.00	0.5000
	C	0.1176	0.0294	0.2381	0.1351	-	0.3421
	D	-	-	0.0952	0.0270	-	0.1579
	E	-	-	-	-	-	-
<i>Lr-14b</i>	A	-	0.1538	-	0.0811	-	-
	B	0.4062	0.5128	1.00	0.4459	0.2821	-
	C	0.5938	0.3333	-	0.4730	0.7179	1.00
	D	-	-	-	-	-	-
	E	-	-	-	-	-	-
<i>Lr-21</i>	A	-	-	0.0263	0.0385	0.1625	-
	B	0.5250	0.0256	0.0526	0.2179	0.1375	0.1429
	C	0.4125	0.6154	0.4474	0.6154	0.4125	0.4762
	D	0.0625	0.3590	0.4737	0.1282	0.2750	0.3333
	E	-	-	-	-	0.0125	0.0476
<i>Lr-24</i>	A	0.1622	0.2250	0.0811	0.1053	-	-
	B	0.4054	0.3375	0.3784	0.2105	0.0658	0.2105
	C	0.4324	0.4375	0.5270	0.6842	0.5658	0.6053
	D	-	-	0.0135	-	0.3684	0.1842
	E	-	-	-	-	-	-

## Genetic variability

**Table 1.** Measure of genetic variability (allelic diversity and polymorphism) of hatchery and river populations of *Labeo rohita* in Nepal

Population	No. of sample per locus	No. alleles per locus ( $\pm$ SD)	Effective number of allele per locus ( $\pm$ SD)	Polymorphic loci (%)
FRC, Pokhara	71	2.83 ( $\pm$ 0.75) <sup>a</sup>	2.00 ( $\pm$ 0.46)	100.0
RARS, Tarahara	76	<b>2.66</b> ( $\pm$ 0.52) <sup>b</sup>	<b>1.77</b> ( $\pm$ 0.77)	<b>100.0</b>
FDC, Kailali	64	<b>3.17</b> ( $\pm$ 1.17) <sup>a</sup>	2.12 ( $\pm$ 0.59)	<b>83.0</b>
FDC, Bhairahawa	75	<b>3.17</b> ( $\pm$ 0.41) <sup>a</sup>	2.02 ( $\pm$ 0.30)	100.0
MFH, Dhanusha	74	2.83 ( $\pm$ 1.47) <sup>a</sup>	1.91 ( $\pm$ 0.86)	83.33
Koshi River	37	2.83 ( $\pm$ 1.17) <sup>a</sup>	<b>2.22</b> ( $\pm$ 0.76)	83.33

Superscripted with the same letter in a column are not statistically different ( $P > 0.05$ ) between populations (Archie, 1985)

**Table 2.** Measure of genetic variability (heterozygosity, fixation index ( $F_i$ s), Hardy-Weinberge exact test value\* (Bonferroni corrected;  $P=002$ ) of hatchery and river populations of *Labeo rohita* in Nepal

Population	No. of sample per locus	Heterozygosity		$F_{is}^{\wedge}$
		$H_o$ ( $\pm$ SD) #	$H_e$ ( $\pm$ SD)	
FRC, Pokhara	71	0.15 ( $\pm$ 0.29) <sup>a</sup>	0.48 ( $\pm$ 0.14)	0.69
RARS, Tarahara	76	0.12 ( $\pm$ 0.15) <sup>a</sup>	0.34 ( $\pm$ 0.27)	0.65
FDC, Kailali	64	0.12 ( $\pm$ 0.20) <sup>a</sup>	0.48 ( $\pm$ 0.24)	0.75
FDC, Bhairahawa	75	0.10 ( $\pm$ 0.17) <sup>a</sup>	0.50 ( $\pm$ 0.11)	0.80
MFH, Dhanusha	74	0.18 ( $\pm$ 0.26) <sup>a</sup>	0.40 ( $\pm$ 0.25)	0.55
Koshi River	37	0.16 ( $\pm$ 0.16) <sup>a</sup>	0.49 ( $\pm$ 0.26)	0.67

\*Markov chain method,

# Nei's expected heterozygosity,

Inbreeding coefficient  $^{\wedge}F_{is} = (H_e - H_o) / H_e$



**Table 3. Locus-wise  $F_{is}$**  (Weir and Cockerham, 1984) within each of six populations of *Labeo rohita* in Nepal

Locus	FRC, Pokhara	RARS, Tarahara	FDC, Kailali	FDC, Bhairahawa	MFH, Dhanusha	Koshi River
Lr1	1.000	1.000	0.8529	1.000	1.000	1.000
Lr3	1.000	0.8613	1.000	1.000	1.000	0.5057
Lr10	1.000	1.000	1.000	1.000	-	0.9134
Lr14b	1.000	0.5742	-	0.9527	0.8734	-
Lr21	-0.3174	0.2701	0.0799	0.2158	0.2240	0.4787
Lr24	0.7394	0.8836	0.8583	0.6686	0.0738	0.5262

Most of the locus wise  $F_{is}$  values within each population were different from 0 ( $P < 0.01$ ) after Bonferroni correction. Among the significant test all populations at Lr1, Lr3 and Lr10 were relatively high.

## Genetic differentiation

Table 4. Values for  $F$ -statistics of river and hatchery populations of *Labeo rohita* in Nepal

Locus	$F_{is}$	$F_{st}$
Lr1	0.9747	0.3496*
Lr3	0.9905	0.2969*
Lr10	1.0000	0.1014
Lr14b	0.8681	0.2024*
Lr21	0.2274	0.1107
Lr24	0.6965	0.0860
Mean	0.7589	<b>0.2012</b>
Jackknifing over loci $\pm$ SD	0.7548 $\pm$ 0.1404	0.2018 $\pm$ 0.506

\*

Statistically significant ( $P < 0.001$ -Bonferroni correction)

$F_{st}$  (0.2012) did show significantly population differentiation among the hatchery pop. Pair wise genetic differentiation was also significant in all loci of the five hatchery pop.

**Table 5.** Genetic distance (Nei's 1973) for six populations of *Labeo rohita* below the diagonal and identity above the diagonal.

	FRC, Pokhara	RARS, Tarahara	FDC, Kailali	FDC, Bhairahawa	MFH, Dhanusha	Koshi River
FRC, Pokhara	-	0.7644	0.7212	0.7365	0.7269	0.7069
RARS, Tarahara	0.2686	-	0.8426	0.7907	0.8099	0.7323
FDC, Kailali	0.3269	0.1713	-	0.8023	0.7384	<b>0.5862</b>
FDC, Bhairahawa	0.3059	0.2348	0.2203	-	<b>0.8919</b>	0.7282
MFH, Dhanusha	0.3190	0.2108	0.3033	<b>0.1144</b>	-	0.7816
Koshi River	0.3469	0.3116	<b>0.5342</b>	0.3172	0.2464	-

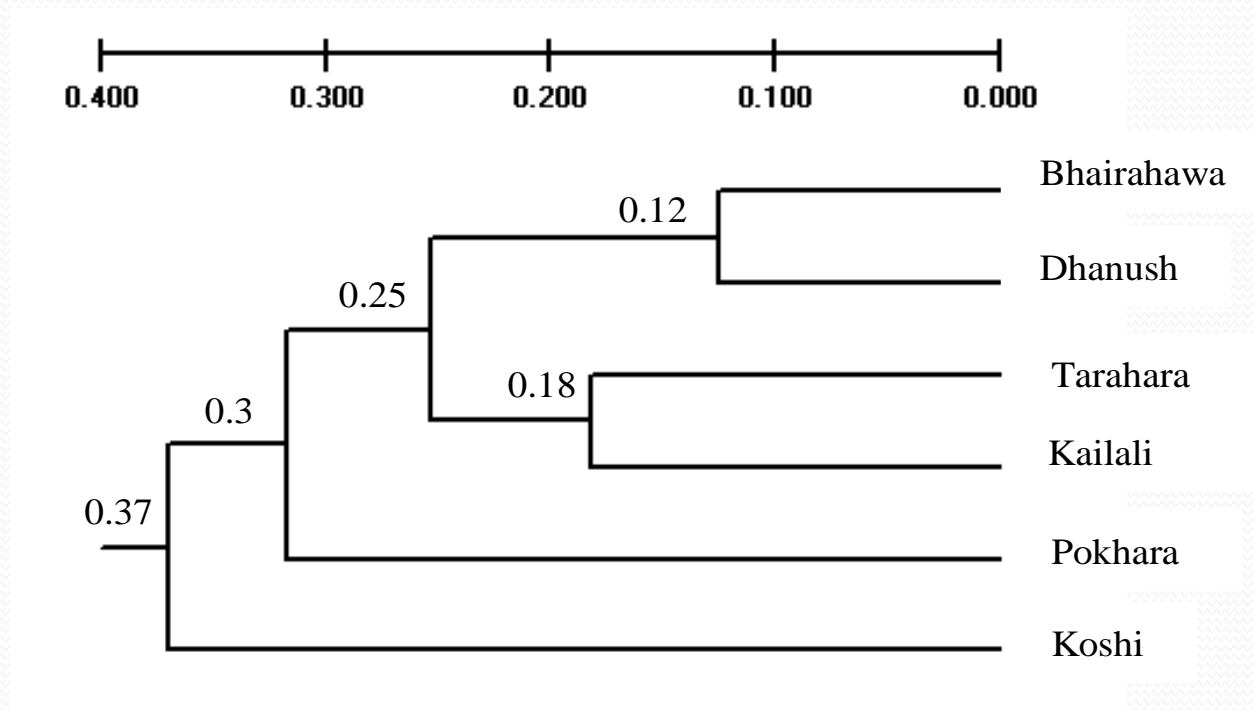


Figure UPGMA dendrogram based on *DA* distance for six populations of *Labeo rohita* using six microsatellite loci



# Conclusion

- The sizes of the alleles of rohu were small ranged from 100 to 200 base pair. Therefore to separate PCR products of rohu differing in only a few base pair in length by using microsatellite markers, 6-10% polyacrylamide gel electrophoresis (PAGE) need to be used.
- Low level of observed heterozygosity found in this study might have resulted from small effective population size.
- High  $F_{ST}$  values averaged across loci indicated significantly population differentiation among the populations.
- The distance value obtained in the present study fall within the range of congeneric. It is possible that lesser differences among these populations may be found by increasing the number of loci surveyed.

# Acknowledgements

- We would like to thank to Mr. Jay Dev Bista, Mr. Arjun B. Thapa, Mr. Mahesh Gupta, Mr. Jageswar Yadav Mr. Babai Lal Mukhiya for providing the sample for the study from their working station.
- We are thankful to Dr. Jwala Devi Bajracharya, former chief of Seed Research Division for providing lab facilities.
- This study was supported by the funding obtained by Nepal Agricultural Research Council (NARC) under Project No.: 32061002.



**THANK YOU**

## Genetic Distance

- The Nei's genetic distance, ranged from 0.0010 to 0.0642.
- Genetic distance values
  - for conspecific populations average 0.05  
(range 0.002 to 0.07)



$F_{IS}$  values greater than zero (+ve) indicating deficiency of heterozygotes was evident in these cases

- $F_{ST} = 0.00-0.05$  may be considered as indicating *little genetic* differentiation
- $F_{ST} = 0.05-0.15$  indicates *moderate* genetic differentiation
- $F_{ST} = 0.15-0.25$  indicates very large genetic differentiation
- $F_{ST} = > 0.25$  indicates extensive genetic differentiation

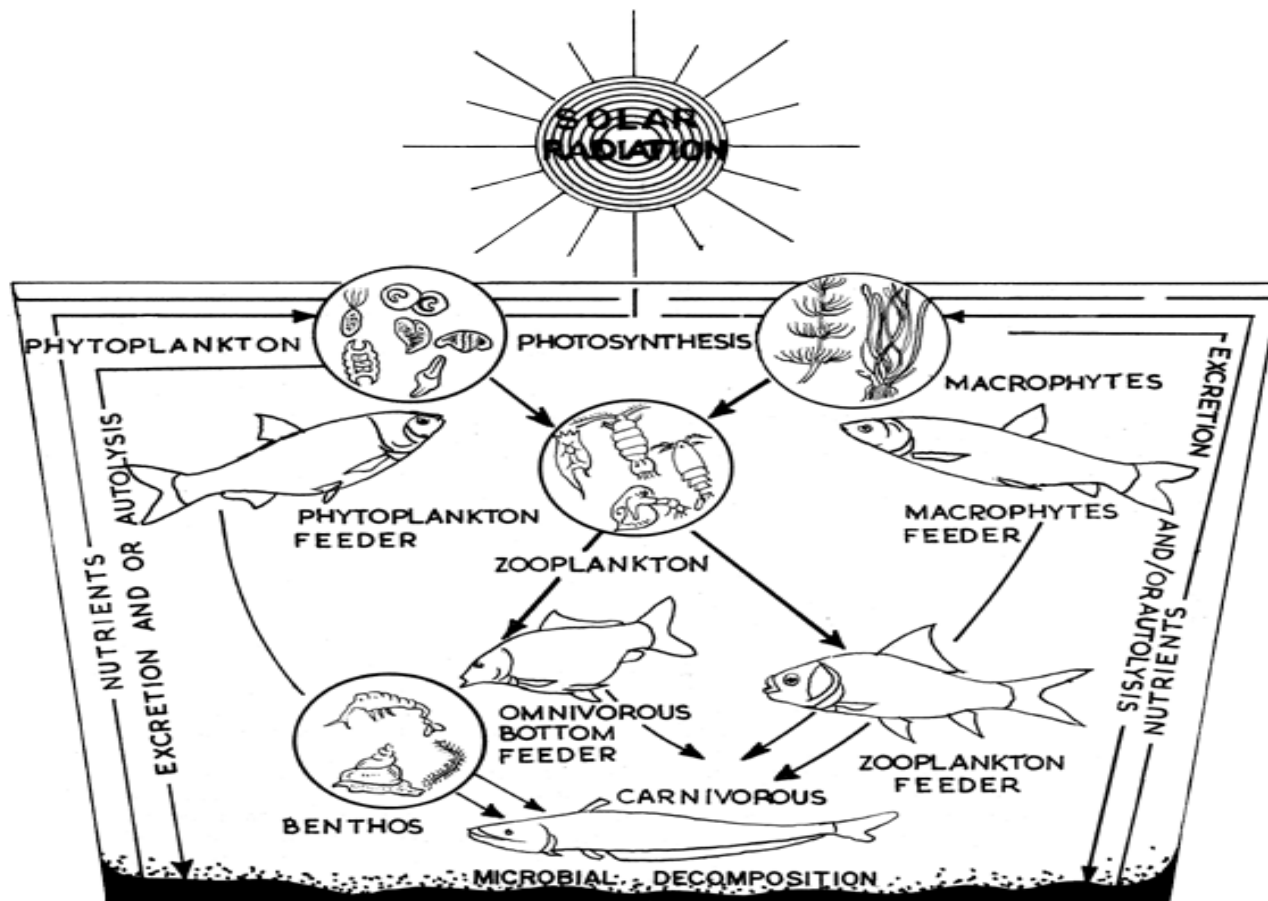


# **IMPACT OF CROSS DAM ON DIVERSITY OF NEPALESE FISHES**

By  
**Deep Bahadur Swar & Prabesh Singh Kunwar**

# 1. INTRODUCTION

- Aquatic Biodiversity
- Importance of Aquatic Biodiversity



**Food chain in freshwater ecosystem**

## 2. COUNTRY BACKGROUND

Physiographic Zone	Area (%)	Elevation (m)	Bioclimatic Zone
High Himal	23	Above 5000	Nival (Tundra and Arctic)
High Mountain	19	4000-5000	Alpine
		3000-4000	Subalpine
Middle Mountain	29	2000-3000	Montane (Temperate)
		1000-2000	Subtropical
Siwalik	15	500-1000	Tropical
Tarai	14	Below 500	Tropical

