

As part of the overall CGIAR 2005 annual performance measurement exercise, the Science Council received 30 individual case studies of Center impact. These were the best examples of impact assessments done by the Centers during 2003–2005. The Science Council's Standing Panel on Impact Assessment (SPIA) identified six of these as being particularly meritorious in terms of quality of analysis and presentation. In recognition of these studies as good examples of emerging 'best practice', SPIA has, with the relevant Center's concurrence, prepared Science Council/SPIA Briefs on each. Publishing quality impact briefs responds to continued calls from donors to the CGIAR for more documented evidence of impacts to be made available in the form of such concise publications.



# SCIENCE COUNCIL BRIEF

## STANDING PANEL ON IMPACT ASSESSMENT

NUMBER 6



Courtesy of the Department of Fisheries, Malaysia

## Improved Tilapia Benefits Asia

Aquaculture, or fish farming, is the world's fastest-growing food-producing sector. In Southeast Asia tilapia farming is a major contributor to this growth. The subsector's expansion began in the 1970s, stimulated by advances in hatchery technology and pond husbandry, but was impeded by a lack of attention to genetics and selective breeding, leading to stagnating yields.

A 1980 conference in Italy identified this shortcoming as a major research and development gap. In 1987, after a series of projects and activities focusing on tilapia genetics, the International Center for Living Aquatic Resources Management (ICLARM, now the WorldFish Center) organized a workshop on tilapia, in Thailand. The participants set out a blueprint for a long-term research and development program to investigate and develop the potential of farmed tilapia. Thus was born the Genetic Improvement of Farmed Tilapia (GIFT) project, a collaborative venture between ICLARM, the Institute for Aquaculture Research (AKVAFORSK) in Norway, and a number of Philippine research agencies.<sup>1</sup> The project, which ran from 1988 to 1997, was funded by the Asian Development Bank (ADB), the United Nations Development Programme (UNDP), ICLARM, and national research partners in Bangladesh, China, the Philippines, Thailand, and Vietnam.

The project was to focus on the selective breeding of Nile tilapia (*Oreochromis niloticus*), chosen because of its growing importance in aquaculture, omnivorous low-cost diet, and short generation span of 8 months. The objective was to increase protein consumption in poor populations in developing countries and to increase the earnings of low-income producers. The GIFT project also aimed to develop a methodology applicable to other fish species in developing countries, to strengthen national institutions in aquaculture genetics research, and to establish an international network for exchanging and evaluating improved fish breeds and research methods and results.

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## What did the GIFT project achieve?

The GIFT project's achievements can be summarized in six main areas:

- Germplasm collection: the project was responsible for the first ever systematic collection and direct transfer of Nile tilapia germplasm from Africa to Southeast Asia with the purpose of initiating a breeding program. Eight strains were studied, four from African countries and four already present in Asia.
- Breeding strategy: the project developed a selective breeding approach that produces positive and predictable results, and that can be widely used in developing countries to cultivate not just tilapia but other improved fish strains.
- Synthetic base population: the project created a genetically diverse base population for use in breeding, thereby fulfilling one of the essential requirements for sustained genetic gain.
- Genebank: the project established a genebank of live tilapia germplasm for use in the breeding program, and of cryopreserved tilapia sperm as insurance and to estimate genetic change.
- Improved strain: a highly productive improved strain of tilapia was developed. Trial results indicated significant improvements in growth rate in successive generations, as well as remarkable survival rates. This became known as the GIFT strain.
- National programs: the project provided GIFT strain fingerlings to participating countries and developed testing and dissemination protocols in collaboration with national scientists.

