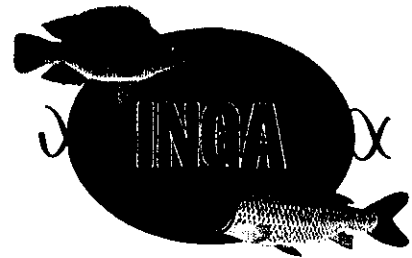




INTERNATIONAL
NETWORK
ON GENETICS
IN AQUACULTURE



**A Global Forum
for Collaborative Research and Training
in Applied Fish Breeding and Genetics**



FUTURE HARVEST

The **INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT (ICLARM)** supports Future Harvest, a public awareness campaign that builds understanding about the importance of agricultural issues and international agricultural research. Future Harvest links respected research institutions, influential public figures and leading agricultural scientists to underscore the wider social benefits of improved agriculture—peace, prosperity, environmental renewal, health and the alleviation of human suffering. Visit its web page at <http://www.futureharvest.org>

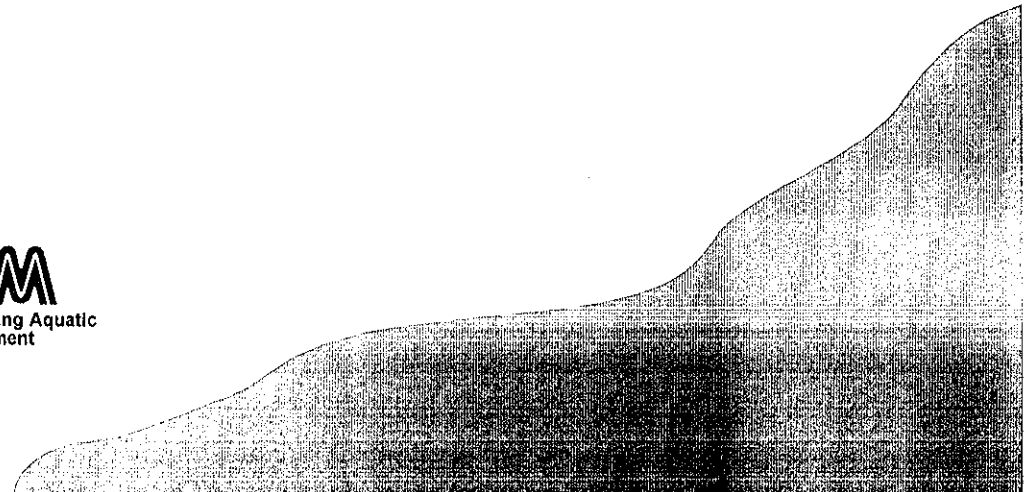
International Network on Genetics in Aquaculture



Modadugu V. Gupta
Belen O. Acosta

1999

ICLARM
International Center for Living Aquatic
Resources Management



International Network on Genetics in Aquaculture

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and Training in Applied Fish Breeding and Genetics

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LIST OF ACRONYMS

AADCP	ASEAN Aquaculture Development Coordination Program
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AKVAFORSK	Institute of Aquaculture Research Ltd. (Norway)
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
CIFA	Central Institute of Freshwater Aquaculture (India)
CNRA	Centre National de Recherche Agronomique (Côte d'Ivoire)
FAO	Food and Agriculture Organization of the United Nations
GIFT	Genetic Improvement of Farmed Tilapias
ICAR	Indian Council of Agricultural Research
ICLARM	International Center for Living Aquatic Resources Management
IDRC	International Development Research Centre
INFIGRAD	Indonesian Network on Fish Genetics Research and Development
INGA	International Network on Genetics in Aquaculture
NACA	Network of Aquaculture Centres in Asia and the Pacific
SEAFDEC	Southeast Asian Fisheries Development Center
SIFAR	Support Unit for International Fisheries and Aquatic Research
UNDP/DGIP	United Nations Development Programme / Division for Global and Interregional Programmes
WRI	Water Research Institute (Ghana)

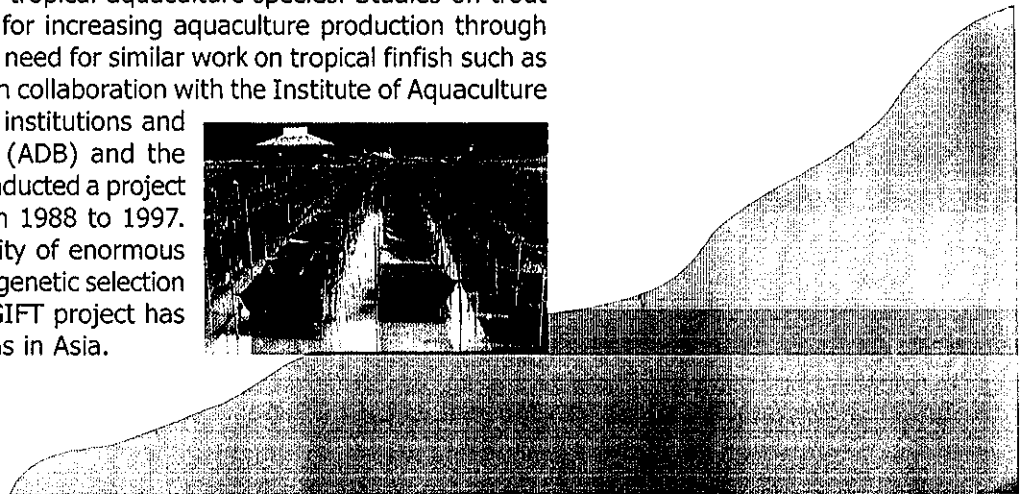
BACKGROUND AND RATIONALE

Fish forms the primary source of animal protein for about one billion people, mostly in developing countries. It contributes as much as 70% of the animal protein intake in some of these countries. Population growth projections indicate that, at a conservative estimate, the demand for food fish will be in the range of 110 to 120 million tonnes (live weight) for the year 2010 as compared to 75 to 80 million tonnes in 1994-95. Available information indicates



that the potential for increasing production from capture fisheries is limited as many of the stocks have either been overexploited or have reached their maximum sustainable yields. On the other hand, aquaculture has increased its contribution to world fisheries production and maintains its position as one of the fastest growing food production sectors in the world. This points to the need for looking at means of increasing production of fish through aquaculture to meet the increasing demand.