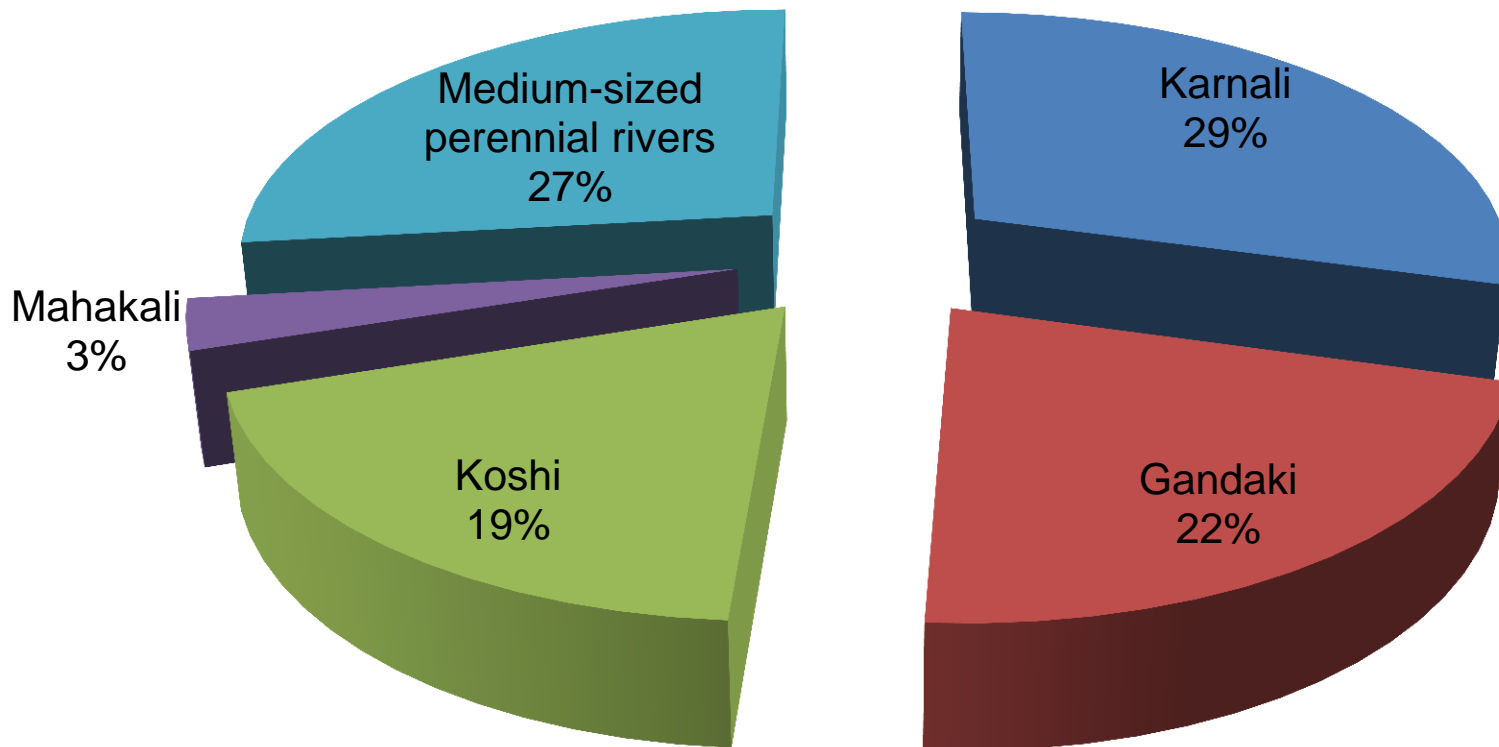


### 3. WATER RESOURCES

#### 3.1. Lakes

#### 3.2. River Systems

Cathcment area covered by different river systems in Nepal

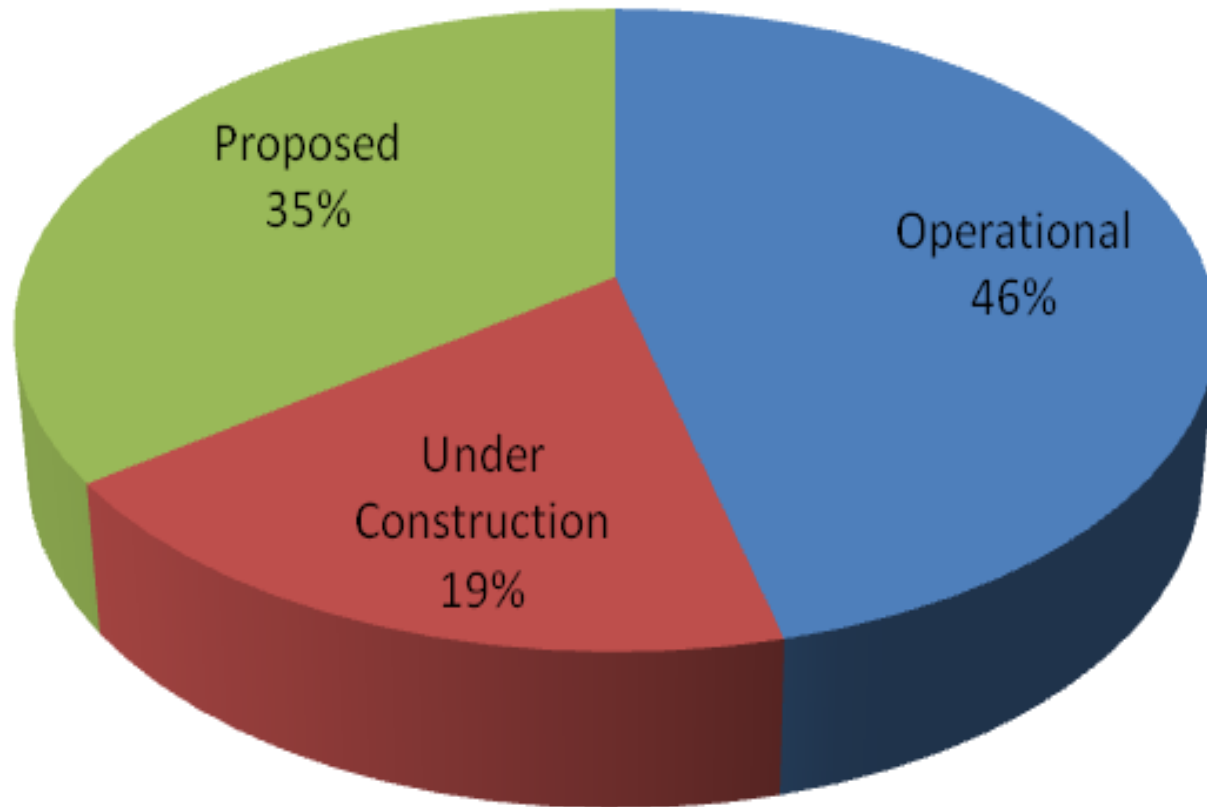




## 4. PURPOSE OF CROSS DAMS

- Hydroelectric
- Irrigation
- Recreation
- Domestic and industrial water supply
- Fish breeding and
- Navigation dams

## 4.1. Hydro Power Dams

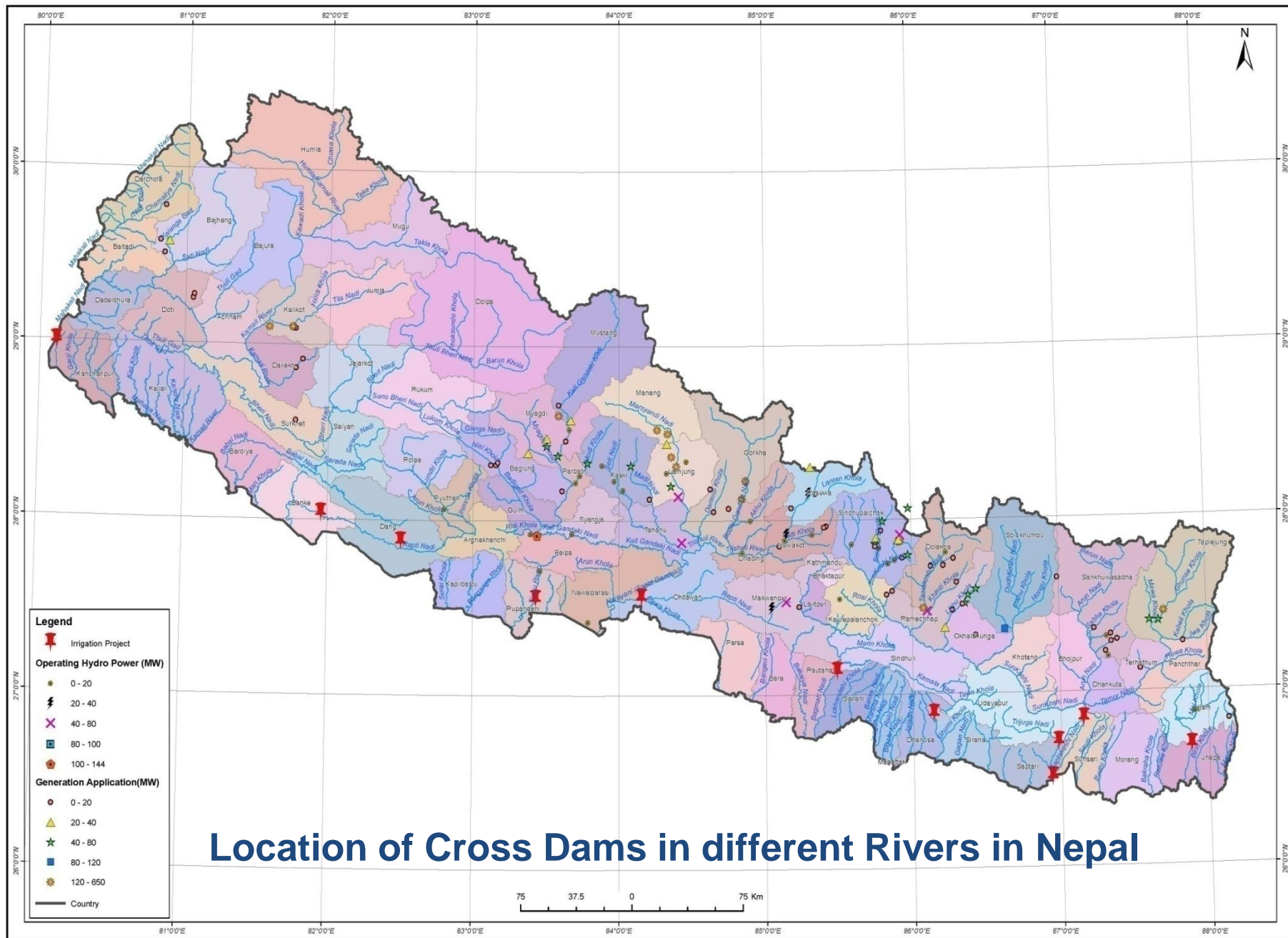


**Status of Cross Dam for Hydropower**



## 4.2. Irrigation Dams

S.N .	Irrigation project	River/Lake	District	Irrigated land ( ha)
1	Sharada	Mahakali	Kanchanpur	6800
2	Rani Jamara(under construction)	Karnali	Kailali	26000
3	Babai	Babai	Bardiya	13,600
4	Sikta (under construction)	Rapti	Banke	36,000
5	Ban Ganga	BanGanga	Kapilvastu	8,000
6.	Gandak	Narayani	Bara, Parsa, Rauthat, Nawal Parasi	51000
7	Eastern Rapti	Eastern Rapti	Chitwan	56,000
8	Bagmati Multipurpose	Bagmati	Bara, Rautahat, Sarlahi	50,200
9	Kamala	Kamala	Dhanusa	
10	Chandra Nahar	Trijuga	Saptari	
11	Koshi	Koshi	Saptari	22000
12	Sunsari	Koshi	Sunsari, Moranr	58000
13	Kankai	Kankai	Jhapa	8000



## 5. AQUATIC RESOURCES

- Fish Diversity: 230 species
- Endemic Fish Species: 16 species

### Migratory species

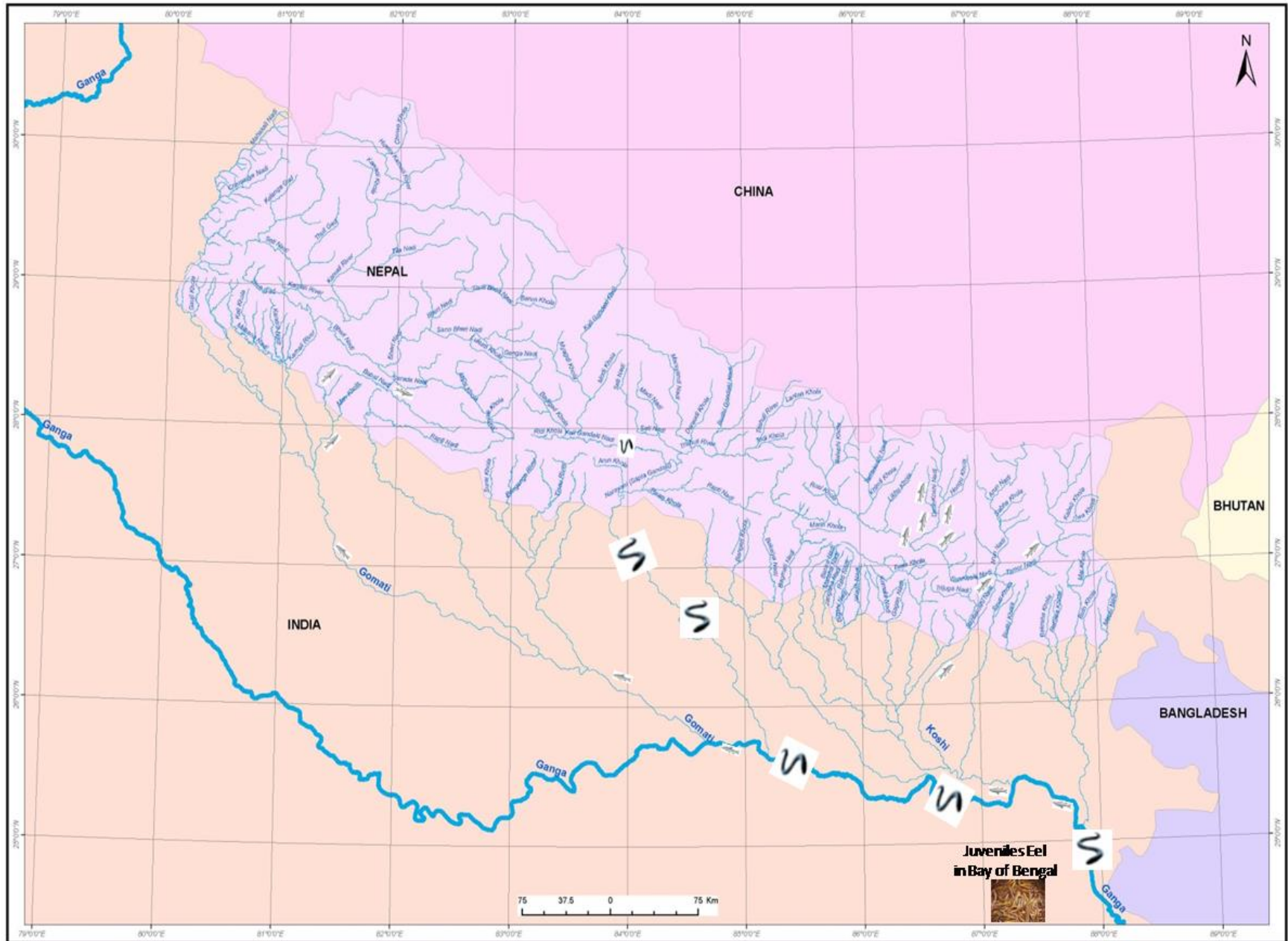
Short Distance	Long Distance
<i>Amphipnous cuchia, Chagunius chagunio, Labeo angra, Labeo boga, Labeo dero, Labeo pangusia, Labeo pangusia, Labeo rohita, Neolissochilus hexagonolepis, Puntius chilinoides, Schizothoraichthys progastus, Schizothorax plagiostomus, Schizothorax richardsoni,</i>	<i>Anguilla bangalensis, Bagarius bagarius, Bagarius yarrellii, Clupisoma gaura, Clupisoma gaura, Ompuk bimaculatus, Pseudeutropius antherinids , Tor putitora, Tor tor,</i>

