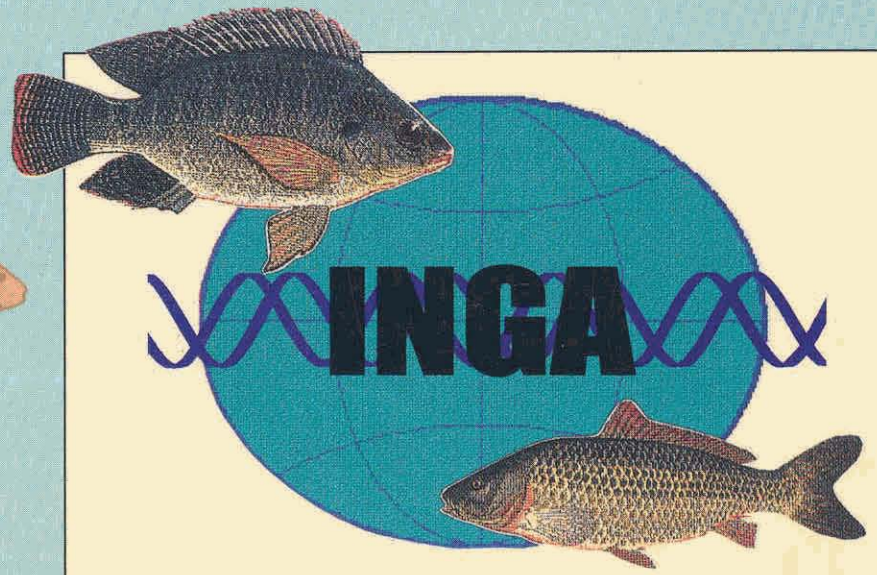


International Network on Genetics in Aquaculture

INGA INGA INGA INGA INGA INGA

International Network on Genetics in Aquaculture

DURVASULA V. SESHU, AMBEKAR E. EKNATH AND ROGER S.V. PULLIN

1994

Published by the International Center for Living
Aquatic Resources Management Manila, MCPO Box 2631
0718 Makati, Metro Manila, Philippines

Printed in Manila, Philippines

Seshu, D.V., A.E. Eknath and R.S.V. Pullin. 1994. International Network on Genetics in Aquaculture. ICLARM, Manila, Philippines. 22 p

ISBN 971-8709-49-5

Contribution No. 1037

Cover design and layout by Christopher M. Bunao.
INGA logo design by Jun Espiritu.

International Network on Genetics in Aquaculture

Seshu, D.V.
A.E. Eknath
R.S.V. Pullin

1994

International Center for Living Aquatic Resources Management
Manila, Philippines

Table of Contents

List of Acronyms iv

Background and Rationale 1

INGA Objectives 4

Network Strategy 6

Network Participation 7

Network Management 9

Forums for Interaction 10

Information Dissemination 11

Research Needs of Member-Countries 11

Cooperative Inputs 14

Networking Gains from INGA 16

Targeted Beneficiaries 17

Targeted Achievements 18

Activities and Outputs 19

Collaborative Research Work Plans 21

List of Main Institutions Participating in INGA 22

List of Acronyms

AADCP	-	Asean Aquaculture Development and Coordination Program
AARD	-	Agency for Agricultural Research and Development (Indonesia)
ADB	-	Asian Development Bank
AGNA	-	Aquaculture Genetics Network in Asia
AIT	-	Asian Institute of Technology
BFAR	-	Bureau of Fisheries and Aquatic Resources (Department of Agriculture, Philippines)
CEC	-	Commission of the European Communities
CRIFI	-	Central Research Institute for Fisheries (Indonesia)
FAC	-	Freshwater Aquaculture of the Philippines
FAO	-	Food and Agriculture Organization of the United Nations
FRI	-	Fisheries Research Institute (Bangladesh)
GIFT	-	Genetic Improvement of Farmed Tilapias
IAB	-	Institute of Aquatic Biology (Ghana)
ICAR	-	Indian Council of Agricultural Research (India)
ICLARM	-	International Center for Living Aquatic Resources Management
IDESSA	-	Institute des Savannes (Côte d'Ivoire)
INGA	-	International Network on Genetics in Aquaculture
IRRI	-	International Rice Research Institute
NACA	-	Network of Aquaculture Centers in Asia
NAC	-	National Aquaculture Center (Egypt)
NARS	-	National Aquatic Research Systems
SADC	-	Southern African Development Community
SCU	-	Suez Canal University (Egypt)
SEAFDEC	-	Southeast Asian Fisheries Development Center
SFU	-	Shanghai Fisheries University (China)
SIFR	-	Strategy for International Fisheries Research
UM	-	University of Malaŵi
UNDP/DGIP	-	United Nations Development Programme / Division for Global and Interregional Programmes

International Network on Genetics in Aquaculture (INGA)

Background and Rationale

Fish, the fifth most important agricultural commodity, account for 7.5% of total world food production. They contribute substantially to the national economies in developing countries, where over one billion people depend on fish as the primary source of animal protein.