Remarkable achievements have been made in the last four decades in increasing the production of crops, livestock and poultry through genetic research and application of breeding programs. Even though the tradition of fish farming dates back thousands of years, scientific breeding and genetic selection techniques have not been used until recently, especially in the case of tropical aquaculture species. Studies on trout and salmon in Norway have clearly indicated the potential for increasing aquaculture production through the application of quantitative genetics. ICLARM realized the need for similar work on tropical finfish such as carps and tilapia, the main species for tropical aquaculture. In collaboration with the Institute of Aquaculture Research in Norway (AKVAFORSK) and Philippine research institutions and with financial support from the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP), ICLARM conducted a project on the genetic improvement of farmed tilapias (GIFT) from 1988 to 1997. This pioneering work has clearly demonstrated the possibility of enormous gains in the production of tropical finfish through a systematic genetic selection program. The strain of Nile tilapia developed through the GIFT project has shown a 60-70% higher growth as compared to local strains in Asia.



INGA IN BRIEF



Establishment

A series of meetings among senior scientists from national institutions in Asia and Africa, advanced scientific institutions, international organizations, and donor agencies, were sponsored by ICLARM and UNDP/DGIP during 1990 and 1992. The need for enhancing fish

genetics research and developing collaborative linkages that could help establish national breeding programs was recognized. The prospects for genetic improvement of tropical finfish had been demonstrated by the GIFT project and the success of an international networking approach for rice genetic improvement suggested the need for the establishment of an aquaculture genetics network. In July 1993, the International Network on Genetics in Aquaculture (INGA) was formed.

Objectives

Primary

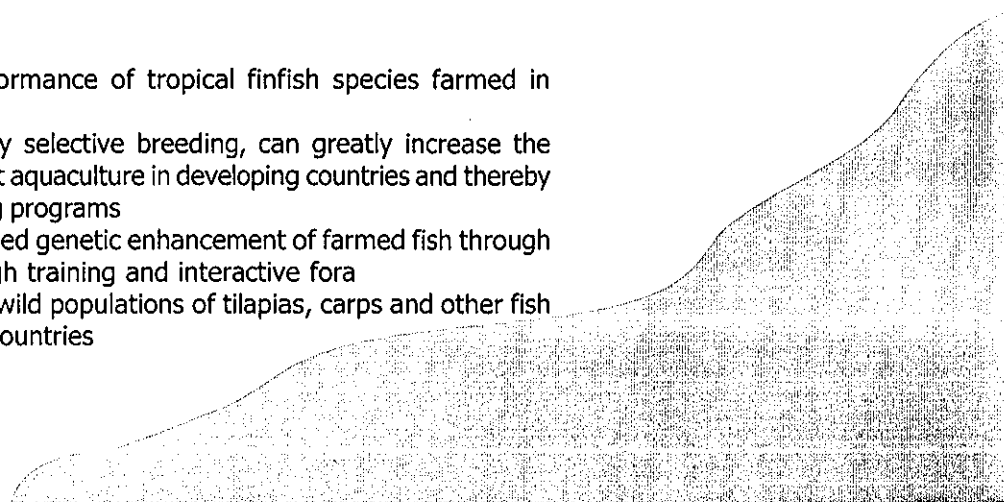
To increase the quantity and quality of fish protein consumed by low-income rural and urban people in tropical developing countries through efficient breeding and selection programs that will increase aquaculture production and increase the incomes of resource-poor fish farmers. The aim is to develop sustainable systems, in harmony with the natural environment, to benefit both producers and consumers.

Immediate

- Assess the needs and opportunities for the application of genetics to aquaculture
- Strengthen national research capacity for continued genetic enhancement of farmed fish
- Facilitate exchange of information, methods, boost efficiency and stimulate thinking in genetics research
- Facilitate exchange of germplasm
- Foster regional and international cooperation in aquaculture genetics research
- Contribute to the domestication of tropical finfish through collaborative research
- Evaluate the performance of promising lines of tilapias and carps
- Assist in the development of strategies for national fish breeding programs

Long-term

- Contribute to the domestication and sustainable performance of tropical finfish species farmed in developing countries
- Demonstrate that the application of genetics, especially selective breeding, can greatly increase the productivity, profitability and sustainability of low-cost input aquaculture in developing countries and thereby generate support for self-sustaining national fish breeding programs
- Strengthen the long-term national capabilities for continued genetic enhancement of farmed fish through exchange of germplasm and methodologies, and through training and interactive fora
- Strive for the conservation of biodiversity in farmed and wild populations of tilapias, carps and other fish species prominent in inland aquaculture in developing countries



Management

INGA is jointly owned and managed by member countries and ICLARM. Participating institutions and ICLARM together conduct research and make the results available to all members for information and follow-up strategies. The products of research (improved fish breeds) are exchanged among member countries.

The network's program is guided by a Steering Committee, comprising one senior scientist from each of the member countries and ICLARM. The Committee meets annually to review progress and formulate plans for further collaborative research activities. In addition to the annual meeting of the Steering Committee, regional meetings for Asia and Africa are organized to ensure that the network research agenda addresses the needs and priorities specific to the region. Within each member country, a national network for aquaculture genetics is formed to serve as a forum for information exchange among local scientists and with those in other countries.

