FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

# ADVANCING AQUACULTURE SYSTEMS PRODUCTIVITY THROUGH CARP GENETIC IMPROVEMENT

This Feed the Future Innovation Lab for Fish activity aimed to produce new generations of improved carp in Bangladesh—catla (*Catla catla*), rohu (*Labeo rohita*), and silver carp (*Hypophthalmichthys molitrix*)—building on genetic improvement programs managed by WorldFish. The activity aimed to produce a cryopreserved sperm repository strategy, disseminate additional genetically improved carp, assess the on-farm performance of generation three (G3) genetically improved rohu, develop a cost-effective pedigree assignment tool, and undertake training activities.

Fish sampling in Shafiujjaman Momin's pond for growth measurement. Photo by Md. Fakhruddin

## NEW GENERATIONS OF IMPROVED CARP

The activity produced generation three (G3) rohu (228 families), generation two (G2) silver carp (240 families), and generation one (G1) catla (203 families). The team produced and maintained a selection line (families selected for rapid growth), a control line (genetically equivalent to unimproved base populations), and a negatively selected line (to be used in future research to identify genes affecting growth) for each species. Representative fish from each of these populations were subsequently shipped to two geographically distant sites, to be maintained as backup populations. The team anticipates that each new generation of selection lines will grow approximately 10% more rapidly than the previous generation, with positive impacts on pond productivity, farmer incomes, and fish availability in the market.

## DISSEMINATION OF ADDITIONAL GENETICALLY IMPROVED CARP

The activity supplied private- and government-owned hatcheries with G3 rohu hatchlings (i.e., the G3 rohu multiplier) to be grown into broodstock in 2021 and 2023. At the conclusion of the activity, 38 geographically disparate private, 18 Department of Fisheries (DoF), one Bangladesh Fisheries Research Institute (BFRI), and two educational institution hatcheries were known to maintain G3 rohu broodstock.

Commercial hatcheries spawned G3 rohu for the first time in 2022. Over that spawning season, seven commercial hatcheries produced 245 kg of spawn. The hatcheries sold spawn produced in 2022 to 65 farmers and 104 nurseries. By the conclusion of the activity, these 104 nurseries had sold seed to approximately 3,000 farmers.

In early 2023, production of G3 rohu spawn by 13 hatcheries grew to 2,826 kg. Assuming 15 farmers are supplied for each kg of spawn produced (as in 2022), the research team expects 42,390 farmers to use G3 rohu spawn in 2023. The team anticipates that G3 rohu spawn production will increase in 2024 and beyond as demand for the product increases.

## ON-FARM PERFORMANCE OF G3 ROHU

To compare the on-farm performance of the G3 rohu population disseminated to hatcheries against fish from the WorldFish control line and a well-regarded commercial strain, the team tagged fish and distributed them for grow-out on 19 semi-commercial farms across two Bangladeshi regions (Jashore and Natore–Rajshahi). At

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## ACTIVITY TEAM

**Lead PI**
Matthew Hamilton, PhD
WorldFish

**Lead Co-PI**
John Benzie, PhD
WorldFish

**Bangladesh PI**
Mohammed Yeasin
WorldFish

**Bangladesh Co-PI**
Mostafa Hossain, PhD
Bangladesh Agricultural University

**U.S. PI**
Terrence Tiersch, PhD
Louisiana State University Agricultural Center

harvest, the G3 multiplier weighed approximately 37% more, on average, than the unimproved control and substantially outperformed both the control and commercial strain on all 19 farms.

## TRAINING ACTIVITIES

As part of the activity, the team organized two hatchery training workshops. These aimed to improve knowledge of genetics, management, and marketing of genetically improved carp. Sixty men and eight women attended the workshops, and the team provided a manual to all participants that is also available online in Bangla and English.

## CRYOPRESERVED SPERM REPOSITORY STRATEGY

In addition to maintaining backup populations in ponds, the activity developed a cryopreserved sperm repository strategy. Germplasm repositories allow storage of sperm for long periods and are unaffected by disease or natural disasters.

## PEDIGREE ASSIGNMENT TOOL

The activity also developed a pedigree assignment tool to test carp DNA to determine the purity of genetically improved strains. For rohu, the team identified a panel of 118 single nucleotide polymorphisms (SNPs), or variations at specific positions in the DNA sequence among individuals. However, accurate parentage assignment (to determine purity of the G3 rohu) using this panel was not possible because a high proportion of SNPs were considered rare variants. For catla, the team developed a larger panel, comprised of 486 SNPs with a high proportion of more common variants. The team anticipates that this panel will allow accurate and routine application of parentage assignment in this species.

## CONCLUSION AND RECOMMENDATIONS

The team recommends the following:

- Continue to engage and monitor private- and public-sector parties involved in G3 rohu dissemination to a) inform future dissemination practices, and b) facilitate the development of research and dissemination partnerships to sustain carp genetic improvement over the long term.
- Undertake research into a) intensive nursing practices to facilitate consolidation in the nursery sector and commercialization of carp genetic improvement; b) mono-sex production, or production of all male or all female populations, for partial intellectual property protection and improved productivity/profitability; c) additional traits (e.g., disease resistance, feed conversion, and resilience); and d) interactions between genetic and environmental factors.
- Develop SNP panels, akin to that developed for catla, for all species to allow a) parentage assignment and communal early rearing; b) sex determination, and c) distinguishing between genetically improved and genetically unimproved populations. In addition, pursue tools required to implement genomic selection.
- Encourage the development of private carp pathogen screening services in Bangladesh.
- Consider the genetic improvement of additional species (e.g., mrigal carp, *Cirrhinus cirrhosus*) and implementation of the cryopreservation strategy.

## ABOUT THE FISH INNOVATION LAB

The Fish Innovation Lab supports the United States Agency for International Development's agricultural research and capacity building work under Feed the Future, the U.S. Government's global hunger and food security initiative. Mississippi State University is the program's management entity. The University of Rhode Island, Texas State University, Washington University in St. Louis, and RTI International serve as management partners.

**www.fishinnovationlab.msstate.edu**

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