While the demand for fish has grown substantially over the past few decades, the supply has continued to rely primarily on capture fisheries. The prospects for further expansion of capture fisheries are limited because of pollution, overexploitation and destructive fishing practices which have led to the deterioration of the traditional fishing grounds. Consequently, aquaculture assumes importance as a potential source of supply to meet some of the increased demand for fish.

World fish production now stands at about 100 million tonnes a year of which approximately 13 million tonnes come from aquaculture. Current population growth projections suggest that an additional 19 million tonnes would be needed annually to maintain consumption at current levels in the year 2000, whereas by 2025 an additional 100 million tonnes will be required to meet the demand, without accounting for additional consumption due to increasing incomes. A Study on International Fisheries Research jointly sponsored by the World Bank, the United Nations Development Programme/Division for Global and Interregional Programmes (UNDP/DGIP), Commission of the European Communities (CEC) and the Food and Agriculture Organization (FAO) emphasized the importance of increasing production from aquaculture as a

Nile tilapia catch as depicted in a painting by M.A. Go-oco.

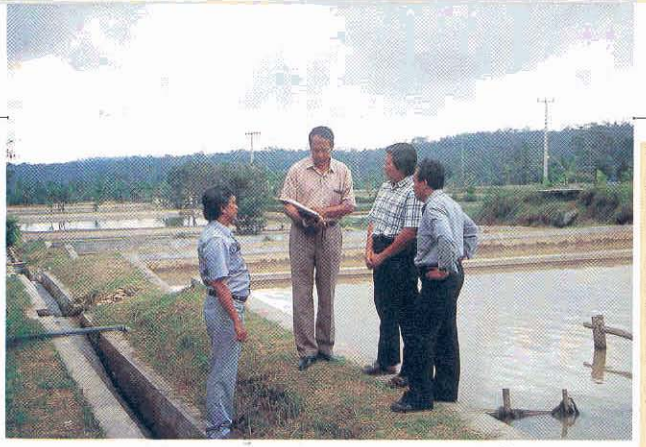
means to meet the demand for fish by the year 2000 and beyond.

Aquaculture is recognized for its efficiency in producing animal protein. Tropical aquaculture species, such as carps and tilapias, which form the mainstay of small-scale enterprises for many resource-poor farmers in the developing world, possess the ability to convert natural feed sources into high quality protein.

While significant contributions have been made in areas of fish health and nutrition, so far there has been no concerted effort towards application of scientific principles of genetics and husbandry to aquaculture, particularly in tropical developing countries. The aquaculture sector, where increased production is needed, has made only modest gains from genetic research to date.

Recent studies have clearly demonstrated the potential for achieving substantial gains in aquaculture production through application of genetics and breeding. Some examples are: improved breeds of salmon and trout developed in Norway, improved tilapia breeds developed in the Philippines by the International Center for Living Aquatic Resources Management (ICLARM) and the collaborating Philippine and Norwegian institutions under a project known as Genetic Improvement of Farmed Tilapias (GIFT), and improved carp breeds developed in China and India. Genetic improvement thus has the potential to lead to increases similar to those in food crops and livestock, provided due care is taken in the conservation of ecosystems and genetic diversity.

Rohu carp catch from intensive culture ponds, Bhubaneswar, India.



The UNDP mission visits the Central Fish Hatchery, Wanayasa, West Java, Indonesia.

