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Selective breeding improves Indian carp culture

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Collaborative research project with CIFA in India and AKVAFORSK in Norway



Rohu are a popular fish choice at this market in Orissa, India.

With a population of 1.04 billion and annual growth of about 18 million, India sets major demands for increased food production. But the availability of land and water resources is depleting day by day. Therefore, an increase in unit-area productivity is strongly required to meet the country's food requirements.

During the last 10 years, India has doubled its production of freshwater fish to 2 million metric tons (MT) per year. The production is mainly based on the carp species catla (*Catla catla*); rohu (*Labeo rohita*); and mrigal (*Cirrhinus mrigala*); each of which amounts to about 500,000 MT per year.

Carp are typically produced in 0.1- to 20-hectare ponds with depths up to 1.5 meters. Polyculture with three to six species in the same pond is the common farming practice. Some farmers also practice monoculture, particularly with rohu, which enjoys a high consumer preference in many states.

Extensive production

The average production level of farmed fish in India is about 2,000 kilograms per hectare pond area. Half of this production is based on the phytoplankton and zooplankton naturally produced in ponds, while the remainder is based on supplementary feed such as ground nut oil cake mixed with rice bran. In more intensive systems, production can reach 10 to 15 MT per hectare.

Feed conversion is generally low, mainly due to inadequate feed and feeding technology. Often more than 2 kg of dried feed is required to produce 1 kg of fish. Thus, there is great potential for increased production within present pond area and feed resources. In addition, there is great untapped potential for cage culture in large water reservoirs.

Inbreeding problems

Genetic improvement through selective breeding has until recently not been applied in Indian aquaculture. Consequently, there is a lack of knowledge and awareness among fishery scientists and fish farmers of the great potential of selective breeding as a means to improve productivity and efficiency.

Furthermore, hatcheries follow few genetic norms in the production of seed. The result is fry with low survival and growth – a problem partly linked to the great reproduction of carp. Often few parental fish are used in the production of new generations, which results in inbreeding depression and reduced performance for important traits like growth and survival.

To make up for these negative effects, fish farmers occasionally catch wild carp from the rivers and breed them with their own broodstock. This reduces the level of inbreeding in the population, but at the same time counteracts the positive effects of the natural selection for growth and other desired traits.

The situation suggests a need for better procedures for seed production, and that the presently farmed stocks may not be the best base material for genetic improvement.



About 500,000 mt of rohu carp are grown in India each year.

Varied rohu stocks

To improve the rohu through selective breeding, a collaborative research project between Central Institute of Freshwater Aquaculture (CIFA) in India and Institute of Aquaculture Research (AKVAFORSK) in Norway was carried out 1992-2003 with funds provided by the Norwegian Agency for Development Cooperation. Fingerlings from five different riverine strains in India were brought to CIFA in Orissa. A farmed local stock reared at CIFA that originated from the Mahanadi River was also included.

Test environments

The growth and survival of the base population of pure stocks, crosses between the stocks, and a high number of full- and half-sib families were compared in monoculture and polyculture farming systems at CIFA. In polyculture, rohu were reared with mrigal and catla carp. Nine year-classes were produced with a total of 412 full-sib families and 18,000 individually tagged fish.

Selection for increased growth has been carried out for four generations. Selected fish and nonselected control fish from three of the last year-classes were tested under commercial conditions in monoculture in the states of Orissa, Andra Pradesh, West Bengal, and Punjab – major regions for carp production in India.

Similar performance

Consistently the wild stocks performed equal to or better than the farmed local stock for growth and survival. The pure stocks, crosses, and full-sib families ranked very similar for harvest body weight in monoculture and polyculture. The development of specialized varieties for each of the two production environments is therefore not required.

Negligible heterosis

For growth and survival, the difference between purebred and crossbred offspring was negligible, suggesting low heterosis. It was therefore concluded that genetic improvement through crossbreeding of rohu stocks had no practical significance.

Genetic variation

The data recorded for the full- and half-sib families revealed a substantial additive genetic variation for both survival and growth, showing that both traits can be improved through selective breeding. The realized selection response per generation for harvest body weight was substantial in both production environments: 31 percent in monoculture and 27 percent in polyculture (Fig. 1). This was also verified in all four states in monoculture. For unknown reasons, the observed selection responses significantly exceeded the theoretical expectations.

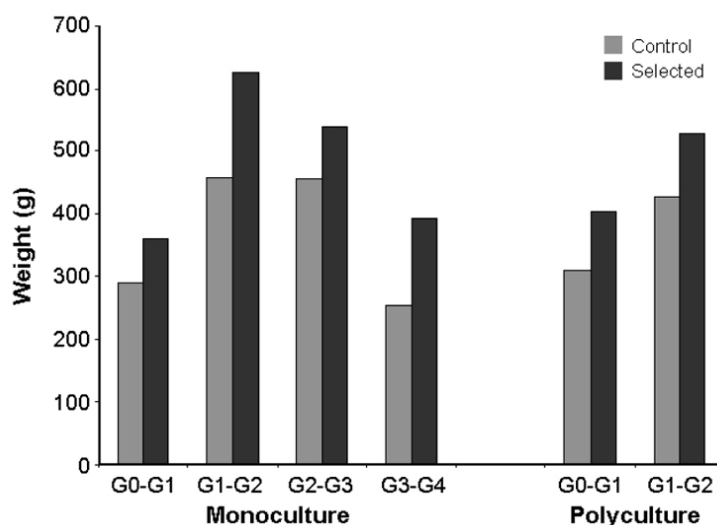


Fig. 1: Realized selection response per generation for harvest body weight of rohu in monoculture and polyculture.

Fast-growing fish utilize available pond area, feed, and water resources more efficiently than slower-growing fish, allowing more fish to be produced with a given amount of resources. Alternatively, the current production can be obtained with fewer resources.

Increased resource efficiency

The project showed that selective breeding is an important technology to increase productivity and resource efficiency in Indian aquaculture. Multiplier units are established in Andhra Pradesh, West Bengal, and Orissa to ensure that the genetically improved seed reaches the rohu farmers in these states. Additional multiplier units will be established in other states. The organization of this work for rohu can also serve as a model for other carp species in India.

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