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

CRYOGENIC SPERM BANKING OF INDIAN MAJOR CARPS AND EXOTIC CARPS FOR COMMERCIAL SEED PRODUCTION AND BROOD BANKING

BACKGROUND

Bangladesh has 260 freshwater and 475 marine fish species, 24 freshwater prawn species, and 36 marine shrimp species. Historically, most fish production came from open-water capture fisheries, but due to environmental and man-made activities, production of capture fisheries decreased. Aquaculture started in the early 1980s and presently about 57% of total fish production (4.76 million metric tons) comes from aquaculture. Indian major carps (IMCs) such as catla (*Catla catla*), rohu (*Labeo rohita*), and mrigal (*Cirrhinus cirrhosus*) contribute about 32% to aquaculture production, and exotic carps such as silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), and grass carp (*Ctenopharyngodon idella*) contribute about 18% to aquaculture production. This increase in carp production through aquaculture is largely due to production of adequate fish seeds in hatcheries and uninterrupted supply to farmers. Even so, sustainable fish production is not yet a reality in Bangladesh.

Harvesting Fish Innovation Lab carp brooders. Photo by M. Gulam Hussain

Deterioration of IMC and exotic carp seed quality is a factor of high concern. Around 984 hatcheries (110 government and 874 private) are involved in seed production through induced spawning, but seed quality deteriorates through inbreeding, hybridization (cross breeding between two different fish species), and negative selection resulting in slow growth, high mortality, and disease susceptibility of seeds. Consequently, the hatchery and nursery operators and small-scale farmers are shifting to other species like tilapia and catfishes. In fact, many hatcheries have stopped producing carp seeds altogether. To mitigate the issues with carp aquaculture production, the government has initiated a broodstock improvement program for IMCs through establishing live brood banks by rearing river-originated seeds in government hatcheries and distributing broods to other hatcheries. To continue the program is difficult as natural seed production is severely reduced, providing <1% of the total requirements. Seed quality of exotic carps is also diminishing, and improvement of their broodstocks is challenging as replenishment of stocks is difficult and expensive.

Establishment of a cryogenic sperm bank of IMCs and exotic carps and the use of cryopreserved sperm in seed production in hatcheries is necessary to resolve the existing genetic problems. This technology can also be used to assist the government and private hatcheries to develop brood banks by protecting and providing quality germplasm. Availability of high-quality broodstocks produced by cryopreserved sperm would also increase the capacity of government and private hatchery operators.

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ESTABLISHING CRYOGENIC SPERM BANKING FOR AQUACULTURE PRODUCTION IN BANGLADESH

To establish the cryogenic sperm bank, the Feed the Future Innovation Lab for Fish team first developed a live brood bank of IMCs by rearing Halda and Padma River-originated fish at the Bangladesh Agricultural University (BAU) campus. Similarly, a brood bank of the three exotic carps was developed by rearing fingerlings imported from China by the Department of Fisheries (DoF), and the team collected sperm from the broods for cryopreservation. Beforehand, the team standardized the parameters of the cryopreservation process for all species. The team then conducted breeding using cryopreserved sperm and fresh sperm of hatchery-owned males (control) in 36 selected public and private commercial hatcheries in Mymensingh, Jashore, Faridpur, and Barishal regions, and 28 hatcheries successfully produced seeds. The hatcheries were able to produce seeds of all six species using cryopreserved sperm, but those seeds had lower fertilization and hatching rates compared to control seeds across all the species. Lower fertilization by cryopreserved sperm might have resulted from injuries during the cryopreservation process.

Before seed production, the team conducted a hands-on training on cryopreservation techniques for breeding hatcheries and technology adoption hatcheries in four regions by inviting around 100 stakeholders (in four batches), including hatchery operators and managers, scientists, and regional DoF officials. To compare the growth of cryopreserved- and fresh sperm-originated seeds for quality assessment, the team reared the seeds in 22 respective breeding hatcheries and four technology adoption hatcheries and fish farms separately for at least 6 months. Cryopreserved sperm-originated seeds demonstrated a significantly higher growth rate than control seeds in all six species due to introducing quality germplasm through cryopreserved sperm. The inferior quality of hatchery-originated seeds might be due to genetic degradation of hatchery-reared parents. The team used DNA microsatellite markers as another quality assessment tool to determine the parental genetic inheritance of the seeds and found that cryopreserved sperm-originated seeds shared alleles with their parents. To facilitate better adoption, the team arranged 16 technology dissemination workshops (four batches in each region and 25 persons in each batch) for around 400 stakeholders including hatchery and nursery operators, fish farmers, scientists, and NGO personnel. Additionally, the team coordinated a technology dissemination workshop for 50 MS and PhD students and junior members of the Fisheries Faculty at BAU and a seminar on fish sperm cryopreservation technology for 150 graduate and undergraduate Fisheries students. Research team members also participated in a 2-week-long advanced training through the Aquatic Germplasm and Genetic Resources Center and Louisiana State University Agricultural Center.

RECOMMENDATIONS

This activity resulted in the development of a cryogenic sperm bank of all six species at the BAU laboratory and investigation of the feasibility of establishing cryogenic sperm banks of carps in different regions. The team recommends that this research should be continued to validate the technology and establish sperm repositories for indigenous and exotic carps. With more than one thousand hatcheries distributed throughout the country, government and non-government organizations should play a key role in setting up sperm repositories centrally as well as in different carp-dominated areas of the country to provide cryopreserved sperm to hatcheries for quality seed and brood production.

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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