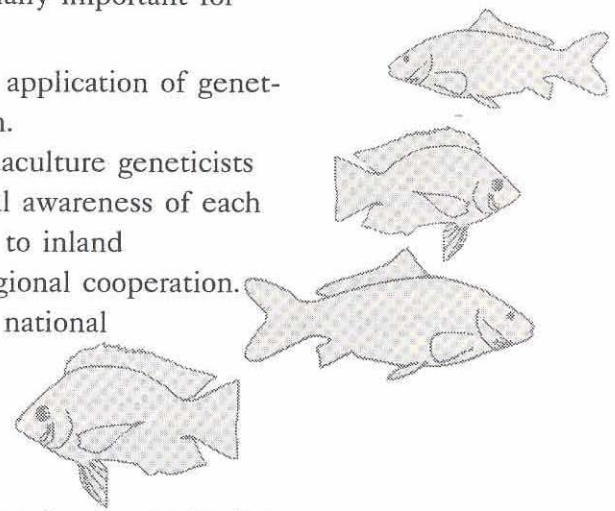
UNDP/DGIP sponsored a technical mission to explore the possibility for networking in aquaculture genetics, being encouraged by 1) the prospects for genetic improvement of fish as demonstrated by the GIFT project and 2) the well-recognized success of international networking approach for rice genetic improvement, for both of which it provided funding support. The mission visited ten potential member-countries, six in Asia (China, India, Indonesia, Philippines, Thailand, Vietnam) and four in Africa (Côte d'Ivoire, Egypt, Ghana and Malawi) during the period February-June, 1993. This was followed by a workshop held at ICLARM headquarters in Manila in July 1993, which provided an important forum for discussion and planning of international cooperation in aquaculture genetics. The participants representing National Aquatic Research Systems (NARS) of the ten countries visited by the mission along with counterpart scientists from ICLARM, strongly recommended the establishment of a scientific research network, designated as an "International Network on Genetics in Aquaculture (INGA)". Such a mechanism for international scientific cooperation was considered to be an urgent need to enable the developing countries to enhance the productivity and profitability of aquaculture, that would ultimately benefit the low-income producers and consumers of fish. The strategic research being pursued by ICLARM focuses, among other things, on improved fish productivity in sustainable inland aquaculture, through germplasm enhancement and breeding, for the benefit of resource-poor small-scale producers. Thus, as a sequel to the abovementioned recommendation, INGA was established in July 1993.

The founders of the INGA at the network planning workshop, July 1993.

INGA Objectives

Immediate

- To evaluate, through linkages among national scientists and institutions, using standardized protocols, the culture performance of promising lines of tilapias and carps in selected countries (representing a range of agroclimatic and developmental scenarios) wherein these species are important or potentially important for poor farmers and consumers.
- To assess the needs and opportunities for the application of genetics to increase the productivity of cultured fish.
- To link together established and potential aquaculture geneticists from different countries so as to ensure mutual awareness of each other's activities in the application of genetics to inland aquaculture, and to foster regional and interregional cooperation.
- To assist in the development of strategies for national fish breeding programs.



Long-term

- To contribute, through collaborative research, to the domestication and sustainable performance of tropical finfish species farmed in developing countries.
- To demonstrate that the application of genetics, especially selective breeding, can greatly increase the productivity, profitability and sustainability of low-cost input agriculture in developing countries

and can thereby generate support for self-sustaining national fish breeding programs.

- To strengthen the long-term national capabilities for continued genetic enhancement of farmed fish through exchange of germplasm and methodologies, and through training and interactive forums.
- To 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.

Developmental Objective

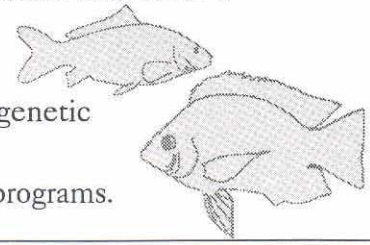
- To increase the quantity and quality of fish protein consumed in low-income rural and urban populations in tropical developing countries. Efficient breeding and selection programs will give aquaculture a new dimension leading to increased incomes for resource-poor fish farmers. As with future agricultural developments, the objective is to aim for sustainable systems, in harmony with the natural environment, to benefit producers and consumers.

The aquaculture industry will be given a new dimension through INGA, resulting in increased incomes for small-scale fishers.

Network Strategy

Aquaculture is potentially important in several countries in the developing world. Variability in fish species, farming practices, and in the production environment makes it emphatic that the task of genetic enhancement in aquaculture can best be accomplished through international cooperation and collaboration. Networking is a well-tested and proven mechanism adopted by various International Agricultural Research Centers (IARCs) to foster international cooperation in seeking solutions to problems of common interest that cut across political boundaries. Technologies with wider applicability, as well as with location-specific applicability, can be generated through networking. The inherent advantages of the networks are that they accelerate exchange of information, experience, methods and materials; boost research efficiency; reduce research costs; combat scientific isolation; offset dispersion of effort; stimulate thinking; reduce the risk of national efforts moving in unproductive directions; and facilitate capitalization of spillover effects from regions where research is conducted by the regions with similar ecologies and infrastructure. Purchase of time is an important dividend for the network scientists in their efforts to develop improved breeds of fish. Networking helps to amalgamate the complementary strengths of the different national programs and the international centers. It is with these clear advantages that an international network approach has been pursued for a sustainable genetic improvement of inland cultured fish, targeted to the aquaculture systems in the developing countries. The network is designated as "International Network on Genetics in Aquaculture (INGA)".