The success of the GIFT project was attributed to: consultative decision-making; clear definition of partner roles; rigorous application of genetic technology, consolidated project management; involvement of beneficiaries; and mutual respect and trust among partners.<sup>2</sup>

## The DEGITA project

DEGITA stands for the Dissemination and Evaluation of Genetically Improved Tilapia. This project grew out of the GIFT project when national partners expressed an interest in introducing the GIFT strain into their domestic fish stocks. The project was funded by ADB, ICLARM, and the five countries that had participated in GIFT. Its objectives were to:

- Evaluate genetic, socio-economic, and environmental aspects of GIFT strain production in participating countries
- Analyze the impact of the GIFT strain on different socioeconomic groups, and
- Disseminate the GIFT strain to small-scale fish farmers.

The DEGITA project also assisted participating countries in developing national tilapia breeding programs.

The project's research indicated that:

- Yields of the GIFT strain were always greater than those of local strains, with the largest increase in Bangladesh and the smallest in China. Productivity was evaluated on-station and on-farm in both cage and pond environments (see Table 1).

**Table 1.**  
Yields of GIFT and local tilapia in on-farm trials in DEGITA-participating countries

Country	Production system	Non-GIFT strain yield (kg/ha)	GIFT strain yield (kg/ha)	Yield gain(%)
Bangladesh	Pond	896	1593	78
China	Cage	310967	389346	25
	Pond	4275	4645	9
Philippines	Cage	15285	23551	54
	Pond	912	1361	49
Thailand	Pond	2044	2829	38
Vietnam	Pond	558	743	33

Source: Dey et al. (2000)<sup>3</sup>

- Production costs per kg of fish were lower for the GIFT strain than for local strains in all participating countries in both cage and pond environments.
- Survival rates of the GIFT strain in on-farm trials were higher than for the existing strains in all countries and significantly greater in two out of five countries.
- The average weight of GIFT strain fish was greater than that of local strains in all countries.

DEGITA also enhanced the expertise of participating scientists, technical staff, and farmers, provided opportunities for interaction among national and international scientists, and promoted the benefits of a multidisciplinary approach.

## International Network on Genetics in Aquaculture (INGA)

INGA was established in 1993 as a global forum at which fish scientists could exchange ideas, research methods, and genetic materials. The network currently has 13 developing countries plus WorldFish as full members, together with advanced scientific institutions, a private-sector company, and other international and regional organizations as associate members. Besides being a member, WorldFish is also INGA's research coordinator.

In the 13 years since it was founded INGA has contributed to national breeding programs, organized

training on genetics and breeding, and collaborated in research efforts. Its strength lies in its breadth as a network and in its many partnerships. Like GIFT, its success is based on consultation, sound management, and mutual respect.

## Advantages of the GIFT strain

Research has shown that the GIFT strain gives a higher yield than existing tilapia strains on both average and above-average farms (categorized in terms of their efficiency).<sup>3</sup> It is also evident that the increase in output is generally consistent across feed and fertilizer levels in all participating countries. The implication is that small and large farms will derive equal benefits per unit of the feed and fertilizer inputs used for GIFT strain production. In other words, this technology package is scale- and wealth-neutral.

Tilapia farming has become an attractive livelihood option in several Asian countries, where the GIFT strain has generated additional income and employment for both fish farmers and hatchery operators. Almost 300,000 people in the Philippines alone now benefit directly or indirectly from employment in the tilapia industry. As Figure 1 shows, farmed tilapia production in the Philippines has increased steadily over the past 20 years. As the cost of production is no higher than that of non-GIFT tilapia and yield is higher, consumers, including the very poor, have also benefited, enjoying lower market prices.



The environmental impact of GIFT has been either non-existent or very slight. In a survey conducted in the participating countries, 521 farmers were asked to assess the displacement (if any) or reduction in catch of existing species found in their natural waterways. Some 16 per cent of respondents in the Philippines claimed to have experienced these effects. A multi-disciplinary team drawn from government and non-government organizations was formed to substantiate these claims but did not find any displacement of existing species except in lakes and reservoirs. An international workshop to assess probable environmental impacts concluded that responsible development and dissemination of GIFT would be unlikely to cause serious environmental damage. A review concluded that 'popularization (of GIFT) accompanied with proper management of cultural practices is unlikely to harm biodiversity or environmental integrity'.<sup>4</sup>

The development and dissemination of GIFT has proved a worthwhile investment with attractive economic returns.<sup>5</sup> The estimated internal rate of return (IRR) is more than 70 per cent over the period 1988 to 2010. In other words, each US\$100 invested is providing an annual return of US\$170.