ICLARM, as an international center with experience in the application of genetics in aquaculture, coordinates the activities of the network. This involves facilitating exchange of information, methodologies and genetic materials among the network members, organizing training programs, workshops, cross country visits of member country scientists and preparation and distribution of research reports. It operates the network in close collaboration with other regional and international organizations (e.g., NACA, SEAFDEC, SIFAR, FAO) and advanced scientific institutions (e.g., AKVAFORSK) so that their expertise can be used to assist in research and training needs of the members and to seek support for the INGA activities with donor organizations (e.g., ADB, ICLARM, IDRC, Norwegian Ministry of Foreign Affairs and UNDP).

Participation

INGA initially consisted of 11 member countries from Asia and Africa: Bangladesh, People's Republic of China, Côte d'Ivoire, Egypt, Ghana, India, Indonesia, Malawi, the Philippines, Thailand and Vietnam. Fiji and Malaysia joined the network in 1996. The member countries represent a range of aquaculture production systems, technical skills and socioeconomic conditions. ICLARM participates in INGA as a member and as its Research Coordinator.

Box 1: List of INGA Member Countries and Nodal Institutions

Bangladesh

Bangladesh Fisheries
Research Institute
Mymensingh 2201

China

Department of Aquaculture
Shanghai Fisheries University
334 Jun Gong Road
Shanghai 200090

Côte d'Ivoire

Centre National
de Recherche Agronomique
Km 17, Rte de Dabou
01 BP 1740, Abidjan 01

Egypt

Central Laboratory of
Aquaculture Research
National Aquaculture Center
Abbassa, Abou Hammad
Sharkia

Fiji

Fisheries Division
Ministry of Agriculture,
Fisheries and Forestry
PO Box 358, Suva

Ghana

Fishery Division
Water Research Institute
(Council for Scientific
and Industrial Research)
PO Box M32, Accra

India

Central Institute
of Freshwater
Aquaculture (CIFA)
PO Kausalyaganga
Bhubaneswar, Orissa

Indonesia

Research Institute
for Freshwater Fisheries
Jalan Raya 2, Sukamandi
Subang 41256,
Jawa Barat

Malawi

Biology Department
Chancellor College
University of Malawi
PO Box 278, Zomba

Malaysia

Institute of Postgraduate
Studies and Research
University of Malaya
50603 Kuala Lumpur

Philippines

Bureau of Fisheries
and Aquatic Resources
860 Quezon Ave.
Quezon City

Thailand

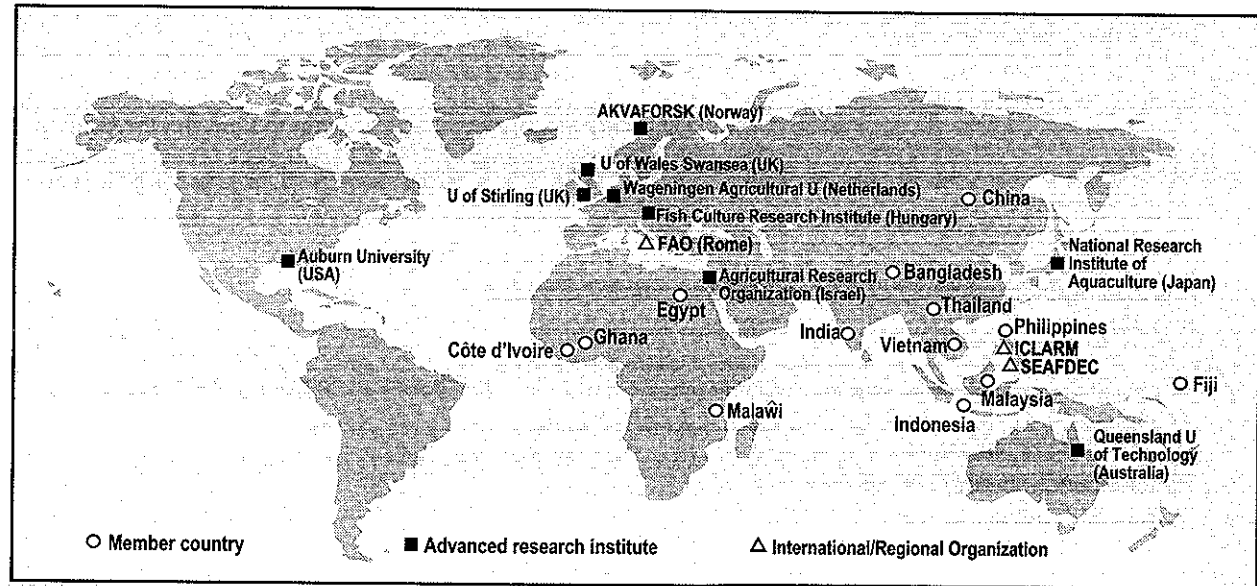
National Aquaculture
Genetics Research
Institute
Tumbon Klongha Amphur
Klonglaung
Pathumthani 12120

Vietnam

Research Institute
for Aquaculture No. 1
Ministry of Fisheries
Dinh Bang, Tien Son
Ha Bac

In addition to 13 member countries, 11 advanced research institutions have joined INGA as Associate Members. These are:

- Agricultural Research Organization (Israel)
- Auburn University (USA)
- Fish Culture Research Institute (Hungary)
- Food and Agriculture Organization of the United Nations (Rome)
- Institute of Aquaculture Research, Ltd. (Norway)
- National Research Institute of Aquaculture (Japan)
- Queensland University of Technology (Australia)
- Southeast Asian Fisheries Development Center, Aquaculture Department (Philippines)
- University of Stirling (UK)
- University of Wales Swansea (UK)
- Wageningen Agricultural University (The Netherlands)



RESEARCH PROFILE OF MEMBER COUNTRIES

For increasing fish production on a sustainable basis, strategic research on germplasm enhancement and breeding is being undertaken in the member countries. This involves the documentation and characterization of economically important fish genetic resources, the utilization of these genetic resources in appropriate breeding programs, and the evaluation of improved products for aquaculture targeted to resource-poor, small-scale producers. As tilapia and carp are the major species of importance for freshwater aquaculture, the activities of the network have been focused initially on these two groups of fish. In Asia, where freshwater aquaculture is well developed, the research is targeted at improvement of breeds of tilapia and carp and evaluation of their performance. In Africa the emphasis is on characterization and evaluation of the native tilapia species for their aquaculture potential.