Species	Migratory patron months												Spawning season	Spawning substrate	Food habit and source	Size at maturity (cm)	Age at spawning	Behaviour	Economic implication	
	J	F	M	A	M	J	J	A	S	O	N	D								
<i>Tor putitora</i> (Golden Mahaseer / Sahar)						↑	↑	↑	↑	↓	↓	↓	Aug.-Sept.	Small gravel and pebbles	Omnivores: Insects, rotifers, protozoa, algae, decaying, organic materials	48	2.5 years	Rest in deep pools excellent game fish attracted with yellow bait fruit jumping morning evening insearch of food	Excellent food fish, sport fish	
<i>Tor tor</i> (Sahar)						↑	↑	↑	↑	↑	↓	↓	↓	Aug.-Sept.	Small gravel and pebbles	Omnivores: Insects, mollusca, macro-vegetation, filamentus, algae, sand and mud	50	2.5 years	Rest in deep pools excellent game fish attracted with yellow bait fruit jumping morning evening insearch of food	Excellent food fish, sport fish



Species	Migratory patron months												Spaw ning season	Spaw ning subst rate	Food habit and source	Size at matur ity (cm)	Age at spawn ing	Behaviour	Economic implicatio n	
	J	F	M	A	M	J	J	A	S	O	N	D								
<i>Bagarius bagarius</i> (Gonch)				↑	↑	↑	↑	↑	↑	↑	↓	↓	↓	July-Aug.	Mud, sand and decaying vegetables	<b>Carnivorou s:</b> Molluscs crabs shrimps, tadpoles, frogs and large insects	75	2.5-3 years	Rest in deep pools excellent game fish attracted with yellow bait fruit jumping morning evening insearch of food	Excellent food fish, sport fish
<i>Clupisoma gaura</i> (Jalkapoor)				↑	↑	↑	↑	↑	↓	↓	↓			June-July	Fine sand pebbles	<b>Carnivorou s:</b> Fish fry, fingerlings, tadpoles, frogs	20	2 years	Annadromous migrant sport fish angling by rod and line	Excellent food fish
<i>Anguilla bangalensis</i> (Raja Bam)			↑	↑	↑	↑	↓	↓	↓					-	Mud sand	<b>Carnivorou s:</b> Small fish, molluscs, shrimps and insects	Not known	Not known at Nepalese river context	Lives together with <i>Labeo dero</i> excellent ganefish (rod and line) in yellow bait, colour pattern changes after death	Food value, sport fish

# Migration Route of Long Distance Migratory Fish (*Tor putitora* and *Anguilla bangalensis*)



## 6. IMPACT OF IMPOUNDMENT

- Obstruction in fish migration
- Conversion of a lotic system into a lentic
- Downstream riverine environment will be converted into dry stretch
- The diversion of smaller fishes and juveniles into penstock and power plants will cause considerable loss to fish population.
- Destruction of fish habitat and food resources like peryphyton, benthic organism aquatic insects.
- Plankton population increases due to eutrophication
- A more pronounced annual drawdown in the reservoir during spawning and egg incubation period.

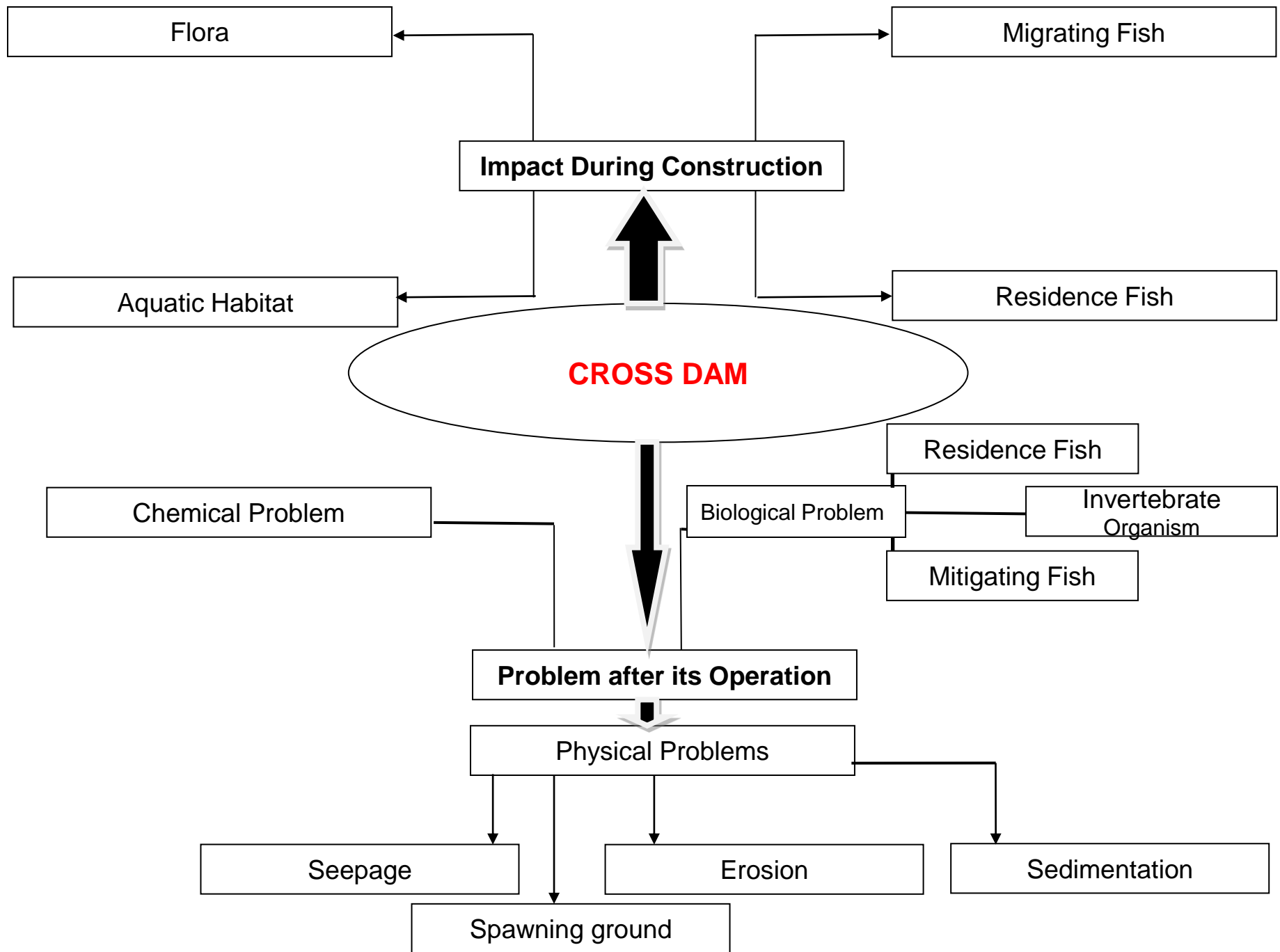
## IMPACT OF IMPOUNDMENT **contd ...**

- Comparatively warmer water will be released in the downstream.
- Shore erosion will increase sedimentation.
- Water discharging from hypolimnion of the reservoirs frequently low on dissolved oxygen and high in BOD. Consequently the oxygen content of the river below the dam will be reduced.

The changes have significant impact on aquatic lives

Both during construction and operation period of the project.





## 7. CASE STUDIES OF SOME SELECTED DAMS

### 7.1. Kali Gandaki A Hydropower Project (KGAHP):

- Located 500 m below the confluence of the Kali Gandaki and Andhikhola at Mirmi
- A 44 m high and 110 m long concrete diversion dam has created a reservoir of 65 ha stretching 5.3 km, with an average depth of 12 m and operating level between 518-524 m.





## Location of KGAHP

A-Downstream of KGA powerhouse, B-In between KGA dam and powerhouse, C-In between AK dam and KGA dam, D-Upstream of AK dam (Andhi Khola River), E-Upstream of KGA dam (Kali Gandaki River)







## Status of aquatic biodiversity

- Out of 230 fish species documented in Nepal, 57 species have been recorded in the Kali Gandaki River
- Fish species adapted to extreme gradient.
- The fish support subsistence, commercial and sport fisheries.
- The main species are: snow trout, Mahseer, carps, catfish, eel, murrel, loach and barbs.



## Status of aquatic biodiversity **contd...**

*Tor putitora* from Phewa



Fishes from West Rapti



# Status of aquatic biodiversity **contd...**

**Fish Ladder in Aandhi Khola**



**A group of people using electricity for catch of fish**





# Discussion with Fishers Group in Kaligandaki





## **7.2. Middle Marshyangdi Hydroelectric Project (MMHEP):**

- Marshyangdi River was dammed at Phalia Sangu and water is diverted through a tunnel to Bhotewadar/Shiudibar to produce hydroelectricity
- The cross dam has no provision of fish pass/ladder.
- There is hardly any water in downstream of the dam up to the confluence of Dordi Khola during nine months in a year.
- Dordi is a spring fed stream. There are several small power project proposed in Dordi but the actual construction has not started yet.
- The length of the river stretch between dam site and powerhouse is about 5.7 km. Dordi kola (khola=stream) joins river after 3 km from the dam site.

## 7.2. Middle Marshyangdi Hydroelectric Project (MMHEP): contd..

- Our fishing effort below the powerhouse. site revealed that there are plenty of buche asala in the river. But other species were not caught.







## Status of aquatic biodiversity:

- Baseline study of fish fauna indicated that Middle Marsyangdi Hydro-electric project area provided shelter to at least 30 indigenous fish species.
- The section of the river between Bhote wodar and Phalia Sangu was a good habitat for snow trout such as *S. richardsoni*, *S. plagiostomus*, *S. progastus*. But the presence of large scale barbells (*Tor. Spp.* and *Neolissohilus hexagonolopis*) rare.
- Out of 30 species snow trout contributed more than 30 percent of the total catch.



### **7.3. Babai Irrigation Project ( Babai River and Dam):**

- The Babai River rises in the Dang Valley and runs through to India where it is known as the Rardar.
- The watershed is 3,260 km<sup>2</sup> and the river is notable as a warm water river in contrast to the majority of rivers in Nepal that are snow fed.
- The Babai dam, which was completed and functioning in October 1993, was constructed for irrigation purposes to improve the productivity of the farming land in the surrounding lower lying Tarai.

#### **The dam comprises of the following components:**

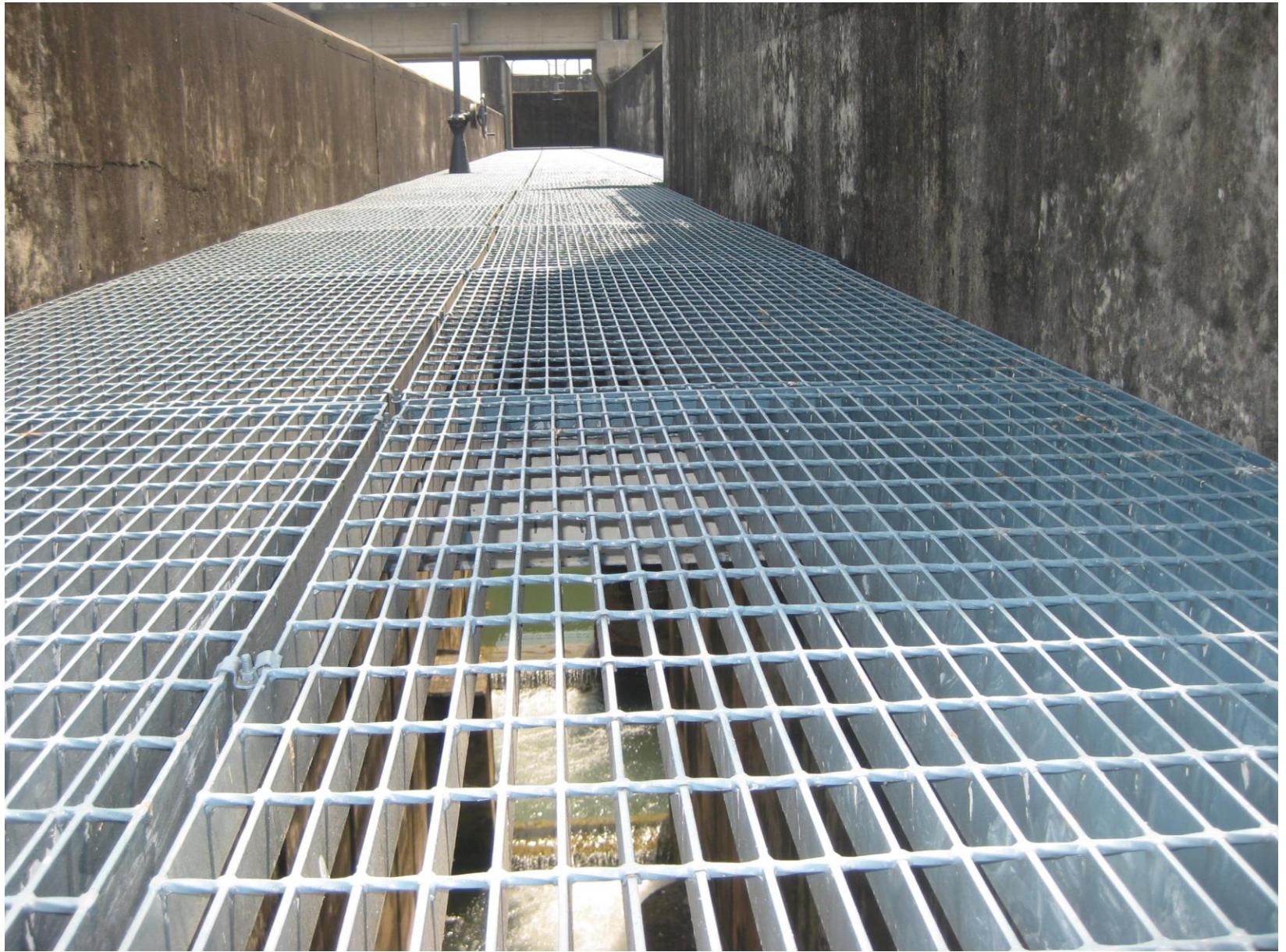
- A weir approximately 245m long with 13 bays below it separated by support buttresses or pontoons.
- A fish pass approximately 4m wide (Figures-10.)
- A 27m wide main river channel which discharges under two vertical lifting sluices
- An 18m wide diversion channel with a vertical lifting sluice which diverts water into the irrigation channel running to the farmer's field.