Genetic improvement of cultured fish consists of three major components that form a continuum:



(i) Conservation and characterization of economically important genetic resources of inland fish species.
(ii) Utilization of identified useful traits in appropriate breeding programs.

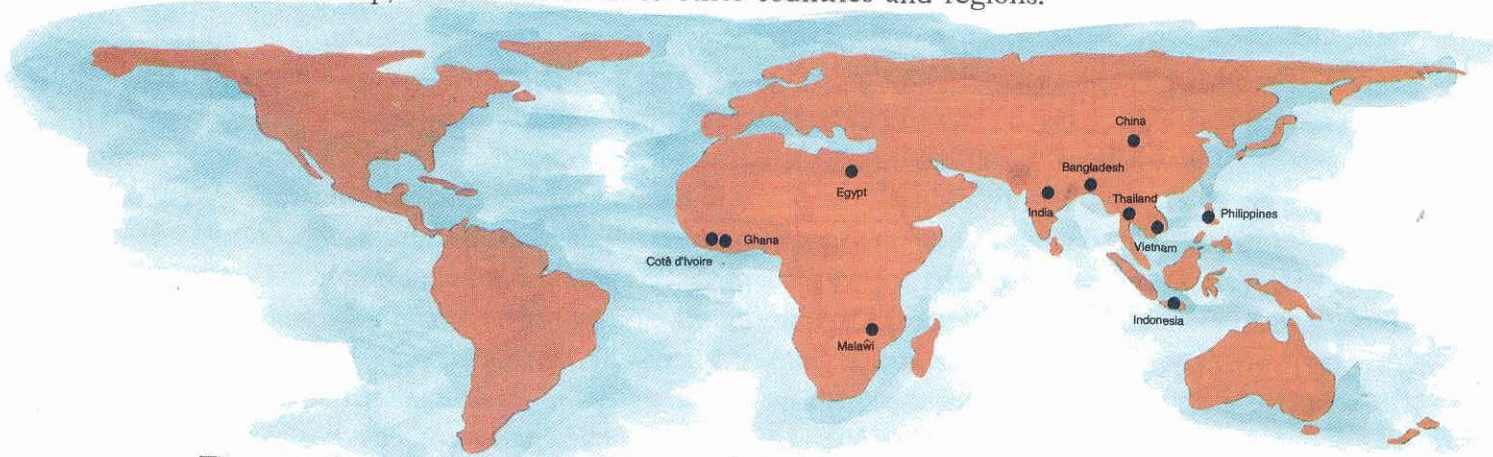
(iii) Evaluation of improved breeds for productive and profitable use in aquaculture.

The above component activities are planned to be implemented through an international network approach involving exchange of information and methodologies, exchange of improved fish breeds where appropriate and subject to environmental and socioeconomic safeguards, exchange of visits of scientists, and training of technical personnel in national institutions. Where transfer of fish is involved, appropriate precautions, including quarantine, will be taken in strict compliance with existing International Codes of Practice and emerging protocols under the International Convention on Biological Diversity that help to prevent harmful impacts on environment. The research in each country will focus on the respective preferred species, with initial emphasis on the tilapias and the carps, while the activities in which the individual member countries will participate will depend upon their needs and resources. Exchange of improved breeds for either evaluation followed by direct use in aquaculture, or for utilization in breeding programs for incorporating specific useful traits, will be guided by the policies of the individual member-countries. Where there are restrictions for importation of exotic breeds, the second and third component activities of genetic improvement mentioned above will be confined to local fish species. In such instances, the countries concerned will derive benefit from the network through access to information and methodologies.