The aquaculture genetics research being pursued in the member countries of INGA is:



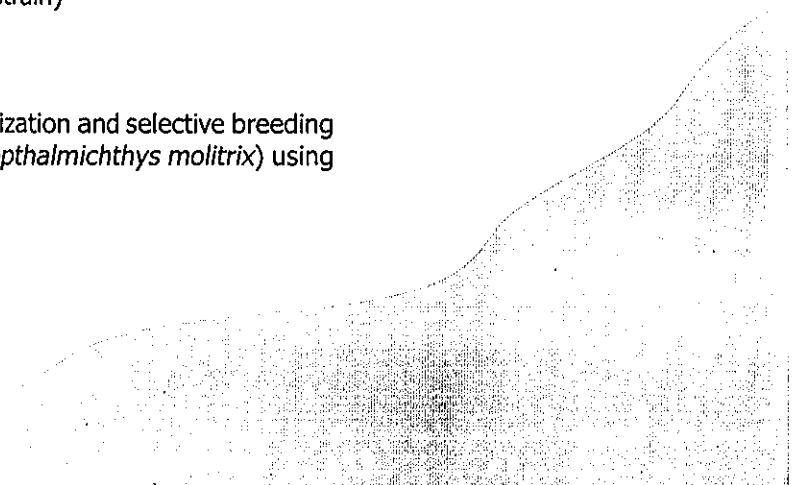
Bangladesh

- Selective breeding of catla (*Catla catla*)
- Genetic manipulation of rohu (*Labeo rohita*) and silver barb (*Barbodes gonionotus*)
- Cross breeding and selective breeding of silver barb
- Continued selective breeding and dissemination of genetically improved Nile tilapia (*Oreochromis niloticus*) (GIFT strain)



China

- Selective breeding of blunt snout bream (*Megalobrama amblycephala*)
- Development of cold-tolerant common carp (*Cyprinus carpio*) through hybridization and selective breeding
- Development of fast growing strains of common carp and silver carp (*Hypophthalmichthys molitrix*) using biotechnological methods (gynogenesis and chromosome manipulation)
- Mass selection for development of fast growing strain of Nile tilapia
- Cross breeding and selective breeding of blue tilapia (*O. aureus*)
- Genetic conservation of aquatic organisms
- Hybridization of Chinese carps, tilapias
- Cell/gene engineering of freshwater fishes



Côte d'Ivoire

- Genetic characterization of the natural populations of Nile tilapia, *Sarotherodon melanotheron* and *Chrysichthys nigrodigitatus*
- Performance evaluation of strains and hybrids of Nile tilapia and introduced tilapia species (*O. aureus*, *O. mossambicus*, *O. macrochir* and *O. hornorum*)
- Evaluation of local tilapia strains in different culture environments and climatic conditions
- Genetic improvement of local tilapia populations by selective breeding



Egypt

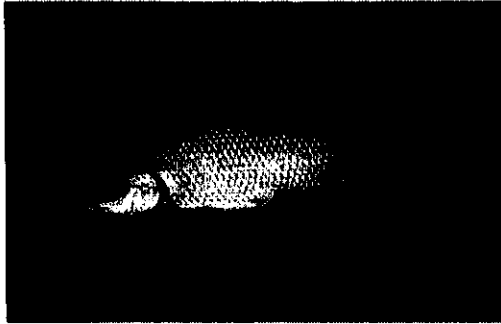
- Growth performance evaluation of local tilapia strains at different salinities
- Genetic characterization (electrophoresis and DNA fingerprinting) of tilapia strains and hybrids
- Evaluation of local tilapia strains in different culture environments (ponds, cages and ricefields)
- Genetic improvement of local populations of Nile tilapia by selective breeding

Fiji

- Evaluation of improved and local tilapia populations for growth performance, survival and reproduction
- Genetic characterization (electrophoresis) of improved and local tilapia populations
- Performance evaluation of GIFT and Chitralada strains of Nile tilapia
- Genetic improvement of tilapia populations by selective breeding

Ghana

- Characterization of various tilapia species (Nile tilapia, *S. galilaeus*, *S. melanotheron*, *Tilapia busumana*, *T. dageti*, *T. discolor*, *T. guineensis*) for conservation and aquaculture purposes
- Evaluation of local tilapia strains in different culture environments
- Genetic improvement of local tilapia populations by selective breeding

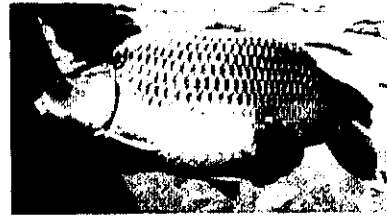


India

- Selective breeding of rohu
- Genetic manipulation of common carp
- Development of appropriate breeding program for catla
- Cryopreservation of spermatozoa of carp and catfish
- Characterization and documentation of fish genetic resources
- *In-situ* conservation and gene banking of selected, endangered and wild strains of fish

Indonesia

- Growth performance evaluation of the improved and local strains of Nile tilapia
- Strain evaluation of common carp
- Development of a national breeding program for the GIFT strain of Nile tilapia
- Selective breeding of common carp