The structure constitutes a total barrier across the Babai River.

## Status of aquatic biodiversity:

A total of 33 species has been silted from Babai river during 1999 (Shrestha 1999). Principle fish species of Babai river project were grouped as follows;

- **Major carps: River carp** (*Labeo dyochailus*, *Labeo dero*), *Sucker had* (*Gara gotaila*), *Garra annandallei*, *Katle* (*Neolissochilus hexagonolopis*).
- **Cat Fish:** *Goanch* (*Bagarius bagarius*)
- **Loaches:** (*Neomachelous armatus*)
- **Eels:** *Sping eel* *Mastacembelus armatus*, *Raj Bam* (*Angulia beengalensis*)
- **Murrells:** *Snakehead* (*Channa punctatus*)
- **Mahaseers:** *Golden Mahaseer* (*Tor putitora*), *Sahar* (*Tor tor*)
- **Minnows:** *Barilius barna*, *Barilius bendalensis* and *Barilius vagra*



**Fish Ladder in Babai Irrigation Dam**

## 7.4. Kulekhani Reservoir

- The Kulekhani Reservoir was formed in 1981 by the construction of a dam (height 114 m) on the kulekhani River.
- It is situated in the mid-hill region of Nepal and has a catchment area of 126 km<sup>2</sup>.
- At full water capacity, Kulekhani Reservoir is about 7km long and 380 meter wide and has a maximum depth of 105m.
- The valley in which the reservoir is located has steep sides and is subjected to large changes in depth.
- This reservoir serves as a water storage basin for hydroelectric power.



## Status of aquatic biodiversity:

- A survey of the fish fauna of the Kulekhani River upstream of the reservoir was carried out during 1984/85 by the Inland Fisheries Project assisted by the International Development Research Center (IDRC) of Canada.
- It was reported that Cyprinidae was the most abundant family by number of species, represented by *Garra lamta* (Gray), *Neolissochilus hexagonolepis* (McClelland), *Puntius chilinoides* (Ham), *Schizothorax richardsonii* (Gray), *Puntius ticto* (Ham) and *Puntius spp.*
- The families Cobitidae and Channidae were represented by *Noemacheilus spp* and *Channa gachua* (Ham) respectively.
- The family Sisoridae was represented by *Glyptosternum spp.* and *Coraglanis spp.*

## 7.5. Dudhkoshi -1 Hydropower Project:

- The Dudhkoshi -1 dam will be located between Okhaldhunga and Khotang district, and about 30 km north west of the confluence of Dudhkoshi River and Sunkoshi River.
- The project site is about 2 km far from Lamidanda airport.
- The Dudh Koshi -1 Hydropower is categorized as a small storage scheme with a crest length of 320 m, flanked on the left bank by gated chute spillway.
- It will consist of a 50 m high dam made of rock fill and impervious core to protect from leakage.
- The power house site will be located at Sunkoshi River bank.
- Gross storage capacity will be  $687.4 \times 10^6 \text{ m}^3$  which will enable annual regulation of natural river flow at the initial stage.

## Status of aquatic biodiversity:

A total of 40 species has been listed from the project area. The principal fish group of Dudh Koshi River is represented as follows:

- **Major Carps:** Katle (*Neolissochilus hexagonolepis*), Snow trout (*Schizothoracichthys esocinus*, *S. progastrus*, *Schizotharax plagiostomus*); minor carp (*Labeo dero*, *Labeo angra*, *L. dyocheilus*); Sucker head (*Garra annandalii*, *G. gotyla*); minor stone carp (*Psilorhynchus pseudoecheneis*, *Crossocheilus latius*, *Chaggunius chagunio*);
- **Cat Fishes:** Cat fish (*Clupisoma gaura*); Bagarid catfish (*Bagarius bagarius*); Torrent catfish (*Glyptothorax cavia*, *G. pectinoterus*, *G. Telchitta*, *Glyptosternum blythi*, *Pseudecheneis sulcatus*)

## Status of aquatic biodiversity: **contd ....**

- **Murrells:** Snake head (*Channa stewartii*)
- **Eels:** Spiny eel (*Mastacembelus armatus*; Mud eel (*Amphipnous cuchia*); Fresh water eel (*Anguilla bengalensis*).
- **Loaches:** Stone loach (*Noemacheilus rupicola*, *N. beavani*, *N. corica*, *Lepidocephalicchthys guntea*, *Botia almorhae*, *B. lohachata*).
- **Mahaseer:** (*Tor putitora*, *Tor tor*)
- **Live fish:** (*Heteropneustes fossilis*)
- **Barb:** (*Puntius chillinoides*)
- **Minnows:** *Barallius barila*, *B. bendelensis*, *B. tileo*)



## **7.6. West Seti Hydropower Project (WHHEP)**

- The proposed West Seti Hydroelectric Project (WSHEP) is located on Seti River in far-western development region of Nepal.
- It lies in the districts of Dadeladhura, Baitadi, Doti and Bajhang.
- It is a storage dam project with a rated capacity of 750 MW.
- The main projects features are a dam and storage reservoir.
- The proposed dam is a 195 m high concrete faced, rock fill structure located on the Seti river immediately downstream of the confluence with the Chama Gad.
- The reservoir will extend 25.1 Km along the Seti River and 3-8 km along its five tributaries.
- The full supply level (FSL) will be at EL 1280 m (true elevation 890 m above the sea level). The reservoir will have a surface area of 1989 ha at FSL.

## Status of Aquatic biodiversity

- Fifteen fish species are reported during field work from the project area.
- Among 15 species, *Tor putitora*, *Ompok bimaculatus*, *Anguilla Bangalensis* and *Bagarius bagarius* are long distance migratory, *Schizothorax plagiostomus*, *Schizothoraichthys progastus*, *Neolisochilus hexagonolepis*, *Labeo pangusia* and *Puntius chelynoids* are short distance migratory and the remaining 6 species are resident.
- Out of the 15 species *Tor putitora* is categorized as endangered, *Puntius chelynoids* as vulnerable and 4 species; *Ompok bimaculatus*, *Bagarius bagarius*, *Neolisochilus hexagonolepis* and *Labeo pangusia* are categorized as near threatened species.

## 8. COMPARATIVE STUDIES

S.N .	Name of the project	Committed mitigative measure	Current practice	Remarks
1	Kaligandaki A	1. Trapping and hauling 2. Fish hatchery 3. Minimal in-stream flow (4m <sup>3</sup> /s) 4. Trash rack	Fish hatchery: 5 species are being bred and other 5 are in preliminary observation	Reduction in fish population/ diversity of mainly migratory fish
2	Middle Marsyangdi	1. Fish hatchery 2. Minimal flow ( 1m <sup>3</sup> /S) 3. Entrainment	No mitigative measures in application	Stocking of 50,000 fish fries produced at Kaligandaki fish hatchery
3	Kulekhani I	No EIA	No mitigative measures	Downstream is permanently dry except during flooding period
4	Babai irrigation project	No EIA	1. Fish ladder 2. Water release ( 1m <sup>3</sup> /S) during dry season	Last three pools of fish ladder are silted
5	Tinau	No EIA	No fish pass facility	
6	Trishuli Hydropower	No EIA	No fish pass facility	
7	Sikta irrigation project (under construction)		Fish Ladder	Location of fish ladder is not appropriate

## COMPARATIVE STUDIES contd...

S.N .	Name of the project	Committed mitigative measure	Current practice	Remarks
8	Phewa Hydro/irrigation project		No fish pass facility	Stocking of fish fries annually
9	Tanahun Hydro (proposed) (Storage)	1. Fish hatchery 2. Minimal flow ( 2.4m <sup>3</sup> /S) 3. Trash rack 4. Fish habitat management program		
10	Khimti Hydropower	1. Ladder 2. Stocking of important species	No fish ladder?	
11	West Seti Hydropower storage type (proposed)	1. Establishment of fish hatchery in project area		
12	Dudh Koshi Hydropower Storage type (proposed)	1. Establishment of fish hatchery in project area		
13	Upper Karnali (Proposed) run-up the river	1. Establishment of fish hatchery in project area	Pool and weir type Fish ladder	



# COMPARATIVE STUDIES contd...

## Migratory fish species in different Dam

Name of the project	Fish species		No. of species recorded	Impact
	<i>Short distance</i>	<i>long distance</i>		
Kaligandaki A	<i>Amphipnous cuchia</i> , <i>Chagunius chagunio</i> , <i>Labeo angra</i> , <i>Labeo dero</i> , <i>Labeo pangusia</i> , <i>N. hexagonolepis</i> , <i>Puntius chilinoides</i>	<i>Tor tor</i> , <i>Tor putitora</i> , <i>Bagarius yarrellii</i> , <i>Clupisoma gaura</i>	57	Reduction in catch per unit effort
Middle Marsyangdi	<i>Neolissochilus hexagonolepis</i> , <i>Schizothorachthys progastus</i> , <i>Schizothorax richardsoni</i> , <i>Schizothorax plagiostomus</i>	<i>Tor putitora</i> , <i>Clupisoma gaura</i> , <i>Anguilla bangalensis</i>	30	Reduction of Tor species
Kulekhani I	<i>puntius chilinoides</i> , <i>Neolissochilus hexagonolepis</i> , <i>Schizothorax richardsoni</i> , <i>Tor tor</i>	<i>Tor putitora</i>	20	Drastic Diclining of indigenous species such as <i>Schizothorax</i> spp., <i>Puntius</i> Spp., <i>Garra Lamta</i> etc
Babai irrigation project	<i>Labeo angra</i> , <i>Labeo dero</i> , <i>Labeo pangusia</i> , <i>Labeo boga</i>	<i>Tor tor</i> , <i>Tor putitora</i> , <i>Bagarius bagarius</i>	33	reduction in fish population

# COMPARATIVE STUDIES contd...

## Migratory fish species in different Dam

Name of the project	Fish species		No. of species recorded	Impact
	<i>Short distance</i>	<i>long distance</i>		
Tinau	<i>Labeo dero</i> , <i>Neolissochilus hexagonolepis</i> ,	<i>Tor putitora</i> , <i>Tor tor</i>	17	Impact on fish diversity is seen mainly above the dam
Trishuli Hydropower	<i>Schizothorax plagiostomus</i> , <i>Schizothorax richardsoni</i> , <i>Schizothoraxichthys progastus</i> , <i>Neolissochilus hexagonolepis</i> , <i>Labeo dero</i>	<i>Tor putitora</i> , <i>Tor tor</i> , <i>Bagarius bagarius</i> , <i>Anguilla bangalensis</i> , <i>Clupisoma gaura</i> ,	28	
Sikta irrigation project	<i>Labeo dero</i> , <i>Labeo pangusia</i> , <i>Labeo rohita</i>	<i>Anguilla bangalensis</i> , <i>Tor putitora</i> , <i>Tor tor</i>	35	
Phewa Hydro/irrigation project	<i>Neolissochilus hexagonolepis</i> , <i>Labeo angra</i> , <i>Labeo rohita</i> , <i>Schizothorax richardsoni</i> ,	<i>Tor tor</i> , <i>Tor putitora</i> , <i>Anguilla bangalensis</i>	25	Reduction of indigenous species due to introduction of alien species like Tilapia and Cat fish
Tanahu Hydro (proposed)	<i>Neolissochilus hexagonolepis</i> , <i>Labeo pangusia</i>	<i>Bagarius bagarius</i> , <i>Tor putitora</i> , <i>Tor tor</i> ,	18	

# COMPARATIVE STUDIES **contd...**

## **Migratory fish species in different Dam**

Name of the project	Fish species		No. of species recorded	Impact
	<i>Short distance</i>	<i>long distance</i>		
Khimti Hydropower	<i>Neolissochilus hexagonolepis, Schizothorax richardsoni, Schizothorax plagiosomus, Labeo angra, Labeo dero</i>	<i>Anguilla bangalensis, Tor tor, Tor putitora, Clupisoma gaura, Bagarius bagarius</i>	45	
West Seti Hydropower	<i>Sichthorax plagiosomus, Schizothorax prograssus, Neolissochilus hexagonolepis, Labeo, panguusia</i>	<i>Tor putitora, Ompok bimaculatus, Anguilla bangalensis</i>	13	
Dudh Koshi Hydropower	<i>Amphipinius cuchia, Chagunius chagunio, Labeo dero, Labeo angra, Labeo dyocheilus Neolissochilus hexagonolepis, Schizothorax annandalei, S. esocinus, S. prograssus, Schizothorax</i>	<i>Anguilla bangalensis, Bagarius bagarius, Clupisoma gaura, Tor tor, Tor putitora,</i>	40	
Upper Karnali	<i>Zenentodon cancala, Schizothorax plagiosomus, S. Richardsoni, S. Prograssus, Neolissochilus hexagonolepis, Barilius vagra, Puntius chilylydes</i>	<i>Anguilla bangalensis, Bagarius bagarius, Clupisoma gaura, Pseudeutropius antherinids, Tor tor, Tor putitora,</i>	48	

## 10. CONCLUSION

- Aquatic diversity is important for human being for several reasons.
- Nepal is rich in both aquatic as well as fisheries resource
- Construction of dams will be increasing in future to meet the energy demand.
- Far western region has less number of dams compared to other regions.
- Comparative studies of various hydro-electric projects sites shows reduction in fish population and diversity mainly migratory species
- No provision of EIA in the previously constructed projects but even new projects are not following committed mitigation measures
- Waiver of EIA for hydropower projects up to 50 MW capacity



## **10. CONCLUSION (Contd.....)**

Declining in fish diversity can not be attributed to dam construction only but it seems to be cumulative effect of illegal fishing, water pollution, faulty agriculture practice, soil erosion and habitat destruction due to developmental works like road construction and so on

## 10. CONCLUSION (Contd.....)

Capture Fisheries alone has provided employment opportunities to 462,070 people from different fisheries community. Therefore protection of fisheries resource is must not only from diversity but also from socioeconomic point of view

## 11. Recommendation

- Institutional arrangement**

### **Designation and organization**

Coordinator Wetland Thematic Sub-Committee

Representative Ministry of Home Affairs

Representative, DOE A

Representative, DOI

Representative, NEA

Representative, NGO

Representative, DONOR

Two individual biodiversity experts

Representative, Ministry of Local Development

Program Director, DOFD, DOA

### **Position in NABSC**

Chairperson

Member

Member

Member

Member

Member

Member

Member

Member

Member Secretary

## 11. Recommendation **contd...**

- Policy and Legal Provision
- National Plan and Strategy
- Technology
- Governance
- Mitigation Measures
- Research and Studies
- Recreation and Sports Promotion



**Thank you all !!!**

# **Mercury in Fish and Fisher Folks' Body in Nepal, Calls for Urgent Actions**

**Ram Charitra Sah**

**Executive Director /Environment Scientist**

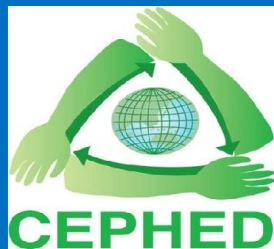
**Center for Public Health and Environment Development (CEPHED) Nepal**

Nayabasti, Imadol-5, Lalitpur, Kathmandu, Nepal

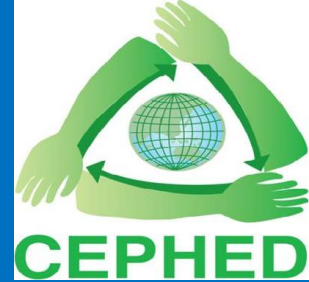
Tel/Fax : 5201786, Mobile: 9803047621

Email: [cephed04@yahoo.com](mailto:cephed04@yahoo.com), [ramcharitra@gmail.com](mailto:ramcharitra@gmail.com)

**First NEFIS Convention and Annual General  
Assembly, January 30-31, 2015, Kathmandu**



# Center for Public Health and Environmental Development



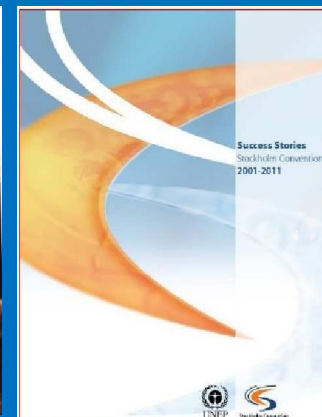
**Established:** October 2004

**Goal:** Improved environment management and public health.

**Vision:** Bridging people with science and technology for healthy living and environment safety.

**Global Linkage:** IPEN, HCWH, GAIA, CEH, Toxics Link, ZMWG/EEB, WAMFD, Asian Center

**Inter/National Recognitions:** CEPHED Works in Public health and Env't. Cons. Recognized all over and also serving many task force formed under Government regimes.