Network Participation

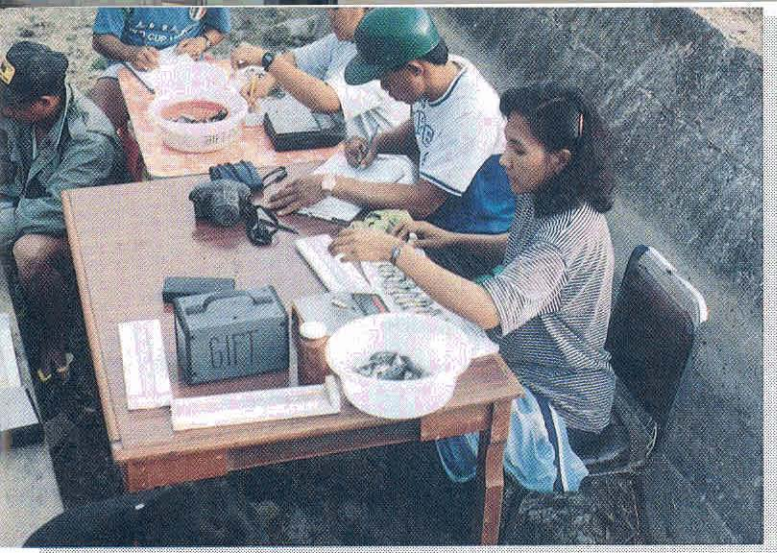
INGA is constituted initially with eleven member-countries from Asia and Africa, representing a range of agroclimatic and developmental scenarios. The countries are: the Bangladesh, China (PROC), Côte d'Ivoire, Egypt, Ghana, India, Indonesia, Malaŵi, the Philippines, Thailand and Vietnam. ICLARM participates in the network as a member, as well as being its coordinator. Once a critical mass has been developed on fish genetics research and

on effective breeding procedures with this initial INGA membership, the results, as well as network membership, can be extended to other countries and regions.



The member-countries were chosen as being representative of a range of production systems and technical progress, as follows:

Aquaculture forms part of a major development strategy in Bangladesh. China is the center of genetic diversity/aquaculture of Chinese carps. India is the center of genetic diversity of the Indian major carps and is the leading aquaculture nation in South Asia. Indonesia is one of the centers of genetic diversity of common carp, with some traditional domesticated breeds. The Philippines is the leading country in Southeast Asia for tilapia culture, and is the base for ICLARM's collaborative genetic research activities. Thailand is a leading country in Southeast Asia for carp, catfish and tilapia culture. Vietnam has a good record of genetic improvement efforts for silver carp and common carp. Egypt is one of the important centers of genetic diversity of Nile tilapia, and is fast developing its aquaculture research programs. Côte d'Ivoire and Ghana are leading countries in aquaculture genetic research in West Africa and centers of genetic diversity for Nile and other tilapias. Malawi is assigned the leadership role in inland fisheries for the SADC region, and it is one of the important centers of genetic diversity of some tilapias.



Network members would benefit from the experience of ICLARM's GIFT project, where research on the Nile tilapia has resulted in a faster-growing strain.

Network Management

INGA is a joint program of all participating countries and ICLARM, and hence, is jointly owned and jointly managed. Participating member countries and ICLARM will carry out the planned cooperative research and trials, and make the results available to each other for information and follow-up strategies. Likewise, the products of research (improved fish breeds) will be exchanged among the interested member countries. The network program planning will be guided by a Steering Committee composed of selected aquaculture geneticists from different member countries. The Committee meets once each year to review progress and discuss the follow-up plans. The chairperson will be elected from among the participating members. The Steering Committee ensures that the network research agenda is responsive to national needs and priorities. Within each country, the network activities form an integral part of the respective national aquaculture research program.

ICLARM, being an international center with considerable experience in application of genetics in aquaculture, has the comparative advantage to coordinate the network. This will involve facilitating exchange of information, methodologies and materials among the network members; organizing training programs, workshops, and joint monitoring visits; and preparation and distribution of network research reports. The coordinator of the network serves as a member-secretary of the Steering Committee. The network will operate in close collaboration with other related regional and interregional programs such as AADCP, AGNA, AIT, NACA, SEAFDEC and SIFR and will seek joint activities with advanced institutions in developed countries where their strength can assist in research and training.