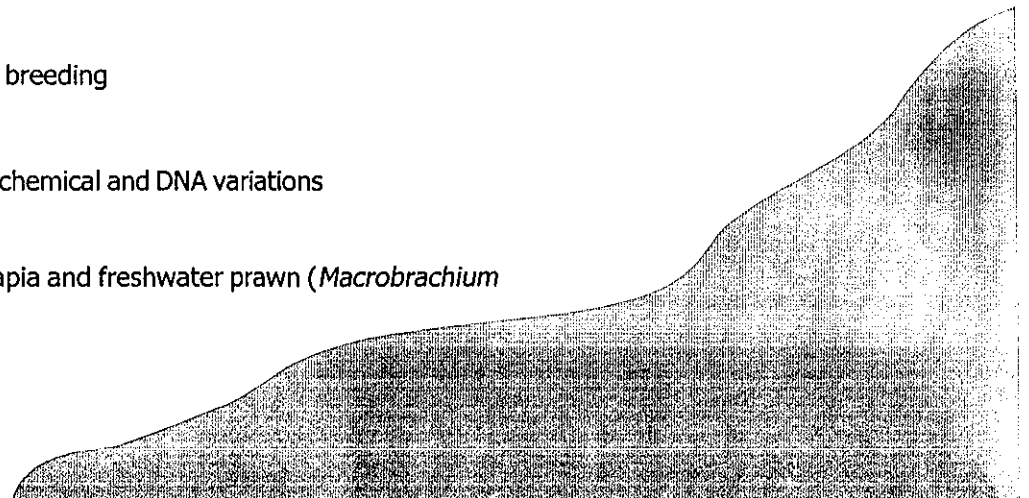


Malawi

- Documentation of indigenous knowledge of different tilapia strains/species in aquaculture
- Genetic characterization of local tilapia populations
- Strain evaluation of local tilapia populations
- Genetic improvement of native tilapia species by selective breeding

Malaysia

- Genetic characterization of tilapia populations through biochemical and DNA variations
- Hybridization in *Oreochromis* sp. and *Clarias* sp.
- Population genetics of riverine cyprinids
- Selection experiments for genetic improvement of red tilapia and freshwater prawn (*Macrobrachium rosenbergii*)
- Induction of triploidy in *Clarias* sp.





Philippines

- Continuous selective breeding of Nile tilapia (GIFT strain) for growth and frequency of sexual maturation
- Selection for fast growing red tilapia
- Selection for salinity tolerant tilapia
- Genetic manipulation for improved tilapia
- National tilapia breeding program

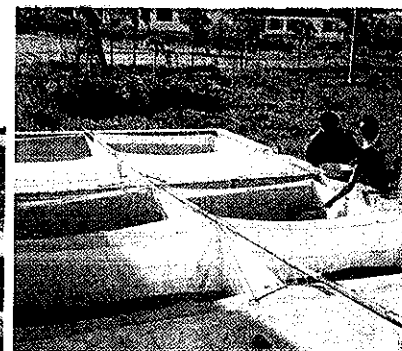


Thailand

- Selective breeding and cross breeding of silver barb
- Genetic characterization of natural populations of silver barb in river systems and hatchery stocks
- Sex control and genetic manipulations of silver barb, Nile tilapia, snakeskin gourami (*Trichogaster pectoralis*) and catfish (*Clarias* sp.)
- Selective breeding of Nile tilapia and common carp
- Cryopreservation of spermatozoa of freshwater fish
- Population genetics of tiger prawn

Vietnam

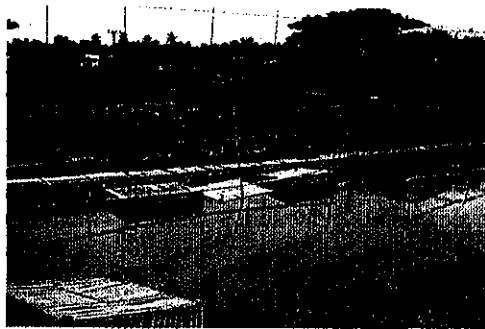
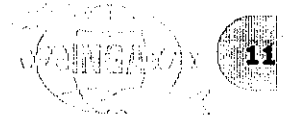
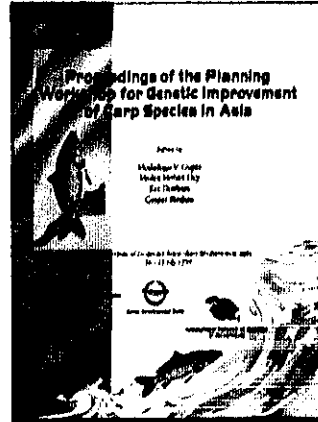
- Mass selection of common carp
- Genetic improvement of silver barb through mass selection and family selection
- Genebanking of economically important cultured species
- Genetic improvement of mrigal (*Cirrhinus mrigala*) by selective breeding



COLLABORATIVE REGIONAL RESEARCH

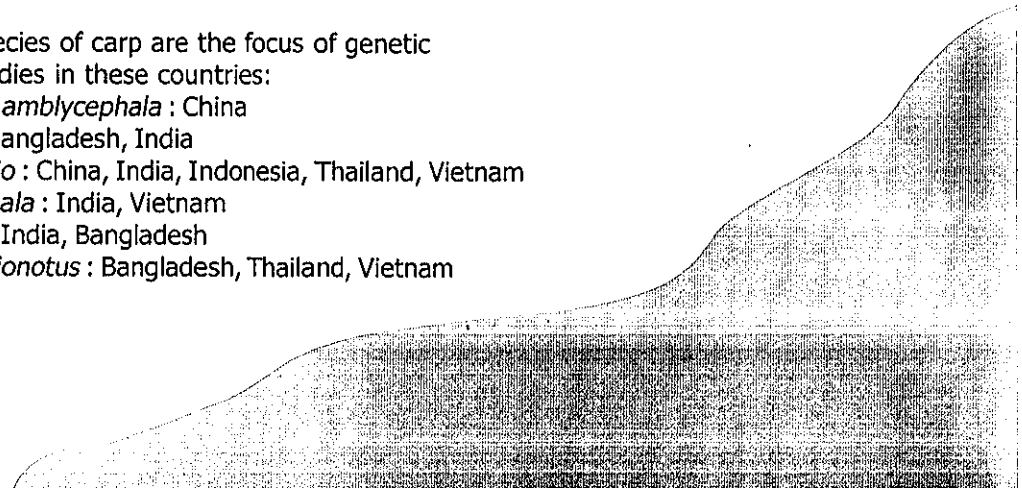
Genetic Improvement of Carp Species in Asia