**CEPHED**

# Mercury: $^{200}\text{Hg}_{80}$

## MERCURY (Hg)

Color: Silvery

Atomic Number: 80

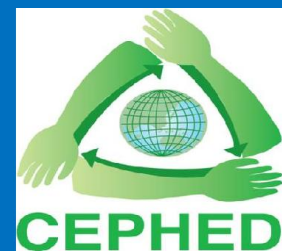
Atomic Weight:  $200.59(2) \text{ g}\cdot\text{mol}^{-1}$

Density:  $13.534 \text{ g}\cdot\text{cm}^{-3}$

Melting point:  $-38.83^\circ\text{C}$ ,

Boiling point:  $356.73^\circ\text{C}$ ,

- Mercury is a pollutant of global concerns.
- Mercury is a Toxic Heavy Metal occurs in nature and used in many products heavily imported and used in Nepal.
- Mercury is a metal which is liquid at ordinary temperature;
- Toxic in all forms: **metallic; inorganic and organic.**
- **Mercury** and mercury containing compounds are highly **toxic** and have a variety of significant adverse effects on **human health, wildlife, aquatic animals and the environment.**





# Objectives

1. To study the mercury contamination in Fish and Depending Communities (Fisher Folks)
2. Share new findings of mercury bio-monitoring in fishes, depending fisher folks and fish consuming female of child bearing age,
3. Raise awareness, identify specific hot spots and populations at risk
4. Contribute to the National and Global Negotiation related to Mercury Convention.



# Material and Methods

- Fishes
- Research Participants (Fisher Folks agreed to provide their hair samples)
- Weighing Machine
- Knives & scissors
- Measuring Tape
- Gloves
- Chipping Board
- Distil Water
- Zip Bag, Markers , Ice Pack
- Threads and Adhesive tape



Figure 3 Fish Tissue Sampling Kit

# Material and Method

- **Fish Sample : 15** in Pokhara Phewa Lake
  - African sharp tooth catfish, Nile tilapia, swamp barb and putitor mahseer
- **Fish Samples: 5** in Kathmandu, Kalimati Market
- Sampling using protocols developed by the Biodiversity Research Institute (BRI 2011)
- Tested at BRI Lab Gorham, USA by using **Direct Mercury Analyzer (DMA)-80** method.



Figure 10 .Weighting Fish Fillet to nearest 0.1g

# Bio Monitoring in Human Body

## Material and Method

- CEPHED sampled of human hair using protocols developed by IPEN ([2011](#)).
- 20 Hair samples [ 15 from Fisher Folks + 5 Dental Health Care Professionals-Doctors & Nurses]
- Biodiversity Research Institute (BRI) measured mercury levels (total mercury content = THg) in both fish and hair samples in their laboratory in Gorham, Maine, USA.





# Sampling Methods: Orientation, Hg Fact Sheets and Collection of Hair Samples with full consent



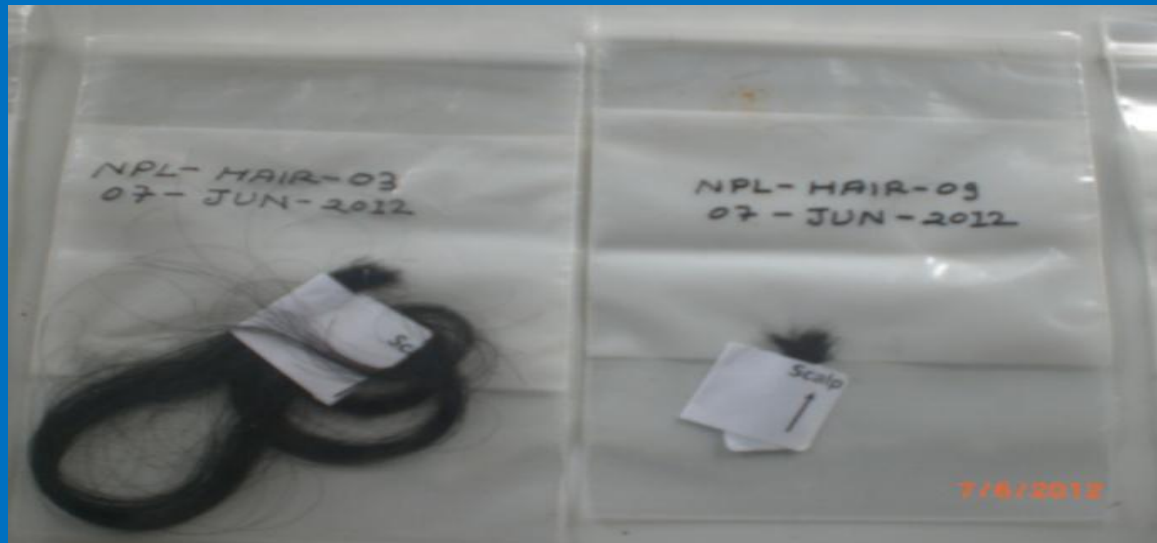
# Hair Samplings



**Hair Sampling (Female)**



**Hair Sampling (Male)**



**Hair Samples (Female and Male)**



# Bio –monitoring of Mercury Contamination in Nepal

## Mercury in Our Food and Body



# Fish Sampling



Figure 6 Field Work- preparing for fillet sampling



Figure 5 Fish Samples for Fillet Collection



Figure 6 measuring the length to nearest 0.1cm



Figure 7. Measuring weights of the sample fish to nearest 0.1 gm



Figure 8 Slicing fish body towards tail



Figure 9 Fish Fillet





# Results of Mercury in 100% Fish ( CEPHED-IPEN 2012)

FISH SPECIES CATCHED FROM PLACE A	Samp. Size	Hg Average (ppm)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Ref. dose (ppm)	Fraction of samples over Ref. Dose
African sharp tooth catfish ( <i>Clarias gariepinus</i> ) <i>Magur</i>	3	0.125	0.029	0.096	0.154	0.22	0%
Nile tilapia ( <i>Oreochromis niloticus</i> ) <i>Tilpia</i>	5	0.025	0.006	0.019	0.032	0.22	0%
Swamp barb ( <i>Puntius chola</i> ) <i>Bhitte</i>	5	0.139	0.062	0.078	0.242	0.22	20% Popular fish among fisherman
Putitor mahseer ( <i>Tor putitora</i> ) <i>Sahar</i>	2	0.075	0.006	0.071	0.079	0.22	0%
All fish samples	15	0.090	0.062	0.019	0.242	0.22	6.7%
PLACE B	4			0.003	0.036	0.22	0

## 100% Positive Result of Mercury Contamination in Human body (Fisher folk) (CEPHED-IPEN 2012)

Locations	Sample Size	Hg Mean (ppm)	St Dev	Min Hg (ppm)	Max Hg (ppm)	Reference dose (ppm)	Fraction of samples over Ref. Dose
Fisher folk (2012)	15	1.057	0.39 3	0.34 5	1.719	1.00	53%

Fisher folk's hair samples contain mercury ranges from 0.345 to 1.719 ppm.

# Summary of Hair Mercury Concentration and fish intake by country for 220 Women of Child Bearing Age (CEPHED-EEB 2013)

Countries	Samples No.	Min ( µg/g)	Max (µg/g)	% results >1 µg/g	Mean Age (yr)	Mean No. fish meals per week
Armenia	25	0.01	0.37	0	33.9	1.4
Bangladesh	40	0.16	2.12	5	27.2	2.9
India	23	0.03	0.97	0	30.9	3.2
Cote D Ivoire	26	0.22	3.20	23	28.4	NA
Japan	24	0.60	4.11	71	33.1	2.7
Mauritius	25	0.19	8.05	36	34.2	1.6
Nepal	20	0.11	1.00	0	28.9	0.4
South Africa	9	0.11	0.98	0	28.7	1.3
Spain	28	0.31	6.38	64	37.4	6.7
<b>Total</b>	<b>220</b>	<b>0.01</b>	<b>8.05</b>	<b>24</b>	<b>31.4</b>	<b>2.8</b>

Source: ZMWG/EEB 2013, p 13



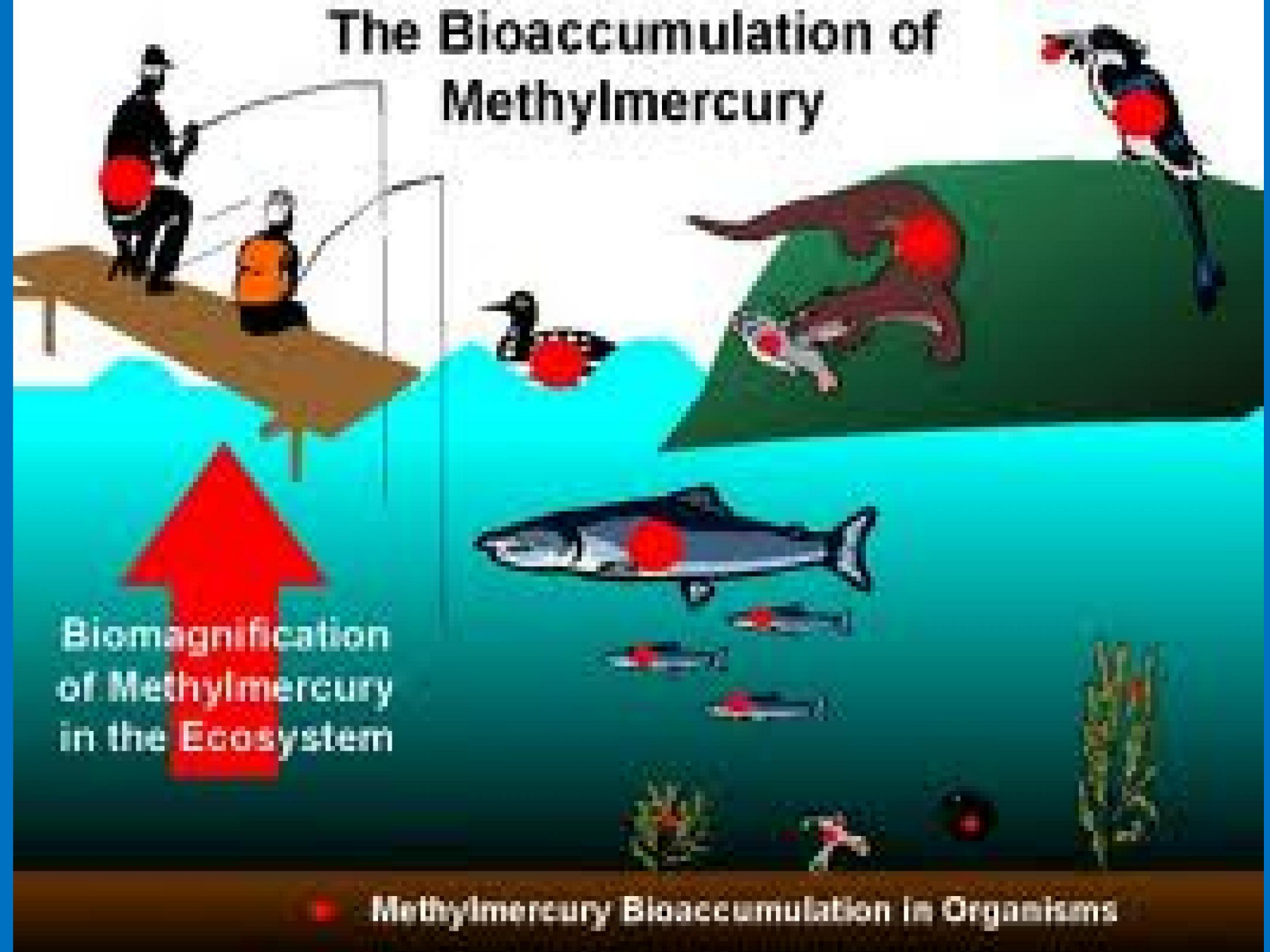
# Bio-monitoring of Mercury in Fish and Human hair (CEPHED-2012 & 2013)

- Fish Samples from Phewa Lake Pokhara and Kalimati Market
- Hair Samples by CEPHED from **15 Fisher Folks**, 5 Doctors and Nurses
- Tested at BRI Lab Gorham, USA by using DMA-80 method.
- Fish samples contain Hg ranges from 0.003 to 0.242 ppm
- **Hg Content in Fisher Community: 345 to 1715  $\mu\text{g}/\text{kg}$  with 53% higher than reference doses.**
- Hg Content in Dental Doctor & Nurses: 205 to 447  $\mu\text{g}/\text{kg}$
- **Hg Content in fish eating female with child bearing age 0.11 to 1 ppm**