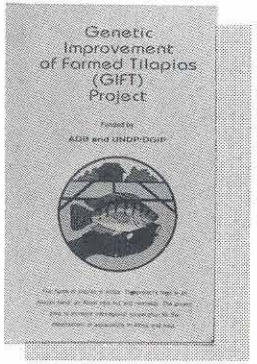
Forums for Interaction

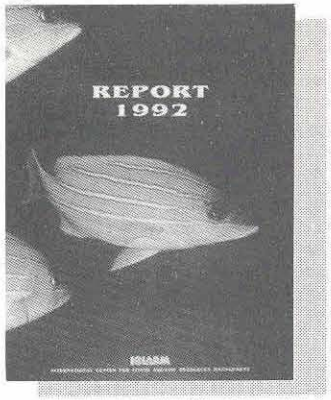
To realize the network's objectives and to be responsive to the needs of different countries, participating scientists from NARS and international centers need to interact periodically and exchange ideas that are relevant to the program. Examples of forums that stimulate this interaction among INGA participants follow:

- The INGA Steering Committee, consisting of representative scientists from NARS and concerned scientists from ICLARM meet annually to review results and formulate plans.

Some of the activities planned for INGA network members and scientists would be training programs and workshops.

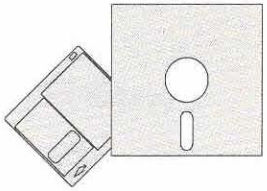
- Annual monitoring visits facilitate joint review of INGA trials at selected sites by a group of scientists from NARS and ICLARM. These reviews provide useful feedback for follow-up trials, help to develop strategies, and are an important mechanism for training young scientists.
- Correspondence, questionnaires and newsletters serve as important avenues for information exchange.





Information Dissemination

Reports on multilocation research and evaluation results, joint site visits, planning meetings, and other relevant information will be published annually and distributed to aquaculture scientists, research administrators and libraries around the world. Scientists use information from these reports to formulate follow-up research trials and strategies.



Research Needs of Member-Countries

Common Needs

- New, domesticated fish breeds that are genetically superior to the breeds currently available for farming; the latter in most instances resemble wild types or are even worse in performance.
- Guidance on how to establish and sustain national fish breeding programs.

- Guidance on how to evaluate and conserve fish biodiversity for present and future utilization.
- Definition of, and typologies for, fish farm environments to facilitate work on genotype x environment interaction.
- Guidance on how to estimate, ex-ante and ex-post, the environmental and socioeconomic impacts of development and utilization of new fish breeds in aquaculture.
- Linkages to facilitate awareness of each other's activities and of global progress in the application of fish genetics to aquaculture and to facilitate regional and interregional cooperation.
- Staff development in aquaculture genetics research.

Specific Needs/Priorities

Asia

Bangladesh:

- Genetic improvement of silver barb through selective breeding and line crossing techniques.
- Evaluation of Nile tilapia and red tilapia.
- Assessing role of tilapia in mono- and polyculture.

Silver barb is an important species in Bangladesh.

China:

- Developing cold- and salt-tolerant tilapias.
- Evaluation of tilapias in mono- and polyculture and under different climatic conditions.

Common carp, a major species in Indonesia, will be among those given priority for research.

- Evaluation of rohu

India:

- Selective breeding of rohu collected from eight major river systems of India
- Evaluation of performance of rohu (and tilapia) under mono- and polyculture

Indonesia:

- Genetic improvement of common carp with emphasis on growth, late maturity, and resistance to external parasites.
- Evaluation of promising strains of tilapia.

Philippines:

- Development of improved breeds of tilapia with emphasis on growth and tolerance to cold temperature and salinity.
- Evaluation of common carp, rohu and bighead carp.

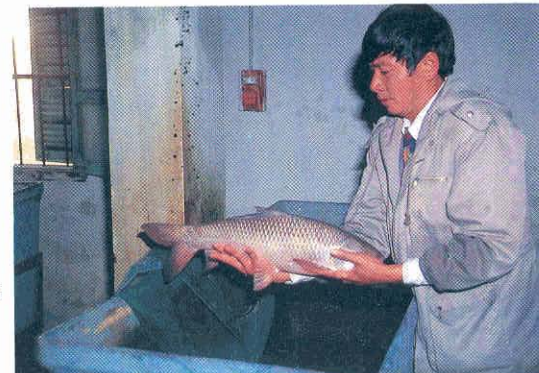
Thailand:

- Selective breeding of different strains of Nile tilapia under farm and experimental station conditions, with emphasis on growth performance.
- Genetic improvement of silver barb
- Evaluation of rohu

Vietnam:

- Selective breeding of common carp with emphasis on increased growth rate and attractive appearance.
- Evaluation of different strains of Nile tilapia with focus on growth rate, survival rate from fry to marketable size, age and size at first maturity, and cold tolerance.
- Evaluation of mrigal with focus on growth rate, fertility and viability.

Vietnam's aquaculture priorities include the evaluation of carps for culture.