## Next steps

The GIFT strain continues to be improved through selective breeding by WorldFish in Malaysia, and by national programs in the participating countries.<sup>6</sup> WorldFish is carrying on the work with GIFT, researching other potentially valuable traits and providing both germplasm and technical support to interested national research groups. Meanwhile, in Africa, where the parent stocks originated, scientists are engaged in selective breeding to develop genetically improved indigenous tilapia (in Egypt, Ghana, and Malawi).

Despite continuing gains in both production and yields, research by WorldFish and its partners indicates that by 2015 the demand for tilapia will outstrip supply. To close the gap, more research and development will be needed. This should include research on how to maintain the genetic integrity of the improved strain.

In 2003 the President of the Philippines, Gloria Arroyo, stated that the local fish, *galunggong*, would soon be replaced by tilapia as the food of the masses. In this context tilapia has a major contribution to make to the Millennium Development Goal target of halving hunger and poverty by 2015. Thus, further research into selective breeding of tilapia would seem both justified and desirable.

Although research needs have been well addressed so far, a still more concerted effort by all concerned, including fish farmers, national aquatic research centers, and a broader range of nonconventional stakeholders, is called for. The future strategy of WorldFish should take into account: end users (whether for food, trading or fish feed), research and development partners, recent scientific advances, the trading environment, intellectual property rights, and private and nongovernment investment.

Governments can play their part by developing appropriate policies to ensure an adequate incentive structure for tilapia culture, as well as timely and well targeted interventions to combat negative factors such as aquatic pollution and loss of fish biodiversity.

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## Notes

The full version of the study on which this brief is based is: Deb U.K. and Dey M.M. 2006. *The History and Impacts of the 'Genetic Improvement of Farmed Tilapia (GIFT)' Project and the 'Dissemination and Evaluation of Genetically Improved Tilapia (DEGITA)' Project*. The WorldFish Center Technical Report, WorldFish Center: Penang, Malaysia. The study is available at <http://impact.cgiar.org/>

- 1 Philippines associates of the project included: National Freshwater Fisheries and Technology Center (NFFTC), Bureau of Fisheries and Aquatic Resources (BFAR) and Freshwater Aquaculture Center—Central Luzon State University (FAC—CLSU), and the University of the Philippines Marine Science Institute (UP-MSI)
- 2 Gupta M.V. and Acosta B.O. 2001. Fish genetics research in member countries and institutions of the international network on genetics in aquaculture. ICLARM Conference Proceedings, 64. ICLARM: Penang, Malaysia.
- 3 Dey M.M., Eknath A.E., Li Sifa Hussain M.G., Tran T.M., Pongthana M., Nguyen V.H., and Paraguas F.J. 2000. Performance and nature of genetically improved-farmed tilapia: a bioeconomic analysis. *Aquaculture Economics and Management*, 4(1&2): 83–106.
- 4 DaSilva Sena. (undated). Popularization of genetically improved *Oreochromis niloticus* ("GIFT fish") in Asia: Environmental considerations. Deakin University: Warrnambool, Victoria, Australia.
- 5 ADB. 2005. Impact Evaluation Study on the Development of Genetically Improved Farmed Tilapia and their Dissemination in Selected Countries. Impact Evaluation Study, Asian Development Bank: Manila, the Philippines.
- 6 Ponzoni R.W., Hamzah A., Tan S., and Kamaruzzaman, N. 2005. Genetic parameters and response to selection for live weight in the GIFT strain of Nile tilapia (*Oreochromis niloticus*). *Aquaculture* 247: 203–210.