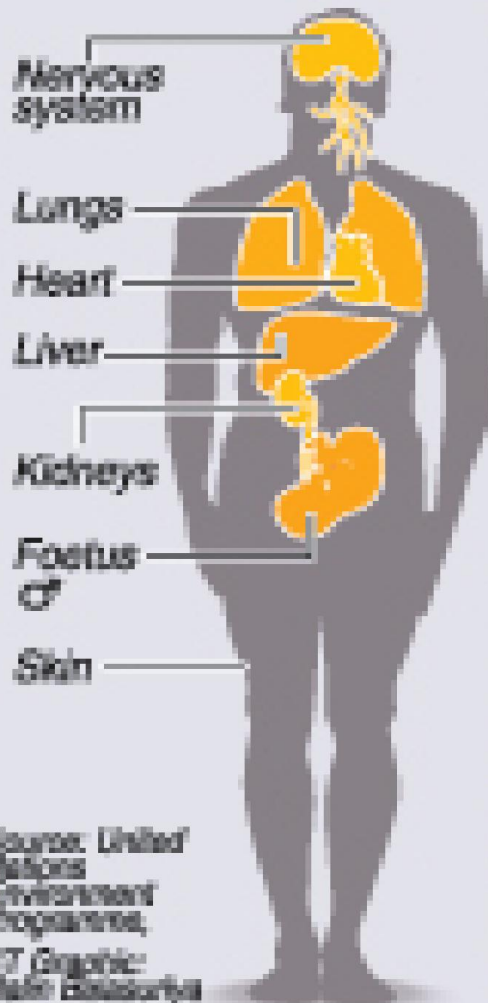
# The Bioaccumulation of Methylmercury



# Health Impacts of Mercury

## Mercury and human health

Most affected organs



### General Exposure



Large predatory fish



Vegetables from contaminated soils



Cosmetics, Soaps



Use and damage products containing mercury



Waste

### Occupational Exposure



Manufacturing of products containing mercury



Industry



Artisanal and small-scale gold mining

Source: United Nations Environment Programme, ST Graphic: Nalin Boonwong



**MERCURY, Mercury Based QUIPMENTS, PRODUCT & WASTES**





च.नं. १(अ)

नेपाल सरकार  
**स्वास्थ्य तथा जनसंख्या मन्त्रालय**  
नीति, योजना तथा अन्तर्राष्ट्रिय सहयोग महाशाखा



रामशाहपथ,  
काठमाण्डौ  
फोन : ४२६२८६२,  
फ्याक्स : ४२६२८९६

मिति : २०६९/१२/१५

विषय : मर्करीयुक्त उपकरणहरुको आयात बन्द गर्ने सम्बन्धमा ।

श्री स्वास्थ्य सेवा विभाग, टेकू ।

श्री औषधि व्यवस्था विभाग, विजुलीबजार ।

श्री आयुर्वेद विभाग, टेकू ।

नेपाल सरकार (सचिवस्तर) वाट २०६९/११/२१ मा आगामी आ.व. २०७०/७१ देखि नेपाल सरकारले मर्करीयुक्त उपकरणहरु खरिद र उपयोग बन्द गर्ने र निजी क्षेत्रलाई पनि खरिद उपयोग नगर्न अनुरोध गर्ने निर्णय भएको हुँदा सोही अनुसार गर्न गराउनु हुन निर्देशानुसार अनुरोध गर्दछु ।

(कविराज खनाल)

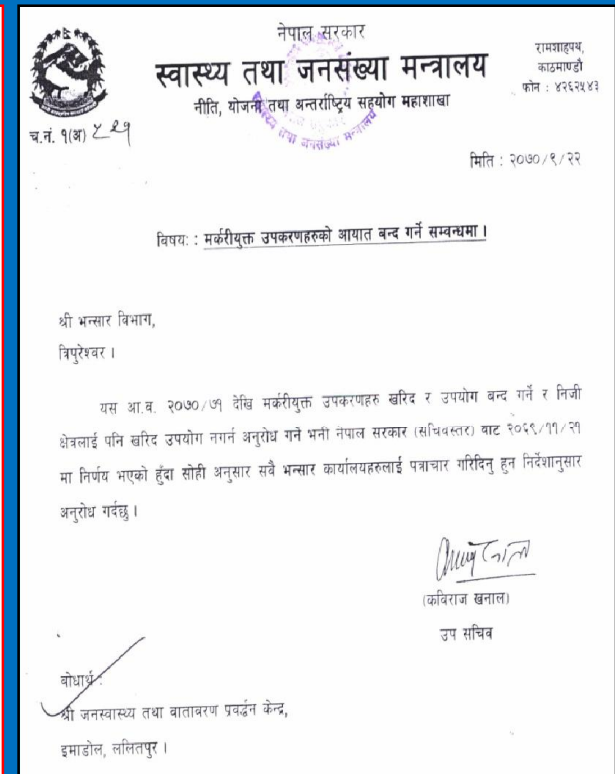
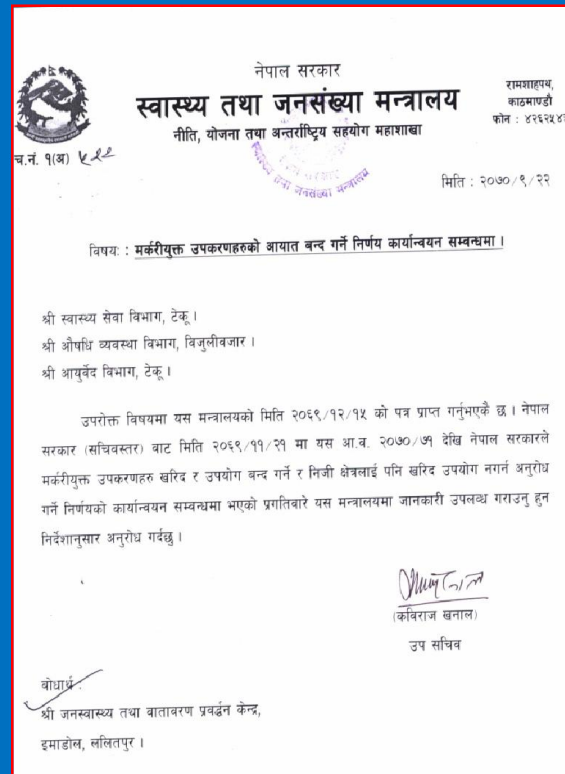
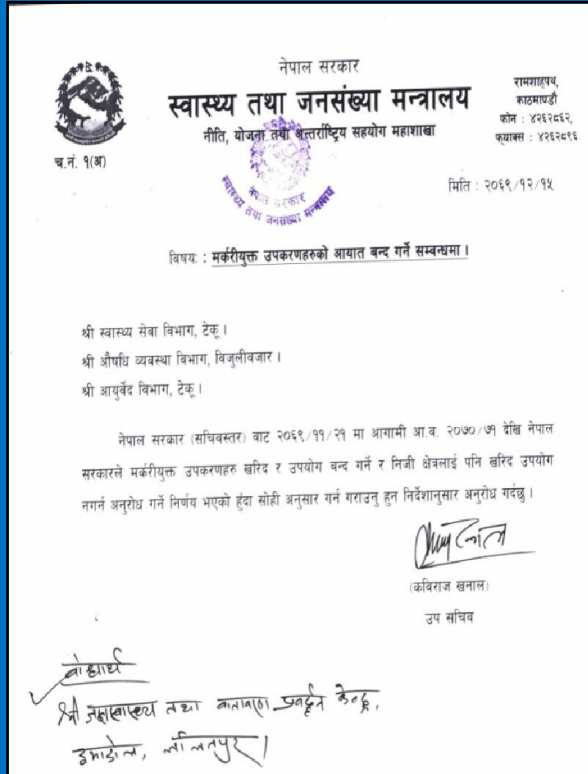
उप सचिव

✓ बोद्धार्थ

श्री जहा स्वास्थ्य तथा जनसंख्या प्रवर्द्धन केन्द्र,  
डुम्राडोल, ललितपुर ।



# Government of Nepal, Ministry of Health and Population (MOHP) banned the Import, Purchase and Use of Mercury based equipments effective from July 16<sup>th</sup> 2013



- (1) Government of Nepal ,Ministry of Health and Population (MOHP) decision
- (2) Follow up letter for effective implementation of the decision
- (3) Letter to the custom department to complete ban the import of mercury based equipments from all entry points.

Additionally, there was a open letter to be sent to anyone relevant person and institutions.





# Conclusion

- Results of mercury in hair of volunteers from **Fisher Folks Community** raise concerns because in more than half number of cases they are higher than US EPA reference dose.
- Results of this study show the need to look closer at mercury levels in both fish and hair in all the areas which depend more on fish diet and have repeated occupational exposure such as Fisher Folks, Fish eating population and Dental health professional, in Nepal.
- There is a high possibility of increased and repeated sources of mercury exposure in our daily consumable items and surrounding environment.



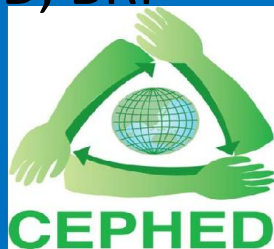
# Recommendations

1. It is **important to recognize the mercury pollution** that mercury once it gets into ecosystem and our bodies also undergoes bioaccumulation and biomagnifications.
2. Time to think **to initiate the appropriate legal and institutional framework** to address the mercury contamination
3. This calls for immediate attention from the concerned government agencies like MOHP and MOEST to work together and **brings mercury free health care policy as well as environment sound management of end-of-life management** of all mercury and mercury based products and waste at earliest possible.
4. The first and foremost things are to **make better choice of shifting from mercury base to non mercury** base practices, products and processes to save our self and future generation and environment.
5. MOHP, MOAgD, MOSTE , NEFIS, FAO should promote more and large study of bio –monitoring of Mercury and other toxic chemicals into aquatic ecosystem and human population.
6. All government and professional Society like **NEFIS should think of Mercury and other toxic pollution issue in the aquatic ecosystem and thus into the Fish and Depending as well as consuming communities.**
7. Immediate ratify the Minamata Convention on Mercury and take advantage from accessing required technical and financial assistance from the Convention secretariat and others.



# Our Initiatives involves

- Researches e.g. bio-monitoring to product testing
- Policy dialogue with government
- Publications and IEC Materials
- Awareness raising and capacity building
- Model development pilot projects
- Working with
  - Government & Development Agencies
  - Professional Associations
  - Hospitals and Health Care Professional
  - Media and Grass Root Communities
  - National and International Networks (IPEN, EEB, WAMFD, BRI etc.



# अब पारोयुक्त उपकरण प्रयोगमा प्रतिबन्ध

राजेश बर्मा

लाई पत्राचार गरिएको जानकारी दिए। विज्ञान प्रयाश्रल। यसले सुने र हेर्ने शक्तिमा हाम्रै ल्याउनुका साथै आन्तरिक विकसामा

काठमाडौं, २४ वैशाख : सरकारले आगम आर्थिक वर्षदेखि चारै (मकरी) युक्त उपकरण प्रयोगमा प्रतिबन्ध लगाउने तयारी गरेको छ। पारोयुक्त उपकरणले जनस्वास्थ्यमा प्रतिकूल असर पार्न सक्ने भएकाले आर्थिक वर्ष २०७०/७१ देखि यसका निर्मित उपकरण खरिद, आयात र उपभोग प्रतिबन्ध लगाउने तयारी गरिएको हो।

स्वास्थ्य तथा जनसंख्या मन्त्रालयको गत फागुन २१ गते बसेको सचिवालय बैठकले पारोयुक्त उपकरण खरिद, आयात र उपभोगमा प्रतिबन्ध लगाउने निर्णय गरेको थियो। मन्त्रालयका उपसचिव कविता खनालका अनुसार पारोयुक्त उपकरण जनस्वास्थ्यमा विभिन्न असर पुर्‍याउँदै आएका प्रतिबन्ध लगाउने निर्णय गरिएको हो। उनले आगम आर्थिक वर्षदेखि यसको आयात, विक्रीवितरण प्रयोगमा प्रतिबन्ध लगाउन स्वास्थ्य सेवा विभाग, औषधि व्यवस्था विभाग, आवुर्वेद विभाग जनस्वास्थ्य तथा वातावरण प्रवर्द्धन केन्द्र (सिफेड



## Nepal signs UN mercury convention

**POST REPORT**  
KATHMANDU, OCT 10

The government on Thursday became the signatory to the United Nations Minamata Convention on Mercury, a legally binding global framework formulated to ban, export and import of a range of mercury containing products by 2020.

A government delegation led by the Ministry of Science, Technology and Environment during a two-

day meeting held in Kumamoto in Japan from October 10-11 agreed to this effect to prevent emissions and releases causing serious public and environmental impacts, said a spokesman.

The treaty, signed by 93 countries on October 10, including Nepal, in Kumamoto, Japan, has been named after the place where thousands of people were poisoned by mercury in the mid-20th century.

The United States has become the first nation to complete the final step

after Kerri-Ann Jones, Assistant Secretary of States for Oceans and International Environmental and Scientific Affairs deposited the 'instrument of acceptance' at the United Nations headquarters on Wednesday.

Dr Jones said, "The Minamata Convention is a major step forward to address mercury exposure and improve public health. The UN Environment Programme's essential role in facilitating the successful negotiation of this convention is deeply appreciated. The US is pleased to be able to join the Convention."

Nepali environment activists have demanded the government to ratify the convention. Center for Public Health and Environmental Develop-

ment, which is working in collaboration with the government and non-governmental organisations in the fight against lead and mercury poisoning, warned that mercury pollution was taking a serious toll on the health of the people.

Mercury's impacts on the human nervous system include impaired thyroid and liver function, irritability, tremors, vision problems, memory loss and cardiovascular problems.

Steiner added, "UNEP has been proud to facilitate and support the treaty negotiations because almost everyone—be they small-scale gold miners, expectant mothers or waste-handlers in developing countries—will benefit from its provisions."

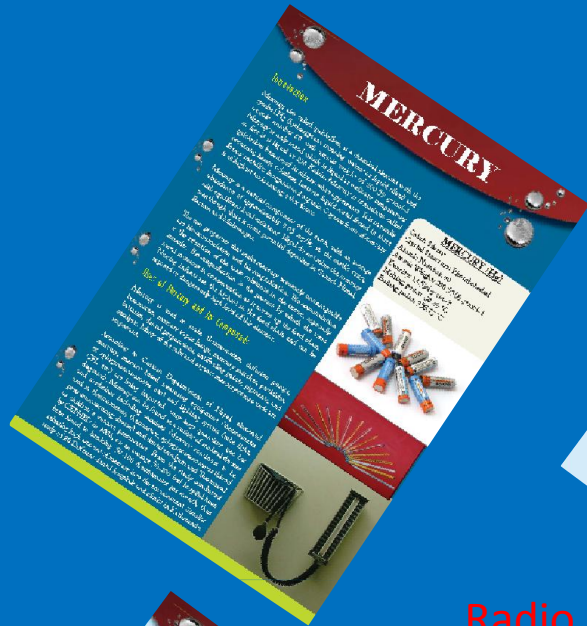
## Nepal urged to ratify mercury convention