Encouraged by the potential benefits of selective breeding of Nile tilapia and prompted by the urgent need to genetically improve the cultured stocks of carp, the six countries (Bangladesh, People's Republic of China, India, Indonesia, Thailand and Vietnam) that are the major carp producers in Asia have initiated a collaborative, regional research program for the genetic improvement of carp. The project, funded by the Asian Development Bank, involves two phases. The focus in phase 1 is to determine research priorities and initiate research leading to the development of high yielding breeds and strains. Phase 2 will concentrate on (i) the continued development of improved breeds, (ii) dissemination and evaluation of improved carp species, and (iii) establishment of carp breeding programs.



The following species of carp are the focus of genetic improvement studies in these countries:

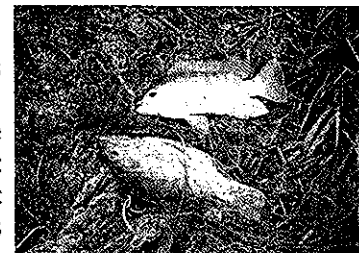
- *Megalobrama amblycephala* : China
- *Catla catla* : Bangladesh, India
- *Cyprinus carpio* : China, India, Indonesia, Thailand, Vietnam
- *Cirrhinus mrigala* : India, Vietnam
- *Labeo rohita* : India, Bangladesh
- *Barbodes gonionotus* : Bangladesh, Thailand, Vietnam





Tilapia Genetics Research in Africa

The development of the aquaculture industry in Côte d'Ivoire, Egypt, Ghana and Malawi, as in most African countries, is still hampered by low fish production due to the slow growth of fish. The network has been coordinating collaborative research programs aimed at conservation of fish genetic resources and increasing production through genetic enhancement of native tilapia strains. With start-up funds provided by the International Development Research Centre (IDRC), the member countries from Africa are undertaking a project on "Collaborative Research and Training for Documentation and Characterization of Tilapia Genetic Resources for Aquaculture in Africa". The project is focusing on: (i) collection and documentation of indigenous knowledge on the culture of tilapia; (ii) characterization and documentation of biochemical and/or performance traits of local tilapia strains that have high potential for culture; and (iii) assessment of the socioeconomic value and the impact of genetic improvement of tilapia.



NATIONAL BREEDING PROGRAMS

INGA has been assisting member countries in the development of plans and strategies for the implementation of national fish breeding programs based on their respective needs and resources. INGA and AKVAFORSK have together assisted the Aquaculture Research Institute No. 1 and 2, in Vietnam in developing breeding plans for: (i) Nile tilapia through combined multi-trait selection; (ii) silver barb through individual (mass) selection to improve growth; and (iii) mrigal through individual selection to improve growth rate. Assistance was also provided to the Research Institute for Freshwater Fisheries (Indonesia) in developing breeding plans for: (i) common carp using multiple trait selection; (ii) Nile tilapia (GIFT strain) using individual selection; and (iii) milkfish (*Chanos chanos*) using individual selection.

The Network also reviews the national breeding programs of member countries at regular intervals.

NATIONAL NETWORKS



As part of the agenda for better coordination and strengthening of aquaculture genetics research, national networks have been formed in India, Indonesia, Malawi, Malaysia and the Philippines.

The Malaysian Network of Fish Genetics Research has three universities, three government fisheries research agencies and a private sector organization as its members.

The Indonesian Network on Fish Genetics Research and Development (INFIGRAD), established in 1993, has recently become the Indonesian chapter of INGA. The network publishes a newsletter in Bahasa Indonesia called the "INFOGENIK Newsletter".

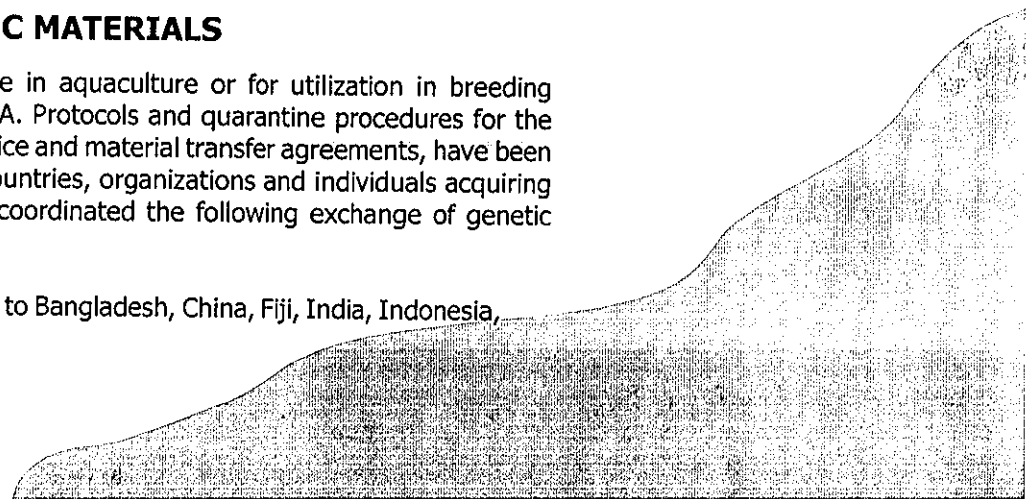
In India, six national research institutions have joined the Fish Genetics Research Network. The network publishes a newsletter "Fish Net" describing the network's activities in fish genetics, nutrition and pathology.