Africa

Egypt:
- Establishment of Nile tilapia germplasm reference collection center for sharing with other countries.
- Genetic characterization and evaluation of promising strains of Nile tilapia.
- Interspecific hybridization for production of all-male tilapia.
- Selection for growth rate and salt tolerance of Nile tilapia.

Ghana:
- Documentation and characterization of indigenous strains of Nile tilapia.
- Evaluation of growth performance of wild stocks of Nile tilapia from four major agroecological zones.

Côte d'Ivoire:
- Documentation and characterization of natural tilapia populations
- Evaluation of growth performance of tilapia, and study of genotype x environment interaction.
- Interspecific and intergeneric hybridization for improved production.

Malawi:
- Documentation and characterization of indigenous tilapia species.
- Evaluation of promising species of tilapia.

Cooperative Inputs

Role of Participating Countries

- commitment of facilities and human resources by each of the participating countries for collaborative fish genetics research and associated training;

Hybrid carp (rohu x catla) developed at Bhubaneswar, India.

- policies and resource allocations to foster the development, free exchange and testing of new fish germplasm;
- commitment to the goals of developing self-sustaining national fish breeding programs;
- free exchange of research products and results and commitment to co-publication;
- strict adherence to International Codes of Practice for all germplasm transfers across national or significant ecological boundaries.

Role of ICLARM

ICLARM will be a regular member of the network and will take responsibility for coordinating the network and hosting its secretariat. It will provide the following inputs:

- pursue funding for efficient coordination and operation of the network;
- organize meetings, exchange visits, and information dissemination to advance the network's agenda;
- facilitate linkages with other institutions and networks as deemed appropriate by the network members;
- publish an annual report on the network's activities and achievements.
- organize appropriate training programs;
- assist the network members where needed, in the planning and organization of their breeding research activities;
- make available its research products (improved fish breeds), and research methods and results;
- strict observance of International Codes of Practice for all germplasm transfers.

Networking Gains from INGA

To Participating Countries

- access to new germplasm for inland aquaculture development;
- new methodologies for fish breeding;
- conservation of aquatic biodiversity;
- evolution of self-sustaining national fish breeding programs;
- scientific interaction;
- international exchange of staff and information;
- staff development.

To ICLARM

- furtherance of the strategic research agenda in ICLARM's Strategic and Mid-Term Plans, relating to improved, sustainable fish productivity through genetics and breeding;
- efficient use of resources for a substantially decentralized fish genetics research thrust through collaboration with NARS and other institutions;
- strengthening the Center's role as a global resource for information on aquatic biodiversity and the application of genetics in aquaculture and as a source of germplasm for some strategic species.

Targeted Beneficiaries

Immediate Beneficiaries

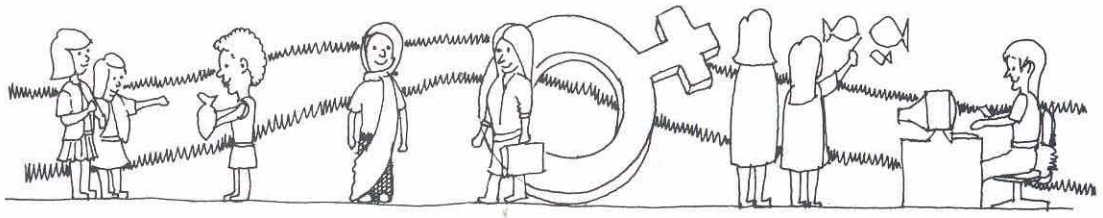
The immediate beneficiaries will be the scientists of the national, regional and international institutions involved in aquaculture genetics research.

Ultimate Beneficiaries

The project is primarily aimed at benefitting resource-poor fish farmers in developing countries, who will achieve a more stable increase in productivity. This increase in production of relatively cheap fish protein is essential in view of increasing cost of other protein sources. Profitability will be an incentive for many families to start small-scale aquaculture enterprises. This will also provide a dependable source of affordable animal protein to rural and urban consumers.

Role of Women

Women have traditionally been involved in aquaculture enterprises, at both family and community levels. Future efforts towards sustainability will involve effective integration of aquaculture into agricultural activities. Women will play an increasing role in aquaculture enterprises in such systems. Demonstration of sustainable productivity and profitability in aquaculture through applied breeding technology will stimulate greater involvement of women in aquaculture, while ensuring benefits for them.