# TV & RADIO

# Large Number of Media outreach

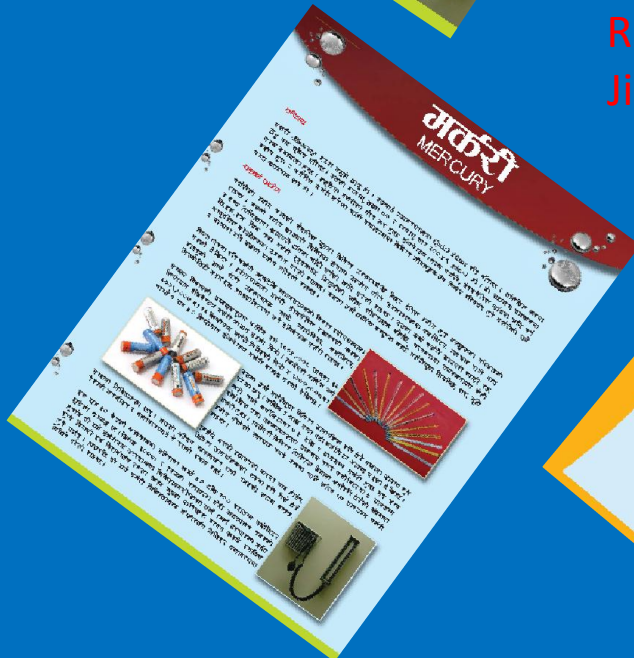


# IEC Materials: Fact Sheets, Video and Radio

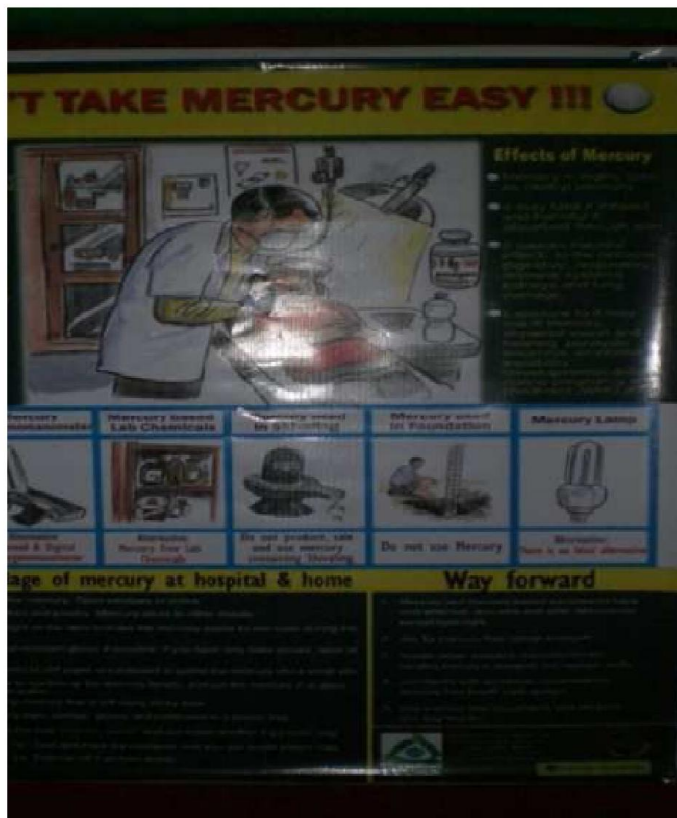


Radio  
Jingle

Video  
Documentary



# IEC Material Production and Disseminations for mercury free health care services and Awareness



Poster on Mercury Free Health Care Services with WHO

Figure 21. CEPHD Poster on Mercury Adapted by Management Division, DOHS/MOHP, Government of Nepal





# THANK YOU

For More details:

[www.cephed.org.np](http://www.cephed.org.np)

Dial: 1618015201786



# **Effect of Different Feeds on Growth and Survival of Gardi (*Labeo dero*) fry**



**Surendra Prasad, Jay D Bista, Ram P Dhakal, Agni P Nepal  
and Md A Husen**

**Fisheries Research Station, Pokhara**



# Introduction

- Gardi (*Labeo dero*) is a native riverine fish species that is relatively easy to breed and rear, thus considered to be suitable for aquaculture
- Fry rearing is one of the important phase and aims at obtaining high growth and survival for production of fingerlings required for stocking into grow out ponds as well as rehabilitation in natural habitat
- Past study had showed gardi could accept artificial food in captivity however, specific studies on different composition of feed and dietary evaluation is limited

# **Objective**

- **To evaluate the effect of three different formulated diets on growth and survival of gardi fry for farming in pond and other aquaculture systems.**

# Methodology

- **Treatment: 3**
  - T1: Micro feed (Practiced at station)**
  - T2: Powdered milk (commercially available) with egg**
  - T3: Soy milk**
- **Replication: 3**
- **Stocking density: 1 million/ha (200/hapa ) in pond**
- **Stocking size: 4 days old**
- **Feeding: 2 times a day**
- **Growing period: 44 days**
- **Water quality parameter were recorded on sampling days**
- **Place: Fisheries research center, Phewa, Pokhara (year 2012-13)**

### Proximate analysis of feed

SN.	Feed Name	CP %	C. Fat %	Moistur e %	C. Ash %
1	Micro feed	43.11	10.67	8.0	
2	Soybean	42.06	8.18	9.6	6.37

### Nutrition Information of Powdered milk by manufacturer\*

SN		Per 100 g powder	
1	Energy	Kj Kcal	2140 510
2	Protein	g	24.1
3	Carbohydrate	g	37.7
4	Fat	g	28.0
5	Vitamin A	µg	350
6	Vitamin D3	µg IU	5.0 200
7	Vitamin C	mg	50
8	Calcium	mg	930

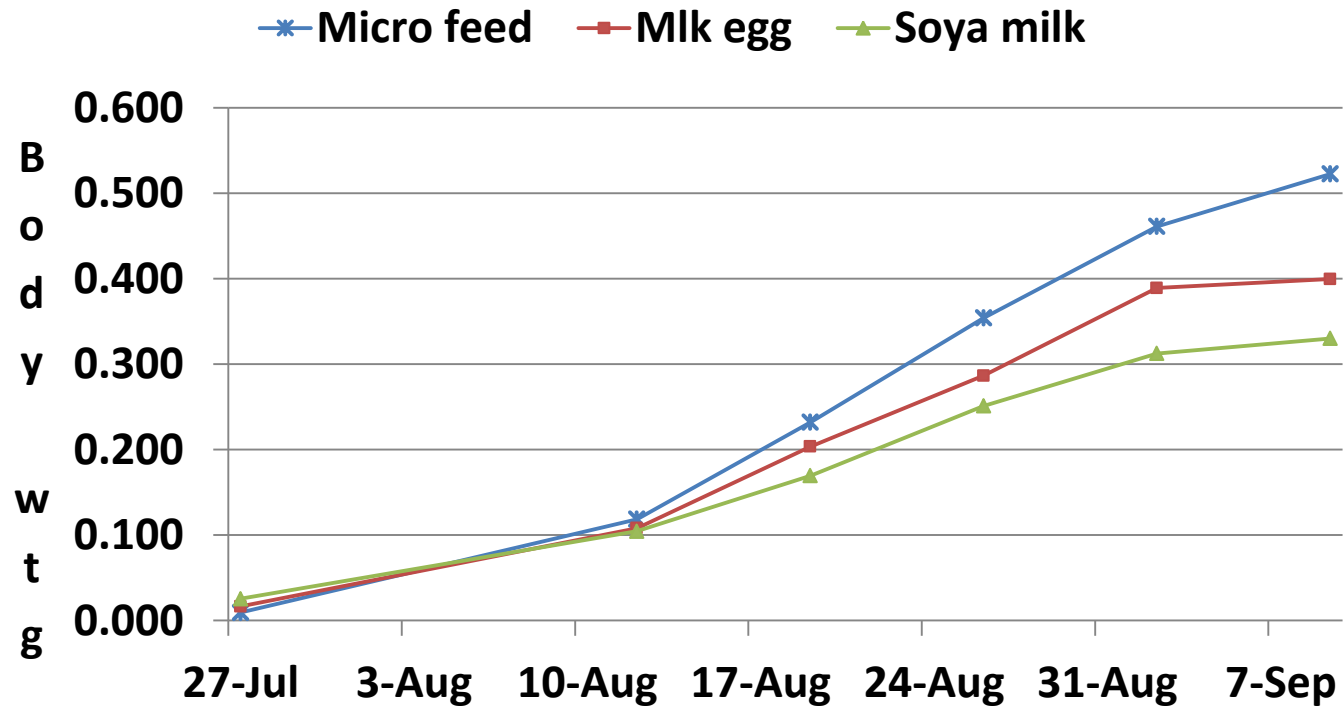


# Results

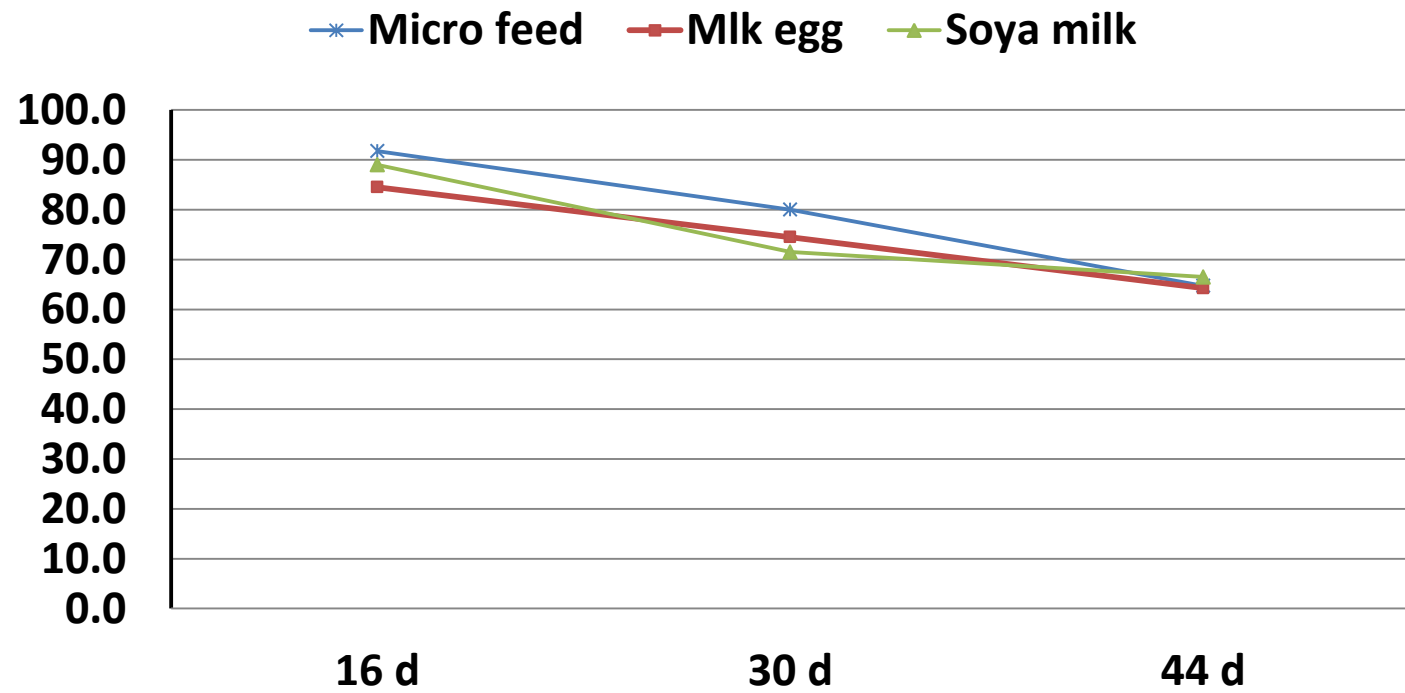
## Water quality

Parameter	27-Jul	12-Aug	19-Aug	26-Aug	2-Sep	9-Sep
DO	7.6	7.7	6.3	8.8	6.9	7.8
Temp 0C	28.3	28.1	29	29.5	29	28.7
pH	7.1	7.5	7.4	7.5	7.8	7.7

## Growth curve

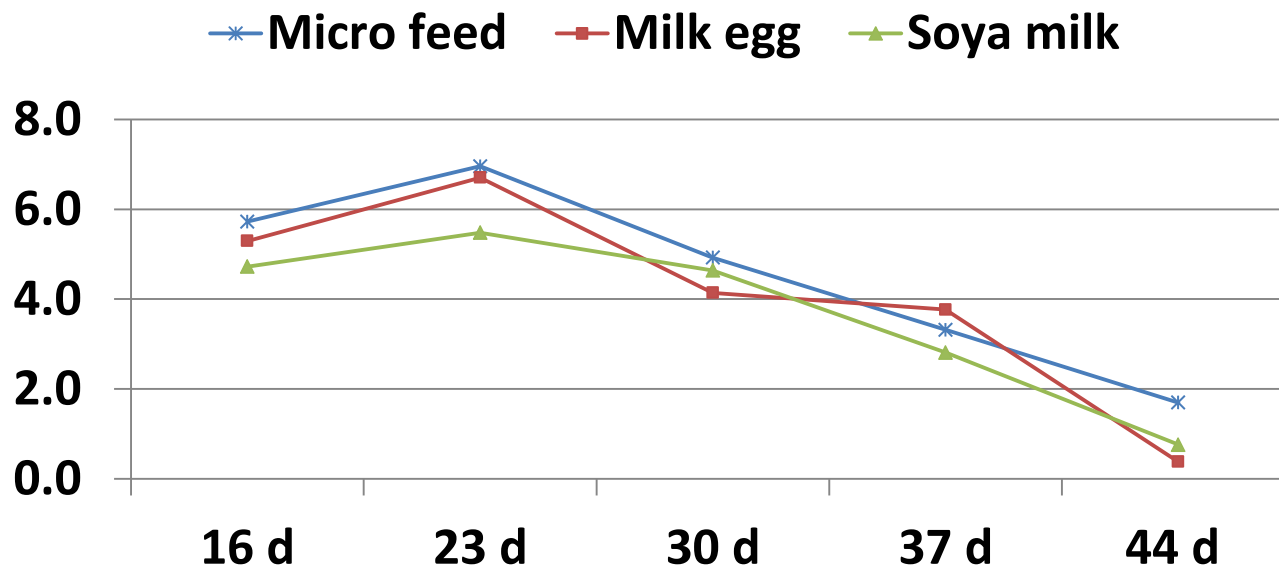


## Survival %





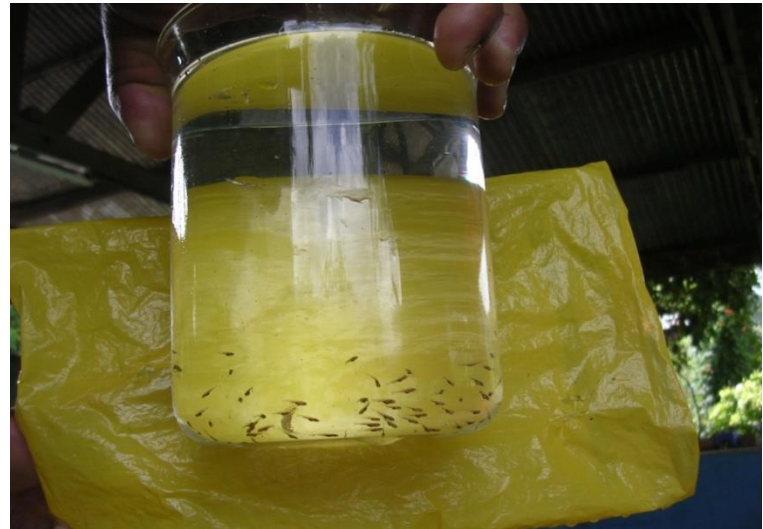
## Relative growth rate %



# Growth parameter

Parameter	Micro feed	Milk powder + egg	Soy milk
Total number of fry stocked	200	200	200
Initial mean weight (g) ± SD	0.010±0.004	0.017±0.012	0.026±0.001
Final mean weight (g) ± SD	0.52±0.080 <sup>a</sup>	0.40±0.029 <sup>b</sup>	0.33±0.034 <sup>c</sup>
Relative growth rate ( % day)	2.23 <sup>ns</sup>	2.18 <sup>ns</sup>	2.10 <sup>ns</sup>
Survival % ± SD	64.8 <sup>ns</sup>	64.3 <sup>ns</sup>	66.5 <sup>ns</sup>