In the Philippines, eight national institutions and two private companies have joined together to form the National Fish Genetics Network.

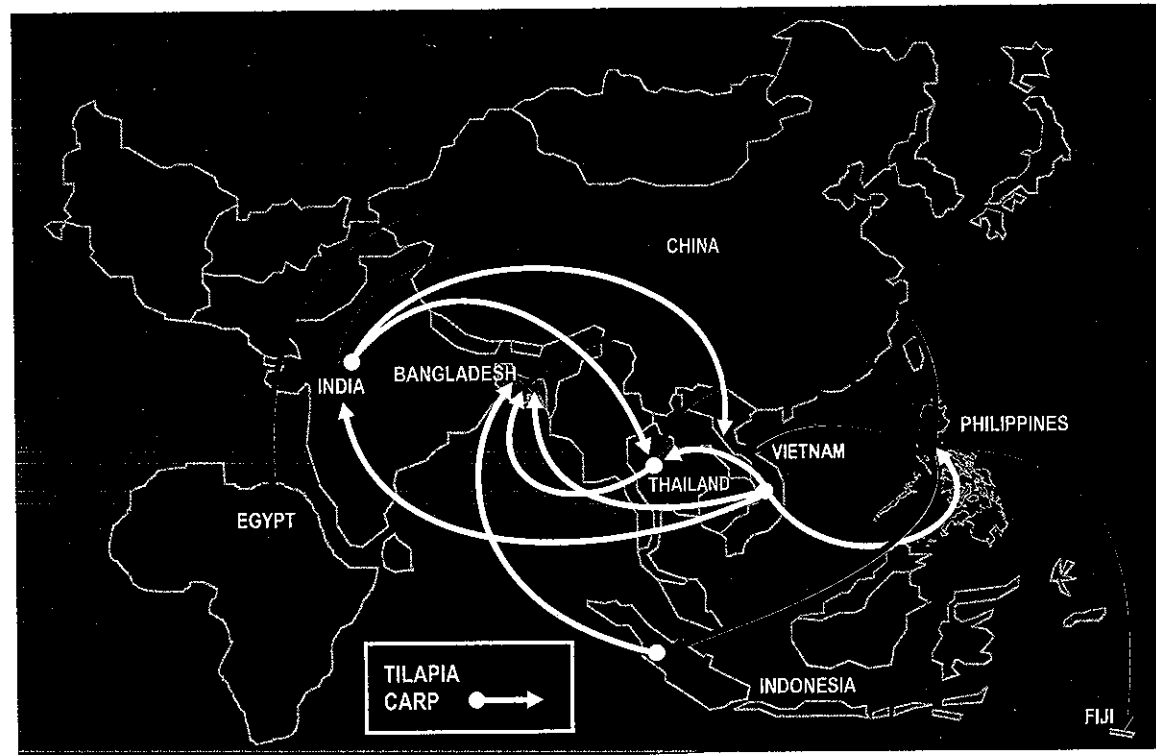
EXCHANGE OF GENETIC MATERIALS

Exchange of fish germplasm for evaluation, for direct use in aquaculture or for utilization in breeding programs is being done by member countries through INGA. Protocols and quarantine procedures for the transfer of germplasm, based on international codes of practice and material transfer agreements, have been formulated by INGA and are being used as guidelines by countries, organizations and individuals acquiring fish germplasm through INGA/ICLARM. The network has coordinated the following exchange of genetic materials, following strict transfer protocols:

- Improved Nile tilapia (GIFT strain) from the Philippines to Bangladesh, China, Fiji, India, Indonesia, Thailand and Vietnam



- Blue tilapia and Nile tilapia from Egypt to China
- Improved common carp strain from Vietnam to Bangladesh, India, Philippines and Thailand
- Diverse stocks of silver barb from Indonesia and Thailand to Bangladesh
- Mrigal from India to Vietnam
- Improved rohu strain from India to Thailand



Germplasm transfer under INGA.

STRENGTHENING RESEARCH CAPACITY

Strengthening the research capacity of national scientists is one of the needs identified by INGA members during various workshops and meetings organized by ICLARM. For most of the national programs, aquaculture genetics is a relatively new research area and national scientists need training and assistance in the implementation of research programs. In response to this, the following training programs were conducted, the first three in collaboration with ICLARM and AKVAFORSK, and the last one by ICLARM, to assist members to undertake genetics research and develop national breeding programs:

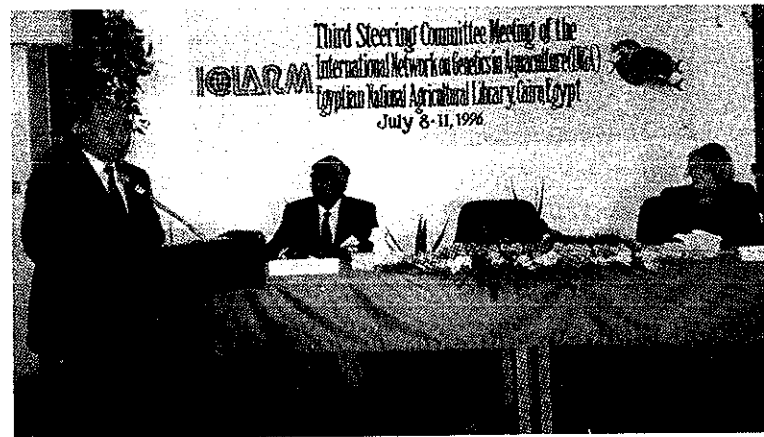
- Four-week intensive training on Quantitative Genetics and its Application to Aquaculture: 32 participants from 11 countries
- Three-week intensive training on Quantitative Genetics and its Application to Aquaculture: 22 participants from 13 countries
- Training workshops on Quantitative Genetics and Selective Breeding in Indonesia and Vietnam: 60 participants
- Three-week intensive training on Impact of Evaluation Framework and Models, Analysis of Experimental Data and Integrating Biological and Social Perspectives in Impact Analysis: 14 participants from 5 countries