Targeted Achievements

INGA aims to achieve the following through international cooperation:

- Development of improved breeds of tilapias and carps as suited for the aquaculture conditions of different member countries.
- Development of improved research methodologies for estimation of genetic parameters and response to selection.
- Characterization of economically important genetic resources of inland fish species.
- Enhanced professional capabilities of scientists involved in aquaculture in different member-countries.

- Development of a research framework to support national fish breeding programs in developing countries.
- Policy guidelines by different countries for release of improved fish breeds with emphasis on possible environmental and socioeconomic impacts.
- Structured international collaboration for addressing current and future issues relating to productivity and profitability in aquaculture.

Activities and Outputs

Immediate objective	Output	Activity	Party responsible
1. Characterization of local fresh-water fish germplasm	Establishment of germplasm collections for strategic research Establishment of database	Systematic collection of local fish germplasm; recording data on morphometric and physiological traits supplemented, where possible, by electrophoretic analysis; recording data on habitat	All member-countries and ICLARM
2. Development of improved fish breeds	Improved strains of carps and tilapias for use in productive and profitable aquaculture	Exchange of promising local and improved breeds of carps and tilapias among different member countries	All member-countries and ICLARM
		Evaluation of growth performance and other economic traits in different farming systems and agro-climatic regions	
		- Local material	All member-countries and ICLARM
		- From other countries	Asian member-countries and Egypt
		Selective breeding	All member-countries and ICLARM
		Cross breeding to combine specific traits	Selected member-countries
		Innovative genetic techniques	Selected member-countries
3. Strengthening capacity of national institutions to carry out selection work and develop national breeding programs	Profesionally competent personnel in national institutions	Training NARS scientists on methodologies involved in application of genetics and selective breeding	ICLARM to organize different activities
		Imparting degree-oriented training	
		Conducting joint visits to experimental stations and farmers' production areas in different member countries and to ICLARM's research sites.	
		Organizing subject matter workshops, planning-oriented meetings, and other interactive forums	

Collaborative Research Work Plans

The research needs and priorities of the INGA member-countries indicate that several areas of research in both tilapias and carps are of common interest across the participating countries, thus warranting the need for collaboration through a network approach. Based on those common needs, following research work plans will be carried out in different countries under the network program:

Tilapias	
1. Evaluation of different strains of tilapias for growth performance, survival rate at different growth stages, age and size at first maturity	All network countries
2. Cold and salt tolerance	China, Egypt, Philippines, Vietnam
3. Selective breeding for general growth performance	China, Egypt, Philippines, Thailand, Vietnam
4. Genetic characterization and documentation	Côte d'Ivoire, Egypt, Ghana, Malaŵi
Carps	
1. Evaluation of different strains of carps for general growth performance	Bangladesh, China, India, Indonesia, Philippines, Thailand, Vietnam
2. Selective breeding for genetic improvement	Bangladesh, India, Indonesia, Thailand, Vietnam
3. Genetic characterization and documentation	China, India, Indonesia, Vietnam

List of Main Institutions Participating in INGA

Bangladesh
Fisheries Research Institute
Freshwater Station
Mymensingh 2201

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

Côte d'Ivoire
Fish Research Center
Institute Des Savanes (IDESSA)
B.P. 633
Bouaké

Egypt
National Aquaculture Center
Abbasa, Abou Hammad
Sharkia

Fish Research Center
Suez Canal University
Ismailia

Ghana
Fishery Division
Institute of Aquatic Biology
P.O. Box 38
Achimota

India
Central Institute of Freshwater Aquaculture (ICAR)
P.O. Kausalyaganga,
Bhubaneswar
Orissa 751 002

Central Institute of Fisheries Education (Deemed University)
ICAR- Ministry of Agriculture
Versova, Bombay 400 061

Indonesia
Central Research Institute for Freshwater Fisheries
(CRIFI/AARD)
Sukamandi

Malawi
University of Malawi
P.O. Box 278
Zomba

Fisheries Department
P.O. Box 593
Lilongwe

Philippines
Bureau of Fisheries & Aquatic Resources
Department of Agriculture
805 Arcadia Building, Quezon Avenue
Quezon City

Freshwater Aquaculture Center
Central Luzon State University
Muñoz, Nueva Ecija

International Center for Living Aquatic Resources Management (ICLARM)
MCPO Box 2631
0718 Makati, Metro Manila

Thailand
National Aquaculture Genetics Research Institute
c/o National Inland Fisheries Institute
Kasetsart University Campus
Bangkhen, Bangkok 10900

Vietnam
Research Institute for Aquaculture
No. 1 Dinh Bang, Tien Son
Ha Bac