## Gardi fry of different age group



## **Conclusion**

- **The result suggested that there was a apparent effect of different diets at the level tested on body weight gain but growth of gardi fry was significantly better with micro feed containing high animal protein**
- **Although growth was comparatively poor, soymilk was equally better to increase survival**



**THANKS**

Thanks

# Improving National Aquaculture Seed Production System



**RAMA NANDA MISHRA**

Program Director

Directorate of Fisheries Development

# Aquaculture in Nepal

- Nepal being land locked has only fresh water aquaculture and contributed 63% in national production last year.
- It is limited to pisci-culture.
- Pond aquaculture contributes nearly 90% in aquaculture production
- Poly-culture of carp is major aquaculture practice.
- Carp contribute more than 95% in total aquaculture production in Nepal of which 70% is contributed by exotic species.
- Success of aquaculture is very much dependent on availability of quality fish seed

**Total Fish Production 57,520 mt.**

**Capture Fisheries 21500 mt.**

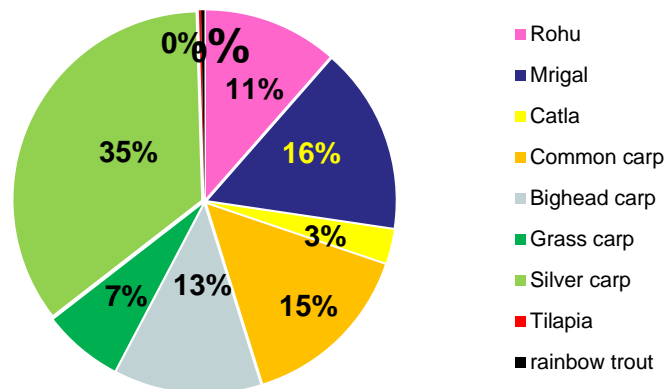
**Culture Fisheries 36020 mt.**

**Employment 551,000**

**AGDP contribution 2.61%**

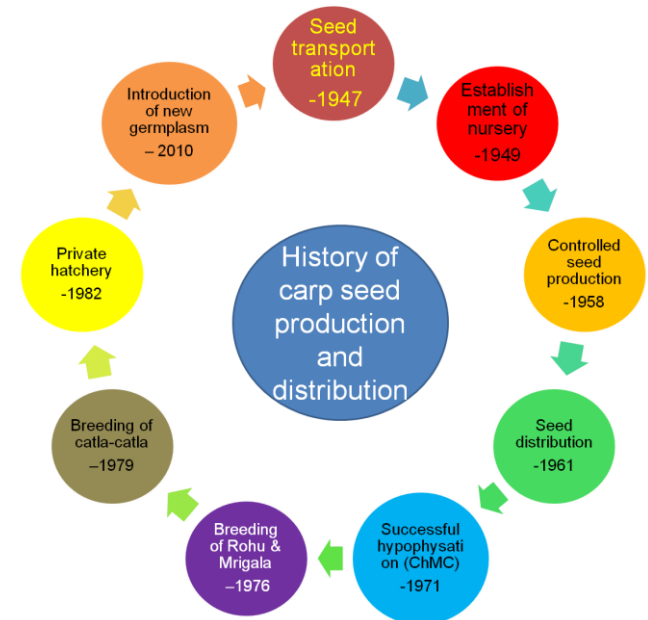
**Per capita availability 2.1 kg.**

**NGDP contribution 0.93 %**



# Status Of Fish Seed in Nepal

- ❑ There is no wild collection of seed for aquaculture in Nepal.
- ❑ Carp seeds are produced in sufficient quantity by the hatcheries.
- ❑ The total carp seed requirement for 2013/14 is 180 million.
- ❑ The share of Private sector in carp seed production has reached 81 % .





contd.

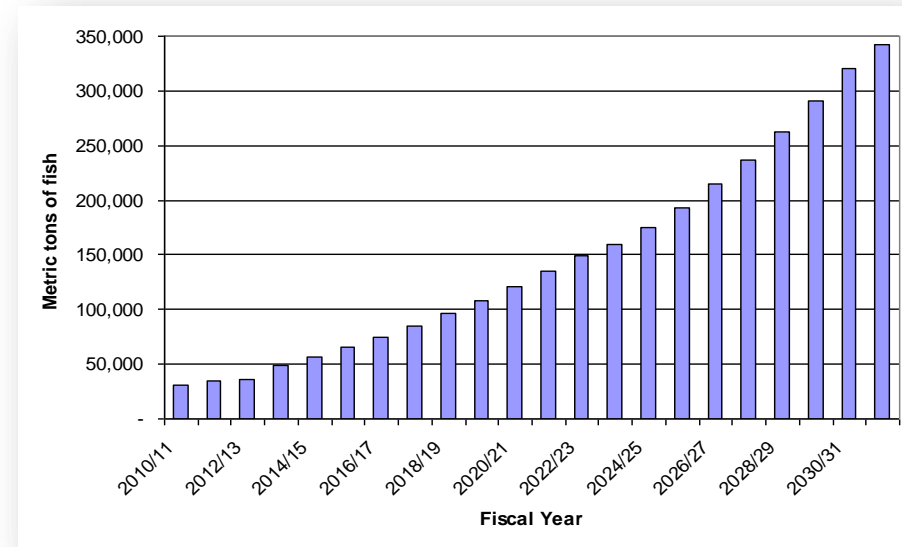
- ❑ There is neither geographical nor regional balance in fish seed production.
- ❑ Hatcheries are concentrated in central and western region.
- ❑ Fish nurseries are also not expanded to larger geographical area.
- ❑ Indian seeds occupies quite good share in eastern and far-western region.
- ❑ Most of the seeds for aquaculture of other species (*Clarias*, *Pungassius* etc.) come from India.

# The Issues of quality

- ❑ Genetically degraded brood stock due to inbreeding, uncontrolled cross breeding, unintended selection and broodstocks of unknown pedigree.
- ❑ Poor brood stock management and hatchery operation practice
- ❑ It has been often reflected in farmers' complaints in terms of :
  - ▶ slow growth and poor survival
  - ▶ reduction in reproductive performance
  - ▶ increased incidence of disease and morphological deformities

# Issues of quantity

- ❑ There are 67 (only 33 functional) private and 14 public fish hatcheries in Nepal
- ❑ 222 private fish nurseries are in operation
- ❑ Most of the seeds for aquaculture of other species (*Clarius*, *Pungassius* etc.) come from India.
- ❑ Around 20 fish seed distributors are involved in the business.
- ❑ No permission is required to do seed business resulting in unhealthy competition

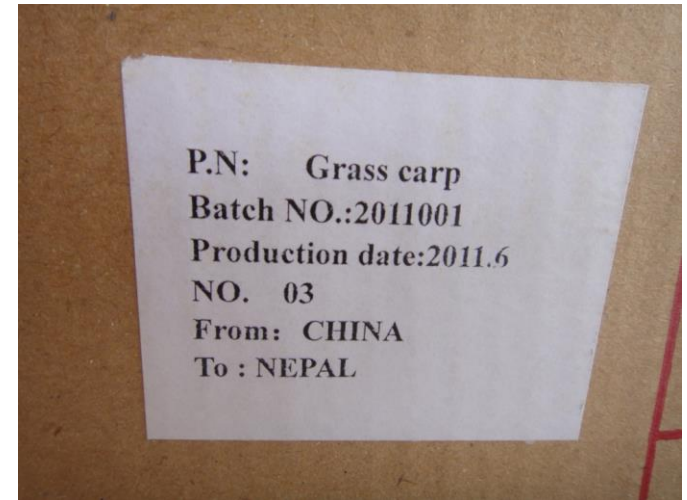


Year	Carps	Tilapia	Catfish	Trout	Total
2012/13	115190	-	-	1000	116,190
2031/32	4313,528	160,556	194,250	19,531	4,687,865

• In 17 years from now we need 4 times more seed

# Efforts so far

- ❑ Introduction of New strains of carps ( Common carp, Silver carp, Bighead carp, Grass carp and Rohu )
- ❑ Initiation of genetic Improvement program for common carp at FRC, Pokhara
- ❑ Establishment of Molecular lab at FRD Godavari and cryo- lab at FDTC, Janakpur.
- ❑ Capacity building in the field of genetics and seed production
- ❑ Preparation of fish seed production and distribution system.
- ❑ Drafting fish seed Act.
- ❑ Identification and strengthening of Nuclear breeding Centres





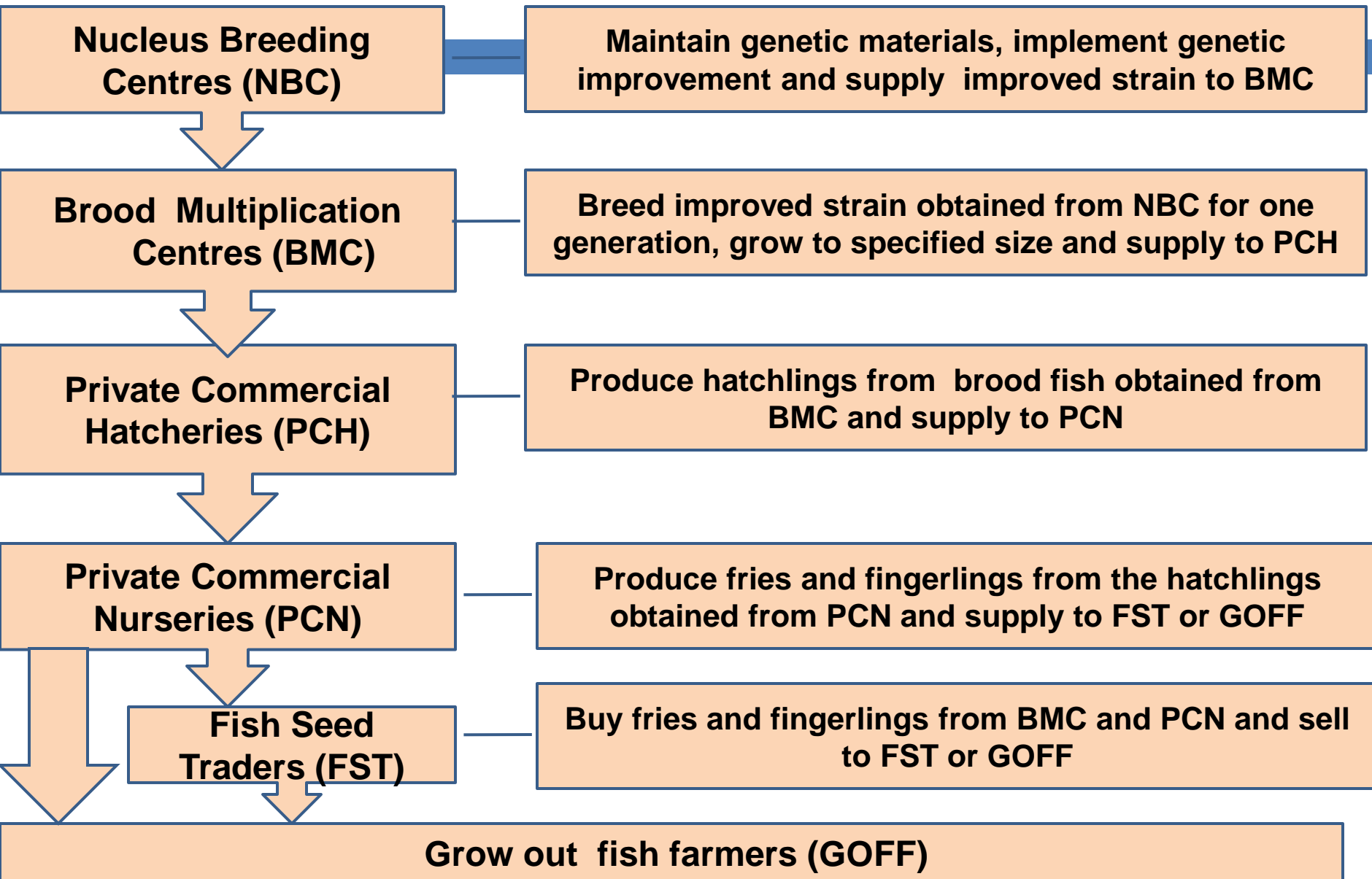
# Highlights of the proposed Fish seed Act

- No person, society, association, farm or body of persons shall carry on production, marketing, sale, storage, supply, export or import of fish seed without first being registered
- Seed not conforming to standard cannot be marketed
- no one can import from abroad any live fish, spawn, fries or post larvae without prior approval
- All the hatchery has to use the certified broods for seed production
- All fish nurseries has to obtain seeds from accredited hatcheries for further rearing
- Fish seed traders/vendors can sale only certified seeds.

# **Hatchery accreditation and seed certification**

- All Public / Private hatcheries/ nurseries will have to get accredited / registered.
- The accredited hatcheries / nurseries will certify its seeds themselves. However, accredited hatcheries/nurseries will be inspected regularly by the concerned authority against its processes and products

# National Fish Seed Production and Distribution System

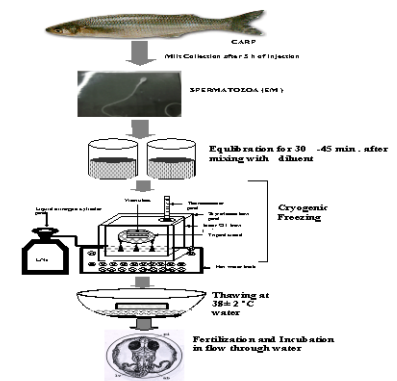


# Approaches for Genetic Improvement of Carp in Nepal

- ❑ Selective breeding program for existing stock of common carp
- ❑ Line/strain maintenance of reintroduced carp
- ❑ Inclusion of wild gene pool of IMC
- ❑ Collection and use of cryo- milt from wild/improved strains for stock upgradation



*cryopreservation protocol for carp spermatozoa*





# Gaps

12

- ❑ Lack of quality brood-stock of major cultured species
- ❑ Lack of institutional support and operational system for effective management of quality fish seed production and distribution
- ❑ No genuine genetic improvement program been effectively implemented
- ❑ No systematic capacity (human & physical) for fish genetic improvement program in the field
- ❑ The draft National Seed Act and regulation is yet to be finalized and approved by the legislative body for enforcement;
- ❑ Standard fish hatchery operational procedure/code of conduct to be internalized and implemented by the hatchery operators

# Future effort should focus on

- Implement national fish seed production system
- Strengthen the capacity of private as well as public sector
- Construction of New hatcheries in deficit areas
- Establishment of nurseries nearest to the production area and networking with hatcheries.
- Improve seed distribution mechanism
- Provide adequate public support and services to private sector hatcheries and Nurseries
- Encourage establishment of monosex tilapia and pangassius hatcheries in private sector.

- ❑ Establish brood bank for quality brood supply in required quantity
- ❑ Maintain pure line and the pedigree of the broods
- ❑ Use cryo-milt for immediate stock improvement
- ❑ Maintain proper genetic protocol in fish breeding
- ❑ Carry out regular genetic improvement program
- ❑ Develop adequate human capacity in the field of fish genetics
- ❑ The National Seed regularitary system should be made effective
- ❑ Standard fish hatchery operational procedure/code of conduct must be implemented by the hatchery operators

# Way Forward

The effort for **improving national aquaculture seed production system** has been initiated which needs commitment and support of all concerned.





**Thanks for Patience  
and Time**

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**Thank You  
For  
your patience**