MEETINGS

Four INGA Steering Committee meetings have been conducted since its establishment in 1993. The first Steering Committee meeting was held in Bangkok, Thailand in 1994, the second in Hyderabad, India in 1995, the third in Cairo, Egypt in 1996, and the fourth was in Manila, Philippines in 1997 - hosted by the governments of Thailand, India, Egypt, and the Philippines, respectively. The meetings were funded by UNDP, Norway, ICAR/India and ICLARM.

A two-day INGA Planning Meeting of senior officials from member countries and ICLARM was held in the Philippines in February 1997 to discuss strategies for strengthening the activities of the network. The main output of the meeting was the *Manila Resolution: Strengthening Partnerships to Advance the Science of Fish Breeding and Genetics and Development of National Fish Breeding Programs*, which formalized the support of member countries to INGA activities. The meeting was funded by ICLARM and BFAR/Philippines.

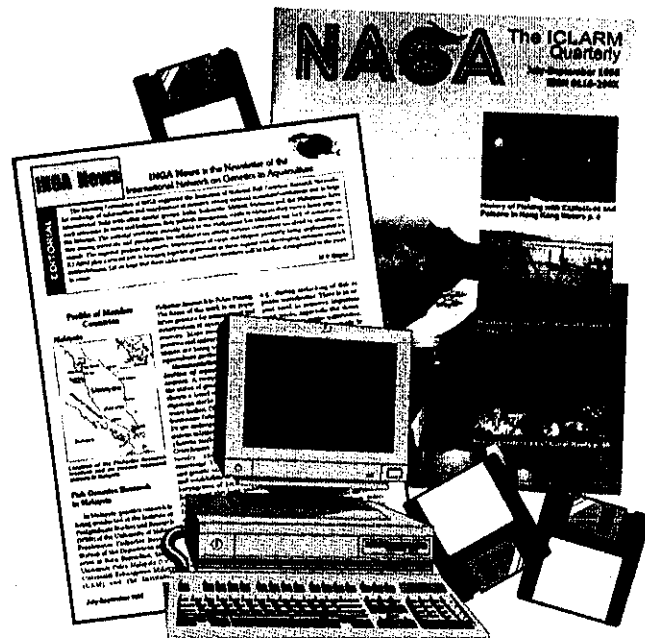


INFORMATION DISSEMINATION

In order to strengthen communication and information exchange among INGA members, a section featuring INGA-related activities and news has been incorporated in *Naga*, the ICLARM Quarterly, starting with the October 1996 issue.

Information dissemination among member countries is also facilitated through the newsletters of national networks, regular communications to the members by e-mail/fax and cross country visits of senior scientists.

A directory of geneticists in INGA member countries is presently being prepared. Those who are interested in being included in the Directory can write to the INGA Research Coordinator at ICLARM.



FOR MORE INFORMATION, PLEASE CONTACT:

Research Coordinator, INGA
International Center for Living Aquatic
Resources Management (ICLARM)
MCPO Box 2631,
0718 Makati City, Philippines
Phone: (632) 812-8641
Fax: (632) 816-3183
E-mail: M.V.Gupta@cglar.org

MANILA RESOLUTION

To Advance Science of Fish Breeding and Genetics

WHEREAS, fish is an important source of animal protein to people of member-countries; increasing fishing pressure and degradation and loss of aquatic habitats are resulting in decrease in fish production from natural resources;

WHEREAS, member-countries have a wealth of aquatic biodiversity that needs to be conserved and utilized in sustainable development;

WHEREAS, the member-countries are making all out efforts for the food security and alleviation of malnutrition through increased availability of fish protein to low-income rural and urban populations and improved economic returns to small-holder farmers;

WHEREAS, the member-countries, recognizing the need to increase fish production to meet the increasing gap between supply and demand for fish are taking a number of steps for conservation of aquatic resources and biodiversity and for their sustainable use in aquaculture; the member-countries are aware that scientific application of quantitative genetics and husbandry can give aquaculture a new dimension, leading to increased production and incomes as has been demonstrated in the case of salmon, trout and Nile tilapia;

WHEREAS, the member-countries recognize that variability in fish species, farming systems and production environment makes it imperative that genetic enhancement in aquaculture best be done through international cooperation and collaboration; networking is a well-tested mechanism for seeking solutions to problems of common interest; networking consolidates the strengths of different national programs and international organizations;

WHEREAS, the Planning Meeting of INGA recognizes the importance of conservation of genetic resources and their sustainable use in aquaculture and the accomplishments of INGA to date:

THEREFORE, we, the participants of the Planning Meeting of INGA hereby resolve to encourage the INGA member-countries, donors and other institutions/organizations to give due emphasis for conservation and sustainable use of aquatic genetic resources and biodiversity by:

- organizing national aquaculture genetics networks and providing support for coordination of activities;
- providing support to national genetics research programs;
- strictly adhering to the germplasm transfer and quarantine protocols approved by the network members which conform to wider international standards and rigorously implementing the guidelines;
- sharing knowledge and methodologies;
- sharing germplasm, with prior informed consent and on mutually agreed terms;
- providing technical and policy inputs to national and international efforts to maintain aquatic biodiversity and genetic resource conservation;
- assisting in the implementation of the Convention on Biological Diversity (CBD); and
- providing support to INGA activities.

